# THE CONSTRUCTION OF THE PLAN OF A HOUSE TEST AND AN INVESTIGATION INTO SOME OF ITS DEVELOPMENTAL AND CLINICAL IMPLICATIONS IN CHILDREN.

M. G. THORSTAD

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A B S T R A C T

A chance finding revealed that a boy with no measurable spatial ability and a history of possible neurological trauma could not draw a plan of his house. As emotionally disturbed children were also inferior in the task, it was hypothesized that they too might have some neurological dysfunction. A test of drawing a plan of a house was constructed as a means of testing this hypothesis.

In the course of the item selection, developmental features were noticed, which suggested that childrens skill in plan drawing was associated with the growing awareness of projective and euclidian space as elucidated by Piaget. Problems in comprehending walls as divisions of a total space were probably not particular to this 3D space, but could also be found in 2D space.

A sex difference in favour of the boys was a constant finding, but when the effects of experience and teaching were explored, the earlier supposition of an innate and possibly neurological difference was modified, and one mediated by personality variables seemed to fit the facts more appropriately.

Introspection as to the nature of the task suggested that spatial ability might be involved, but a factor analysis, using the scores of clinic children, revealed that the Plan test loaded also on verbal and visuo-motor factors. The extent to which this result can be generalized to normal and older populations is limited by the samples' psychiatric disorder, its young age and inadequacies of the battery of tests forming the factor structure.

Contrary to expectations and to findings on other visuo-motor tests, hemiplegic children did not show a specific disability on this test, nor was there any support for the hypothesis that children with left hemisphere damage would score higher than those with right hemisphere damage.

Clinic children with reactive and neurotic disorders scored lower on the test than non-clinic children. There was also some association with neuroticism on the NMP1, but not with the Rutter or Rotter scales of maladjustment.

As a test it was reliable and the results were not influenced by previous experience or teaching, except those of a few individual girls. Concurrent and construct validity with emotional disturbance was established.

The initial hypothesis that this test might reveal a disability common to children with a psychiatric disorder and to those with neurological dysfunctions was not supported.

ACKNOWLEDGEMENTS

I should like to express my gratitude for guidance and encouragement from Professor B.M. Foss, who has supervised my research. Special thanks are also due to Dr. W.H. King of the Institute of Education for his practical help and advice on the standardization of the test. I also appreciated the advice on statistical analysis by Mr. J. Valentine and the use of the Friendly Factor Analysis programmed by Dr. R. Meddis and Mr. R. Stephens at the Computer Terminal. Mrs. R. Westley and the other technical staff were also supportive. Lastly I should like to thank the staff of the schools, who co-operated with me in the research and the children who drew the plans.

# C O N T E N T S

## PREFACE

This test was constructed as a result of certain observations made while testing a 12 year old boy, who had been referred for educational advice. He had, until then, been educated in a day preparatory school, but it had long been accepted that he was not capable of following the usual curriculum leading to the Common Entrance Examination at 13 years. The query was whether he could manage in a normal school or whether he would need extra attention provided in an Educationally Subnormal School. In fact, the latter proved the case.

When tested at his home, he was found to have a verbal IQ of 70 on the Wechsler Intelligence Scale for Children (Wechsler, 1949) but an IQ below 45 on the performance scale, because he scored nil on the two tests measuring spatial ability, Block Design, and Object Assembly. His rote reading age was 12 years.

From his spatial difficulties, it might have been expected that he would have had route finding difficulties in everyday life. However, his description of his leisure activities indicated that most of his time was spent in taking long cycle rides in the surrounding country, during which, he said, he was never lost. When asked to point to three towns each ten miles away, he indicated the different directions accurately. In order to see if he could transfer this kind of knowledge to paper, he was asked to draw a plan of his house. He understood that a plan should be horizontal and was able to indicate the correct direction of the rooms, but he was not able to draw their outline (Figure 0.1).

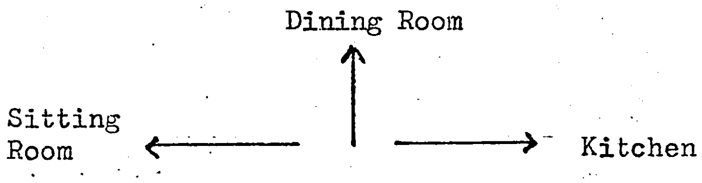



Figure 0.1 A drawing of the plan of his house by a 12 year old boy with a verbal IQ of 70 and a performance IQ below 45.

This result provoked the question as to whether this inability to draw a plan was due to his generally below average intelligence or to his more specific spatial disability, and if it was the latter, was it in any way connected with the threatened abortions during his mother's pregnancy implying possible neurological dysfunction.

In order to gain some idea as to how other children drew plans, the task was given to children aged mainly from 7 to 10 years referred for psychiatric reasons to the local Child Guidance Clinic. None of them produced the same kind of plan as the first boy, but instead, a bewildering medly of drawings, many of which did not represent the house horizontally. In spite of all attempts made to explain what was meant by the word plan, they drew pictures of houses viewed from the outside, sometimes simultaneously showing parts of the interior of the house including the upstairs. If they did get the idea of drawing the rooms on the ground floor, they were unsure about which was the floor and which was the wall and they had no idea as to how one room was connected to another, occasionally scattering them over the page.

By using this sample it had been hoped to gain some idea of how a child of average intelligence drew a plan, but obviously there were not only great changes due to age at this stage, but also, as these were all emotionally disturbed children, this fact too could have been affecting their ability to draw plans.

It became apparent then that in order to look at the effect on plan drawing of general cognitive disability, specific spatial disability and now emotional disturbance, it would be necessary to first look at the normal child's ability to draw a plan of his house and evolve some kind of scale to which the aberrant groups could be compared.

Such a test was only going to be justified if the ability being measured was sufficiently abstract and independent of environmental influences to be transferrable to other samples in different parts of the country and used in subsequent years.

Two possible sources of environmental influence were the type of house a child lived in and what teaching he had had on plan drawing. Concerning the former, it rapidly became apparent that only the rare child, who lived in a very large rambling house was adversely affected by its size and shape, and that although a check was kept on the correspondence between the correctness of the plan and the actual house, this proved unnecessary, for the kind of conceptual difficulties children were having in plan drawing were of an abstract nature and not related to particular constructions. It followed from this latter point that plan drawing was not as easy to teach as might appear at first and conversations with the children indicated how difficult it was to enable them to improve their plan drawing and therefore how impervious to teaching it was likely to be in school.

Having verified these two points by a clinical enquiry method, arrangements were made to construct a test in plan drawing as a research tool (Part One), before continuing to use it to explore children's normal (Part Two) and abnormal development (Part Three).

PART ONE: TEST CONSTRUCTION

This was started by an initial perusal of the available plans for developmental stages. However, it became evident that although they could be broadly categorized, such categories would be unsatisfactory from the research point of view, because the drawings were so complex that some would inevitably be difficult to classify and any classification was likely to be so subjective as to be unrepeatable by another classifier with any degree of reliability. Moreover, categorization would mean that later experimental investigations would be restricted to the use of non-parametric statistical techniques with their inevitable limitations. It was therefore decided to evolve a scale of items, in the same way that Goodenough (1926) had done for the drawing of a man, which would reflect the general developmental changes and at the same time produce sccres that could be used parametrically. It was also realised that if the scale could be standardized then scores could be obtained which took the effect of age into account and were more directly comparable to standard scores in other cognitive tests already available. At this stage its reliability as a measure was investigated and improved where possible.

PART TWO: THE RELATIONSHIP OF THE PLAN TEST TO GENERAL COGNITIVE DEVELOPMENT.

The second stage involved the use of this measure to investigate observations made during the standardization procedure itself. From which observations arose the following questions about general cognitive development.

1. What developmental stages did the Plan test reveal.
2. How did these stages in plan drawing relate to other concurrent cognitive development in the understanding of 3D space and perception of 2D space.
3. To what extent were children aware of the nature of the task and were they able to verbalise it.
4. How influential was previous experience.
5. How susceptible was plan drawing to improvement when it was well taught.
6. What was the nature of the ability, as defined by the statistical technique of factor analysis.
7. To what extent were sex differences revealed in the task and how did they relate to other differences in cognitive ability and personality.

PART THREE: PLAN DRAWING IN CHILDREN SHOWING SIGNS OF ORGANIC OR PSYCHOLOGICAL PATHOLOGY.

This stage was an investigation into the two initial observations on plan drawing mentioned earlier, in which it was found that a boy with low spatial ability and a history of pregnancy complications, implying possible neurological dysfunction and children referred to a Child Guidance Clinic for emotional disturbance both drew poor plans. A rather different test measuring the visuo-motor integrations in children, the Bender Gestalt (Bender 1938), is known to reveal weaknesses in children with brain damage and emotional disturbance. It is possible that this is a chance occurrence or that a common cause influences both or that one causes another. In the case of the last speculation Koppitz (1963) who has investigated the BG test in brain damaged and emotionally disturbed children "concurs with Bender (1938) who claims that neurotic disturbances do not result in disturbances in perception or in visual-motor function. On the contrary .... that emotional problems develop secondary to perceptual problems"

As the plan test is also basically a visual-motor test, although it involves conceptual integration at a higher level, it was considered that it might throw some light on the causal interaction between neurological dysfunction and emotional disturbance. In order to do this it first had to be shown that children with medically diagnosed neurological impairment drew plans which scored lower than children with no known impairment, and that children with a psychiatric diagnosis of emotional disturbance scored lower than those without such diagnosis. In practice this involved investigating the following two groups.

1. Children with hemiplegia, a sub group of the cerebral palsies, which is a result of a lesion or maldevelopment of the brain, non progressive in character and existing from earliest childhood.
2. Children defined as maladjusted either by a questionnaire or referred to a Child Guidance Clinic.

Following these investigations, the Plan test was evaluated as a test for emotionally disturbed children and the results examined to see what they revealed, if anything, about the relationship of emotional disturbance to neurological dysfunction.

# PART ONE: TEST CONSTRUCTION

## CHAPTER I

## ITEM SELECTION

### INTRODUCTION

Most cognitive tests are composed of many items which are scored as either right or wrong. These lead automatically to totals of raw scores, which are then standardized in terms of mental ages or standard scores. Group intelligence tests with a small age range depend mainly on the increasing complexity of their items to discriminate between bright and dull children and are composed of a deliberate mixture of easy and difficult items, according to the requirements of the task for which the test is being conducted.

The older individual intelligence tests, which can be used over much wider age ranges, such as the Stanford-Binet (Terman and Merrill, 1961) are also composed of items and some depend on increasing complexity of the same task, but most of the items are based on the effect of maturation, such that an increasing percentage of children get them right as they get older.

A different type of test is one where a single task is assessed on a variety of items, all of which show an increasing percentage of success with age. Such a test is Goodenough's Draw-a-Man (DAM), which Harris restandardized in 1963. Here one protocol is scored on 73 items, each one being validated on its capacity to show a regular and rapid increase with age, the resulting total score being expressed as a standard score. As the Plan test belongs to this type in that there is one protocol that will have to be scored on a variety of items, it is worth looking at the evolution of the DAM test.

The early period of investigation into children's ability to draw a human figure came first at the end of the 19th Century and was in terms of broad descriptive categories, the complexity and accuracy of which increased with age. This culminated in the publication of Burt's developmental stages in 1921, when he discerned 7 stages. This was followed in 1926 by Goodenough's demonstration that development in children's drawings of a man could more effectively be expressed in terms of points for individual items, which when summed together could be given as an age score, so following the example set by the SB. This was then taken one step further by Harris, who, when seeing the advantages of the standard score in intelligence tests, increased the scorable items in the drawing of a man and expressed the totals as standard scores.

Another visuo-motor test, the Bender Gestalt (BG) also passed through similar stages. Bender first found in 1936, that children's copies of Wertheimer's figures, illustrating the laws of 'gute gestalt' showed progressive changes according to age, which could be categorized in stages. Pascal and Suttell (1951) then itemised the test and used it to differentiate clinical groups of adults. Later in 1963 Koppitz used these type of scores as a basis to derive a point scale for children, so that the protocols could be assessed in terms of age levels.

From these results it might seem that the construction of scales for the measurement of children's protocols might be simple, but an essential step is the choice of items and their validation. Santucci and Galifret-Granjon, (1961) also constructed a scoring system for the BG test producing items based on a priori logic. These were not validated, but when 305 protocols of children from 6 to 14 years were scored, the total scores were found to increase with age. When however, the author has used it with cerebral palsied children with a known visuo-motor difficulty, their scoring did not reveal it in the way that Koppitz's did, which indicated the need for item validation if the test is to be truly effective. Moreover it showed that however logical the item might be, it would not necessarily have any clinical significance.

Thus the evolution of both these tests went from a preliminary stage of broad categorization to one of itemization, which suggested the same stages might be found in the construction of the Plan test. The failure of the Santucci and Galifret-Granjon also gave a warning that all items scores are not effective in discriminating clinical groups, even if standardised.

SAMPLE

Criteria

1. In order to keep the task as uniform as possible, it was decided to choose areas where the children lived in houses rather than flats. In addition it was considered desirable that the houses drawn should present about the same degree of difficulty and be typical of the country as a whole, such as the semi-detached house built in great numbers from 1930.

2. In order that the children should be as representative as possible schools should be chosen in which:-

a) the socio economic classes were likely to be the same as the Registrar General's.

b) the distribution of intelligence should approximate to the normal for the area of South Buckinghamshire.

Subjects

Children in two primary schools, and one secondary school were chosen because they were thought to conform to the above criteria.

METHOD

A. Conditions.

Children were tested in their own classrooms mostly sitting in their own or nearby desks, during the Autumn term of 1964. The test took about 45 minutes to give so that it was possible to test four classes a day, two in the morning, one before and one after break, and two in the afternoon, again one before and one after break. Having introduced the tester to the class, the teacher usually left the room.

B. Materials.

The children had nothing on their desks except the materials needed, paper, pencils and rubbers. Rulers were not allowed. A blackboard was needed for the tester.

C. Procedure.

1. Introduction

a) The tester was introduced to the class by the teacher as an educational psychologist, who was studying the way in which children of different ages drew plans.

b) In order to allay any anxiety, it was emphasized that all drawings were acceptable and that they were not going to be marked right or wrong, so that it was not a measure of their ability.

c) In order to forestall possible complaints from parents, it was emphasized that the tester was looking at how the children drew a plan, not what kind of house they lived in.

2. Seating.

To reduce copying children were spread over the available space as widely as possible.

3. Materials.

Paper, pencils and rubbers were distributed and desks were inspected to see that rulers and books had been put away.

4. Identification Data.

The class was asked to put the following information on the top of their papers:-

a) Name, age, class and address in the left hand corner.

b) Whether they lived in a house, flat, bungalow, maisonette or caravan in the middle.

c) The day's date written in numbers, with their date of birth underneath in the right hand corner. Children over 9 years were shown how to subtract the latter from the former to give their exact age.

5. Specific instructions on plan drawing

a) "I want you to draw a plan of your house. I only want the ground-floor. Imagine that you are a bird and are looking straight down on top of it. Imagine that you have taken away the roof and the bedrooms, so that you can see the ground-floor. I want you to show me where the kitchen is, the hall, the stairs, the dining-room, the sitting-room (lounge, living-room, front-room) and any other rooms you have. Show me where the doors and the windows are. Put the name of the rooms into your plan."

b) All the names of the parts of the house required were written on the blackboard.

c) An opportunity was given to the class to ask questions about the nature of a plan and full verbal answers were given, but no illustrations.

6. Prevention of Copying.

To eliminate this every alternate child began by drawing a plan and the others a man. Each child continued with the alternate task when they had finished the first one. As soon as they had finished both tasks, their papers were checked and collected, and they took out a book to read.

7. Checking.

Each paper was inspected to make sure that all necessary parts of the plan were labelled and no spaces left unidentified, so that they could be scored later. If essential parts were completely missing, such as doors or windows, the omission was pointed out once and a chance given for their insertion.

## DEVELOPMENT OF THE SCORING SYSTEM

The scoring system evolved in an empirical, inductive manner. An attempt was first made to categorize according to age and then to select items which seemed to change with age. The items were only retained if they satisfied the criteria of a regular and rapid increase with age in the percentage of children scoring it correctly.

Three scoring systems were evolved in this way until the fourth and final system was found. Two other criteria were then used to discover if the percentage appearance of an item showed a relationship to general intelligence, and if success or failure on an item in a particular child was related to his total score on the test.

For each scoring system the method, results and changes in items are recorded briefly, followed by the scoring system used and tables showing the percentage occurrence of the items at each age level.

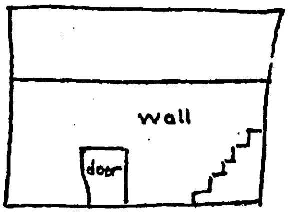
## FIRST SCORING SYSTEM

When the protocols were arranged in yearly age groups it became obvious that while very few seven-year olds had the slightest idea about how to draw a plan, and could only draw pictures or vertical sections of houses, most of the ten-year olds could make some attempt, even if not completely accurate. It was noticed in particular that the stairs and doors seemed to create additional difficulty and were worthy of being scored in their own right. Twenty-five items were made in this way and 288 protocols from children aged from 7 to 10 years were scored.

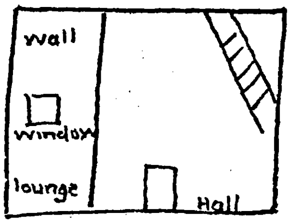
When the percentages of children passing each item at six monthly intervals were calculated (Table 1.1) it was seen that all items were useful except 1 and 2, Inside house and Rooms indicated; 11 and 12, various types of stairs and 25 Atypical plan. Items 1 and 2 were 100% present, items 11, 12 and 25 rarely appeared and showed no development. It was decided to discard 25, but 1 and 2 were retained because it was thought they might be more discriminating with younger children, and 11 and 12 were amalgamated.

## FIRST SCORING SYSTEM

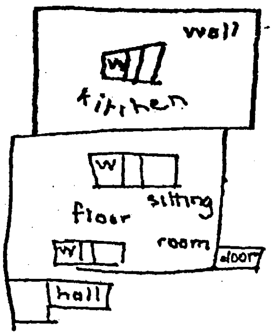
1. Inside house.



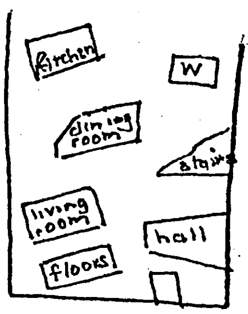

2. Rooms indicated.



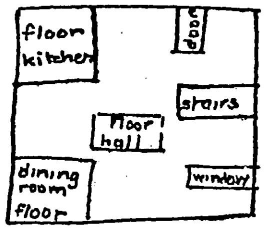

3. Some horizontal rooms



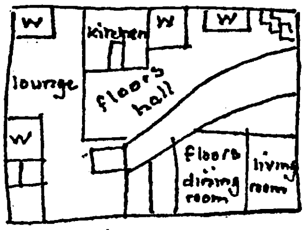

4. All horizontal rooms.



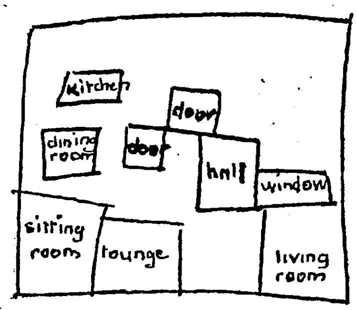

5. All rooms separated.



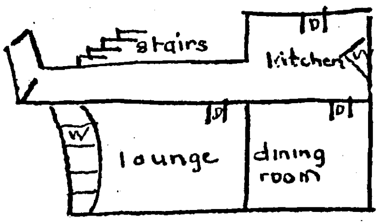

6. Hall linking all rooms.



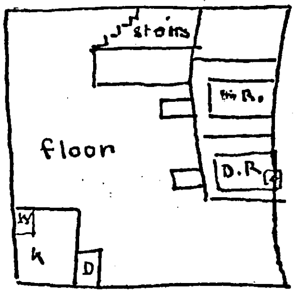

7. Some walls common.



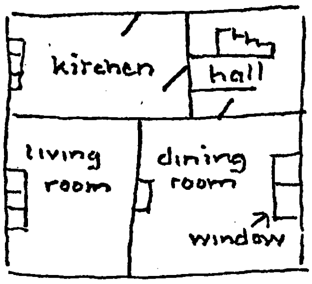

8. All walls common.



9. Outside wall present in horizontal plan.



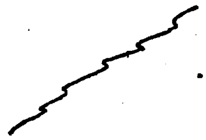

10. Outside wall a function of inside.



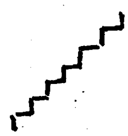

11. Stairs indicated from a side view.

12. Stairs indicated from a side view.

13. Stairs indicated from a side view.



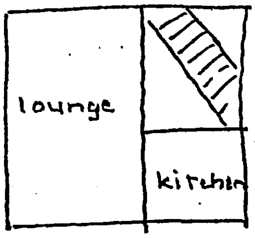
14. Stairs indicated from a side view.



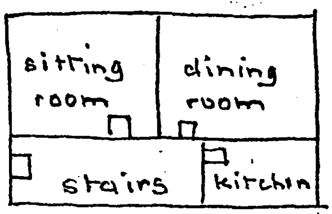
15. Stairs indicated from a front view.

16. Stairs indicated from a front view.

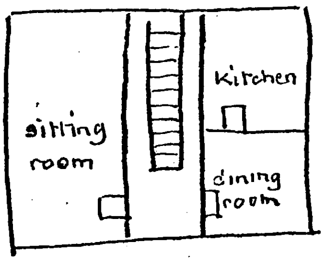
17. Stairs vertical although steps indicated correctly.



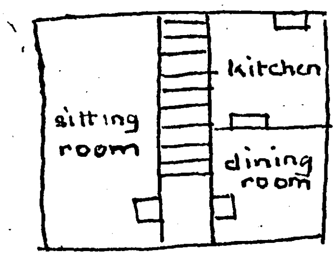

18. Stairs blank.



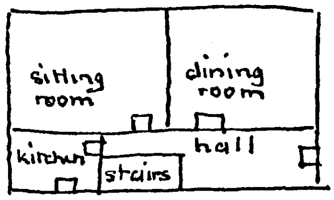

19. Stairs rectangular.



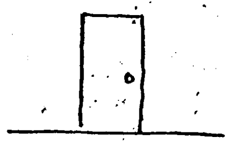

20. Staircase correctly integrated.



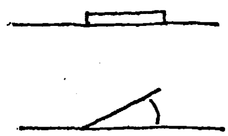

21. Hall correctly integrated.




22. Door indicated as a picture.



23. Door indicated as a horizontal section.



24. Proportions of rooms correct.

25. Atypical plan.

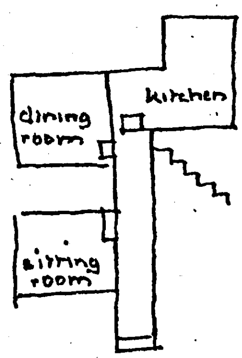


TABLE 1.1

FIRST SCORING SYSTEM

PERCENTAGES OF ITEMS APPEARING AT SIX MONTHLY AGE LEVELS

| YEARS | 7-6 | | 8-0 | | 8-6 | | 9-0 | | 9-6 | | 10-0 | | 10-6 | | 11-0 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RAW SCORES | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| 1 | 30 | 100 | 53 | 100 | 39 | 100 | 38 | 100 | 45 | 100 | 34 | 100 | 29 | 100 | 20 | 100 |
| 2 | 30 | 100 | 53 | 100 | 39 | 100 | 38 | 100 | 45 | 100 | 31 | 91 | 29 | 100 | 20 | 100 |
| 3 | 22 | 73 | 39 | 74 | 31 | 58 | 32 | 60 | 42 | 93 | 29 | 85 | 28 | 97 | 20 | 100 |
| 4 | 20 | 67 | 31 | 58 | 28 | 53 | 26 | 49 | 41 | 91 | 30 | 88 | 25 | 86 | 20 | 100 |
| 5 | 4 | 13 | 10 | 19 | 13 | 25 | 8 | 15 | 1 | 2 | 3 | 9 | 3 | 10 | 0 | 0 |
| 6 | 8 | 27 | 24 | 45 | 23 | 43 | 23 | 43 | 38 | 84 | 28 | 82 | 26 | 90 | 19 | 95 |
| 7 | 11 | 37 | 28 | 53 | 19 | 36 | 21 | 40 | 39 | 87 | 29 | 85 | 26 | 90 | 20 | 100 |
| 8 | 9 | 30 | 21 | 40 | 16 | 30 | 18 | 34 | 34 | 76 | 26 | 76 | 24 | 83 | 18 | 90 |
| 9 | 11 | 37 | 28 | 53 | 21 | 40 | 21 | 40 | 37 | 82 | 30 | 88 | 27 | 93 | 19 | 95 |
| 10 | 9 | 30 | 18 | 34 | 18 | 34 | 18 | 34 | 32 | 71 | 24 | 71 | 23 | 79 | 18 | 90 |
| 11 | 0 | 0 | 2 | 4 | 2 | 4 | 5 | 9 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 5 |
| 12 | 1 | 3 | 0 | 0 | 2 | 4 | 1 | 2 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 | 2 | 7 | 2 | 4 | 10 | 19 | 1 | 2 | 3 | 7 | 0 | 0 | 1 | 3 | 0 | 0 |
| 14 | 17 | 57 | 20 | 38 | 10 | 19 | 12 | 23 | 9 | 20 | 3 | 9 | 2 | 7 | 0 | 6 |
| 15 | 1 | 3 | 1 | 2 | 2 | 4 | 2 | 4 | 2 | 4 | 4 | 12 | 3 | 10 | 1 | 5 |
| 16 | 5 | 17 | 18 | 34 | 8 | 15 | 13 | 25 | 26 | 58 | 15 | 44 | 22 | 76 | 15 | 75 |
| 17 | 3 | 10 | 8 | 15 | 10 | 19 | 5 | 9 | 11 | 24 | 7 | 21 | 15 | 52 | 16 | 80 |
| 18 | 2 | 7 | 2 | 4 | 10 | 19 | 1 | 2 | 5 | 11 | 3 | 9 | 2 | 7 | 4 | 20 |
| 19 | 2 | 7 | 9 | 17 | 10 | 19 | 11 | 21 | 24 | 54 | 16 | 47 | 18 | 62 | 15 | 75 |
| 20 | 0 | 0 | 3 | 6 | 3 | 6 | 19 | 17 | 12 | 27 | 13 | 38 | 10 | 34 | 13 | 65 |
| 21 | 2 | 7 | 12 | 23 | 15 | 28 | 16 | 30 | 29 | 64 | 22 | 65 | 20 | 69 | 16 | 80 |
| 22 | 30 | 100 | 51 | 96 | 32 | 60 | 37 | 70 | 45 | 100 | 31 | 91 | 29 | 100 | 20 | 100 |
| 23 | 3 | 10 | 7 | 13 | 8 | 15 | 13 | 25 | 23 | 51 | 16 | 47 | 20 | 69 | 14 | 70 |
| 24 | 0 | 0 | 2 | 4 | 2 | 4 | 8 | 15 | 19 | 42 | 12 | 35 | 13 | 45 | 10 | 50 |
| 25 | 0 | 0 | 1 | 2 | 3 | 6 | 0 | 0 | 2 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| N | 30 | | 53 | | 39 | | 38 | | 45 | | 34 | | 29 | | 20 | |

TOTAL NUMBER 288

SECOND SCORING SYSTEM

The number of items was then expanded to 34 by adding new items to express in more detail the development of the representation of depth in vertical houses, of the progressive delineation of the horizontal space, of increasing competence of integrating the outside wall with the interior and the different types of vertical and horizontal stairs.

The percentage occurrence of the items was again calculated and Table 1.2 indicated that some items still did not show clear trends, particularly the stairs. Moreover, in the course of scoring it was found necessary to improve the items in many ways in order to provide an adequate, finely differentiated number from which to extract the final selection. It was then decided to develop the Third Scoring System in the following way:

a) Increase the size of the sample, so that it was more likely to include all possible renderings of an item.

b) Adopt an explicit categorization of items so that any new variation could easily be added as it occurred.

c) Make the items more objective by replacing the some/all type by numbers or percentages.

d) Make items more independent, such as by judging the connectedness of rooms irrespective of the outside wall or the horizontal stairs in the terms of treads and staircase separately.

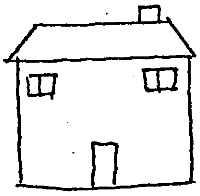
e) Define items such as numbers of doors and windows or proportions in terms of the internal consistency of the drawing.

f) Add items which would extend the upper age range, such as numbers of doors and windows, type of windows, proportions, absence of any unaccounted for space or vertical walls, cupboard or space under the stairs, double lines for walls and quality of lines and angles in drawing.

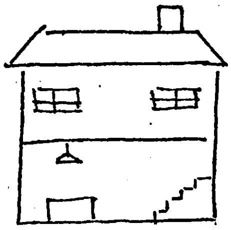
As a result of these changes the Third Scoring System was evolved of 122 items.

SECOND SCORING SYSTEM

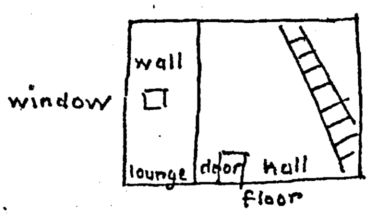
1. Picture of the outside



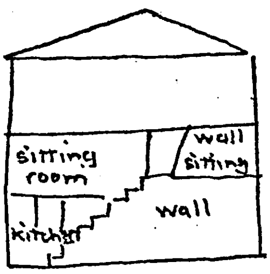
2. Outside and inside shown simultaneously.



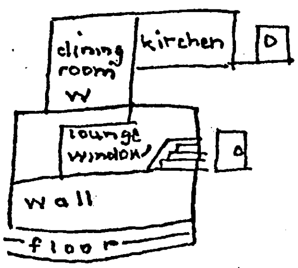
3. Picture of inside.



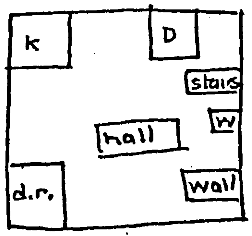

4. Vertical rooms with some indication of depth



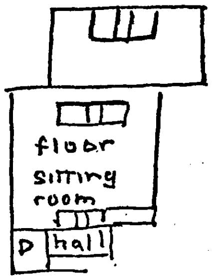

5. As for 4. but the rooms outlined.




6. As for 5. but with an outside wall added.

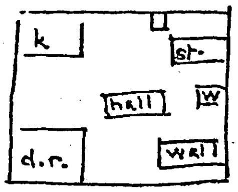



7. Some horizontal rooms

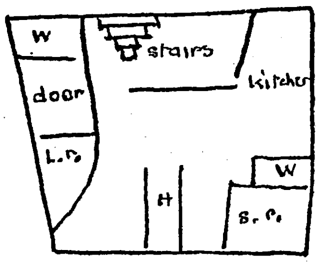



8. All horizontal rooms

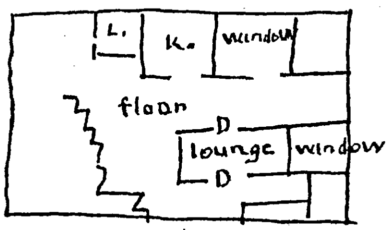
9. All rooms separate



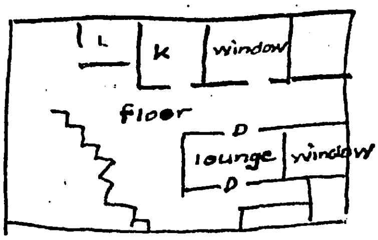

10. Some rooms grouped



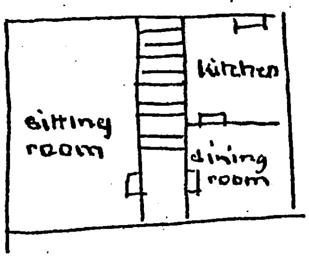

11. All rooms grouped



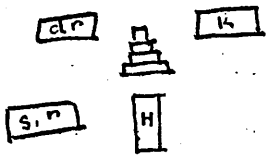
12. Some walls common



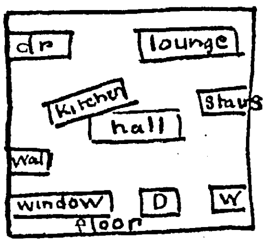

13. All walls common



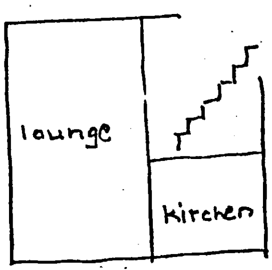

14. No outside wall.



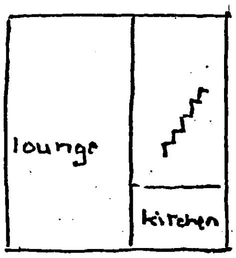

15. Outside wall separate



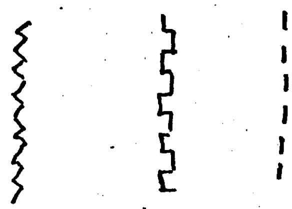

16. Outside wall function of inner rooms, but discontinuous



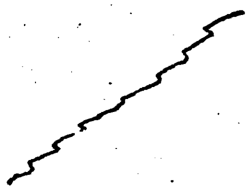

17. As for 16. but outside wall continuous



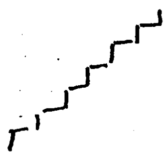

18. Vertical stairs indicated from a side view



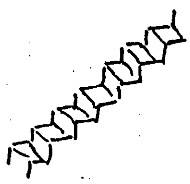
19. Vertical stairs indicated from a side view.



20. Vertical stairs indicated from a side view

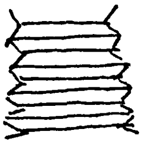


21. Vertical stairs indicated from a side view

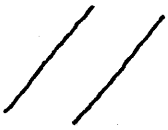


22. Vertical stairs indicated from a front view.

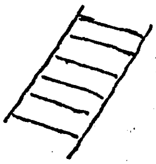
23. Vertical stairs indicated from a front view.



24. Oblique stairs without treads.

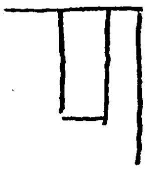


25. Oblique stairs with treads.

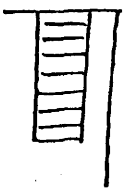


26. Horizontal rectangular stairs.

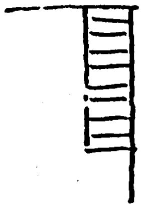
27. Horizontal rectangular stairs without treads.



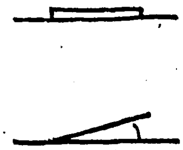
28. Horizontal rectangular stairs with treads.



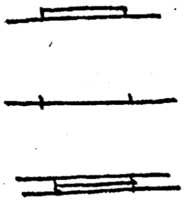
29. Stairs correctly integrated with plan



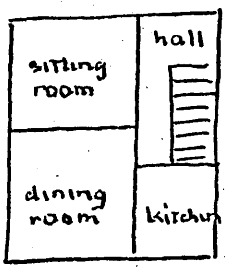
30. Doors indicated as a horizontal section.



31. Windows correct



32. Hall integrated correctly.




33. Proportions of rooms correct.

34. All items correct.

PERCENTAGES OF ITEMS APPEARING AT SIX MONTHLY AGE LEVELS

| | 6-6 | | 7-0 | | 7-6 | | 8-0 | | 8-6 | | 9-0 | | 9-6 | | 10-0 | | 10-6 | | 11-0 | | 11-6 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % | N | % |
| 1 | 4 | 35 | 9 | 26 | 1 | 4 | 1 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 0 | 0 | 3 | 9 | 3 | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3 | 6 | 50 | 12 | 29 | 7 | 30 | 2 | 7 | 4 | 9 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 |
| 4 | 1 | 8 | 2 | 6 | 1 | 4 | 3 | 10 | 3 | 7 | 1 | 3 | 3 | 9 | 0 | 0 | 1 | 3 | 1 | 3 | 1 | 4 |
| 5 | 0 | 0 | 2 | 6 | 1 | 4 | 1 | 3 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 6 | 0 | 0 | 2 | 6 | 3 | 13 | 3 | 10 | 5 | 11 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 4 |
| 7 | 0 | 0 | 1 | 3 | 1 | 4 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8 | 1 | 8 | 4 | 11 | 6 | 26 | 19 | 66 | 30 | 67 | 34 | 94 | 31 | 94 | 29 | 100 | 28 | 93 | 32 | 97 | 23 | 96 |
| 9 | 0 | 0 | 1 | 6 | 2 | 9 | 3 | 10 | 3 | 7 | 3 | 8 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 2 | 6 | 1 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 1 | 2 | 4 | 11 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12 | 1 | 8 | 2 | 6 | 1 | 4 | 2 | 7 | 2 | 4 | 7 | 19 | 1 | 3 | 1 | 3 | 1 | 3 | 0 | 0 | 1 | 4 |
| 13 | 0 | 0 | 2 | 6 | 3 | 13 | 14 | 48 | 23 | 61 | 24 | 67 | 26 | 79 | 27 | 93 | 27 | 90 | 32 | 97 | 22 | 92 |
| 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 15 | 0 | 0 | 0 | 0 | 2 | 9 | 2 | 7 | 1 | 2 | 2 | 6 | 0 | 0 | 2 | 7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | 1 | 8 | 1 | 3 | 0 | 0 | 1 | 3 | 7 | 16 | 11 | 31 | 4 | 12 | 2 | 7 | 1 | 3 | 3 | 9 | 6 | 25 |
| 17 | 0 | 0 | 1 | 3 | 13 | 13 | 15 | 52 | 20 | 44 | 18 | 50 | 22 | 67 | 22 | 76 | 28 | 93 | 29 | 88 | 13 | 54 |
| 18 | 1 | 8 | 5 | 14 | 4 | 17 | 4 | 14 | 3 | 7 | 1 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 |
| 19 | 5 | 42 | 2 | 6 | 2 | 9 | 0 | 0 | 3 | 7 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 3 | 0 | 0 |
| 20 | 3 | 25 | 9 | 26 | 11 | 48 | 10 | 34 | 18 | 40 | 4 | 11 | 4 | 12 | 3 | 10 | 2 | 7 | 3 | 9 | 1 | 4 |
| 21 | 1 | 8 | 3 | 9 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22 | 0 | 0 | 6 | 17 | 1 | 3 | 2 | 7 | 3 | 7 | 2 | 6 | 2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 4 |
| 24 | 0 | 0 | 1 | 3 | 1 | 3 | 3 | 10 | 2 | 4 | 0 | 0 | 2 | 6 | 2 | 7 | 6 | 20 | 3 | 9 | 5 | 21 |
| 25 | 2 | | 7 | 20 | 2 | 6 | 4 | 14 | 9 | 20 | 3 | 8 | 8 | 24 | 6 | 21 | 3 | 10 | 5 | 15 | 6 | 25 |
| 26 | 0 | 0 | 0 | 0 | 1 | 3 | 4 | 14 | 4 | 9 | 4 | 11 | 15 | 45 | 13 | 45 | 16 | 53 | 17 | 52 | 9 | 38 |
| 27 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 4 | 2 | 6 | 2 | 6 | 6 | 21 | 7 | 23 | 6 | 0 | 1 | 4 |
| 28 | 0 | 0 | 0 | 0 | 1 | 3 | 3 | 14 | 3 | 7 | 2 | 6 | 13 | 39 | 6 | 21 | 10 | 35 | 11 | 33 | 9 | 38 |
| 29 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 1 | 3 | 4 | 13 | 2 | 6 | 2 | 8 |
| 30 | 0 | 0 | 1 | 3 | 1 | 4 | 10 | 34 | 12 | 27 | 17 | 47 | 22 | 67 | 18 | 62 | 21 | 70 | 22 | 67 | 17 | 71 |
| 31 | 0 | 0 | 1 | 3 | 1 | 4 | 9 | 31 | 11 | 24 | 14 | 39 | 22 | 67 | 17 | 59 | 22 | 73 | 22 | 67 | 14 | 58 |
| 32 | 0 | 0 | 0 | 0 | 1 | 4 | 9 | 31 | 12 | 27 | 21 | 58 | 21 | 64 | 18 | 62 | 21 | 70 | 22 | 67 | 16 | 67 |
| 33 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 1 | 2 | 2 | 6 | 3 | 9 | 7 | 24 | 24 | 80 | 6 | 18 | 1 | 4 |
| 34 | 0 | 0 | 0 | 0 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 1 | 3 | 0 | 0 | 1 | 4 |
| | 12 | | 35 | | 23 | | 29 | | 45 | | 36 | | 33 | | 29 | | 30 | | 33 | | 24 | |

TOTAL NUMBER 329

THIRD SCORING SYSTEM

This scoring system of 122 items, was given to 1,250 children aged between 6 yrs 6 mths and 14 yrs 6 mths. It was hoped that this large pool of items would cover most of the ways in which children drew plans, and by enlarging the sample it would increase the chances of idiosyncratic plans appearing and also confirm common trends.

Protocols were therefore scored and percentages of children passing at six monthly intervals calculated (Appendix Ia). Modes, medians, upper and lower quartiles were also found to give additional information about the possibility of parallel development in some of the items, particularly in those which appeared in young children but disappeared in older children (Appendix Ib). Graphs were drawn to aid selection by inspection, but have not been included here.

It was decided that items should be:

1. Retained in their present form if they showed a regular and fairly rapid increase with age in the percentage of children gaining the score.
2. Amalgamated if, when they belonged to the same category, they showed progressive changes in scores with age, had the same modes, medians and quartiles suggesting parallel development, but were used by few children.
3. Discarded if the percentages of children scoring on them declined with age, or the modes, medians and quartiles of a series of items showed confused order, or if there were few children scoring on the items.

## THIRD SCORING SYSTEM

I MAIN STRUCTURE

VERTICALITY VERSUS HORIZONTALITY

A VERTICAL

1. All plan vertical
2. All plan vertical with floor labelled
3. 1% to 24% horizontal
4. 25% to 49% horizontal

B HORIZONTAL

1. 50% horizontal
2. 51% to 74% horizontal
3. 75% to 99% horizontal
4. All plan horizontal

This scoring was elaborated in this way to discover the most useful categories, those based on bands with mid points at 12.5, 37.5 etc. or taking the 50th% as a cut off point.

A VERTICAL PLANS

Plans less than 50% horizontal

a. Roof absent

b. Chimney absent

c. Upstairs

1 Present    2 Doubtful    3 Absent

d. Plane of outside wall absent

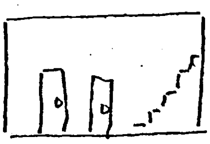
1 0%    2 25%    3 50%    4 75%    5 100%

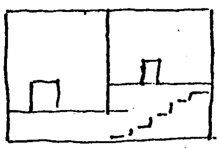
e. Floor

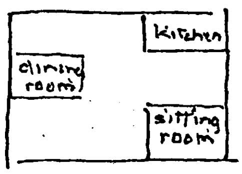
1 Floor absent    2 Floor named or self evident    3 Floor demarcated and named

f. Depth

1 No depth    2 Some indication of depth    3 Depth indicated and rooms outlined

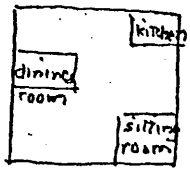




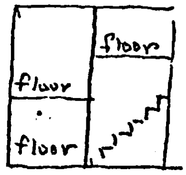


g. Outer wall

1 Enclosed in outside wall with large areas of unidentified space inside




2 Enclosed in outside wall with little unidentified space inside




3 Enclosed in outside wall with no unidentified space inside


B HORIZONTAL PLANS

Plans at least 50% horizontal. They may or may not have an outer wall

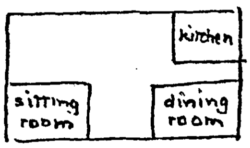
a. CONNECTEDNESS OF ROOMS

The rooms are counted as connected if any part of them touches another room, even if the boundaries of the rooms are incomplete.

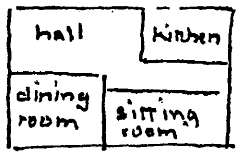
1 No rooms connected 2 Some rooms connected 3 All rooms connected

b. COMMONALITY OF WALLS

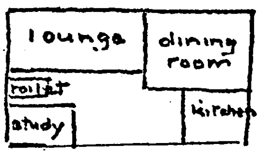
1. No Common Walls



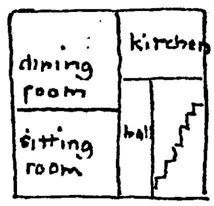

2. One common wall




3. More than one common wall but incomplete

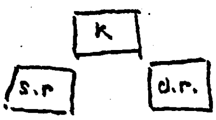



4. All walls common

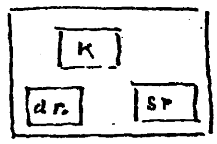



c. OUTER WALL

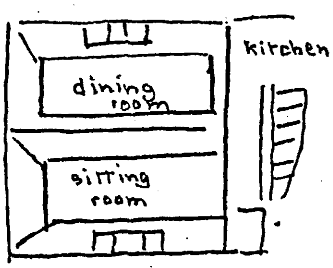
1. No outside wall



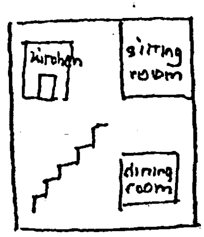

2. Outer wall separate




3. Outer wall common to rooms but vertical

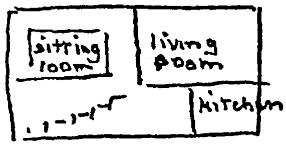



4. 1% - 25% of outer wall common with interior

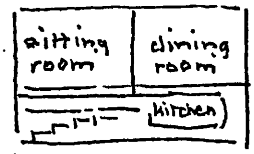


c. OUTER WALL (Continued)

5. 26% - 49% of outer wall common with interior




6. 50% of outer wall common with interior




7. 51% - 74% of outer wall common with interior

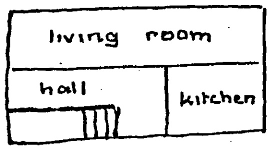
8. 75% of outer wall common with interior

9. 76% - 99% of outer wall common with interior

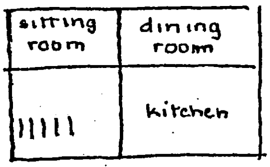
10. Outer wall completely common with interior

d. PROPORTION OF ROOMS

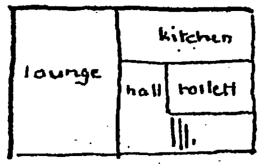
Length of room must not be greater than twice breadth




Kitchen must not be larger than largest living room

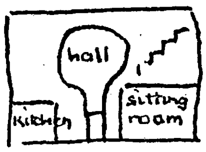



Toilette or cloakroom must not be greater than half of kitchen

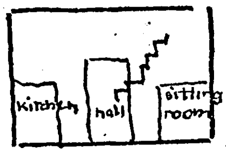



e. HALL

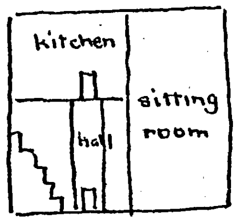
1. Hall present




2. One end wall correct

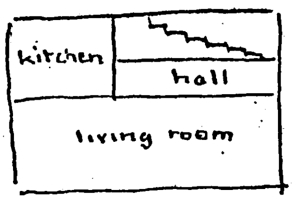



3. Any two walls correct

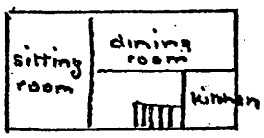



4. Any three walls correct

Usually nearly correct except for staircase




5. Four walls correct




f. PROPORTION OF HALL

Proportion reasonable. Not greater than half width of largest room.

II STAIRS

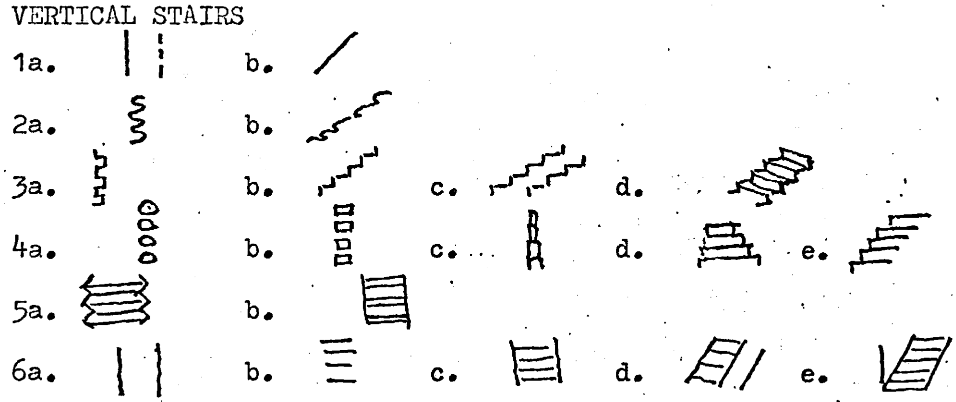
VERTICALITY VERSUS HORIZONTALITY

A Vertical Stairs

B Horizontality of stairs doubtful

C Horizontal stairs

A VERTICAL STAIRS



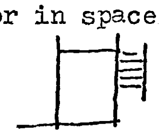

B HORIZONTALITY OF STAIRS DOUBTFUL

Scored as below.

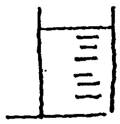
C HORIZONTAL STAIRS

a. Outline of Staircase

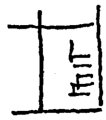
1a. Outside house or in space



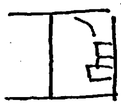
b. No outline



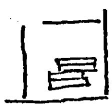
c. Minimal outline



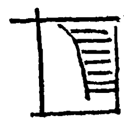
2a. Outline wavey or curving



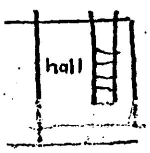
b. Sides straight but incorrect



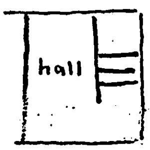
c. Sides curved



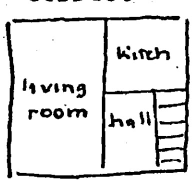
3. One side correct



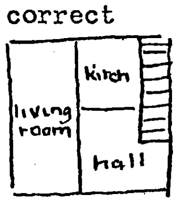

4. Two sides correct



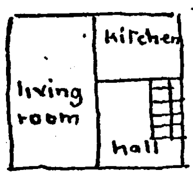

5a. Upper limit correct



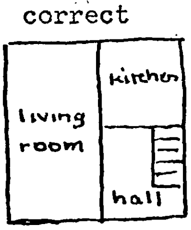

b. Lower limit correct




6. Three sides correct



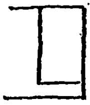

7. Completely correct




8. Width in proportion. (Less than a third of width of largest room)

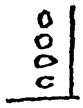
b. TREADS

1a. No treads



b. Diagonal lines

c. Inadequate symbol

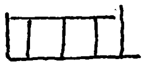


2a. Only treads

2b. Pyramid

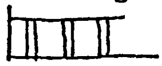
2c. Correct but roughly drawn

3a. Treads too deep

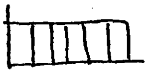


b. Treads too shallow.

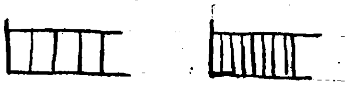
C. Treads grouped



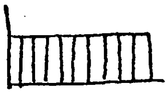
4. Treads almost correct but uneven



5. Treads correct, evenly spaced
If 5 correct, consider 6 and 7



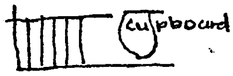
6. Treads correct and with correct proportion



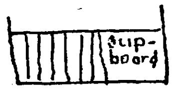
7. No. of treads possible, less than 20

c. SPACE BELOW STAIRS INDICATED

1 Some space indicated




2 Space clearly indicated




3 At least some space indicated

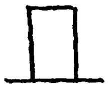
III DOORS

A NUMBER OF DOORS

1. One door
2. Two doors
3. Three doors
4. Access to all rooms

B TYPES OF DOORS

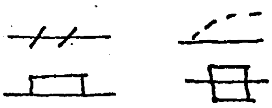
1. Vertical picture of doors



2. Vertical picture of door frames

3. Some poor and some fair doors

4. All fair doors



5. Some good and some fair doors

6. All doors correct

7. All doors correct, all the same size and in proportion. No more than $\frac{1}{4}$ of the width of the largest room, or less than $\frac{1}{6}$ of the width of the kitchen.

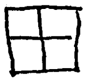
IV WINDOWS

A NUMBER OF WINDOWS

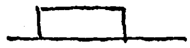
1. One window
2. Two windows
3. Three windows or more
4. All rooms with a window

B TYPES OF WINDOWS

1. Window as a vertical picture

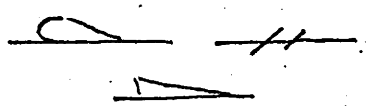


2. Windows may be vertical or horizontal sections



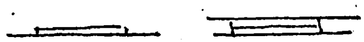
3. Some poor and some fair windows

4. All fair windows



5. Windows nearly correct

6. All windows correct



V UNACCOUNTED FOR SPACE AND VERTICAL WALLS

A No unaccounted for space

B No vertical walls

C Neither unaccounted for space or vertical walls

VI NUMBER OF PROPORTIONS CORRECT

1. One proportion correct
2. Two proportions correct
3. Three proportions correct
4. Four proportions correct
5. Five proportions correct

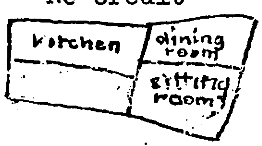
VII DOUBLE LINES FOR WALLS

1. Some walls drawn with double lines
2. All walls drawn with double lines
3. At least some walls drawn with double lines

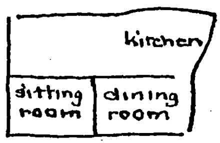
VIII QUALITY OF DRAWING

1. At least half the lines are straight and two of the corners of the outer walls are right angles.

No credit




Credit




2. All lines straight and parallel.

RESULTS INDICATING WHICH ITEMS SHOULD BE RETAINED OF THIRD SCORING SYSTEM

(See percentages in Appendix Ia and modes, medians and quartiles in Appendix Ib)

I MAIN STRUCTURE

Verticality Versus Horizontality

It was found that it was not necessary to retain the six quantitatively graded items because the majority of children drew either vertical or horizontal plans. For the very few who did score in the middle, it was possible for those whose plans had 50% or more of their rooms horizontal to be classified as horizontal and those whose plans had less than 50% of their rooms horizontal to be classified as vertical. It was therefore decided to classify the plan as either vertical or horizontal and allot a score if horizontal.

A VERTICAL PLANS

a. Roof Absent

This item showed a steady increase with age and was retained.

b. Chimney Absent

This item also showed a steady increase with age and was retained.

c. Upstairs Absent

Item 1 decreased with age and was discarded. Item 2 was used by few children and also discarded. Item 3 showed a steady increase in percentage of successes and was retained.

d. Vertical Plane of Outside Wall Absent

Item 1 decreased with age and was discarded. Items 2, 3 and 4 were rarely used and also discarded. Item 5 showed a steady increase in percentage of successes with age and was retained.

e. Floor

Item 1 decreased with age and was discarded. Items 2 and 3 were amalgamated because they both showed an increase with age and there was no difference in their modes, medians and quartiles, which suggested they were measuring parallel development.

f. Depth

Item 1 was discarded because its appearance decreased with age and item 2 was discarded because its use did not change with age. Item 3 was the most important, showing an increasing appreciation of how to represent depth and was therefore retained.

g. Outer Wall

Item 1 was discarded because there was no change with age. Item 2 showed a steady increase with age, but was only meaningful when it applied to vertical plans. Various aspects of this score were used in other ways with horizontal plans. As this item could not apply to both vertical and horizontal plans it was discarded. Developmentally it was interesting because it suggested one way that some children might make the transition from drawing vertical to the horizontal plans.

B. HORIZONTAL PLANS

a. Connectedness of Rooms

The modes, medians and quartiles of items 1, 2 and 3 increased with age in the expected direction; but the use of item I decreased with age and was discarded; item 2 was rarely used and also discarded; while item 3 showed a steady increase with age and was retained.

b. Commonality of Walls

The modes, medians and quartiles showed an increase in the expected direction. Item 1 was discarded because its use decreased with age and 2 and 3 because they were rarely used. Item 4 showed a steady increase and was retained.

c. Outer Wall

The succession of modes, medians and quartiles showed an unexpected pattern. Two weak items 1 and 3 had modes and medians at a higher age level than items recording better responses. They were used by few children and were discarded. The modes, medians and quartiles were similar for items 4 and 5, and 6 and 7, but even when amalgamated they were used by few children and so were discarded. When 8 and 9 were amalgamated for the same reason, they were used by many children and showed an increase, then decrease with age which was probably due to the increase of item 10 and so were retained. Item 10, outer wall completely common with interior, showed a steady increase with age and was retained.

d. Proportions of Rooms

This item generally showed a steady increase with age until 13 years when it dropped a little. As this phenomenon was seen in the other more advanced scores and it was later found that grammar school children did better than secondary school children on it, it was retained.

e. Hall

The items 1, 2 and 3 showed little increase with age and were rarely used so were discarded. Item 4 showed an increase to 12.0 yrs. when it started to fall probably because children were by this time starting to get item 5 correct. Item 5 showed a steady increase with age until 14.6 yrs when other more advanced items declined too. Both items 4 and 5 were retained.

f. Proportion of Hall

This item showed a steady increase in the older age groups and was used by a large number of children, so was retained.

II STAIRS

The large majority of children either drew vertical or horizontal stairs. As the numbers of vertical stairs decreased with age, only horizontal stairs were retained as an item.

A. VERTICAL STAIRS

Only items 2b and 3b were used extensively. It seemed from inspection of the modes, medians and quartiles that some of these types of stairs may be showing parallel development. Much more work of longitudinal development would need to be done before such representations could be used. This category was therefore entirely discarded.

B. STAIRS OF DOUBTFUL HORIZONTALITY

Too few protocols came into this category and so this item was discarded.

C. HORIZONTAL STAIRS

a. Outlines of Staircase

Items 1a, b and c, 2a, b and c, 3 and 4 were rarely used, showed no clear progression in terms of modes, medians and quartiles so were discarded. Item 7 showed increasing use with age and so did 5a, 5b and 6 when amalgamated, They were both retained.

b. Proportion of Staircase

This item showed a steady increase in percentages in the upper age groups and was retained.

c. Treads

Many of the items were scarcely used and showed little differentiation with age. The sequence of modes, medians and quartiles was confused, 1a 'No Treads' appearing most frequently in the top age group. Items 1a, b, c and 2a, b, c were discarded. Items 3a, b, c and 4 were amalgamated being redefined as 'Treads drawn with parallel lines'. Items 5, 6 and 7 were also amalgamated and redefined as 'Treads almost or wholly correct; equal spacing, sppropriate depth and less than 20'.

d. Space Below Stairs Indicated

This was only used by the oldest and most intelligent children. As no more than 25% ever use it, it was discarded. It should be considered if the test were ever used for adults.

III DOORS

A. Number of Doors

Most of the modes, medians and quartiles for the items 1, 2, 3 and 4 had the same rank order. Item 1 was discarded because it was used by few children and showed no clear progression with age. Item 2 'Two Doors' was also used by few children and showed no clear progression, but it was retained and amalgamated with item 3 in order not to penalize children living in houses with only two doors. Item 3 showed a steady increase in percentages with age until 10 yrs. and more when children probably started to put in all the doors. Item 4 'Access to all rooms' always showed the highest rank order and a steady increase in percentages in the upper age groups.

B. Types of Doors

The results showed that the tendency for children to draw doors as in architects' plans increased in the older age groups (Item 5 + 6) also 'Doors nearly correct', (item 5.) Both these were retained. Items 1 and 2 'Vertical picture of door or door frame showed a steady decrease and were discarded, while item 4 'All doors fair, or some good and some poor' showed an increase in the middle age groups before it declined, so was also retained.

C. Proportions Satisfactory in Correct Doors

The percentage of correct proportions only increased slightly in the upper age groups and was rarely used, but as the grammar school children used it more than the secondary modern children, it was considered to be a useful score. In order to increase its scope the definition was changed to include all doors where width of door frame was indicated (Item 5).

IV WINDOWS

A Numbers of Windows

All the modes, medians and quartiles of all the items had the same rank order in the expected direction with the older children putting in more windows. Item 1 showed a decrease in appearance in the older age groups and was discarded, Items 2 and 3 were amalgamated in order to include houses of all sizes, and item 4 was retained as it was.

B Types of Windows

The modes, medians and quartiles of all the items had practically the same rank in the expected direction with item 1 'Window as a vertical picture' lowest and item 6 'All windows correct as in an architects' plan' highest. Item 1 showed a steady percentage decrease as the age of the groups increased and was discarded. Items 2, 3, 4 and 5 appeared most in the middle age groups and were retained, while item 6 showed an increase in the upper age groups and was also retained.

V UNACCOUNTED FOR SPACE AND VERTICAL WALLS

A No Unaccounted for Space

The percentage appearance of this item increased steadily with the age of the children and was therefore retained.

B No Vertical Walls

The percentage appearance of this item also increased steadily with the age of the children and was also retained.

C Neither Vertical Walls Nor Unaccounted for Space

This followed the same pattern as its component items, but as the modes, medians and quartiles did not indicate any additional discrimination, it was discarded.

VI NUMBERS OF PROPORTIONS CORRECT

The lower quartiles showed an increase of age with the number of proportions correct, but the order of modes, medians and upper quartiles was more confused because the 13 yr. olds did better than the 14 yr. olds on this item. The increase of percentages with age was satisfactory for items 1, 2 and 3 and they were retained. Items 4 and 5 'Four and Five Proportions correct' were rarely used, mainly because items II C 6 and III, B, 7 'Proportions of treads and doors' were also rarely used. As item II C 6 was to be discarded and the definition of item III B 7 changed to encompass more protocols, it was decided to discard items II C 6 but retain item III B 7 in expectation that it would improve with modification.

VII DOUBLE LINES FOR WALLS

The modes, medians and quartiles were in the expected direction with item 2 'All walls with double lines' higher than item 1. However, the percentages revealed that there was not only no steady progress of increase with age, but that there were peaks at 9-6 yrs, 13-6 yrs and 14-0 yrs even when items 1 and 2 were amalgamated in item 3. All these items were therefore discarded.

VIII QUALITY OF DRAWING

The modes, medians and quartiles were in the expected direction with item 2 'All lines straight and parallel and angles 90°' being the higher. The percentages too showed a satisfactory increase with age and so both items were retained.

As a result of this procedure the number of items was reduced from 122 to 40 to form the fourth and final scoring system.

## FOURTH AND FINAL SCORING SYSTEM

The definitions and examples are set out on pages 40 to 64

## Item validation

The following criteria were used for the validation of the items:

1. The items should show a regular and fairly rapid increase with age in the percentage of children gaining the score.
2. The items should show a relationship to some general measure of intelligence.
3. The items should differentiate between children scoring high and scoring low on the scale as a whole.

## Criterion One

Since the scores suggested that the boys scored higher than girls at each age level, separate percentages were calculated for each sex (Table 1.3) and graphs drawn (Graphs 1.1 to 1.40). These results showed that, while there was little difference in the first 6 items, there were large differences in most of the others with boys scoring better than girls, suggesting that they were developing their skills more quickly. This characteristic eventually altered the standardization procedure, for, whereas it had originally been intended to standardize the test on boys and girls together, it was discovered that they had to be standardized separately.

## Criterion Two

The scores from grammar school pupils were used from the standardization sample at this point to verify that the items showed a relationship to intelligence as well as age. As these children had been selected for a grammar school on the 11+ verbal reasoning test because they came in the top 25%, it could be expected that they would do better on these items than children attending a secondary modern school. The percentage success on the items was found (Table 1.4) and the points plotted on a graph. As inspection of the graphs indicated a clear difference between grammar and secondary modern children, the grammar children scoring higher, it was not considered necessary to assess the statistical difference between the proportions.

## Criterion Three

The internal consistency of the items was then examined by using the method of "upper and lower thirds". A group of 99 girls, aged between 10-0 and 10-11 years, was chosen because it was the age group in the middle which would reveal the greatest spread of difficulty and where a validity test was most appropriate. The results can be seen in Table 1.5. As expected in this age group, the first 6 items had little or no validity because they were too easy, and items 21, 25, 26, 27, 31, 32, 36, 37, 38, 40, mainly relating to proportion, also had little validity because they were too difficult. However, 23 useful items were left.

The other age groups were not tested for item consistency, but it was anticipated that the easier items would show internal consistency for the younger children and the harder items for the older children.

## Conclusions

It was considered that the final 40 items selected for the Fourth and Final Scoring System conformed to the three criteria in that they showed a regular and rapid increase with age in the percentage of children gaining the score, that they revealed a relationship to a general measure of intelligence and thet they differentiated between children scoring high and low on the scale as a whole.

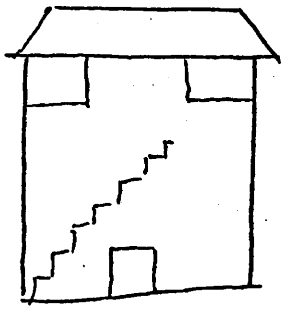
These 40 items were therefore used in the scoring of the plans drawn by children in the standardization sample.

## FOURTH AND FINAL SCORING SYSTEM

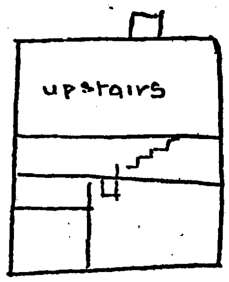
Items 1-7 apply to all plans. Items 8-40 apply only to horizontal plans.

1. ROOF ABSENT

No Credit

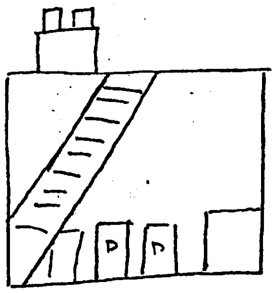


Credit

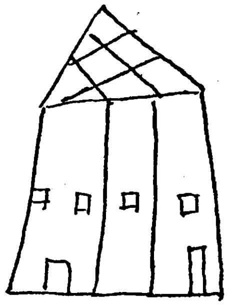



2. CHIMNEY ABSENT

No Credit

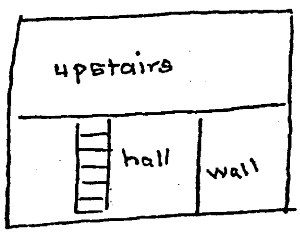


Credit

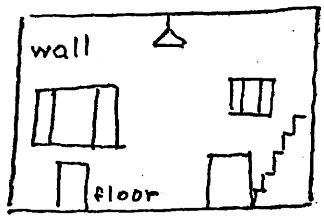


3. UPSTAIRS ABSENT

No Credit

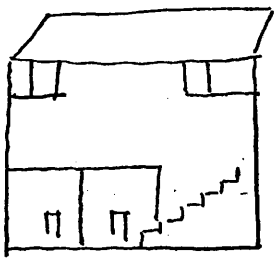



Credit

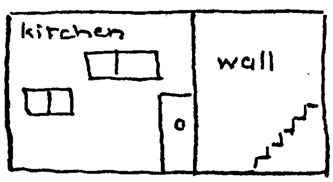



4. PLANE OF OUTSIDE WALL ABSENT

No Credit

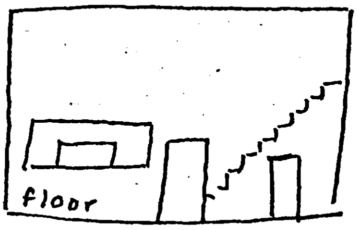


Credit

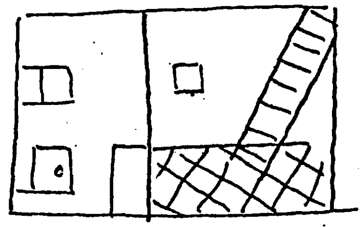


5. FLOOR — Floor marked by word or self evident

Credit

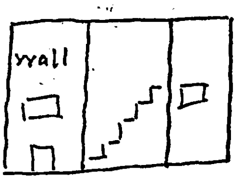



Credit

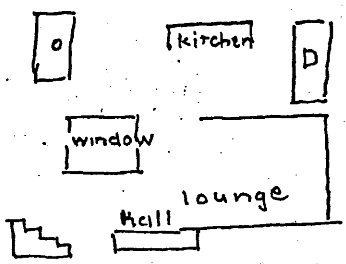


6. DEPTH — Depth indicated. May or may not have outer wall.

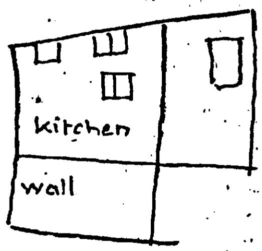
No credit




Credit

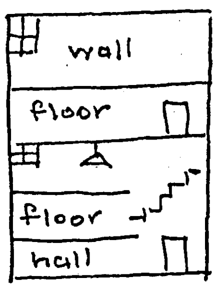



Credit

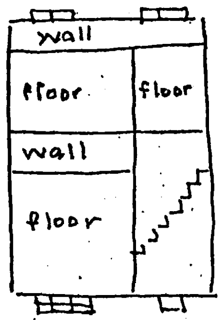



7. HORIZONTAL STRUCTURE More than 50% of each room horizontal

Vertical



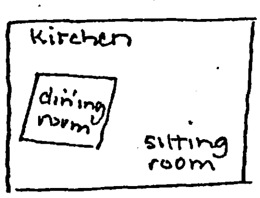

Horizontal



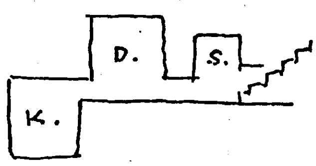

NOTE: Only proceed if this item is correct.

8. CONNECTEDNESS — All rooms connected in some way, even if by vertical walls and doors.

No Credit



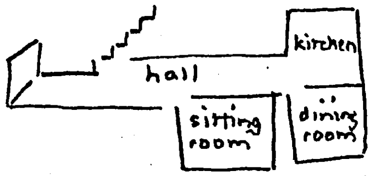

Credit



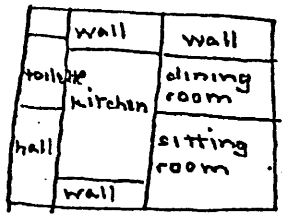

NOTE: If Item 8 is incorrect do not consider any other items except 16, 20, 22, 24, 25, 26, 27, 28, 30, 31, 32 and 34.

COMMONALITY All walls of rooms and hall common.

No Credit

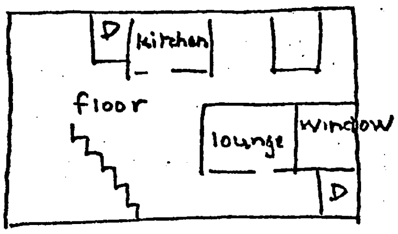



Credit

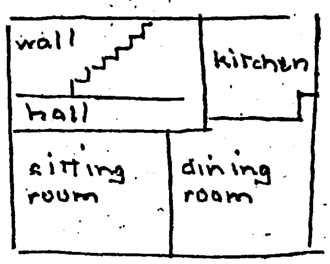



OUTER WALL I At least three quarters of outer wall common with internal rooms. Only walls drawn as cross-sections included.

No Credit

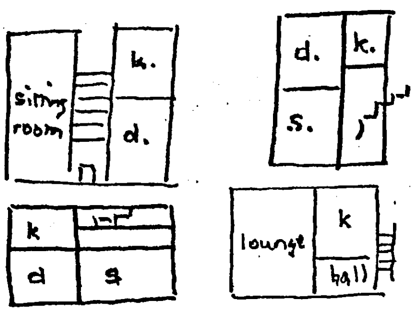



Credit

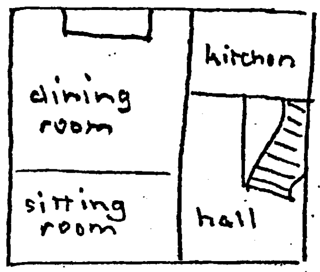



OUTER WALL II Completely correct. Do not credit if there is a break in the wall by the stairs, or if stairs are drawn outside wall.

No Credit

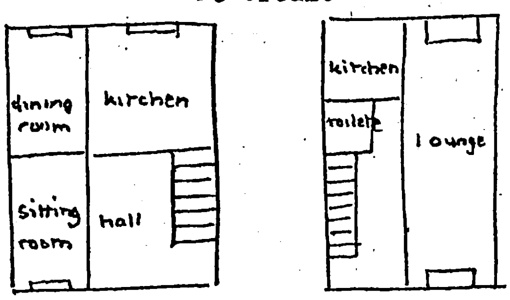



Credit

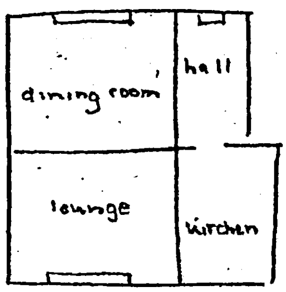



ROOMS: PROPORTIONS No room should have the length greater than twice the width, except a through room where length may be two and a half times width. The area of the kitchen should be less than the largest living room and greater than one sixth. The toilet, cloakroom or cupboard should not be greater than the area of half the kitchen. Only consider this item if the rooms are rectangular.

No Credit

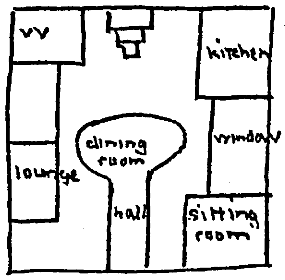



Credit

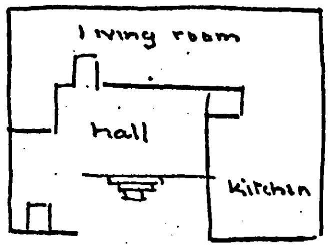


13. HALL I At least three walls correct. The fourth may be incorrect owing to the stairs being vertical.

No Credit

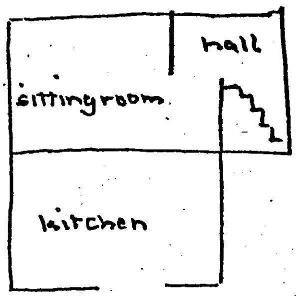



Credit

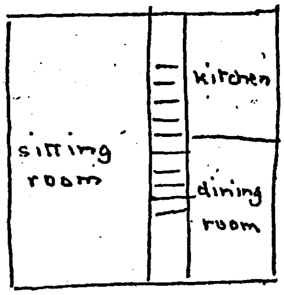



14. HALL II Three walls correct and limits adjoining staircase correctly indicated.

No Credit

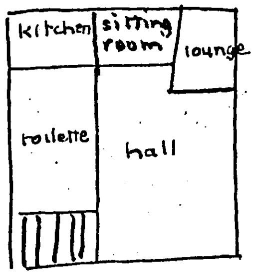



Credit

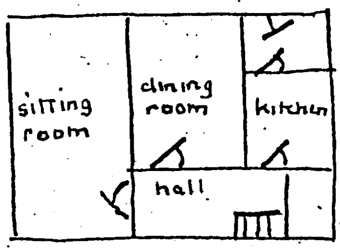



15. HALL : PROPORTIONS The width should be less than half-width of largest room but greater than one sixth. Only consider if Item 14 is correct.

No Credit



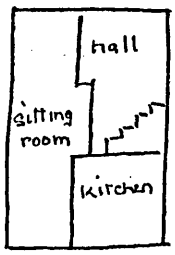

Credit

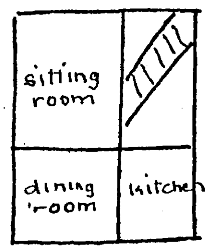



NOTE: If stairs are drawn vertically continue with Item 22.

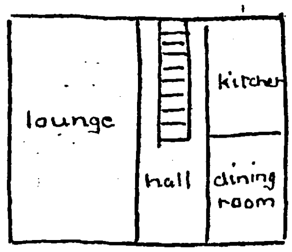
16. HORIZONTAL STAIRS The staircase is usually rectangular and always parallel or at right angles to a wall.

No Credit

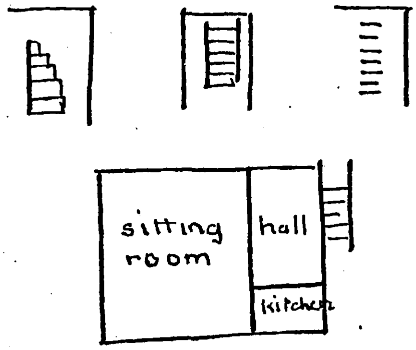

Credit



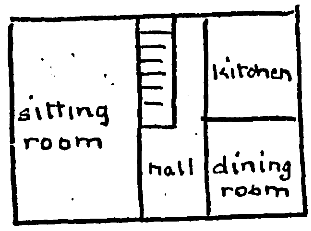
17. STAIRCASE I

The staircase is correctly integrated with the plan, with no vertical walls or unaccounted for spaces, but upper or lower limits may be incorrect.

No Credit




Credit

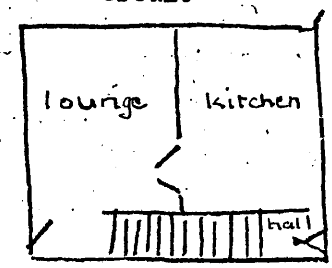



18. STAIRCASE II

Staircase completely correct, rectangular, integrated with plan and upper and lower limits correct.

No Credit

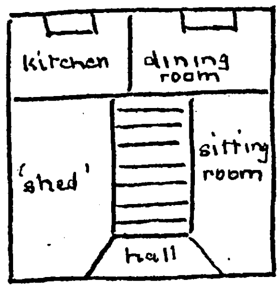

Credit




19. STAIRCASE : PROPORTION

Width of staircase should not be less than one sixth or greater than one third of width of largest room. Item 17 must be correct.

No Credit

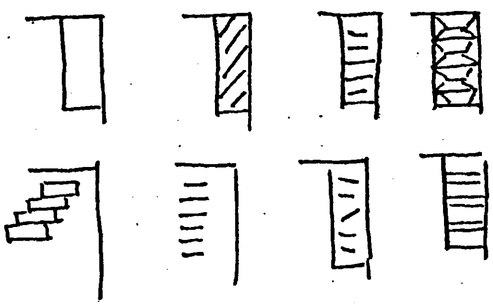



Credit

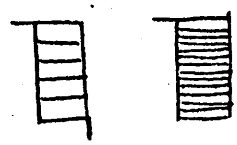

20. TREADS I

Treads drawn carefully with parallel lines. Only consider if Item 16 is correct.

No Credit

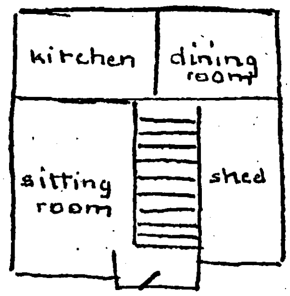


Credit



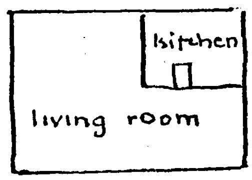
21. TREADS II — Treads almost or wholly correct; equal spacing, appropriate depth and less than 20.

Credit

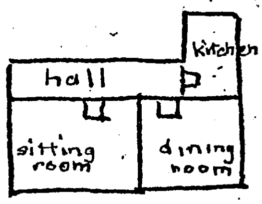



22. DOORS: NUMBER I — At least two or more doors, but incomplete because some rooms are without necessary access. Any representation acceptable.

No Credit



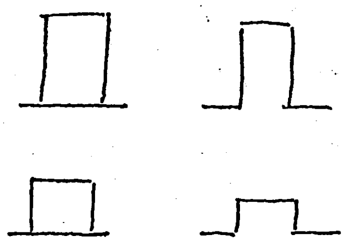

Credit



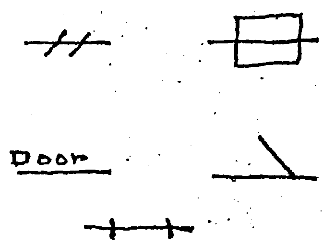

23. DOORS: NUMBER II — All doors present. No room without access together with a front and back door.

24. DOORS: TYPE I — Type of door is judged independently of the number of doors. A vertical picture is not acceptable.

No Credit



Credit



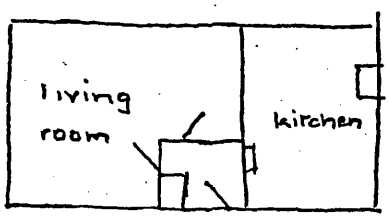

25. DOORS: TYPE II — Position and width of door or its frame indicated.

Credit

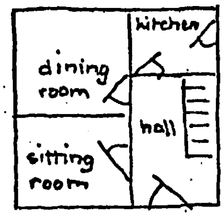
26. DOORS : TYPE III

All doors indicated as in architects' plans.

No credit



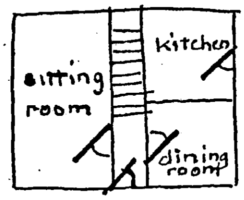

Credit



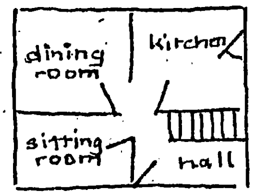

27. DOORS : PROPORTION

Width should not be more than one quarter of largest room, or less than one sixth of the width of the kitchen. Only consider if item 25 is correct and all doors are the same size.

No credit



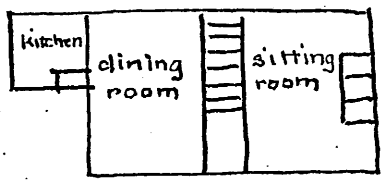

Credit



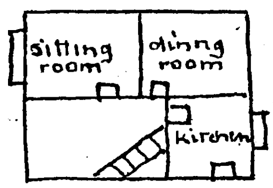

28. WINDOWS : NUMBER I

At least two or more windows present, but one or more rooms without windows. Any type of window acceptable. Window must be attached to outside wall.

No credit



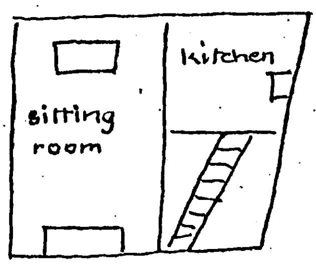

Credit



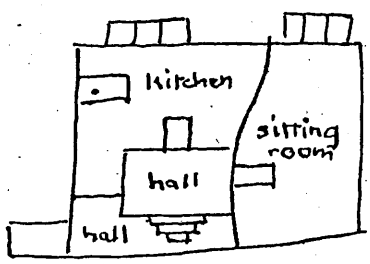

29. WINDOWS : NUMBER II

All windows present, any type accepted if attached to outside wall

No credit



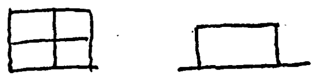

Credit



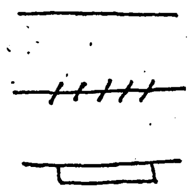
30. WINDOW : TYPE I

Type of window, judged independently of number of windows. Vertical picture not accepted.

No Credit



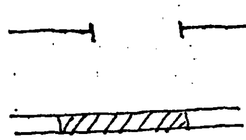
Credit

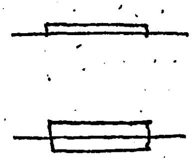


31. WINDOW : TYPE II

Width of window indicated

Credit

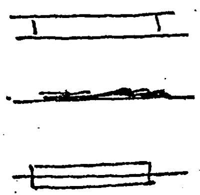




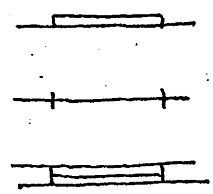
32. WINDOW : TYPE III

All windows indicated as in architects' plans and carefully drawn.

No Credit



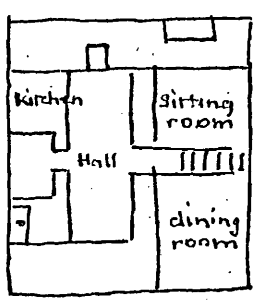
Credit



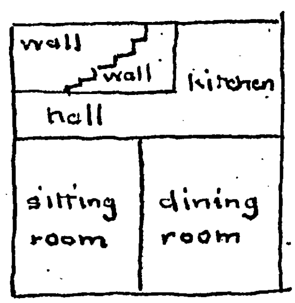
33. NO UNACCOUNTED FOR SPACE

Usually unaccounted for spaces occur where the walls are not common or when the staircase is incorrect.

No Credit

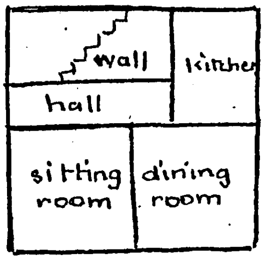



Credit

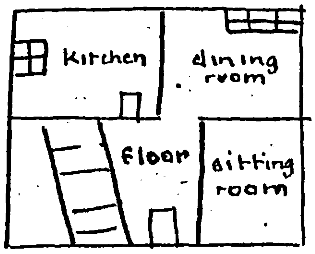


34. NO VERTICAL WALLS — Vertical walls of rooms are sometimes seen and often associated with the stairs.

No Credit




Credit

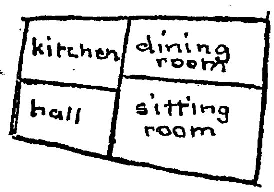



NOTE: Look at Numbers 12, 15, 19 and 27 and score 35 to 38.

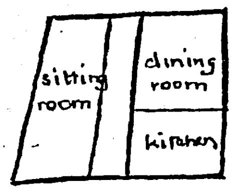
| | | |
|---|---|---|
| 35. | PROPORTIONS I | At least one correct proportion |
| 36. | PROPORTIONS II | " " two " proportions |
| 37. | PROPORTIONS III | " " three " " |
| 38. | PROPORTIONS IV | " " four " " |

39. QUALITY OF DRAWING I — At least half the lines are straight and two of the corners of the outer wall right angles.

No Credit




Credit




40. QUALITY OF DRAWING II — All lines straight and parallel.

Credit

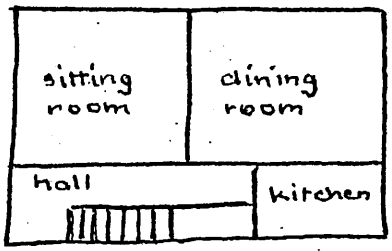


TABLE 1.3

FOURTH AND FINAL SCORING SYSTEM

PERCENTAGES OF ITEMS APPEARING AT SIX MONTHLY INTERVALS

| AGES | 1. ROOF ABSENT | | 2. CHIMNEY ABSENT | | 3. UPSTAIRS ABSENT | | 4. PLANE OF OUTER WALL ABSENT | |
|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G |
| 7-0 to 7-5 | 55 | 61 | 59 | 62 | 59 | 55 | 61 | 67 |
| 7-6 to 7-11 | 65 | 83 | 65 | 81 | 65 | 75 | 62 | 85 |
| 8-0 to 8-5 | 88 | 92 | 90 | 94 | 90 | 78 | 96 | 96 |
| 8-6 to 8-11 | 97 | 94 | 97 | 95 | 97 | 86 | 97 | 95 |
| 9-0 to 9-5 | 98 | 96 | 98 | 96 | 98 | 89 | 98 | 98 |
| 9-6 to 9-11 | 98 | 93 | 98 | 96 | 98 | 98 | 100 | 100 |
| 10-0 to 10-5 | 100 | 100 | 100 | 100 | 100 | 98 | 100 | 100 |
| 10-6 to 10-11 | 100 | 100 | 100 | 100 | 100 | 100 | 95 | 100 |
| 11-0 to 11-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 11-6 to 11-11 | 100 | 100 | 100 | 100 | 96 | 100 | 100 | 100 |
| 12-0 to 12-5 | 100 | 96 | 100 | 96 | 93 | 100 | 100 | 100 |
| 12-6 to 12-11 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 13-0 to 13-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 13-6 to 13-11 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 14-0 to 14-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 14-6 to 14-11 | 96 | 100 | 96 | 100 | 96 | 100 | 96 | 100 |
| 15-0 to 15-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

| | 5. FLOOR | | 6. DEPTH | | 7. HOR. ROOMS | | 8. CONNECTEDNESS | | 9. COMMONALITY | |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G | B | G |
| 7-0 to 7-5 | 37 | 35 | 31 | 33 | 8 | 12 | 8 | 8 | 8 | 5 |
| 7-6 to 7-11 | 51 | 60 | 43 | 67 | 27 | 23 | 11 | 13 | 8 | 10 |
| 8-0 to 8-5 | 85 | 75 | 81 | 86 | 63 | 53 | 48 | 39 | 38 | 35 |
| 8-6 to 8-11 | 95 | 92 | 84 | 92 | 68 | 55 | 63 | 51 | 58 | 42 |
| 9-0 to 9-5 | 95 | 93 | 90 | 93 | 90 | 75 | 90 | 68 | 80 | 52 |
| 9-6 to 9-11 | 98 | 96 | 100 | 100 | 91 | 82 | 96 | 82 | 62 | 69 |
| 10-10 to 10-5 | 94 | 98 | 100 | 93 | 94 | 91 | 90 | 81 | 86 | 62 |
| 10-6 to 10-11 | 100 | 98 | 98 | 98 | 93 | 93 | 86 | 89 | 81 | 75 |
| 11-0 to 11-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 96 | 95 |
| 11-6 to 11-11 | 100 | 100 | 100 | 100 | 92 | 100 | 92 | 100 | 83 | 81 |
| 12-0 to 12-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 96 | 93 | 88 |
| 12-6 to 12-11 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 81 |
| 13-0 to 13-5 | 100 | 100 | 100 | 100 | 96 | 100 | 96 | 100 | 96 | 100 |
| 13-6 to 13-11 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 14-0 to 14-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 14-6 to 14-11 | 96 | 100 | 96 | 100 | 93 | 100 | 93 | 100 | 93 | 100 |
| 15-0 to 15-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

| AGES | 10. OUTER WALL I | | 11. OUTER WALL II | | 12. ROOMS: PROPORTIONS | | 13.HALL I | | 14.HALL II | |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G | B | G |
| 7-0 to 7-5 | 8 | 5 | 4 | 2 | 4 | 2 | 8 | 2 | 4 | 2 |
| 7-6 to 7-11 | 11 | 13 | 5 | 8 | 8 | 4 | 8 | 10 | 5 | 4 |
| 8-0 to 8-5 | 42 | 24 | 29 | 14 | 13 | 14 | 33 | 18 | 15 | 10 |
| 8-6 to 8-11 | 51 | 48 | 42 | 18 | 18 | 14 | 47 | 31 | 23 | 14 |
| 9-0 to 9-5 | 78 | 50 | 68 | 20 | 23 | 14 | 78 | 41 | 60 | 18 |
| 9-6 to 9-11 | 81 | 60 | 62 | 29 | 34 | 22 | 74 | 60 | 57 | 26 |
| 10-0 to 10-5 | 82 | 43 | 80 | 43 | 38 | 30 | 80 | 60 | 52 | 28 |
| 10-6 to 10-11 | 81 | 77 | 76 | 45 | 40 | 36 | 76 | 68 | 60 | 41 |
| 11-0 to 11-5 | 98 | 95 | 84 | 53 | 63 | 63 | 96 | 89 | 89 | 32 |
| 11-6 to 11-11 | 75 | 88 | 75 | 53 | 33 | 52 | 88 | 71 | 52 | 57 |
| 12-0 to 12-5 | 93 | 86 | 83 | 57 | 69 | 54 | 90 | 81 | 66 | 38 |
| 12-6 to 12-11 | 100 | 88 | 100 | 54 | 74 | 46 | 100 | 73 | 89 | 38 |
| 13-0 to 13-5 | 96 | 81 | 96 | 62 | 61 | 80 | 96 | 96 | 96 | 68 |
| 13-6 to 13-11 | 100 | 100 | 87 | 88 | 60 | 70 | 87 | 96 | 80 | 72 |
| 14-0 to 14-5 | 100 | 96 | 97 | 88 | 69 | 54 | 100 | 100 | 97 | 88 |
| 14-6 to 14-11 | 92 | 100 | 85 | 96 | 89 | 58 | 89 | 97 | 85 | 83 |
| 15-0 to 15-5 | 100 | 87 | 100 | 97 | 63 | 83 | 94 | 100 | 88 | 100 |

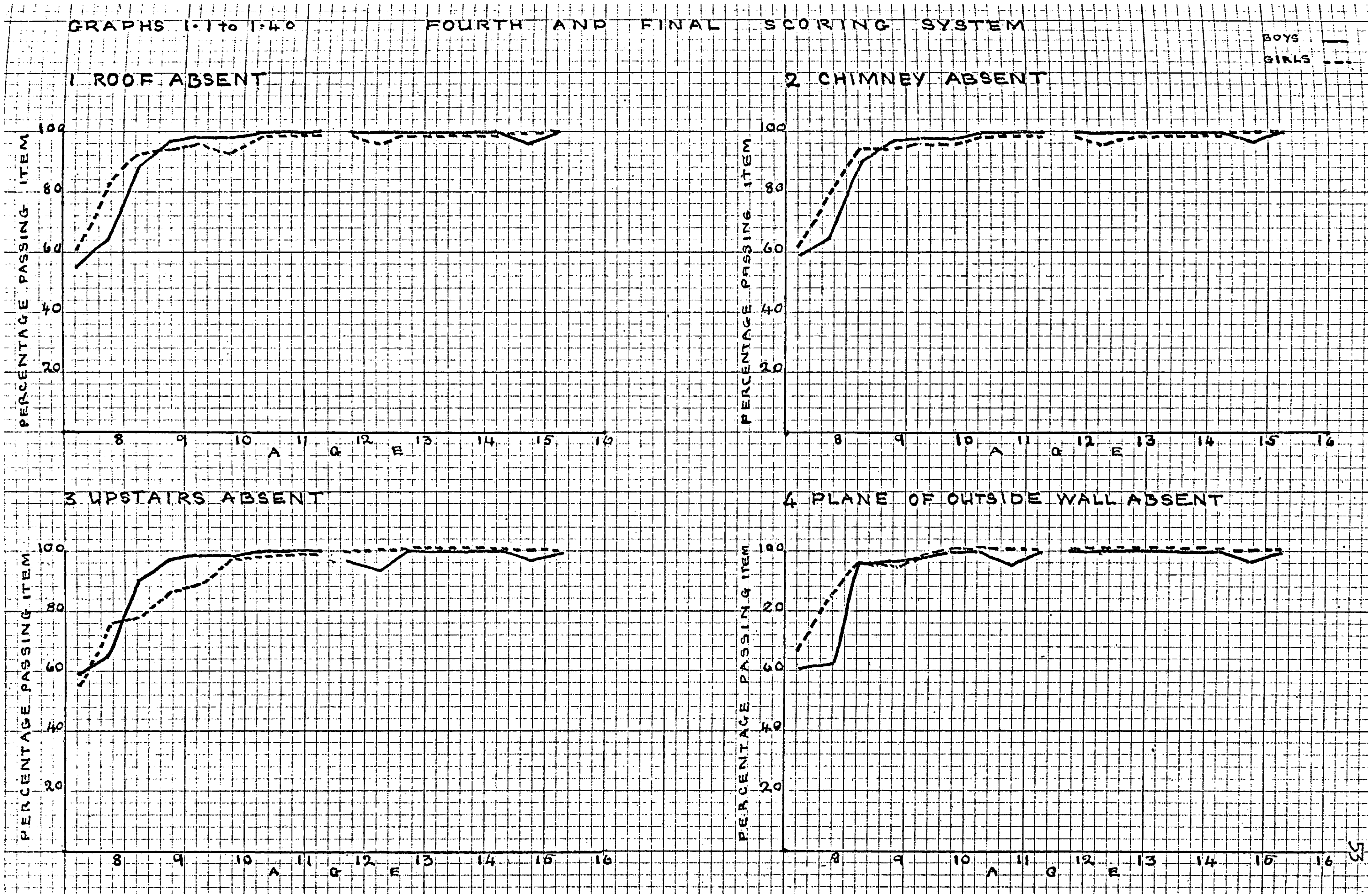
| | 15. HALL PROP. | | 16. HOR. STAIRS | | 17. STAIR-CASE I | | 18. STAIR-CASE II | | 19. STAIR-CASE PR. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G | B | G |
| 7-0 to 7-5 | 4 | 0 | 4 | 2 | 2 | 0 | 4 | 0 | 2 | 0 |
| 7-6 to 7-11 | 5 | 0 | 14 | 10 | 5 | 4 | 5 | 2 | 3 | 2 |
| 8-0 to 8-5 | 13 | 4 | 35 | 14 | 15 | 8 | 33 | 4 | 0 | 4 |
| 8-6 to 8-11 | 11 | 6 | 43 | 23 | 21 | 14 | 23 | 8 | 8 | 5 |
| 9-0 to 9-5 | 23 | 11 | 73 | 54 | 50 | 34 | 48 | 9 | 10 | 11 |
| 9-6 to 9-11 | 17 | 16 | 72 | 44 | 49 | 24 | 47 | 18 | 4 | 13 |
| 10-0 to 10-5 | 32 | 9 | 74 | 49 | 50 | 28 | 36 | 13 | 20 | 11 |
| 10-6 to 10-11 | 26 | 16 | 71 | 52 | 57 | 36 | 50 | 30 | 24 | 20 |
| 11-0 to 11-5 | 39 | 16 | 79 | 63 | 61 | 37 | 56 | 5 | 25 | 16 |
| 11-6 to 11-11 | 42 | 29 | 58 | 67 | 38 | 48 | 25 | 29 | 25 | 14 |
| 12-0 to 12-5 | 59 | 27 | 79 | 50 | 41 | 36 | 52 | 23 | 34 | 8 |
| 12-6 to 12-11 | 74 | 19 | 95 | 65 | 79 | 35 | 79 | 12 | 63 | 12 |
| 13-0 to 13-5 | 83 | 52 | 83 | 76 | 65 | 40 | 57 | 40 | 57 | 44 |
| 13-6 to 13-11 | 60 | 56 | 93 | 80 | 60 | 56 | 67 | 48 | 67 | 48 |
| 14-0 to 14-5 | 90 | 50 | 86 | 92 | 59 | 73 | 76 | 62 | 45 | 38 |
| 14-6 to 14-11 | 85 | 56 | 85 | 83 | 78 | 72 | 67 | 64 | 63 | 28 |
| 15-0 to 15-5 | 81 | 83 | 88 | 94 | 88 | 83 | 81 | 78 | 56 | 39 |

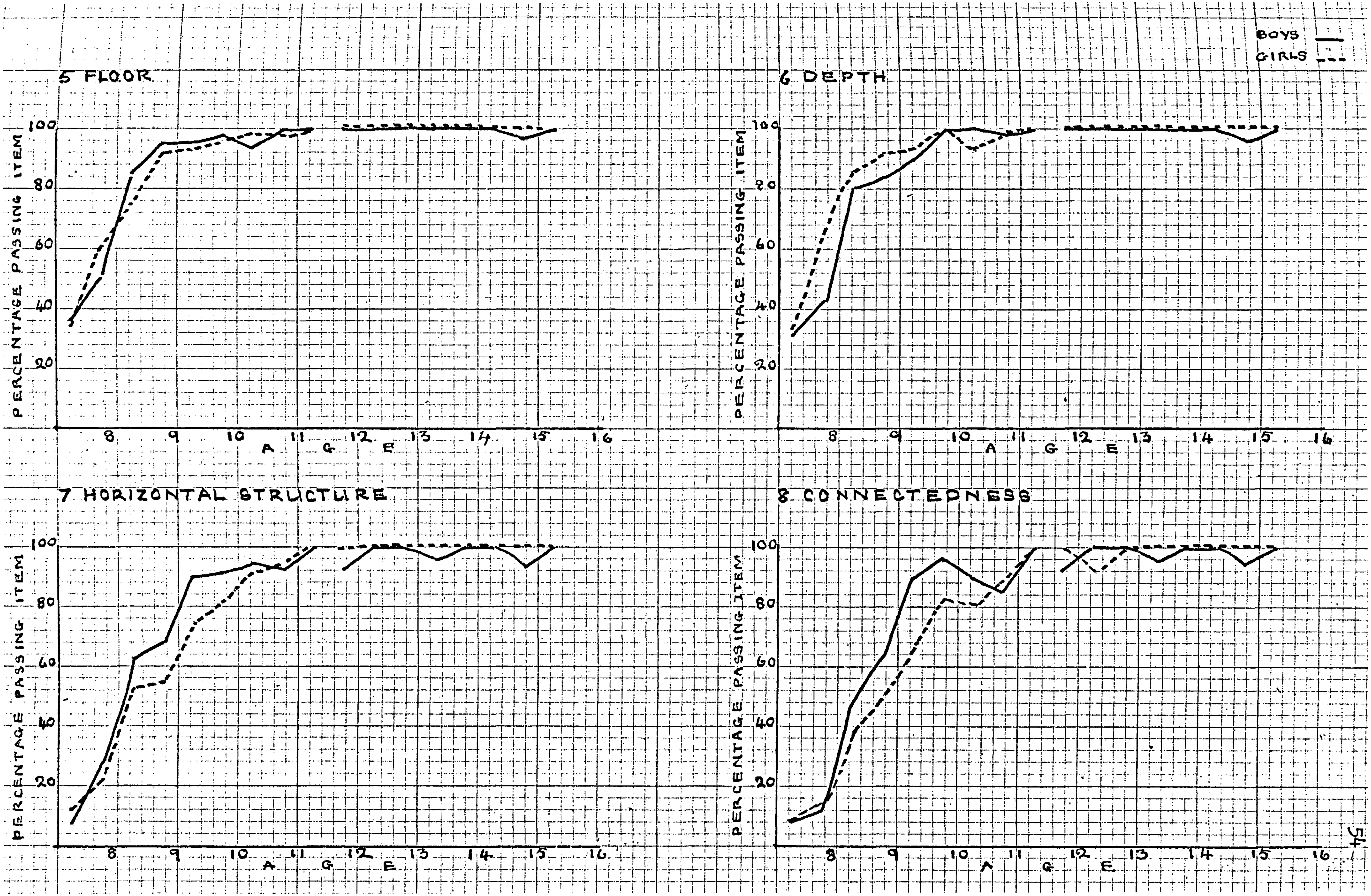
| AGES | 20. TREADS I | | 21.TREADS II | | 22.DOORS NO.I | | 23.DOORS NO.II | | 14.DOORS TYPE I | | 25.DOORS TYPE II | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G | B | G | B | G |
| 7-0 to 7-5 | 4 | 0 | 0 | 0 | 6 | 3 | 2 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 8 | 6 | 3 | 0 | 16 | 15 | 5 | 6 | 11 | 8 | 11 | 8 |
| 8-0 to 8-5 | 21 | 4 | 2 | 4 | 48 | 33 | 15 | 12 | 31 | 16 | 21 | 12 |
| 8-6 to 8-11 | 27 | 17 | 3 | 6 | 61 | 46 | 18 | 14 | 42 | 22 | 18 | 14 |
| 9-0 to 9-5 | 50 | 45 | 3 | 9 | 90 | 55 | 50 | 23 | 60 | 25 | 55 | 11 |
| 9-6 to 9-11 | 62 | 36 | 0 | 7 | 85 | 78 | 40 | 31 | 70 | 49 | 57 | 22 |
| 10-10 to 10-5 | 44 | 32 | 2 | 0 | 88 | 83 | 52 | 40 | 68 | 36 | 52 | 23 |
| 10-6 to 1-11 | 38 | 27 | 7 | 7 | 90 | 84 | 48 | 55 | 79 | 57 | 55 | 41 |
| 11-0 to 11-5 | 56 | 37 | 4 | 0 | 98 | 100 | 63 | 63 | 95 | 42 | 84 | 42 |
| 11-6 to 11-11 | 54 | 48 | 17 | 14 | 83 | 100 | 54 | 71 | 71 | 57 | 63 | 43 |
| 12-0 to 12-5 | 62 | 38 | 3 | 8 | 100 | 96 | 69 | 65 | 86 | 62 | 71 | 27 |
| 12-6 to 12-11 | 63 | 69 | 32 | 19 | 100 | 96 | 89 | 50 | 95 | 69 | 79 | 42 |
| 13-0 to 13-5 | 74 | 64 | 35 | 16 | 96 | 100 | 87 | 96 | 74 | 80 | 70 | 72 |
| 13-6 to 13-11 | 80 | 68 | 27 | 12 | 100 | 100 | 93 | 92 | 93 | 96 | 73 | 96 |
| 14-0 to 14-5 | 59 | 65 | 17 | 19 | 100 | 100 | 86 | 92 | 100 | 81 | 93 | 69 |
| 14-6 to 14-11 | 63 | 44 | 89 | 17 | 93 | 100 | 81 | 89 | 89 | 78 | 85 | 47 |
| 15-0 to 15-5 | 88 | 89 | 63 | 67 | 100 | 100 | 88 | 83 | 100 | 100 | 100 | 89 |

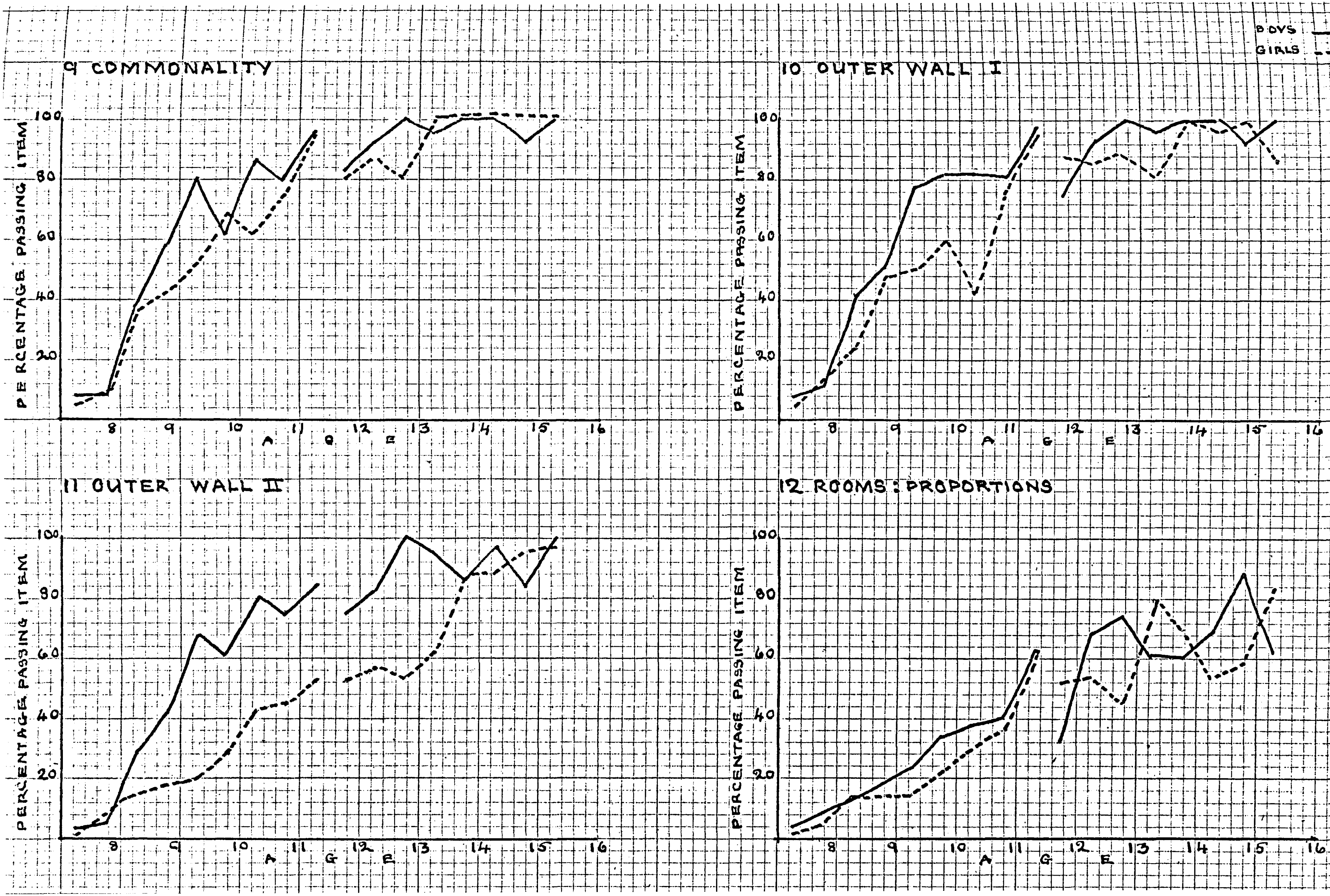
| | 26.DOORS TYPE III | | 17.DOOR PROP. | | 28.WINDOWS NO. I | | 29.WINDOWS NO.II | | 30.WINDOW TYPE I | | 31.WINDOW TYPE II | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G | B | G | B | G |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 6 | 2 | 0 | 0 | 2 | 0 | 0 | 0 |
| 7-6 to 7-11 | 5 | 0 | 0 | 0 | 11 | 10 | 5 | 0 | 8 | 8 | 5 | 2 |
| 8-0 to 8-5 | 4 | 0 | 0 | 0 | 25 | 24 | 15 | 8 | 17 | 10 | 8 | 4 |
| 8-6 to 8-11 | 11 | 0 | 0 | 0 | 43 | 43 | 11 | 22 | 31 | 17 | 11 | 11 |
| 9-0 to 9-5 | 13 | 2 | 0 | 0 | 78 | 43 | 50 | 25 | 50 | 16 | 38 | 7 |
| 9-6 to 9-11 | 13 | 4 | 4 | 0 | 79 | 69 | 40 | 31 | 60 | 40 | 32 | 16 |
| 10-0 to 10-5 | 24 | 8 | 0 | 0 | 80 | 72 | 58 | 51 | 56 | 25 | 36 | 9 |
| 10-6 to 10-11 | 21 | 7 | 2 | 2 | 83 | 84 | 69 | 64 | 71 | 45 | 40 | 25 |
| 11-0 to 11-5 | 18 | 0 | 4 | 0 | 95 | 89 | 81 | 53 | 89 | 37 | 67 | 37 |
| 11-6 to 11-11 | 13 | 10 | 8 | 5 | 88 | 90 | 63 | 62 | 71 | 52 | 33 | 48 |
| 12-0 to 12-5 | 38 | 8 | 3 | 4 | 97 | 84 | 83 | 84 | 76 | 65 | 55 | 19 |
| 12-6 to 12-11 | 32 | 8 | 26 | 23 | 100 | 96 | 89 | 73 | 84 | 46 | 58 | 23 |
| 13-0 to 13-5 | 52 | 44 | 22 | 12 | 96 | 100 | 87 | 92 | 83 | 80 | 74 | 68 |
| 13-6 to 13-11 | 67 | 44 | 60 | 36 | 100 | 100 | 87 | 92 | 93 | 96 | 73 | 84 |
| 14-0 to 14-5 | 52 | 46 | 55 | 12 | 100 | 100 | 90 | 96 | 97 | 96 | 86 | 73 |
| 14-6 to 14-11 | 44 | 47 | 74 | 19 | 93 | 97 | 85 | 92 | 85 | 89 | 81 | 69 |
| 15-0 to 15-5 | 63 | 72 | 44 | 67 | 100 | 100 | 100 | 100 | 100 | 94 | 100 | 89 |

| AGES | 32. WINDOW TYPE III | | 33. NO UNACC. SPACE | | 34. NO VERT. WALLS | | 35. PROP. I | | 36. PROP. II | |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G | B | G |
| 7-0 to 7-5 | 2 | 0 | 2 | 0 | 4 | 0 | 4 | 2 | 4 | 0 |
| 7-6 to 7-11 | 0 | 0 | 3 | 4 | 11 | 6 | 8 | 4 | 5 | 4 |
| 8-0 to 8-5 | 0 | 0 | 8 | 10 | 31 | 16 | 21 | 14 | 4 | 4 |
| 8-6 to 8-11 | 0 | 0 | 16 | 5 | 42 | 51 | 21 | 15 | 10 | 5 |
| 9-0 to 9-5 | 8 | 0 | 45 | 21 | 85 | 48 | 38 | 27 | 18 | 9 |
| 9-6 to 9-11 | 0 | 0 | 49 | 18 | 81 | 40 | 43 | 36 | 15 | 13 |
| 10-0 to 10-5 | 6 | 0 | 46 | 23 | 78 | 58 | 52 | 32 | 28 | 15 |
| 10-6 to 10-11 | 5 | 0 | 48 | 36 | 88 | 57 | 48 | 48 | 24 | 18 |
| 11-0 to 11-5 | 2 | 0 | 77 | 21 | 96 | 68 | 79 | 68 | 44 | 16 |
| 11-6 to 11-11 | 13 | 24 | 50 | 57 | 79 | 67 | 46 | 62 | 38 | 29 |
| 12-0 to 12-5 | 21 | 4 | 62 | 38 | 90 | 65 | 79 | 58 | 59 | 27 |
| 12-6 to 12-11 | 37 | 12 | 95 | 46 | 100 | 73 | 95 | 46 | 84 | 27 |
| 13-0 to 13-5 | 57 | 48 | 91 | 64 | 91 | 100 | 87 | 92 | 70 | 64 |
| 13-6 to 13-11 | 60 | 48 | 67 | 60 | 100 | 100 | 73 | 88 | 60 | 68 |
| 14-0 to 14-5 | 62 | 31 | 79 | 81 | 100 | 96 | 100 | 81 | 86 | 50 |
| 14-6 to 14-11 | 44 | 25 | 93 | 89 | 93 | 94 | 93 | 83 | 85 | 50 |
| 15-0 to 15-5 | 56 | 67 | 88 | 89 | 100 | 100 | 94 | 77 | 81 | 54 |

| | 37. PROP. III | | 38. PROP. IV | | 39. LINE QUAL. I | | 40. LINE QUAL. II | |
|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G |
| 7-0 to 7-5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 0 | 4 | 0 | 0 | 15 | 18 | 0 | 0 |
| 8-6 to 8-11 | 6 | 2 | 0 | 0 | 26 | 11 | 0 | 0 |
| 9-0 to 9-5 | 8 | 2 | 0 | 0 | 45 | 14 | 3 | 0 |
| 9-6 to 9-11 | 0 | 2 | 0 | 0 | 64 | 20 | 4 | 0 |
| 10-0 to 10-5 | 12 | 6 | 4 | 0 | 68 | 26 | 2 | 6 |
| 10-6 to 10-11 | 19 | 9 | 2 | 0 | 64 | 48 | 10 | 7 |
| 11-0 to 11-5 | 7 | 11 | 2 | 0 | 81 | 71 | 7 | 15 |
| 11-6 to 11-11 | 17 | 5 | 4 | 0 | 71 | 62 | 4 | 5 |
| 12-0 to 12-5 | 24 | 12 | 0 | 0 | 90 | 54 | 3 | 12 |
| 12-6 to 12-11 | 47 | 15 | 21 | 0 | 100 | 50 | 5 | 27 |
| 13-0 to 13-5 | 39 | 28 | 22 | 0 | 91 | 88 | 30 | 32 |
| 13-6 to 13-11 | 47 | 36 | 40 | 16 | 93 | 96 | 80 | 48 |
| 14-0 to 14-5 | 45 | 15 | 86 | 0 | 100 | 84 | 55 | 69 |
| 14-6 to 14-11 | 59 | 28 | 22 | 8 | 93 | 92 | 37 | 83 |
| 15-0 to 15-5 | 50 | 31 | 13 | 0 | 94 | 90 | 44 | 80 |


GRAPHS 1·1 to 1·40
FOURTH AND FINAL SCORING SYSTEM
BOYS
GIRLS
1 ROOF ABSENT
2 CHIMNEY ABSENT
3 UPSTAIRS ABSENT
4 PLANE OF OUTSIDE WALL ABSENT
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE


BOYS
GIRLS
5 FLOOR
6 DEPTH
7 HORIZONTAL STRUCTURE
8 CONNECTEDNESS
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE

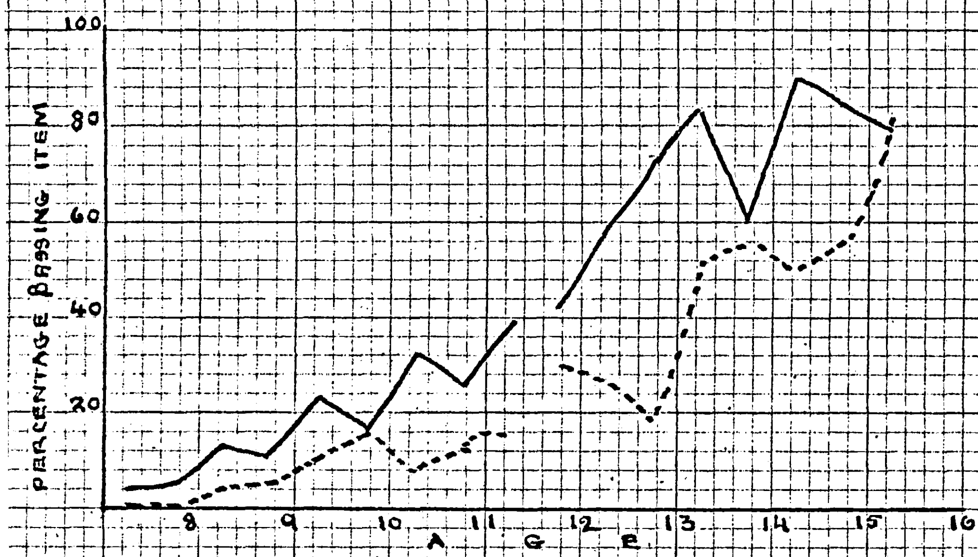

BOYS
GIRLS
9 COMMONALITY
10 OUTER WALL I
11 OUTER WALL II
12 ROOMS: PROPORTIONS
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE

BOYS ——
GIRLS - - -

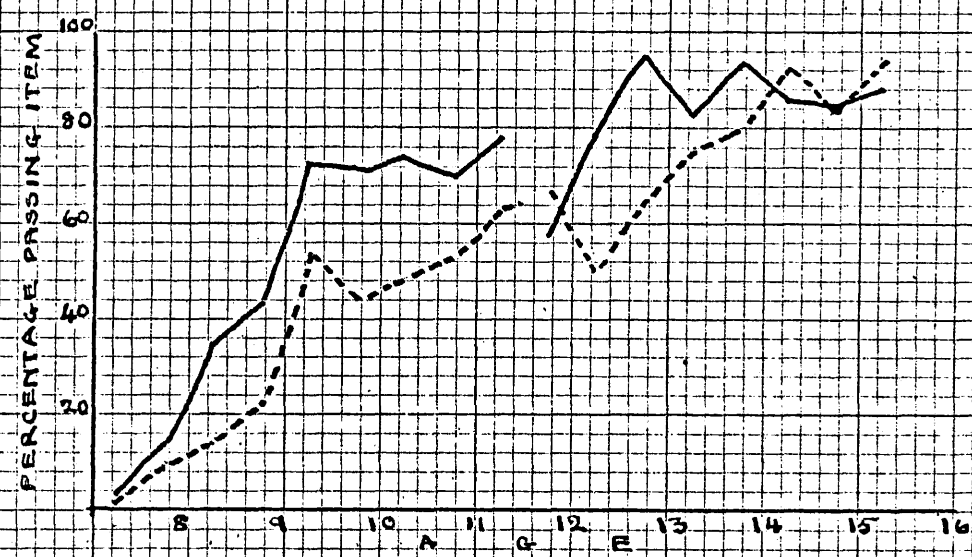
13 HALL I


14 HALL II


15 HALL: PROPORTIONS



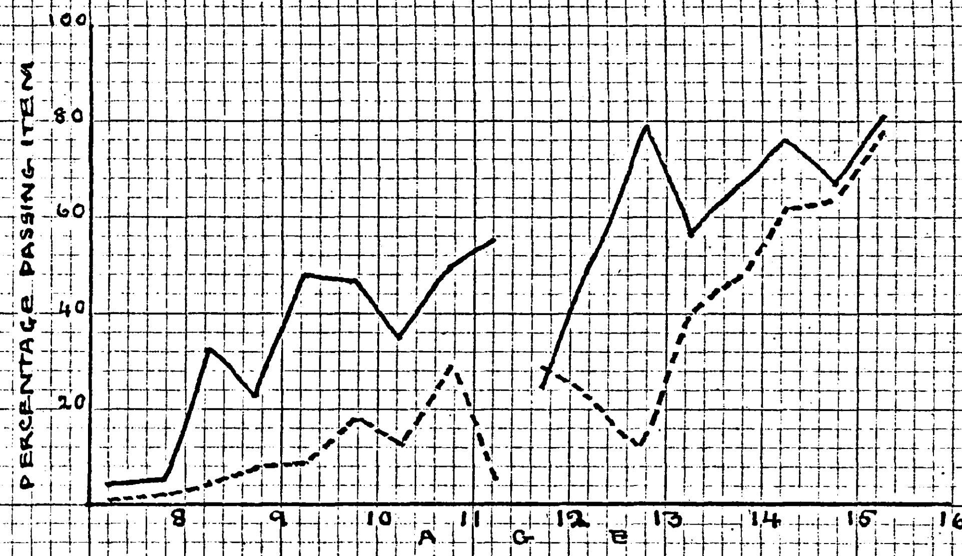

16 HORIZONTAL STAIRS



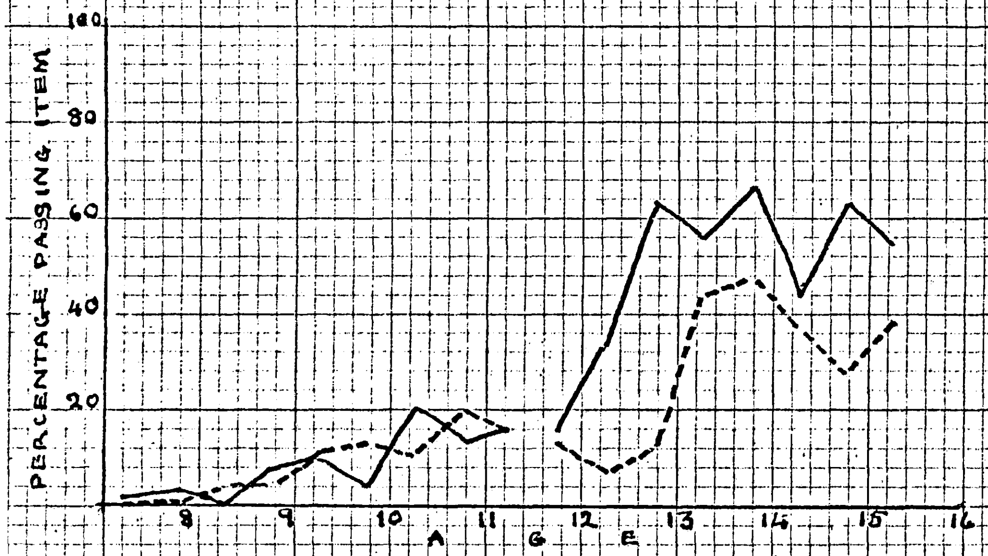
BOYS —
GIRLS ---

17 STAIRCASE I

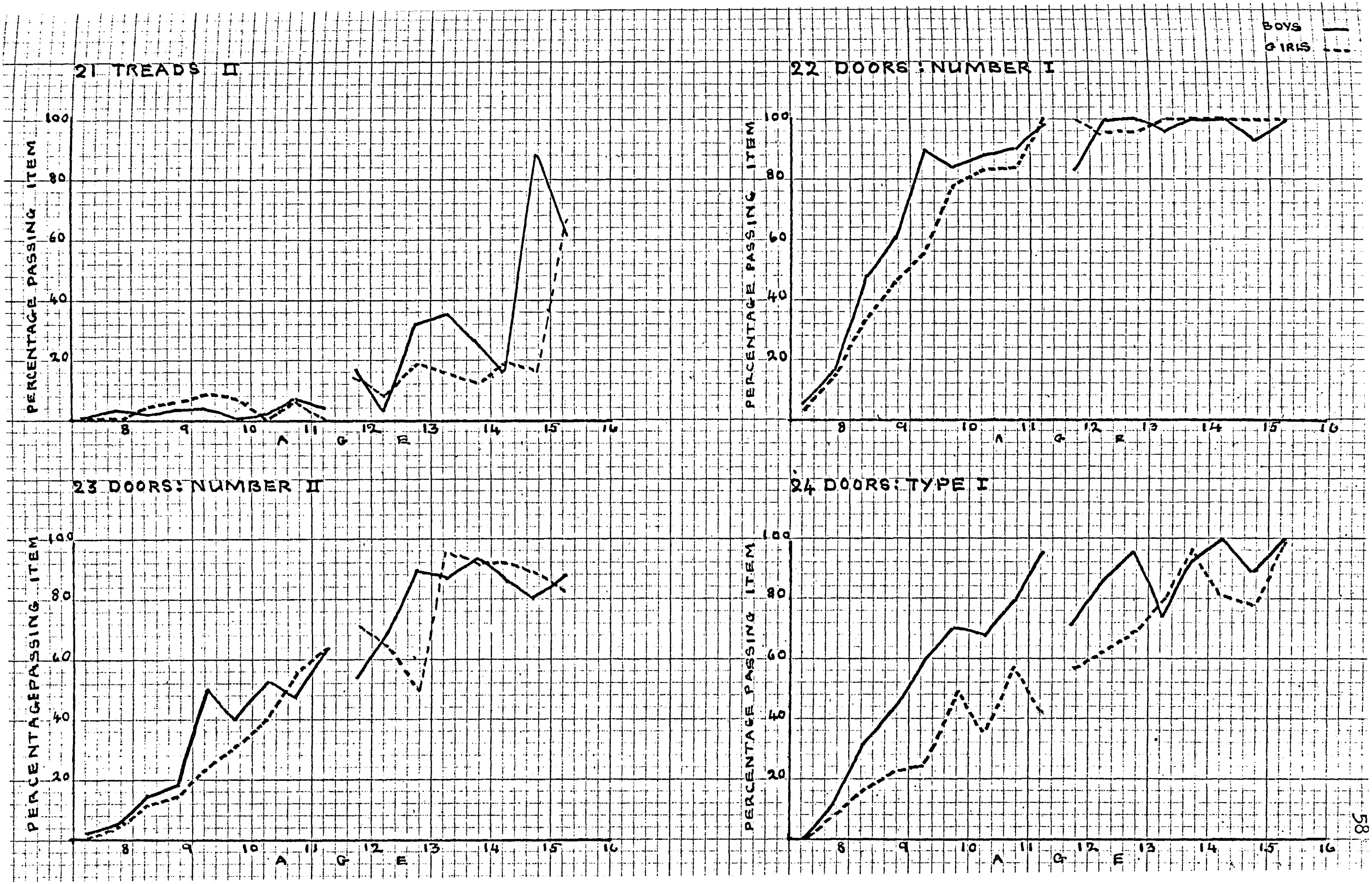

18 STAIRCASE II




19 STAIRCASE: PROPOPORTION

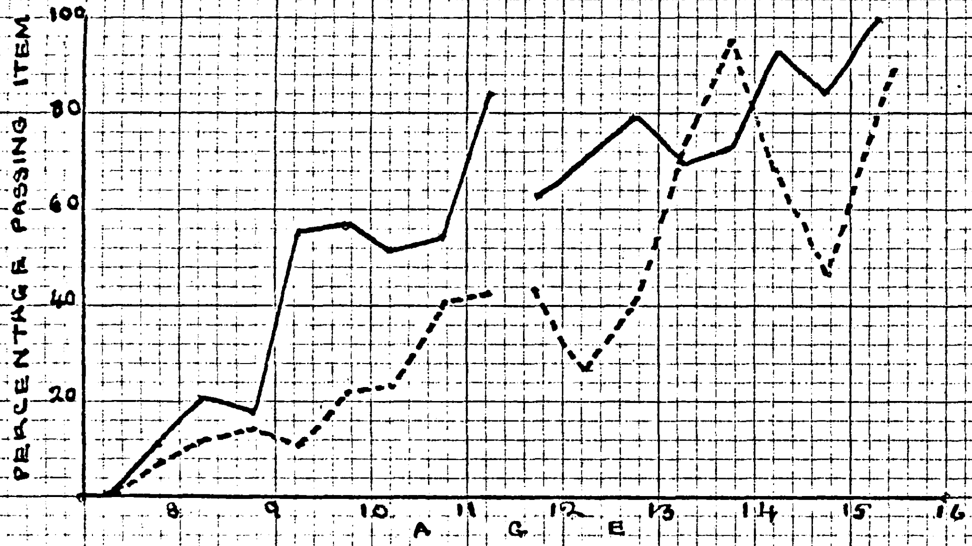



20 TREADS I

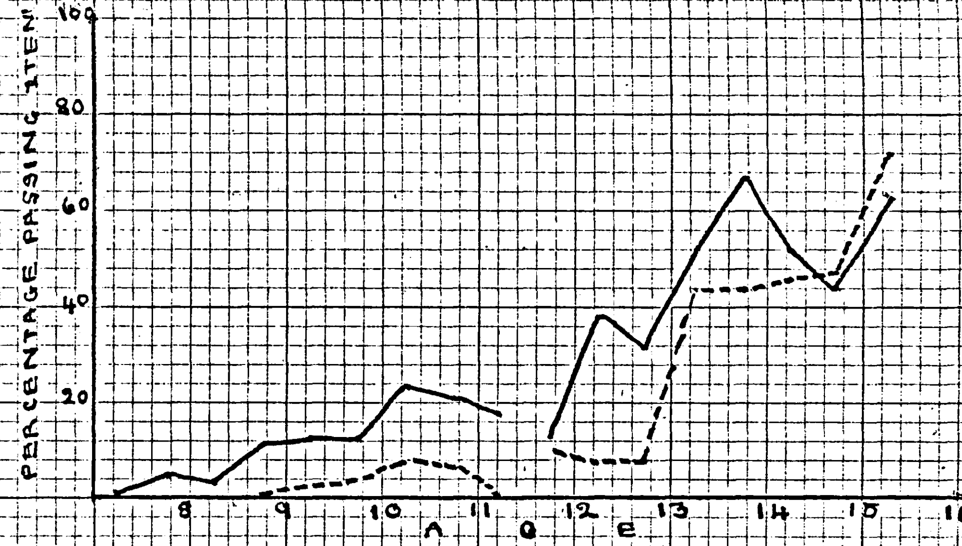

BOYS
GIRLS
21 TREADS II
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE
22 DOORS: NUMBER I
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE
23 DOORS: NUMBER II
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE
24 DOORS: TYPE I
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE

BOYS —— GIRLS - - -

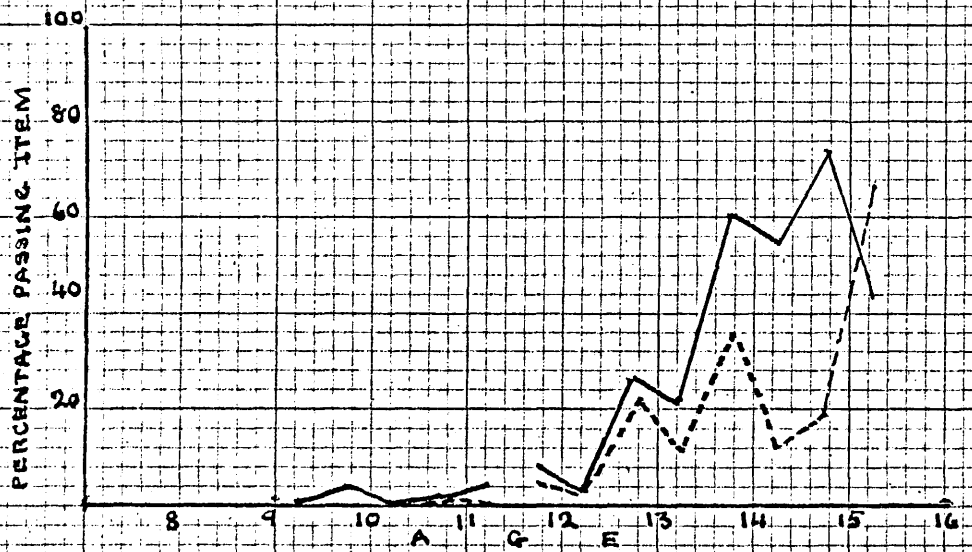
25 DOORS: TYPE II



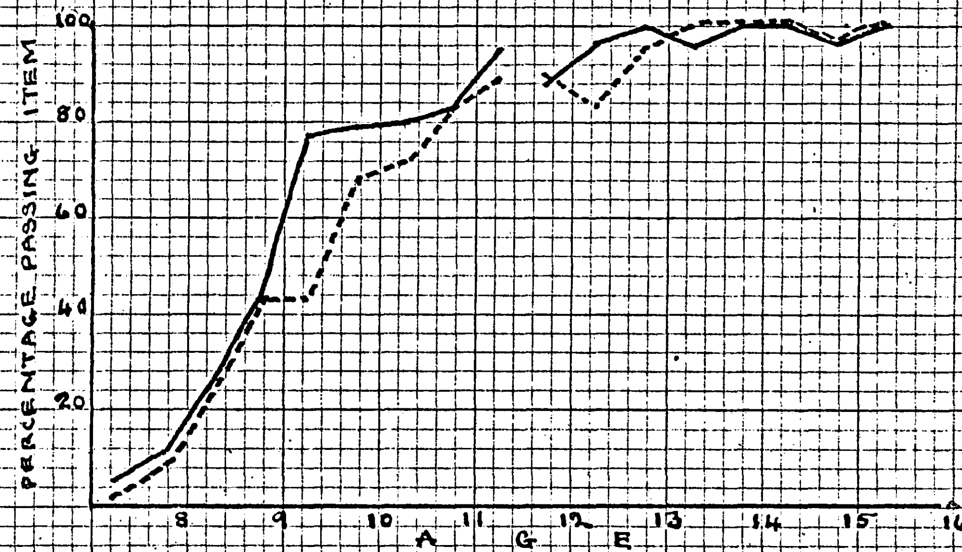

26 DOORS: TYPE III

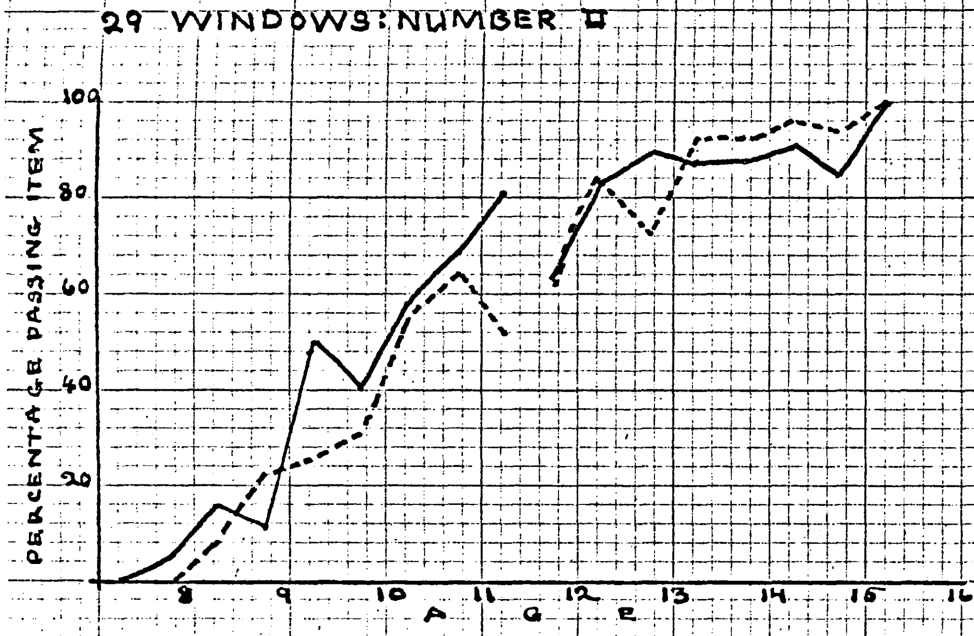


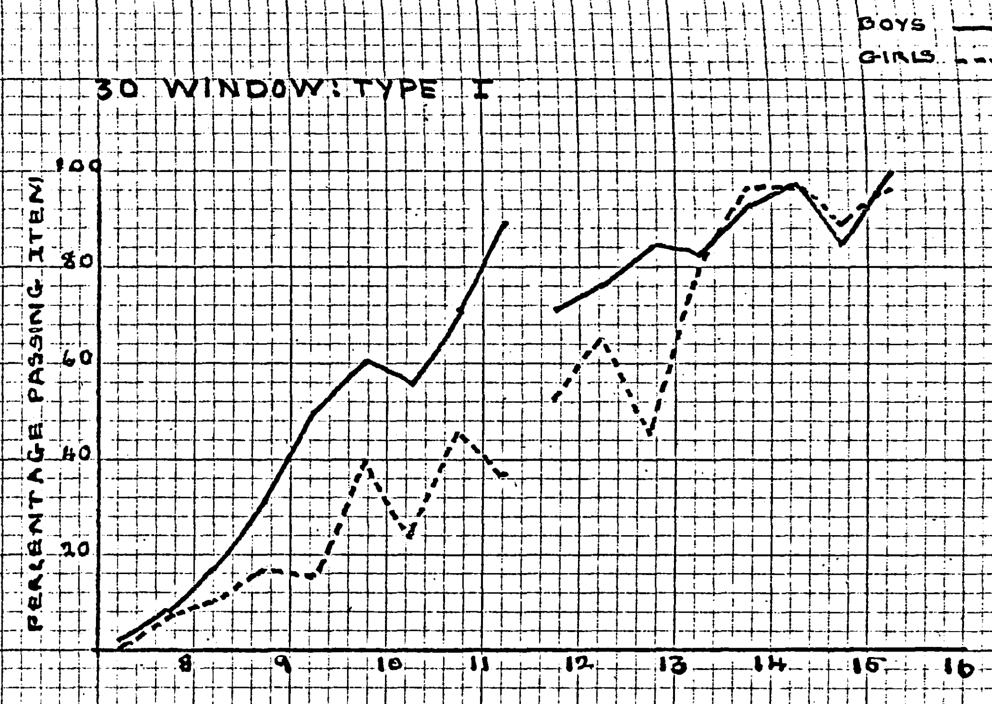

27 DOORS: PROPORTION

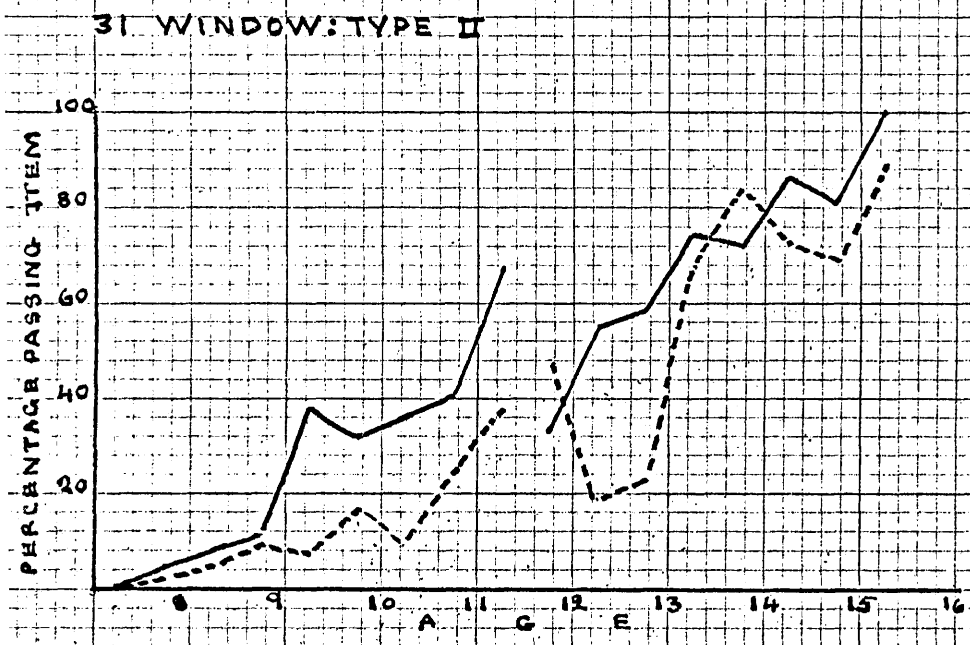


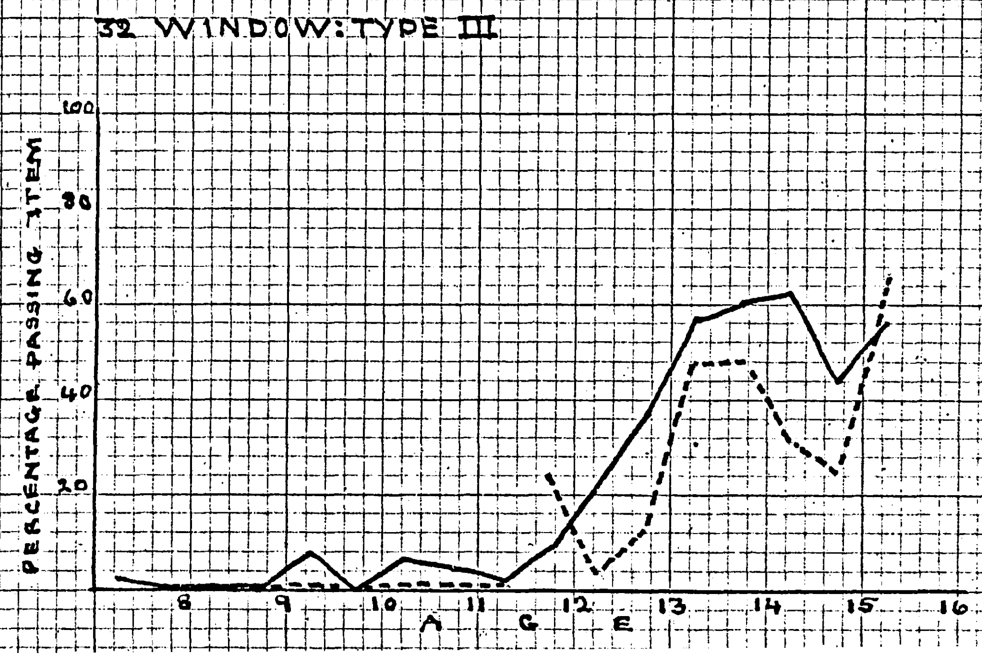

28 WINDOWS: NUMBER I

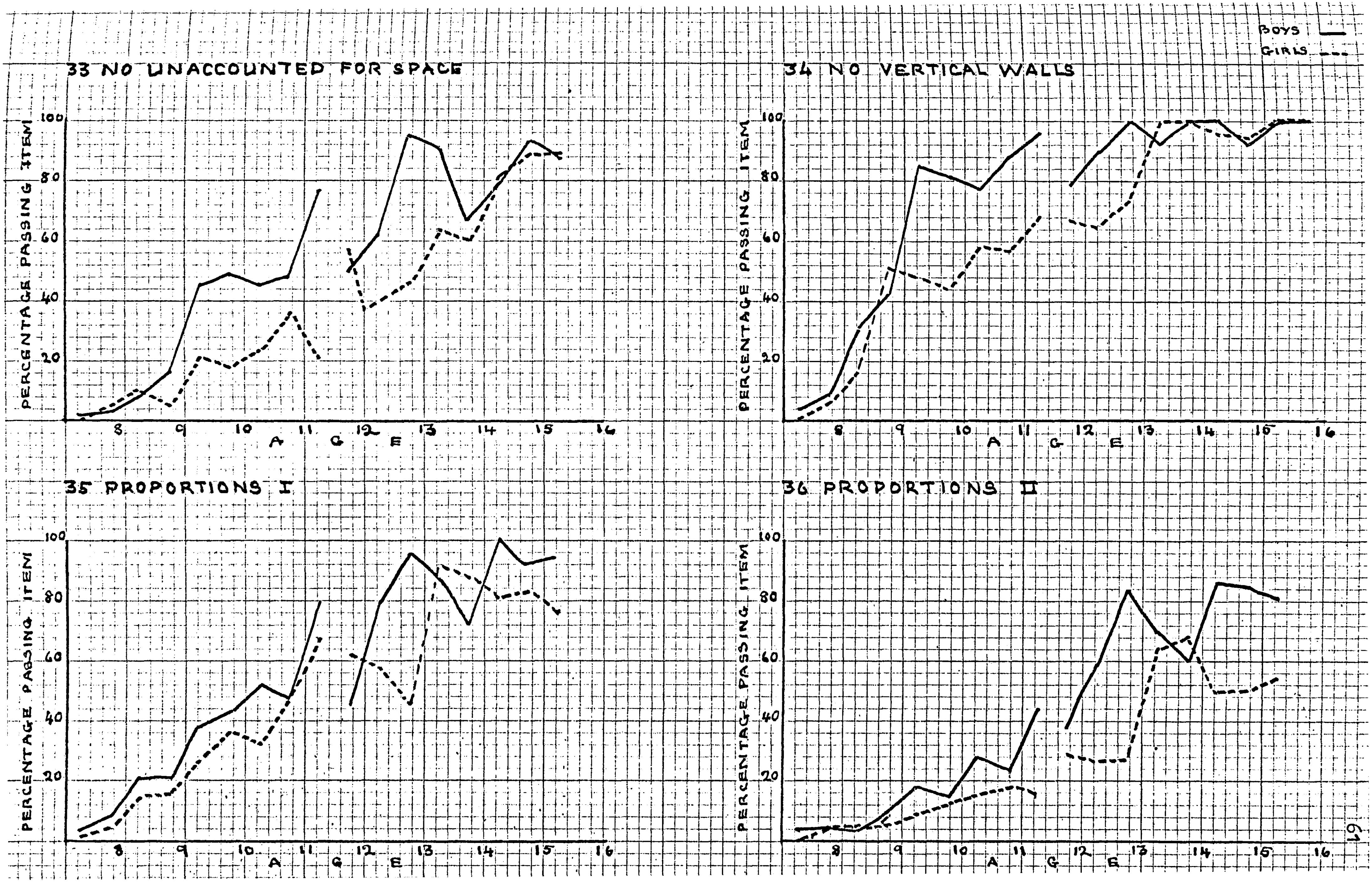



29 WINDOWS: NUMBER II
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE


BOYS
GIRLS
30 WINDOW: TYPE I
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16


31 WINDOW: TYPE II
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE


32 WINDOW: TYPE III
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE


BOYS
GIRLS
33 NO UNACCOUNTED FOR SPACE
34 NO VERTICAL WALLS
35 PROPORTIONS I
36 PROPORTIONS II
PERCENTAGE PASSING ITEM
100
80
60
40
20
8
9
10
11
12
13
14
15
16
AGE

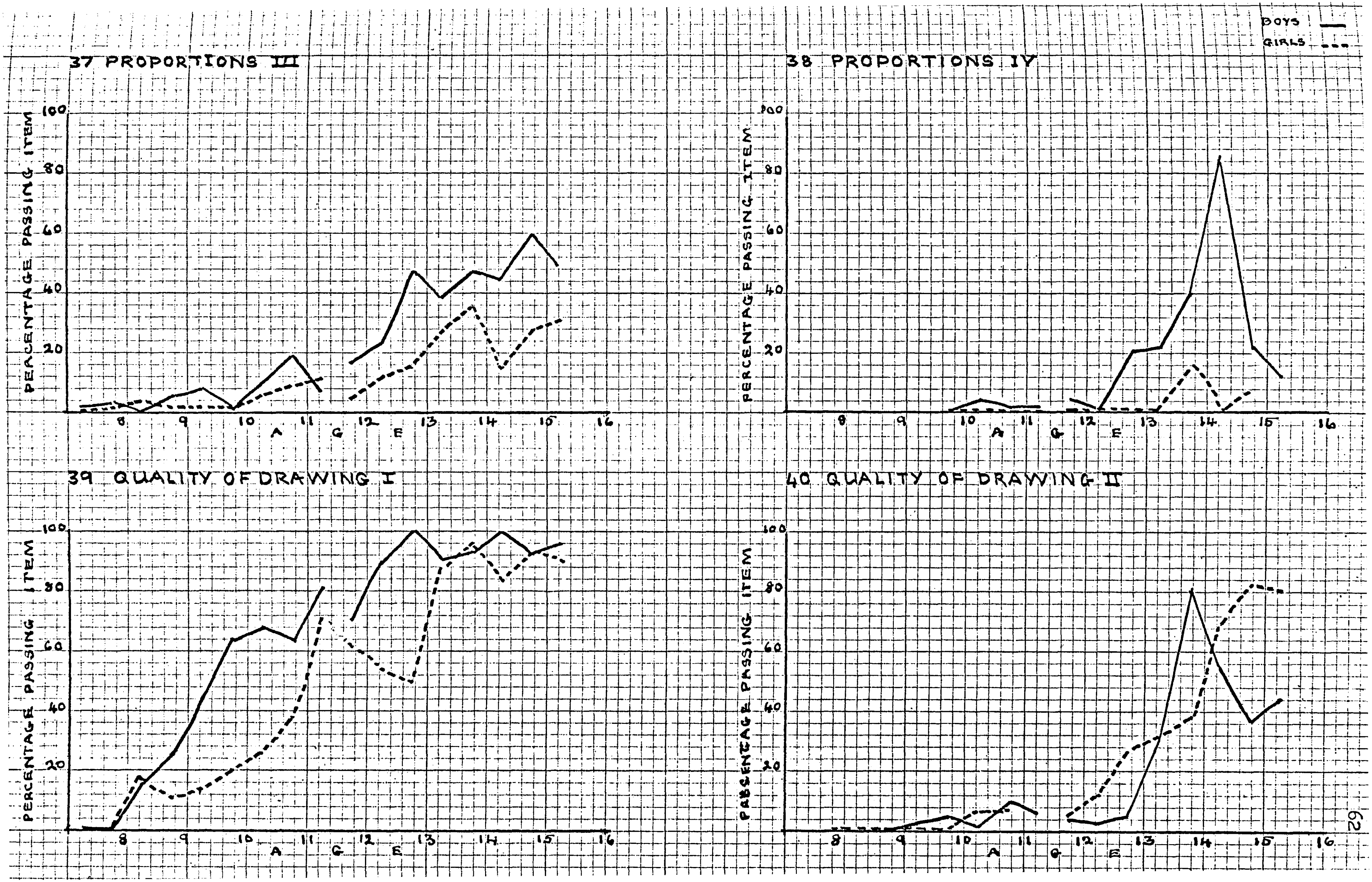

BOYS
GIRLS
37 PROPORTIONS III
38 PROPORTIONS IV
39 QUALITY OF DRAWING I
40 QUALITY OF DRAWING II
PERCENTAGE PASSING ITEM
AGE
100
80
60
40
20
8
9
10
11
12
13
14
15
16

TABLE 1.4.

FOURTH AND FINAL SCORING SYSTEM

PERCENTAGES OF BOYS AND GIRLS FROM GRAMMAR SCHOOLS PASSING ITEMS CORRECTLY AT SIX MONTHLY AGE LEVELS.

| AGES | 1. ROOF ABSENT | | 2. CHIMNEY ABSENT | | 3. UPSTAIRS ABSENT | | 4. PLANE OF OUTS. WALL AB. | |
|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G |
| 11-6 to 11-11 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 12-0 to 12-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 12-6 to 12-11 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 13-0 to 13-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

| | 6. DEPTH | | 7. HORIZ-ONTALITY | | 8. CONNECT-EDNESS | | 9. COMMON-ALITY | | 10. OUTER WALLS I | |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G | B | G |
| 11-6 to 11-11 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| 12-0 to 12-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 98 |
| 12-6 to 12-11 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 92 | 100 | 100 |
| 13-0 to 13-5 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

| | 11. OUTER WALL II | | 12. OUTER WALL III | | 13. HALL I | | 14. HALL II | | 15. HALL PROP. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G | B | G |
| 11-6 to 11-11 | 93 | 100 | 83 | 50 | 100 | 91 | 100 | 79 | 77 | 41 |
| 12-0 to 12-5 | 100 | 93 | 86 | 57 | 100 | 98 | 93 | 94 | 69 | 59 |
| 12-6 to 12-11 | 96 | 87 | 88 | 37 | 96 | 97 | 92 | 82 | 73 | 55 |
| 13-0 to 13-5 | 95 | 100 | 81 | 85 | 100 | 100 | 95 | 100 | 71 | 78 |

| | 16. HOR. STAIRS | | 17. STAIR CASE I | | 18. STAIR CASE II | | 19. STAIR CASE PROP. | | 20 TREADS I | |
|---|---|---|---|---|---|---|---|---|---|---|
| | B | G | B | G | B | G | B | G | B | G |
| 11-6 to 11-11 | 97 | 76 | 57 | 74 | 60 | 50 | 51 | 35 | 90 | 52 |
| 12-0 to 12-5 | 97 | 83 | 86 | 78 | 76 | 74 | 72 | 52 | 100 | 70 |
| 12-6 to 12-11 | 100 | 95 | 81 | 68 | 73 | 58 | 58 | 42 | 73 | 71 |
| 13-0 to 13-5 | 90 | 100 | 81 | 96 | 71 | 74 | 76 | 52 | 81 | 89 |

| | 21. TREADS II B | 21. TREADS II G | 22. DOORS NO. I B | 22. DOORS NO. I G | 23. DOORS NO. II B | 23. DOORS NO. II G | 24. DOORS TYPE I B | 24. DOORS TYPE I G | 25. DOORS TYPE II B | 25. DOORS TYPE II G |
|---|---|---|---|---|---|---|---|---|---|---|
| 11-6 to 11-11 | 67 | 29 | 100 | 100 | 93 | 97 | 93 | 91 | 93 | 82 |
| 12-0 to 12-5 | 66 | 15 | 100 | 100 | 100 | 89 | 97 | 93 | 97 | 85 |
| 12-6 to 12-11 | 23 | 24 | 100 | 100 | 96 | 84 | 100 | 97 | 96 | 82 |
| 13-0 to 13-5 | 48 | 63 | 100 | 100 | 100 | 93 | 100 | 96 | 100 | 96 |

| | 26. DOORS TYPE III B | 26. DOORS TYPE III G | 27. DOORS PROP. B | 27. DOORS PROP. G | 28. WINDOW NO. I B | 28. WINDOW NO. I G | 29. WINDOW NO. II B | 29. WINDOW NO. II G | 30. WINDOW TYPE I B | 30. WINDOW TYPE I G |
|---|---|---|---|---|---|---|---|---|---|---|
| 11-6 to 11-11 | 73 | 53 | 67 | 18 | 100 | 100 | 83 | 100 | 90 | 91 |
| 12-0 to 12-5 | 79 | 43 | 48 | 13 | 100 | 100 | 93 | 98 | 93 | 93 |
| 12-6 to 12-11 | 88 | 39 | 38 | 34 | 100 | 100 | 96 | 97 | 96 | 97 |
| 13-0 to 13-5 | 81 | 33 | 100 | 26 | 100 | 100 | 95 | 96 | 100 | 89 |

| | 31. WINDOW TYPE II B | 31. WINDOW TYPE II G | 32. WINDOW TYPE III B | 32. WINDOW TYPE III G | 33. NO UNACC. SPACE B | 33. NO UNACC. SPACE G | 34. NO VERT. WALLS B | 34. NO VERT. WALLS G | 35. PROP. I B | 35. PROP. I G |
|---|---|---|---|---|---|---|---|---|---|---|
| 11-6 to 11-11 | 87 | 76 | 40 | 12 | 90 | 85 | 97 | 91 | 90 | 71 |
| 12-0 to 12-5 | 86 | 85 | 38 | 80 | 93 | 87 | 100 | 93 | 100 | 74 |
| 12-6 to 12-11 | 92 | 82 | 23 | 40 | 92 | 79 | 96 | 97 | 92 | 79 |
| 13-0 to 13-5 | 90 | 93 | 62 | 41 | 81 | 93 | 100 | 100 | 95 | 100 |

| | 36. PROP. II B | 36. PROP. II G | 37. PROP. III B | 37. PROP. III G | 38. PROP. IV B | 38. PROP. IV G | 39. LINE QUAL. I B | 39. LINE QUAL. I G | 40. LINE QUAL. II B | 40. LINE QUAL. II G |
|---|---|---|---|---|---|---|---|---|---|---|
| 11-6 to 11-11 | 83 | 57 | 53 | 24 | 13 | 3 | 93 | 88 | 27 | 79 |
| 12-0 to 12-5 | 83 | 48 | 69 | 24 | 34 | 4 | 100 | 93 | 31 | 70 |
| 12-6 to 12-11 | 84 | 45 | 50 | 29 | 27 | 8 | 83 | 92 | 23 | 29 |
| 13-0 to 13-5 | 90 | 63 | 62 | 30 | 33 | 11 | 100 | 100 | 38 | 56 |

TABLE 1.5

FOURTH AND FINAL SCORING SYSTEM

VALIDITY AND DIFFICULTY OF ITEMS FOR A SAMPLE OF 99 GIRLS AGED FROM 10 yrs. to 10 yrs. 11 mths.

| ITEM | U Upper third | M Middle third | L Lower third | DIFFICULTY $100 - \frac{U+M+L}{3}$ | VALIDITY U - L |
|---|---|---|---|---|---|
| 1 | 100 | 100 | 94 | 2 | 6 |
| 2 | 100 | 100 | 94 | 2 | 6 |
| 3 | 100 | 100 | 91 | 3 | 9 |
| 4 | 100 | 100 | 100 | 0 | 0 |
| 5 | 100 | 100 | 94 | 2 | 6 |
| 6 | 100 | 100 | 100 | 0 | 0 |
| 7 | 100 | 100 | 70 | 10 | 30 |
| 8 | 100 | 100 | 52 | 16 | 48 |
| 9 | 100 | 88 | 21 | 30 | 79 |
| 10 | 100 | 94 | 18 | 29 | 82 |
| 11 | 91 | 39 | 0 | 57 | 91 |
| 12 | 67 | 11 | 0 | 77 | 67 |
| 13 | 100 | 82 | 12 | 35 | 88 |
| 14 | 88 | 12 | 0 | 77 | 88 |
| 15 | 36 | 0 | 0 | 88 | 36 |
| 16 | 100 | 24 | 24 | 51 | 76 |
| 17 | 82 | 12 | 0 | 69 | 82 |
| 18 | 61 | 0 | 0 | 80 | 61 |
| 19 | 48 | 0 | 0 | 84 | 48 |
| 20 | 58 | 12 | 15 | 72 | 43 |
| 21 | 15 | 0 | 0 | 95 | 15 |
| 22 | 100 | 100 | 48 | 17 | 52 |
| 23 | 73 | 45 | 6 | 59 | 67 |
| 24 | 58 | 30 | 3 | 70 | 55 |
| 25 | 12 | 9 | 3 | 92 | 9 |
| 26 | 15 | 0 | 0 | 95 | 5 |
| 27 | 6 | 0 | 0 | 98 | 6 |
| 28 | 100 | 100 | 36 | 21 | 64 |
| 29 | 94 | 67 | 6 | 54 | 88 |
| 30 | 33 | 6 | 0 | 87 | 33 |
| 31 | 6 | 0 | 0 | 98 | 6 |
| 32 | 0 | 0 | 0 | 0 | 0 |
| 33 | 79 | 9 | 0 | 71 | 79 |
| 34 | 100 | 52 | 18 | 44 | 82 |
| 35 | 85 | 27 | 0 | 66 | 85 |
| 36 | 48 | 0 | 0 | 84 | 48 |
| 37 | 21 | 0 | 0 | 93 | 21 |
| 38 | 18 | 0 | 0 | 94 | 18 |
| 39 | 79 | 36 | 0 | 62 | 43 |
| 40 | 9 | 0 | 0 | 99 | 3 |

# CHAPTER II

## STANDARDIZATION

### A CHARACTERISTICS OF THE SAMPLE

#### INTRODUCTION

Cognitive tests for children are constructed to help in the diagnosis of some psychopathology and/or educational or vocational guidance. From the initial work with the Plan test it seemed that it might be useful in one or more of these capacities, but that before it could be used it would need to be standardized.

In the case of adult tests, it is possible to select simple discrete tasks, which all neurologically intact adults of normal intelligence can do and raw scores alone will distinguish between normal and pathological groups, such as Pascal's and Suttell's (1951) scoring of the BG test. In children, however, the effects of age and intelligence are seen in any skill, which is in the process of being developed and this limits the use of raw scores in research groups, where these factors can be controlled experimentally or can be taken into account statistically.

Once a test has been standardized, it has the additional advantage that it can reveal differences between normal and clinical samples based on quantitve scores showing degree of maturity, as well as distinctive qualitative signs. The latter being the chief source of scores in the adult population. The average DAM score for instance in the child guidance clinic population is lower than for the normal population because the drawings are more immature (Hanvik, 1953; Lehman and Levy, 1971). The normal and cerebral palsied population, however, can be distinguished by qualitative signs that are not found in normal development. Thus a standardized test produces an additional tool to the research worker in differentiating samples as well as making the clinical diagnosis more reliable.

In addition, knowledge of developmentally based tests also affects the theoretical interpretations for many signs of neurological dysfunction in an older age group are typical of a younger age group and therefore a hypothesis of delayed maturation has to be considered, as well as cerebral trauma. This is most clearly seen in the Koppitz (1963) scoring of the BG test, where qualitative signs are interpreted differently according to the child's age.

Then, as well as producing a quantitative measurement for research worker and clinician, a standardized test based on developmental phenomena is also of interest to the educationalist. The usual group verbal or non-verbal test incorporates a small range of types of items based on analogy and sequence whose effectiveness depends upon their increasing complexity. Tests based on developmental phenomena reveal instead the stage of reasoning that a child is at and this can form the basis for teaching. Taking a simple illustration in the visuo-motor sphere, it is useless to try and teach a three year old child to draw a diamond for it is not until a year later that the average child can cope with angles in a square or triangle and not until the age of seven years that he can copy a diamond, according to the SB (1961).

Acknowledging then the need to standardize on a normal population any clinical test to be used on children, the next question concerns the selection of the standardization sample. Just as ultimately the validity of a test is a function of the item selection, so the reliability of the test, in the sense of its transferability, is a function of the sample selected for standardization

Ideally the standardization sample of a clinic test should come from the same area where the test is going to be used. This would ensure that the range of ability, as a product of innate capacity and environmental opportunity, Hebb's Intelligence B (1949), would be the same, so that any discrepancy between the clinic and normal sample may be attributed to psychopathology.

However, the standardization of all tests on the population in which they are going to be used is not feasible and they are frequently used on those differing from the original sample. Just how great this difference can be is in itself a subject of investigation, the largest, most recent study being Vernon's Intelligence and Cultural Environment (1969).

Unfortunately the standardization of tests is not determined solely by the rationale of test construction, but by circumstances such as the type of test, ease of administration and scoring, and the financial support that can be obtained, which in turn determines the number of research workers and the geographical area that can be covered.

Group tests of ability and attainments, which are quick to administer and score have usually been standardized on large numbers often over a restricted age range and geographical area, both in Britain and America. Most of the National Foundation of Educational Research (NFER) tests are standardized on 2 to 4,000 children for each year covered, which enables a graduated monthly allowance to be calculated. However, the area from which the sample is drawn is usually limited to one or two towns and therefore the score is not really applicable to other areas of the country, particularly when the population is markedly different, either due to environmental or other reasons. Where an exact score is needed, such as when selecting for secondary education, the test is restandardized on the local population.

Widely used individual clinical tests on the other hand, such as the Wechsler Intelligence Scale for Children (WISC) or the SB have been standardized on only 200 children per age group, but the sampling has been more carefully done both socially and geographically in order to provide national norms. The smaller numbers used for each year and the smaller number of optimally difficult items at the bottom and top of the scale, precludes the calculation of such accurate age allowances, as with the group tests. Such tests always present problems when they are used outside the original sampling area, even if the items are still valid because of the similarity in culture, the standard scores may be inaccurate. However, as these tests are used frequently, some countries restandardize them, such as the Scottish Standardization of the WISC in 1965 or at least have some information about how the standard scores are likely to vary because the tests have been used in extensive studies. In England, for instance, in urban samples, the mean raw scores are known to be higher in both the WISC and SB. (Jones, 1962) which is in the same direction as the original U.S. urban sample population (Seashore, Wesman and Doppelt, 1950). Such knowledge enables allowances to be made in interpretations.

In a rather different class are the more specialized tests often standardized in America on smaller, less carefully selected populations, like those testing language or visuo-motor abilities. These by reason of the limitations of their original samples may be expected to have poor transfer reliability when used in this country, but the results so far are encouraging. The experimental version of the Illinois Test of Psychologuistic Abilities (ITPA) (McCarthy and Kirk, 1963) was only standardized on 25 boys and 25 girls at six monthly intervals in one town in Illinois, yet when 100 nursery school children aged 4 yrs in Reading were given the same test, their scores corresponded closely to the American sample (Mittler and Ward, 1970).

Similar useful results were obtained for the BG test when Keogh (1968) used the Koppitz scoring to assess copies of the BG designs done by Birmingham children. Koppitz had standardized her scores on 1104 children aged 5-0 and 10-11 yrs in 12 schools in the Midwest and Eastern States and when Keogh used the same items, she obtained "results generally consistent with American norms", although the means were all slightly higher and the test did not discriminate between 8 and 9 year olds. This difference may have been due to the group presentation accentuating some types of errors. Butterfield (1970) too found that 29 London children with a mean age of 10 yrs 11 mths also made the same number of errors as in the Koppitz sample (Table 13.4).

Studies of the DAM have usually been more concerned with the scorer reliability and concurrent validity than with transferability and the mean scores obtained for the different age groups are not given. One London study that does give the means found that in testing 506 children aged from 7 to 11 years, the means were generally higher than the American norms. (Sinha, 1970). The author, however, in 1965 when testing 659 Buckinghamshire children from 8 yrs to 11 yrs 11 mths found the means and standard deviation practically the same as the American sample and Butterfield (1970) in the study cited earlier also had similar results. (Table 13.4).

The results on the ITPA, BG and DAM suggest that tests can be used within a Western Europe type of culture without a severe loss in reliability. This is encouraging since the Plan falls into the same type of group.

The Plan, however, may seem to suffer from one source of unreliability, which is not present in other tests and that is of the variation in the layout of houses themselves, while in all other tests the task itself is the same. However, if the socring items are studied carefully, it can be seen that they are not measuring a child's ability to draw a plan of his own particular house, but a house in general. To this extent it resembles the DAM which is measuring the maturity of a child's conception of a human figure, through his capacity to portray one figure in particular.

On the other hand, all types of living accommodation do not present the same opportunities of learning, nor have all the same scorable items. Children living in bungalows and flats do not have the same opportunity to study stairs, nor can they put them in their plans and hence cannot be scored. Also children living in flats or part of houses do not have the same opportunity of learning the relationship between the outer and inner appearance of the outside wall in the same way as children who live in houses and can walk round them. For these reasons it is necessary that only children living in houses should be used in this standardization and plans of children living in flats and bungalows should be standardized separately.

SAMPLE

The same criteria was used for the selection of this sample as for that of the item selection sample: namely, that the housing should be as uniform and typical of the country as a whole and that the children should be as representative as possible of the area, both socially and intellectually.

Two towns and one urban district were chosen in Buckinghamshire; High Wycombe, Chesham and Amersham. Advice was taken from the education officers regarding distribution of social class and intelligence and as a result, 10 schools were chosen. one infants, four primary three secondary and two grammar schools

High Wycombe; and Raans Secondary School, Dr. Challoner's High School for Girls and Dr. Challoner's Grammar School for Boys in Amersham.

There was a full range of intelligence quotients in children in the primary schools, but in the secondary modern schools, children with IQ's below 75 had usually been placed in an ESN school and children with IQ's above 115 had been placed in grammar schools. This would have produced slightly skewed distribution of intelligence in the schools for children over 11 years.

All the children's plans were included in the final results, except those from foreign children and those who were absent on the day of testing. There were very few absent, so further visits were not arranged.

METHOD

Conditions, materials and procedure were as for the Item Selection (Chapter I).

RESULTS

The item selection had already suggested that boys were ahead of girls and that their total scores were likely to be higher. Mean scores were therefore found for each yearly age group, boys and girls separately. All were significantly different statistically except the primary 7 year olds and grammar 13 year olds (Table 2.1). These results showed that the boys' and girls' scores should be scaled separately, not amalgamated as originally intended.

As separate scales had to be constructed for boys and girls, the original intention of scaling at six monthly intervals had to be abandoned for there would have been less than 50 protocols for each interval. Instead, yearly intervals were decided upon. Often for such scales, children were selected whose birthdays come within two months either side of the required age, but this would again have reduced the numbers. Instead, it was decided to look at the average age of each year group and, if they were near the mid point of 5.5 months, to use all the protocols. Table 2.2 indicates that the average age was near the mid point and so all the protocols were used.
Only the means of the primary 11 year olds and grammar 13 year olds were low, because some 11 year olds were already in the secondary or grammar school and some grammar 13 year olds were working in with the 14 year olds, which were not tested.

TABLE 2.1

SEX DIFFERENCE IN MEANS OF RAW SCORES

| AGE | BOYS | | | GIRLS | | | t | P |
|---|---|---|---|---|---|---|---|---|
| PRIMARY | N | X | B.D. | N | X | S.D. | | |
| 7-0 to 7-11 | 86 | 5.22 | 6.64 | 114 | 4.79 | 4.24 | .599 | NS |
| 8-0 to 8-11 | 110 | 13.34 | 8.59 | 116 | 10.85 | 7.37 | 2.345 | .02 |
| 9-0 to 9-11 | 87 | 21.48 | 8.46 | 101 | 15.10 | 8.50 | 8.923 | .001 |
| 10-0 to 10-11 | 92 | 22.95 | 8.37 | 96 | 18.19 | 8.15 | 3.953 | .001 |
| 11-0 to 11-11 | 87 | 27.17 | 5.26 | 62 | 22.19 | 6.85 | 4.806 | .001 |
| SECONDARY | | | | | | | | |
| 12-0 to 12-11 | 85 | 28.21 | 6.61 | 130 | 23.71 | 7.19 | 4.716 | .001 |
| 13-0 to 13-11 | 105 | 29.78 | 7.77 | 114 | 27.92 | 7.45 | 1.553 | .2 |
| 14-0 to 14-11 | 118 | 31.48 | 6.84 | 118 | 28.56 | 5.95 | 3.467 | .001 |
| GRAMMAR | | | | | | | | |
| 11-0 to 11-11 | 44 | 32.29 | 5.37 | 39 | 29.46 | 5.68 | 1.635 | .1 |
| 12-0 to 12-11 | 55 | 33.21 | 5.24 | 84 | 30.30 | 5.50 | 3.142 | .001 |
| 13-0 to 13-11 | 21 | 34.86 | 4.91 | 30 | 33.10 | 4.25 | 1.331 | .2 |

TABLE 2.2

DISTRIBUTION OF AGES IN MONTHS

BOYS

| Months | PRIMARY 7y. | 8y. | 9y. | 10y. | SECONDARY 11y. | 12y. | 13y. | 14y. |
|---|---|---|---|---|---|---|---|---|
| 11 | 9 | 8 | 5 | 9 | 0 | 1 | 4 | 3 |
| 10 | 6 | 7 | 8 | 6 | 1 | 6 | 11 | 9 |
| 9 | 4 | 14 | 8 | 11 | 1 | 7 | 9 | 14 |
| 8 | 6 | 11 | 6 | 3 | 3 | 3 | 10 | 4 |
| 7 | 6 | 12 | 7 | 5 | 5 | 11 | 12 | 11 |
| 6 | 6 | 10 | 13 | 8 | 1 | 9 | 7 | 9 |
| 5 | 3 | 14 | 8 | 5 | 13 | 8 | 6 | 11 |
| 4 | 7 | 11 | 4 | 7 | 11 | 8 | 12 | 9 |
| 3 | 14 | 7 | 6 | 8 | 15 | 8 | 8 | 14 |
| 2 | 9 | 5 | 5 | 9 | 15 | 7 | 14 | 12 |
| 1 | 8 | 6 | 9 | 13 | 9 | 6 | 6 | 5 |
| 0 | 8 | 5 | 8 | 8 | 13 | 11 | 6 | 17 |
| No. | 86 | 110 | 87 | 92 | 87 | 85 | 105 | 118 |
| MEAN | 5.0 | 6.1 | 5.5 | 5.0 | 3.2 | 4.8 | 5.5 | 4.9 |
| MEDIAN | 4.1 | 6.2 | 5.7 | 4.7 | 3.0 | 4.9 | 5.6 | 4.6 |

| Months | GRAMMAR 11y. | 12y. | 13y. | PRI.SEC. GRAM. 11y. | SEC. GRAM. 12y. | SEC. GRAM. 13y. |
|---|---|---|---|---|---|---|
| 11 | 4 | 4 | 0 | 11 | 3 | 4 |
| 10 | 2 | 11 | 0 | 7 | 12 | 11 |
| 9 | 2 | 4 | 0 | 6 | 9 | 9 |
| 8 | 7 | 2 | 0 | 11 | 4 | 10 |
| 7 | 7 | 3 | 0 | 9 | 12 | 12 |
| 6 | 8 | 2 | 1 | 8 | 10 | 8 |
| 5 | 3 | 4 | 4 | 13 | 10 | 13 |
| 4 | 4 | 4 | 1 | 12 | 10 | 14 |
| 3 | 3 | 4 | 7 | 15 | 10 | 20 |
| 2 | 2 | 3 | 2 | 15 | 8 | 17 |
| 1 | 0 | 7 | 2 | 9 | 9 | 10 |
| 0 | 2 | 7 | 4 | 14 | 15 | 12 |
| No. | 44 | 55 | 21 | 130 | 113 | 140 |
| MEAN | 6.3 | 5.5 | 2.7 | 4.9 | 4.9 | 4.8 |
| MEDIAN | 6.5 | 5.2 | 2.9 | 4.5 | 5.1 | 5.3 |

TABLE 2.2

DISTRIBUTION OF AGES IN MONTHS

GIRLS

| | PRIMARY | | | | SECONDARY | | | |
|---|---|---|---|---|---|---|---|---|
| Months | 7y. | 8y. | 9y. | 10y. | 11y. | 12y. | 13y. | 14y. |
| 11 | 8 | 14 | 11 | 12 | 9 | 9 | 10 | 5 |
| 10 | 9 | 9 | 8 | 7 | 9 | 7 | 7 | 10 |
| 9 | 8 | 9 | 5 | 9 | 6 | 6 | 7 | 16 |
| 8 | 11 | 11 | 9 | 6 | 6 | 12 | 9 | 6 |
| 7 | 4 | 10 | 7 | 4 | 7 | 7 | 9 | 10 |
| 6 | 8 | 12 | 5 | 5 | 3 | 15 | 11 | 8 |
| 5 | 10 | 8 | 10 | 3 | 4 | 9 | 18 | 13 |
| 4 | 8 | 9 | 8 | 11 | 7 | 9 | 8 | 13 |
| 3 | 13 | 5 | 8 | 12 | 7 | 17 | 9 | 9 |
| 2 | 14 | 11 | 12 | 11 | 6 | 9 | 10 | 10 |
| 1 | 7 | 7 | 8 | 9 | 6 | 12 | 5 | 8 |
| 0 | 14 | 11 | 10 | 7 | 6 | 17 | 11 | 10 |
| No. | 114 | 116 | 101 | 96 | 62 | 130 | 114 | 118 |
| MEAN | 5.0 | 5.8 | 5.4 | 5.4 | 4.8 | 4.8 | 5.4 | 5.4 |
| MEDIAN | 4.6 | 5.1 | 5.0 | 5.3 | 4.8 | 4.6 | 5.3 | 5.2 |

| | GRAMMAR | | | PRI.SEC. GRAM. | SEC. GRAM. | SEC. GRAM. |
|---|---|---|---|---|---|---|
| Months | 11y. | 12y. | 13y. | 11y. | 12y. | 13y. |
| 11 | 5 | 5 | 0 | 5 | 11 | 10 |
| 10 | 9 | 6 | 0 | 5 | 10 | 7 |
| 9 | 7 | 4 | 0 | 11 | 7 | 7 |
| 8 | 4 | 7 | 0 | 11 | 17 | 9 |
| 7 | 4 | 12 | 0 | 10 | 13 | 9 |
| 6 | 3 | 4 | 1 | 15 | 17 | 12 |
| 5 | 5 | 12 | 2 | 3 | 15 | 20 |
| 4 | 0 | 5 | 11 | 4 | 12 | 23 |
| 3 | 2 | 7 | 3 | 7 | 21 | 13 |
| 2 | 0 | 8 | 5 | 7 | 14 | 17 |
| 1 | 0 | 7 | 5 | 6 | 13 | 10 |
| 0 | 0 | 7 | 3 | 6 | 23 | 15 |
| No. | 39 | 84 | 30 | 90 | 173 | 152 |
| MEAN | 8.0 | 5.2 | 2.8 | 5.8 | 4.7 | 4.8 |
| MEDIAN | 7.8 | 5.2 | 5.2 | 5.3 | 4.0 | 4.4 |

As it was desirable for a child's score to be assessed against the whole ability range of his age group only the age groups from 7 to 10 years in the primary school were satisfactory in this respect. Eleven year olds were found in three types of school and 12 and 13 year olds were found in secondary and grammar schools. It was therefore considered necessary to amalgamate in such proportions as would still be representative of a normal range of intelligence.

Thus the total number of 11 year old children found in primary and secondary schools were added together and one third of that number was also taken from the grammar school because 25% of the children were selected by taking every third one.

In the 12 year old group one half of the grammar school children were needed and in the 13 year old group 5/3 of the boys and 4/3 of the girls were needed. A greater proportion of grammar school 13 year olds were required because the actual numbers were low for there were probably some 13 year olds among the 14 year old age group which was not tested. Random selection of every other child for the 12 year group proved unsatisfactory for that group* and was impossible for the 13 year olds, so that appropriate proportions of cases in each score interval were added to those in the secondary schools in order to maintain the same distribution.

The numbers were increased as in Table 2.3.

TABLE 2.3

NUMBER OF CHILDREN AMALGAMATED

| | 11 yrs. | | 12 yrs. | | 13 yrs. | |
|---|---|---|---|---|---|---|
| | B | G | B | G | B | G |
| Primary | 87 | 62 | - | - | - | - |
| Secondary | 32 | 21 | 85 | 130 | 105 | 114 |
| Grammar | 11 | 7 | 27 | 43 | 35 | 38 |
| TOTAL | 130 | 90 | 112 | 173 | 140 | 152 |

The amalgamated score distribution can be seen in Table 2.4.

*because it altered the distribution of the scores

TABLE 2.4

DISTRIBUTION OF RAW SCORES

BOYS

| Scores | PRIMARY 7y. | 8y. | 9y. | 10y. | 11y. | SECONDARY 12y. | 13y. | 14y. |
|---|---|---|---|---|---|---|---|---|
| 39-40 | 0 | 0 | 0 | 0 | 1 | 0 | 11 | 8 |
| 36-38 | 1 | 0 | 0 | 4 | 4 | 5 | 11 | 28 |
| 33-35 | 0 | 0 | 3 | 7 | 5 | 18 | 24 | 26 |
| 30-32 | 0 | 3 | 13 | 12 | 20 | 20 | 17 | 25 |
| 27-29 | 2 | 8 | 13 | 11 | 24 | 19 | 15 | 16 |
| 24-26 | 1 | 8 | 11 | 14 | 11 | 7 | 9 | 7 |
| 21-23 | 1 | 6 | 16 | 12 | 11 | 7 | 6 | 1 |
| 18-20 | 1 | 13 | 8 | 9 | 7 | 3 | 6 | 3 |
| 15-17 | 1 | 8 | 6 | 7 | 4 | 1 | 1 | 0 |
| 12-14 | 1 | 12 | 3 | 7 | 0 | 2 | 1 | 0 |
| 9-11 | 1 | 3 | 3 | 1 | 0 | 1 | 0 | 0 |
| 6- 8 | 14 | 27 | 5 | 5 | 0 | 1 | 2 | 2 |
| 3- 5 | 30 | 16 | 5 | 3 | 0 | 1 | 2 | 2 |
| 0- 2 | 33 | 6 | 1 | 0 | 0 | 0 | 0 | 0 |
| | 86 | 110 | 87 | 92 | 87 | 85 | 105 | 118 |
| MEAN | 5.22 | 13.35 | 21.48 | 22.95 | 27.17 | 28.21 | 29.78 | 31.48 |
| S D | 6.64 | 8.59 | 8.46 | 8.37 | 5.26 | 6.61 | 7.77 | 6.84 |
| MEDIAN | 3.5 | 12.2 | 22.8 | 23.9 | 27.8 | 29.6 | 31.5 | 32.8 |

| Scores | GRAMMAR 11y. | 12y. | 13y. | PRI.SEC. GRAM. 11y. | SEC+ GRAM. 12y. | SEC+ GRAM. 13y. |
|---|---|---|---|---|---|---|
| 39-40 | 2 | 9 | 5 | 2 | 5 | 21 |
| 36-38 | 10 | 14 | 7 | 8 | 12 | 21 |
| 33-35 | 13 | 11 | 4 | 12 | 23 | 29 |
| 30-32 | 11 | 17 | 2 | 29 | 29 | 22 |
| 27-29 | 4 | 2 | 1 | 28 | 20 | 17 |
| 24-26 | 1 | 1 | 1 | 13 | 7 | 11 |
| 21-23 | 1 | 1 | 1 | 16 | 7 | 7 |
| 18-20 | 0 | 0 | 0 | 11 | 3 | 6 |
| 15-17 | 1 | 0 | 0 | 7 | 1 | 1 |
| 12-14 | 1 | 0 | 0 | 0 | 2 | 1 |
| 9-11 | 0 | 0 | 0 | 1 | 1 | 0 |
| 6- 8 | 0 | 0 | 0 | 2 | 1 | 2 |
| 3- 5 | 0 | 0 | 0 | 1 | 1 | 2 |
| 0- 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 44 | 55 | 21 | 130 | 112 | 140 |
| MEAN | 32.29 | 33.21 | 34.86 | 29.63 | 29.68 | 31.13 |
| S D | 5.37 | 5.24 | 4.91 | 7.59 | 5.11 | 8.01 |
| MEDIAN | 33.2 | 34.3 | 36.1 | 28.0 | 30.8 | 32.6 |

TABLE 2.4

DISTRIBUTION OF RAW SCORES

GIRLS

| | PRIMARY | | | | SECONDARY | | | |
|---|---|---|---|---|---|---|---|---|
| Scores | 7y. | 8y. | 9y. | 10y. | 11y. | 12y. | 13y. | 14y. |
| 39-40 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 1 |
| 36-38 | 0 | 0 | 0 | 0 | 0 | 2 | 6 | 8 |
| 33-35 | 0 | 2 | 2 | 3 | 2 | 12 | 22 | 23 |
| 30-32 | 0 | 1 | 4 | 8 | 5 | 15 | 28 | 24 |
| 27-29 | 0 | 2 | 6 | 8 | 11 | 20 | 20 | 29 |
| 24-26 | 1 | 4 | 6 | 10 | 9 | 21 | 11 | 15 |
| 21-23 | 0 | 5 | 10 | 5 | 15 | 17 | 11 | 7 |
| 18-20 | 2 | 6 | 6 | 13 | 5 | 17 | 2 | 4 |
| 15-17 | 3 | 12 | 16 | 16 | 7 | 11 | 2 | 4 |
| 12-14 | 3 | 12 | 14 | 13 | 4 | 5 | 2 | 0 |
| 9-11 | 1 | 7 | 10 | 4 | 3 | 4 | 1 | 2 |
| 6- 8 | 24 | 38 | 13 | 12 | 0 | 4 | 6 | 1 |
| 3- 5 | 46 | 23 | 13 | 4 | 0 | 1 | 0 | 0 |
| 0- 2 | 34 | 4 | 1 | 0 | 1 | 0 | 0 | 0 |
| | 114 | 116 | 101 | 96 | 62 | 130 | 114 | 118 |
| MEAN | 4.79 | 10.85 | 15.10 | 18.19 | 22.19 | 23.71 | 27.92 | 28.56 |
| S D | 4.24 | 7.37 | 8.50 | 8.15 | 6.85 | 7.19 | 7.45 | 5.95 |
| MEDIAN | 4.0 | 7.9 | 14.3 | 17.4 | 22.7 | 24.3 | 29.7 | 29.1 |

| | GRAMMAR | | | PRI.SEC. GRAM. | SEC+ GRAM. | SEC+ GRAM. |
|---|---|---|---|---|---|---|
| Scores | 11y. | 12y. | 13y. | 11y. | 12y. | 13y. |
| 39-40 | 0 | 3 | 3 | 0 | 2 | 7 |
| 36-38 | 7 | 13 | 5 | 3 | 9 | 11 |
| 33-35 | 4 | 14 | 10 | 8 | 19 | 35 |
| 30-32 | 11 | 21 | 8 | 9 | 26 | 39 |
| 27-29 | 7 | 15 | 1 | 15 | 28 | 21 |
| 24-26 | 4 | 9 | 2 | 10 | 25 | 14 |
| 21-23 | 3 | 4 | 1 | 18 | 19 | 12 |
| 18-20 | 2 | 3 | 0 | 5 | 19 | 2 |
| 15-17 | 0 | 1 | 0 | 10 | 12 | 2 |
| 12-14 | 1 | 0 | 0 | 6 | 5 | 2 |
| 9-11 | 0 | 1 | 0 | 5 | 4 | 1 |
| 6- 8 | 0 | 0 | 0 | 0 | 4 | 6 |
| 3- 5 | 0 | 0 | 0 | 0 | 1 | 0 |
| 0- 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| | 39 | 84 | 30 | 90 | 173 | 152 |
| MEAN | 29.46 | 30.30 | 33.10 | 22.46 | 25.33 | 29.18 |
| S D | 5.68 | 5.50 | 4.25 | 7.73 | 7.73 | 8.498 |
| MEDIAN | 30.2 | 30.8 | 33.4 | 23.5 | 26.2 | 30.7 |

Although each child had drawn a man in order to reduce the possible copying*, it was considered useful to score them up to the age of 11 yrs as an indication of the intellectual maturity of the sample. The results were very close to those of Harris's standardization sample and suggested that this sample was of average ability (Table 2.5).

TABLE 2.5

MEANS AND STANDARD DEVIATIONS OF THE HARRIS DAM TEST FROM BUCKINGHAMSHIRE CHILDREN COMPARED WITH THE AMERICAN STANDARDIZATION SAMPLE

BOYS

| | BUCKS | | | U.S.A. | | |
|---|---|---|---|---|---|---|
| AGE | N | M | S.D. | N | M | S.D. |
| 8-0 to 8-11 | 94 | 25.97 | 7.20 | 75 | 26.3 | 7.99 |
| 9-0 to 9-11 | 86 | 29.77 | 8.39 | 75 | 30.0 | 8.53 |
| 10-0 to 10-11 | 92 | 37.08 | 9.87 | 75 | 36.0 | 10.32 |
| 11-0 to 11-11 | 79 | 38.46 | 8.18 | 75 | 37.6 | 10.67 |

GIRLS

| | BUCKS | | | U.S.A. | | |
|---|---|---|---|---|---|---|
| | N | M | S.D. | N | M | S.D. |
| 8-0 to 8-11 | 90 | 24.40 | 8.00 | 75 | 27.2 | 7.82 |
| 9-0 to 9-11 | 90 | 32.40 | 7.32 | 75 | 31.2 | 8.95 |
| 10-0 to 10-11 | 92 | 35.42 | 8.44 | 75 | 37.1 | 9.27 |
| 11-0 to 11-11 | 36 | 40.77 | 10.61 | 75 | 40.1 | 9.84 |

*See page 14

## B SCALING

### INTRODUCTION: POSSIBLE METHODS OF STANDARDIZATION

#### Age Norms

Any trait that shows progressive changes with age can be measured in terms of age norms. This is the simplest method and was first used historically in test construction, the most well known being the SB.

It is unsatisfactory however, for the following reasons:

1 There is evidence to show that psychological abilities do not develop at a linear rate and when mean raw scores of age groups are plotted against age then a typical growth curve emerges. Hence mental ages cannot be regarded as equal units. This implies that such a scale can only be an ordinal scale, not an equal interval scale, with all the computational restrictions that that implies.

2 Not only does development not take place at a regular pace, but it also does not continue throughout life, so that there is no means of measuring above average traits when the growth curve has reached its maximum although it is sometimes done by extrapolation as in Vernon's Graded Word Reading Test (GWRT) of 1938 and in the SB.

3 Even if it was an equal interval scale it would still not be possible to compare degrees of backwardness or advancement in a skill, for one year behind or in advance has a different value at eight years than at twelve years. As a relative constancy in mental ability is one of the basic assumptions of all testing of untaught skills then it is necessary to use a statistical device which theoretically should give a constant figure irrespective of age. This was achieved initially by assuming there was a linear relationship between mental age and chronological age and calculating a mental ratio, which was transformed into a quotient by multiplying by 100, in order to avoid decimals. The difficulty of using this method to describe adult's intellectual ability was always recognised and overcome by using a fictitious maximum mental age, which still however did not take into account the decline in some mental abilities after thirty years of age.

The recognised disadvantages related however to age norms and it was only later realized that irregularities in IQs had been built into the system, because their different dispersions at various age levels had not been taken into account. Wechsler (1944) pointed out that standard deviations in the Revised Stanford Binet (Form L) varied by 7.5 units. Thus an individual whose position is 2 standard deviations from the mean at 6 would obtain an IQ of 75 and at the age of 12 an IQ of 60.

Thus the assumption that the IQ is a constant factor was not entirely supported by the statistical technique used and its ability to predict scores at later ages or on other tests, one of its principle functions, was impaired.

Percentiles

Percentile norms were an improvement on mental age norms because they provided a basis for interpreting a raw score in terms of a position that a subject attains in a group, which is usually defined by age in the case of children. They can therefore be used to preduct children's positions on future occasions in similar groups and does not suffer from the disadvantages of the mental age.

It is particularly useful where the standardization sample is small and no assumptions can be made about a normal distribution. Where it has been used with psychological tests the percentiles are often grouped in intervals of five or ten and given as grades, as in Raven's Matrices (1936).

It has the disadvantage that the units are systematically unequal in all but a rectangular distribution, being closer together around the median and farther apart in the upper and lower quantiles, and consequently cannot be used arithmetically.

Standard Deviation Scores

Standard deviation scores, if based on a normal distribution have the same advantage as percentiles in that they give a subjects position in the order of achievement in a reference group, but have in addition the advantage of having some of the attributes of an equal interval scale. Sometimes the norms are given as Z scores, which are just expressed directly in standard deviation units, as in the Merrill Palmer test (Stutsman 1931). This, however, has the inconvenience of involving decimal points and requiring plus and minus signs and is usually overcome by multiplying the standard deviation by a constant to avoid the former and adding on a constant to avoid the latter. Some American group tests have used T scores where the standard deviation is multiplied by 10 and a constant of 50 is added and some have used stanine scores where the mean is 5 and standard deviation 2. As, however, the first widely used children's intelligence test the SB had an approximate mean of 100 and a standard deviation of between 12 and 20, most subsequent children's tests, group or individual, have adopted a mean of 100 and standard deviation of 15.

Normalized Standard Scores

Since one of the reasons for using standard scores is to render comparable scores on different tests, standard deviation scores can only be used when the raw scores of the sample are approximate to a normal distribution. This is often not the case when the number in the sample is small, being measured in hundreds or less per age group rather than in thousands. Skewness occurs when the raw scores do not represent equal units throughout the range of scores owing to a sudden increase in the difficulty of some items, or because the range of items is too limited, producing a positively skewed distribution at the younder age levels and a negatively skewed distribution at the older age levels. As the standard score deviation scores reproduce the original distribution of raw scores, the quality of skewedness is also reproduced. This means that the particular relationship which is present between percentiles and standard scores in a normal distribution is absent and the mean for instance no longer coincides with the median.

In order to obtain comparability of scores from dissimilarly shaped distribution the non linear method of normalized standard scores is used. In this the raw scores are transformed into percentiles and then into the standard score, which corresponds to that particular percentile in a normal distribution. Like linearly derived standard scores, normalized standard scores can be put in any convenient form. Usually the mean is 100 and the S D 15, although in the subtests of the WISC Wechsler used 10 and 3.

TREATMENT OF RESULTS

As the sample sizes were small and it was known that they were likely to be positively skewed in the lower ages and negatively skewed in the upper age groups it was decided to use normalized standard scores. Also to further reduce chance irregularities to read off the resulting standard scores from graphs, rather than using tables.

RESULTS

As expected inspection of the tables giving the distribution of the raw scores (Table 2.4) showed that the scores in the younger age groups of 7 and 8 years were positively skewed and those in the older age groups of 13 and 14 years were negatively skewed. Raw scores corresponding to percentile values were therefore calculated (Table 2.6). These were then plotted on Graphs 2.1 (a) and (b) and the standard scores read to form the tables (Table 2.7). As normal distributions would have produced straight lines the curves found here further indicate that the distributions were not normal (France,1968).

TABLE 2.6

PERCENTILES CORRESPONDING TO RAW SCORES

BOYS

| Percentile Rank | PRIMARY RAW SCORES 7y. | 8y. | 9y. | 10y. | 11y. | SECONDARY RAW SCORES 12y. | 13y. | 14y. |
|---|---|---|---|---|---|---|---|---|
| 5 | .4 | 2.7 | 3.5 | 6.4 | 17.7 | 13.3 | 17.6 | 19.4 |
| 10 | .8 | 3.4 | 7.1 | 11.6 | 19.5 | 20.0 | 20.2 | 25.1 |
| 20 | 1.6 | 5.5 | 14.7 | 15.5 | 22.2 | 23.9 | 24.8 | 28.1 |
| 30 | 2.3 | 6.7 | 18.7 | 19.0 | 24.6 | 26.9 | 27.6 | 30.0 |
| 40 | 2.6 | 8.0 | 21.2 | 21.7 | 26.7 | 28.2 | 29.7 | 31.4 |
| 50 | 3.5 | 12.2 | 22.8 | 23.9 | 27.8 | 29.5 | 31.5 | 32.8 |
| 60 | 4.4 | 15.2 | 24.9 | 25.5 | 28.9 | 30.8 | 33.1 | 34.2 |
| 70 | 5.2 | 18.2 | 27.2 | 28.2 | 30.1 | 32.1 | 34.4 | 35.6 |
| 80 | 6.7 | 22.0 | 29.2 | 30.6 | 31.4 | 33.5 | 36.1 | 36.8 |
| 90 | 9.7 | 26.5 | 31.2 | 33.2 | 33.3 | 34.9 | 38.6 | 38.1 |
| 95 | 22.6 | 28.6 | 32.2 | 35.2 | 35.9 | 35.9 | 39.5 | 39.0 |

| Percentile Rank | GRAMMAR RAW SCORES 11y. | 12y. | 13y. | PRI.SEC GRAM. RAW SCORES 11y. | SEC+ GRAM. 12y. | SEC+ GRAM. 13y. |
|---|---|---|---|---|---|---|
| 5 | 21.1 | 26.8 | 28.5 | 15.6 | 16.3 | 18.0 |
| 10 | 26.8 | 29.8 | 26.8 | 18.0 | 21.4 | 21.4 |
| 20 | 29.7 | 30.7 | 31.3 | 21.2 | 25.8 | 26.0 |
| 30 | 30.9 | 31.6 | 33.5 | 23.7 | 27.9 | 28.6 |
| 40 | 32.1 | 32.8 | 35.0 | 26.6 | 29.6 | 30.7 |
| 50 | 33.2 | 34.3 | 36.1 | 28.0 | 30.8 | 32.6 |
| 60 | 34.2 | 35.7 | 37.0 | 29.5 | 32.0 | 34.0 |
| 70 | 35.2 | 36.9 | 37.9 | 30.6 | 33.3 | 35.5 |
| 80 | 36.5 | 38.1 | 38.7 | 32.1 | 34.7 | 37.5 |
| 90 | 37.8 | 38.9 | 39.6 | 34.7 | 36.8 | 38.8 |
| 95 | 38.4 | 39.8 | 40.1 | 36.8 | 38.2 | 39.2 |

TABLE 2.6

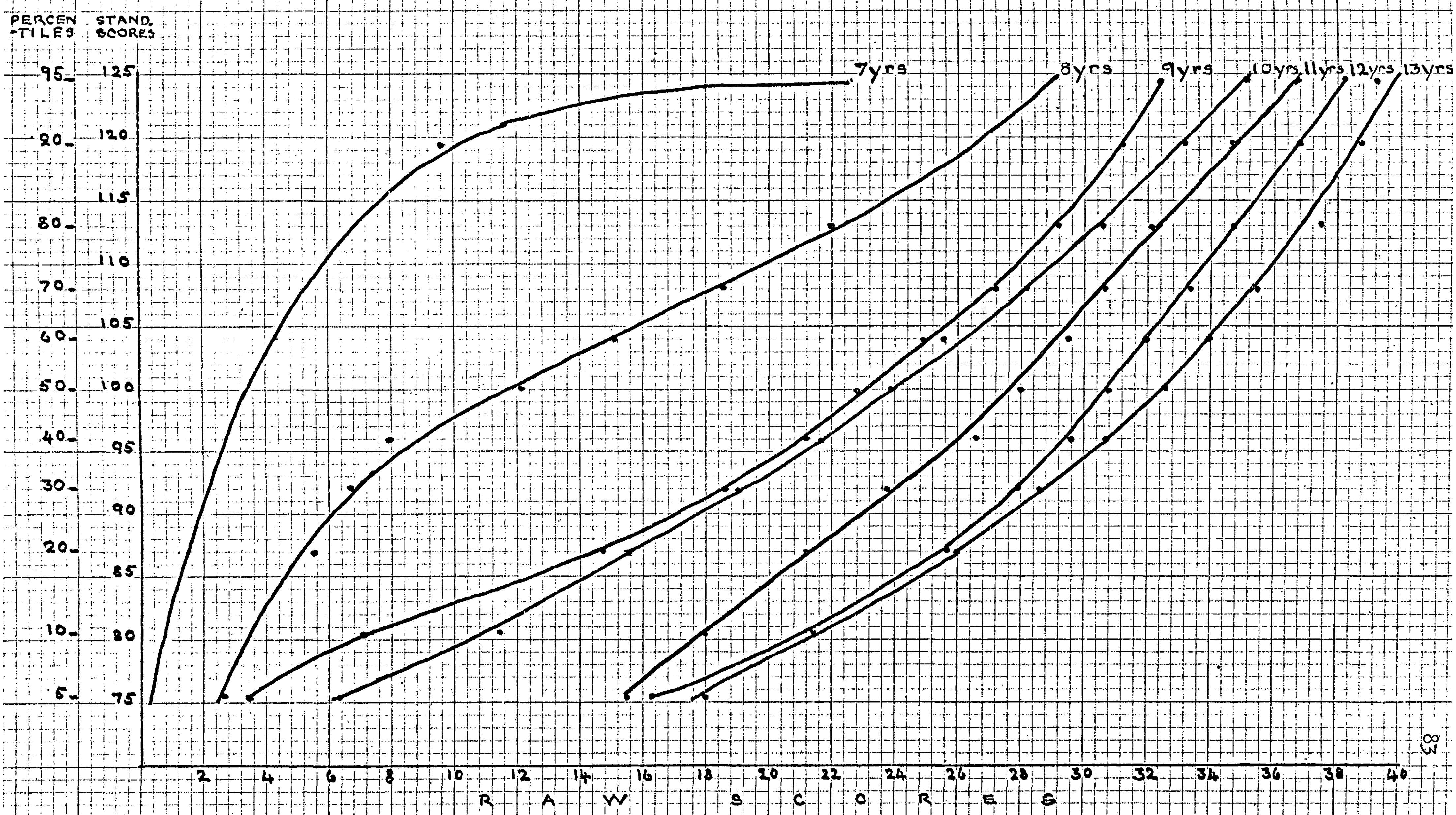
PERCENTILES CORRESPONDING TO RAW SCORES

GIRLS

| Percential Rank | PRIMARY RAW SCORES 7y. | 8y. | 9y. | 10y. | 11y. | SECONDARY RAW SCORES 12y. | 13y. | 14y. |
|---|---|---|---|---|---|---|---|---|
| 5 | .3 | 2.7 | 3.5 | 5.7 | 10.6 | 9.6 | 8.3 | 16.7 |
| 10 | 1.0 | 3.5 | 4.6 | 6.9 | 13.1 | 13.9 | 18.1 | 20.8 |
| 20 | 2.0 | 5.0 | 6.9 | 10.9 | 16.2 | 17.7 | 28.2 | 24.6 |
| 30 | 2.5 | 6.1 | 9.5 | 13.5 | 19.7 | 20.1 | 26.3 | 26.7 |
| 40 | 3.2 | 7.0 | 12.3 | 15.5 | 21.5 | 22.3 | 28.1 | 27.9 |
| 50 | 4.0 | 7.9 | 14.3 | 17.4 | 22.7 | 24.3 | 29.7 | 29.1 |
| 60 | 4.8 | 10.5 | 16.3 | 19.5 | 24.2 | 26.2 | 30.5 | 30.6 |
| 70 | 5.4 | 13.8 | 19.3 | 23.6 | 26.1 | 28.1 | 32.2 | 32.1 |
| 80 | 7.0 | 16.7 | 22.7 | 26.4 | 28.1 | 30.3 | 33.6 | 33.6 |
| 90 | 8.4 | 21.9 | 27.4 | 30.0 | 30.0 | 33.0 | 35.2 | 35.1 |
| 95 | 15.8 | 26.3 | 30.1 | 31.8 | 31.8 | 34.6 | 37.1 | 36.7 |

| | GRAMMAR RAW SCORES 11y. | 12y. | 13y. | PRI.SEC. GRAM. RAW SCORES 11y. | SEC+ GRAM. 12y. | SEC+ GRAM. 13y. |
|---|---|---|---|---|---|---|
| 5 | 18.8 | 19.7 | 24.2 | 10.6 | 11.2 | 12.4 |
| 10 | 21.4 | 23.0 | 26.5 | 13.0 | 15.4 | 21.0 |
| 20 | 24.8 | 26.1 | 30.2 | 16.3 | 18.8 | 24.7 |
| 30 | 27.2 | 27.9 | 31.4 | 20.5 | 21.6 | 27.4 |
| 40 | 28.9 | 29.6 | 32.5 | 22.0 | 24.1 | 29.6 |
| 50 | 30.2 | 30.8 | 33.4 | 23.5 | 26.2 | 30.7 |
| 60 | 31.3 | 31.9 | 34.3 | 26.2 | 28.1 | 31.9 |
| 70 | 32.3 | 33.5 | 35.2 | 28.1 | 30.0 | 33.1 |
| 80 | 34.9 | 35.3 | 36.7 | 30.2 | 32.0 | 34.4 |
| 90 | 36.8 | 37.2 | 38.5 | 33.2 | 34.5 | 36.3 |
| 95 | 37.6 | 38.2 | 40.0 | 34.4 | 36.2 | 38.3 |

GRAPH 2.1(a) STANDARD SCORES FROM PERCENTILES BOYS



GRAPH 2.1 (b) STANDARD SCORES FROM PERCENTILES GIRLS

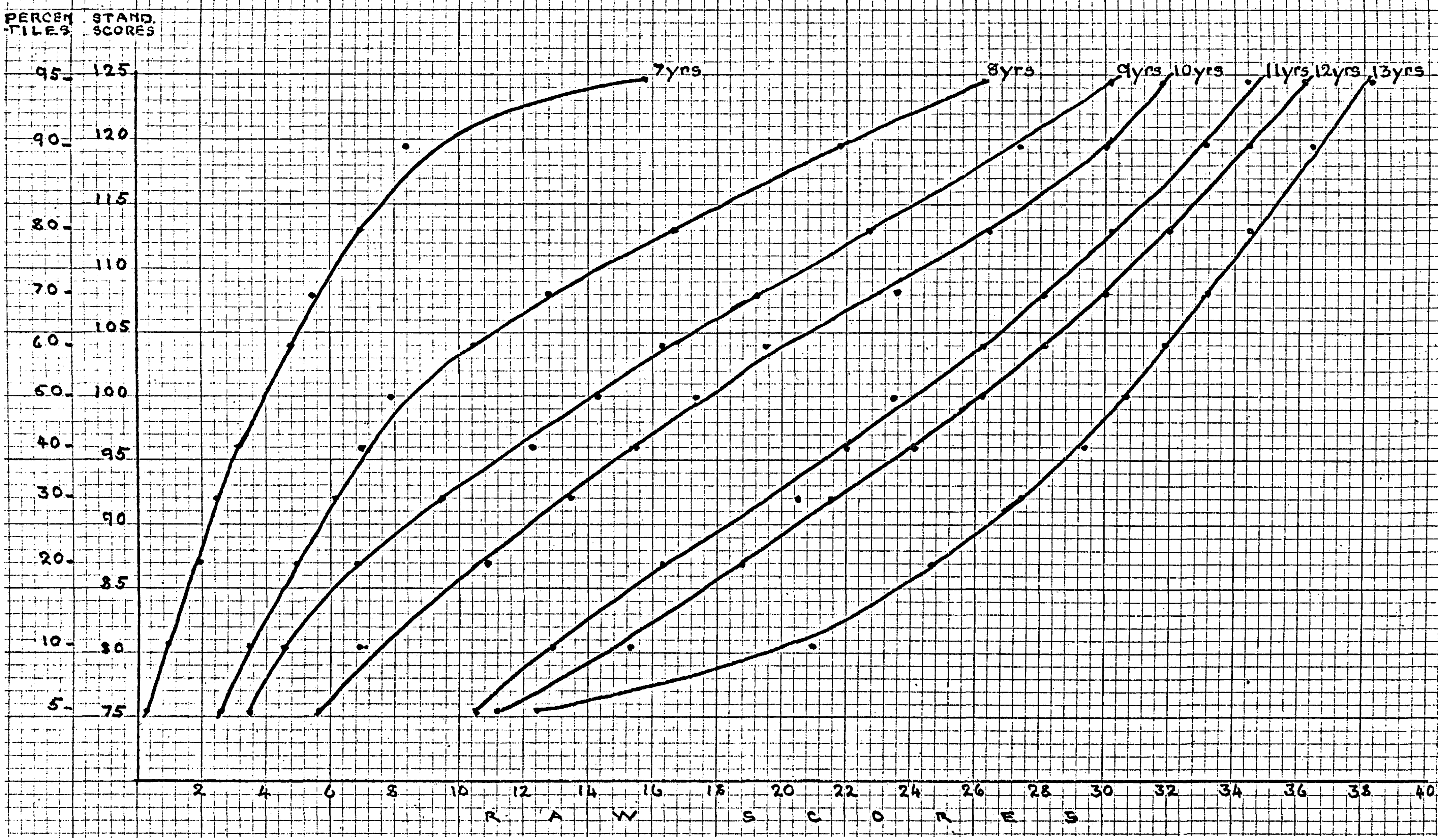


TABLE 2.7

STANDARD SCORE EQUIVALENTS FOR RAW SCORES BASED ON TOTAL SAMPLE

BOYS — CHRONOLOGICAL AGE

| RAW SCORE | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|
| 40 | | | | | | | 125 |
| 39 | | | | | | | 121 |
| 38 | | | | | | 125 | 117 |
| 37 | | | | | 125 | 120 | 113 |
| 36 | | | | | 123 | 117 | 110 |
| 35 | | | | 125 | 120 | 114 | 107 |
| 34 | | | | 121 | 117 | 110 | 104 |
| 33 | | | 125 | 119 | 115 | 108 | 101 |
| 32 | | | 122 | 116 | 112 | 104 | 99 |
| 31 | | | 119 | 114 | 110 | 101 | 96 |
| 30 | | | 116 | 112 | 107 | 98 | 94 |
| 29 | | 125 | 113 | 109 | 104 | 95 | 93 |
| 28 | | 123 | 110 | 108 | 101 | 93 | 91 |
| 27 | | 121 | 108 | 105 | 98 | 90 | 89 |
| 26 | | 119 | 106 | 104 | 96 | 88 | 87 |
| 25 | | 117 | 103 | 102 | 94 | 86 | 86 |
| 24 | | 115 | 101 | 100 | 92 | 84 | 84 |
| 23 | | 114 | 99 | 98 | 90 | 83 | 82 |
| 22 | | 113 | 98 | 96 | 88 | 82 | 81 |
| 21 | | 111 | 96 | 95 | 86 | 81 | 80 |
| 20 | 124 | 110 | 94 | 93 | 85 | 80 | 79 |
| 19 | 124 | 109 | 93 | 92 | 83 | 78 | 77 |
| 18 | 124 | 108 | 91 | 91 | 81 | 77 | 75 |
| 17 | 123 | 106 | 90 | 89 | 79 | 76 | |
| 16 | 123 | 105 | 89 | 88 | 77 | 75 | |
| 15 | 122 | 104 | 88 | 87 | 75 | | |
| 14 | 122 | 103 | 87 | 87 | | | |
| 13 | 121 | 102 | 87 | 84 | | | |
| 12 | 121 | 100 | 86 | 82 | | | |
| 11 | 120 | 99 | 85 | 81 | | | |
| 10 | 119 | 98 | 84 | 80 | | | |
| 9 | 118 | 97 | 83 | 78 | | | |
| 8 | 116 | 95 | 82 | 77 | | | |
| 7 | 113 | 93 | 80 | 76 | | | |
| 6 | 111 | 90 | 79 | 75 | | | |
| 5 | 107 | 87 | 78 | | | | |
| 4 | 103 | 83 | 77 | | | | |
| 3 | 98 | 80 | 75 | | | | |
| 2 | 90 | 75 | | | | | |
| 1 | 81 | | | | | | |
| 0 | 75 | | | | | | |

GIRLS — CHRONOLOGICAL AGE

| RAW SCORE | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|
| 40 | | | | | | | |
| 39 | | | | | | | |
| 38 | | | | | | | 125 |
| 37 | | | | | | | 121 |
| 36 | | | | | | 125 | 118 |
| 35 | | | | | 125 | 121 | 115 |
| 34 | | | | | 122 | 117 | 112 |
| 33 | | | | | 119 | 115 | 108 |
| 32 | | | | 125 | 116 | 113 | 105 |
| 31 | | | | 121 | 114 | 110 | 102 |
| 30 | | | 125 | 119 | 113 | 108 | 99 |
| 29 | | | 122 | 117 | 110 | 106 | 96 |
| 28 | | | 120 | 115 | 108 | 103 | 94 |
| 27 | | | 119 | 113 | 106 | 102 | 92 |
| 26 | | 125 | 117 | 112 | 104 | 100 | 90 |
| 25 | | 123 | 115 | 110 | 102 | 98 | 88 |
| 24 | | 122 | 114 | 109 | 100 | 96 | 86 |
| 23 | | 121 | 113 | 108 | 98 | 94 | 85 |
| 22 | | 120 | 111 | 106 | 96 | 93 | 83 |
| 21 | | 118 | 110 | 105 | 95 | 90 | 82 |
| 20 | | 117 | 109 | 104 | 93 | 89 | 81 |
| 19 | | 116 | 107 | 102 | 91 | 87 | 80 |
| 18 | | 115 | 106 | 100 | 89 | 86 | 79 |
| 17 | | 114 | 105 | 99 | 88 | 84 | 78 |
| 16 | 125 | 112 | 103 | 97 | 86 | 82 | 77 |
| 15 | 124 | 111 | 101 | 95 | 85 | 80 | 77 |
| 14 | 124 | 109 | 99 | 93 | 83 | 79 | 76 |
| 13 | 123 | 108 | 97 | 92 | 81 | 77 | 75 |
| 12 | 122 | 106 | 96 | 90 | 79 | 76 | 75 |
| 11 | 121 | 105 | 94 | 88 | 77 | 75 | |
| 10 | 120 | 103 | 93 | 86 | 75 | | |
| 9 | 118 | 101 | 91 | 84 | | | |
| 8 | 116 | 99 | 90 | 82 | | | |
| 7 | 113 | 96 | 87 | 80 | | | |
| 6 | 109 | 92 | 85 | 77 | | | |
| 5 | 104 | 88 | 82 | 75 | | | |
| 4 | 100 | 84 | 78 | | | | |
| 3 | 94 | 79 | 75 | | | | |
| 2 | 87 | 75 | | | | | |
| 1 | 81 | | | | | | |
| 0 | | | | | | | |

TABLE 2.8

STANDARD SCORE EQUIVALENTS FOR RAW SCORES IN DIFFERENT TYPES OF SCHOOLS

| RAW SCORE | PRI-MARY | SECONDARY MODERN | | | GRAMMAR | | | RAW SCORE | PRI-MARY | SECONDARY MODERN | | | GRAMMAR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 11 | 12 | 13 | 14 | 11 | 12 | 13 | | 11 | 12 | 13 | 14 | 11 | 12 | 13 |
| 40 | | | | | | 125 | 123 | 40 | | | | | | | 124 |
| 39 | | | 120 | 120 | 125 | 119 | 115 | 39 | | | | | | | 121 |
| 38 | | | 118 | 118 | 121 | 114 | 108 | 38 | | | | | | 120 | 117 |
| 37 | | | 115 | 113 | 117 | 108 | 105 | 37 | | | | | 120 | 118 | 113 |
| 36 | 127 | 125 | 113 | 110 | 111 | 105 | 100 | 36 | | | 120 | | 117 | 115 | 110 |
| 35 | 124 | 120 | 110 | 107 | 107 | 102 | 96 | 35 | | | 115 | 120 | 113 | 112 | 107 |
| 34 | 120 | 117 | 107 | 103 | 103 | 98 | 93 | 34 | | | 111 | 114 | 110 | 108 | 103 |
| 33 | 117 | 113 | 104 | 100 | 99 | 95 | 85 | 33 | | 120 | 108 | 110 | 106 | 104 | 99 |
| 32 | 114 | 109 | 101 | 97 | 96 | 91 | 87 | 32 | | 117 | 105 | 108 | 104 | 101 | 96 |
| 31 | 111 | 105 | 99 | 95 | 92 | 88 | 84 | 31 | 120 | 115 | 103 | 105 | 102 | 97 | 93 |
| 30 | 108 | 101 | 96 | 92 | 89 | 85 | 82 | 30 | 118 | 112 | 100 | 102 | 99 | 94 | 91 |
| 29 | 104 | 98 | 94 | 89 | 86 | 82 | 81 | 29 | 115 | 110 | 98 | 100 | 96 | 91 | 88 |
| 28 | 101 | 95 | 92 | 87 | 84 | 79 | 79 | 28 | 113 | 108 | 96 | 96 | 93 | 87 | 86 |
| 27 | 98 | 92 | 98 | 85 | 81 | 76 | 78 | 27 | 110 | 105 | 94 | 92 | 91 | 84 | 83 |
| 26 | 95 | 90 | 91 | 83 | 80 | | 76 | 26 | 108 | 104 | 92 | 90 | 89 | 80 | 80 |
| 25 | 93 | 88 | 89 | 81 | 79 | | 75 | 25 | 105 | 101 | 90 | 88 | 87 | | |
| 24 | 91 | 86 | 87 | 80 | 78 | | | 24 | 103 | 99 | 88 | 86 | 85 | | |
| 23 | 89 | 85 | 85 | | 77 | | | 23 | 100 | 97 | 87 | 84 | 83 | | |
| 22 | 87 | 83 | 84 | | | | | 22 | 97 | 95 | 85 | 83 | 82 | | |
| 21 | 85 | 82 | 83 | | | | | 21 | 95 | 94 | 84 | 81 | 80 | | |
| 20 | 82 | 81 | 81 | | | | | 20 | 93 | 92 | 83 | 80 | | | |
| 19 | 80 | 80 | 80 | | | | | 19 | 91 | 90 | 82 | | | | |
| 18 | 78 | | | | | | | 18 | 89 | 88 | 80 | | | | |
| 17 | | | | | | | | 17 | 87 | 86 | | | | | |
| 16 | | | | | | | | 16 | 86 | 85 | | | | | |
| 15 | | | | | | | | 15 | 84 | 83 | | | | | |
| 14 | | | | | | | | 14 | 83 | 82 | | | | | |
| 13 | | | | | | | | 13 | 81 | 81 | | | | | |
| 12 | | | | | | | | 12 | 80 | 80 | | | | | |
| 11 | | | | | | | | 11 | | | | | | | |
| 10 | | | | | | | | 10 | | | | | | | |
| 9 | | | | | | | | 9 | | | | | | | |
| 8 | | | | | | | | 8 | | | | | | | |
| 7 | | | | | | | | 7 | | | | | | | |
| 6 | | | | | | | | 6 | | | | | | | |
| 5 | | | | | | | | 5 | | | | | | | |
| 4 | | | | | | | | 4 | | | | | | | |
| 3 | | | | | | | | 3 | | | | | | | |
| 2 | | | | | | | | 2 | | | | | | | |
| 1 | | | | | | | | 1 | | | | | | | |
| 0 | | | | | | | | 0 | | | | | | | |

Standard scores were not found for the 14 year age groups because grammar school children of that age had not been tested and so could not be amalgamated with the secondary modern children, but there is reason to suppose that school children show very little improvement after 13 years for the mean scores of the secondary 14 year olds show little increase above the 13 year olds. However, in order to use the raw scores of 14 year olds in subsequent studies standard scores were found for that age group based solely on the secondary school group. They are given in Table 2.8 together with all the secondary groups standardized separately according to the type of school from which they were taken.

CONCLUSION

Owing to the positive skewness of the scale at the 7 year level and the restriction of sampling over 13 years, the scale is not applicable for children outside the ages of 8 and 13 years. This general rule has been followed in the subsequent studies except in a few special cases.

# CHAPTER III

## RELIABILITY

Reliability of the Plan test will now be assessed according to these four aspects:

### A TEST RELIABILITY

At this point, reliability, meaning coefficient of equivalence, was the only aspect of the test that could be assessed. Testing for homogeneity, although important, was not feasible at this stage.

Even the reliability of equivalence is difficult to measure. It would have been best to have used a parallel set of items, but one did not exist. The only method that could be used was some type of split-half technique. The applicability of this was open to question, because it is designed for tests composed of individual items, whereas many of the Plan items are qualitative progressions of one item category. Thus the split-half correlations could be spuriously high. Moreover, the usual method of splitting the test into odd and even items was not really adequate because they ought to be equated in terms of difficulty. However, that would have been laborious and time consuming. It was therefore decided to use the simplest method and formula, Spearman-Brown's and look at the results, which are in Table 3.1.

TABLE 3.1

SPLIT HALF RELIABILITY

BOYS

| AGE | N | M | S.D. | r | RELIABILITY |
|---|---|---|---|---|---|
| 7 | 86 | 2.74<br>2.66 | 3.22<br>3.20 | .9580 | .98 |
| 8 | 110 | 6.09<br>7.109 | 3.97<br>4.75 | .9244 | .96 |
| 9 | 87 | 10.11<br>11.18 | 4.21<br>4.51 | .8722 | .93 |
| 10 | 92 | 10.88<br>11.95 | 4.43<br>4.32 | .8584 | .92 |
| 11 | 87 | 13.46<br>13.90 | 2.76 | .7087 | .82 |
| 12 | 85 | 14.01<br>14.20 | 3.72<br>3.34 | .8081 | .89 |
| 13 | 105 | 14.91<br>14.83 | 4.04<br>3.95 | .9190 | .95 |

GIRLS

| AGE | N | M | S.D. | r | RELIABILITY |
|---|---|---|---|---|---|
| 7 | 114 | 2.47<br>2.20 | 2.33<br>2.08 | .9280 | .96 |
| 8 | 116 | 5.305<br>5.43 | 3.60<br>4.06 | .9162 | .96 |
| 9 | 101 | 7.03<br>7.87 | 4.07<br>4.35 | .8692 | .93 |
| 10 | 96 | 8.04<br>8.38 | 3.72<br>3.35 | .7979 | .89 |
| 11 | 62 | 10.08<br>12.01 | 3.18<br>4.05 | .6152 | .76 |
| 12 | 130 | 11.57<br>11.92 | 4.01<br>3.52 | .8713 | .93 |
| 13 | 114 | 13.95<br>13.91 | 4.00<br>3.70 | .8776 | .93 |

All the reliability coefficients were high, being frequently marginally higher for boys than for girls, although the same trends were seen in both. The reliability was highest in the seven and eight year olds, when the great majority of the items used by the bottom 50% of scorers were independent. It was in the higher age groups, where more progressive items were used that the coefficients were lower, which suggests that while progressive items can enhance a reliability score, they can also detract from it. It must also be remembered that the samples were more homogeneous in ability from 11 yrs upward, which would also have reduced the split-half correlations.

B SCORER RELIABILITY

The reliability of the Plan score is not likely to be affected by inaccuracies due to either the recording of the subject or the arithmetic of the scores, but it is likely to be affected by the judgement of the scorer.

This was first investigated by selecting protocols ranging, according to the writer's scoring, from 0 to 32. Most of them contained items which were difficult to score. They were given to four trainee psychologists, who had already had some months in learning test technique, but they did not have any special coaching in scoring this one, as it was intended to replicate the circumstances of a trained psychologist having to pick up the instructions of a new test on his own.

Although the number of protocols was only 35 and a normal distributions of scores could not be assumed, it was considered that the product moment method of correlation was robust enough to use. The results can be seen in Table 3.2.

TABLE 3.2

INTERSCORER CORRELATIONS I

| SCORER First | SCORER Second | MEAN First | MEAN Second | S.D. First | S.D. Second | CORRELATION |
|---|---|---|---|---|---|---|
| A | B | 12.48 | 11.36 | 7.78 | 7.79 | .93 |
| A | C | 12.48 | 12.58 | 7.78 | 7.91 | .97 |
| A | D | 12.48 | 12.39 | 7.78 | 7.51 | .91 |
| B | C | 11.36 | 12.58 | 7.91 | 7.91 | .90 |
| B | D | 11.36 | 12.39 | 7.78 | 7.51 | .91 |
| C | D | 12.58 | 12.39 | 7.91 | 7.51 | .98 |

The coefficients range from .90 to .98, which is currently regarded as being an acceptable degree of reliability. However, although from inspection it could be seen that most of the raw scores were similar, there were one or two showing larger differences, the greatest being a girl of 10y 6m, whose score by A was 29 and by B was 19, a difference of 10 raw scores.

When transposed into standard scores, they became 102 and 122 respectively giving a difference of 20 standard score units. Such a large difference should be avoided in a clinic test and the items were examined individually to see where inter scorer agreement was least.

This was done by recording all four scorers judgements for each item, both when the item was scored present and absent. Percentages of incorrect responses were then calculated by counting the odd one out in four as incorrect, or counting as incorrect where the items were found present by two and absent by two; for each item, using this method the percentage items judged correctly are shown in Table 3.3.

TABLE 3.3

SHOWING THE PERCENTAGE AGREEMENT OF FOUR SCORERS ON EACH ITEM

| ITEM NO. | % AGREEMENT | ITEM NO. | % AGREEMENT |
|---|---|---|---|
| 1 | 100 | 21 | 99 |
| 2 | 100 | 22 | 95 |
| 3 | 100 | 23 | 97 |
| 4 | 100 | 24 | 96 |
| 5 | 100 | 25 | 93 |
| 6 | 99 | 26 | 95 |
| 7 | 99 | 27 | 99 |
| 8 | 98 | 28 | 97 |
| 9 | 99 | 29 | 97 |
| 10 | 100 | 30 | 94 |
| 11 | 100 | 31 | 91 |
| 12 | 92 | 32 | 94 |
| 13 | 93 | 33 | 96 |
| 14 | 95 | 34 | 100 |
| 15 | 93 | 35 | 96 |
| 16 | 96 | 36 | 93 |
| 17 | 95 | 37 | 91 |
| 18 | 95 | 38 | 93 |
| 19 | 96 | 39 | 91 |
| 20 | 94 | 40 | 93 |

In general items are easier to score at the beginning than at the end of the test. This is possibly because there are more items there that have to be judged present or absent, while later on the items are concerned with degrees of quality. As a result of this, investigation suggestions were invited from the scorers as to how the instructions could be clarified and the necessary changes made.

Then another 34 protocols were given to 5 more scorers including the writer. They were from boys and girls of 7 to 13 yrs, scoring from 0 to 32 according to the author. The results are in Table 3.4.

TABLE 3.4

INTER SCORER CORRELATIONS II

| SCORER | | MEAN | | S.D. | | |
|---|---|---|---|---|---|---|
| First | Second | First | Second | First | Second | |
| E | A | 14.89 | 17.36 | 9.66 | 10.14 | .89 |
| E | B | 14.89 | 14.30 | 9.66 | 9.35 | .96 |
| E | C | 14.89 | 17.42 | 9.66 | 10.23 | .94 |
| E | D | 14.89 | 14.55 | 9.66 | 9.10 | .94 |
| A | B | 17.36 | 14.30 | 10.14 | 9.35 | .93 |
| A | C | 17.36 | 17.42 | 10.14 | 10.23 | .93 |
| A | D | 17.36 | 14.55 | 10.14 | 9.10 | .92 |
| B | C | 14.30 | 17.42 | 9.35 | 10.23 | .93 |
| B | D | 14.30 | 14.55 | 9.35 | 9.10 | .96 |
| C | D | 17.42 | 14.55 | 10.23 | 9.10 | .97 |

Although the instructions had been clarified according to the suggestions of the previous scorers, the correlations were no higher. The means of the scorers still show a discrepancy with three scorers including the writer gaining means of 14.55, 14.30 and 14.89 and the two others17.36 and 17.42.

Once again, although most of the children have only small differences in their scores, there was one boy of 12 yrs. 4 mths. who was given a raw score of 21 by (the writer) and a score of 32 by E. These are equivalent to standard scores of 82 and 109, a difference of 27 standard score units. Enquiry into the cause of the difference revealed that scoring instructions of the stairs had been misinterpreted by this scorer alone, and group discussion upheld the writer's scoring and that of the three others.

It is possible that inter scorer reliability was lowered by the lack of motivation of some of the scorers. They were following an intensive course and had so much to learn that was of primary necessity that the scoring of these protocols without prior detailed instructions for no particular clinical reason could have been tedious and concentration might well have been low.

As the test literature only gives intercorrelations between scorers and does not usually give information about the differences in their mean scores, still less of particular cases, it was decided to look at the same scorers assessment of ten drawings of a man earlier in the course. The sample had not been selected with this purpose in mind and had not been well selected for the age range of the children was narrow, 6y 1m to 9y 3m and therefore the range of possible raw scores was narrow, varying between 7 and 37 out of a possible 73. Once again the product moment method of correlation was used, producing the intercorrelation coefficients seen in Table 3.5.

TABLE 3.5

RELIABILITY INTERCORRELATIONS OF FOUR SCORERS ON THE DRAW-A-MAN TEST

| | SCORERS A | B | C | D | | MEAN | S.D. |
|---|---|---|---|---|---|---|---|
| A | | | | | A | 22.10 | 9.25 |
| B | .98 | | | | B | 19.60 | 8.75 |
| C | .97 | .96 | | | C | 20.20 | 8.25 |
| D | .95 | .97 | .94 | | D | 19.50 | 9.04 |

These correlations are in line with those given by Harris (1963) on larger samples of 75 children, and are higher than Yule's. Unfortunately, Harris does not state the range of scores, nor does he give any details of the extreme cases. In this group the largest discrepancy was for a boy of 9y 8m, Scorer A gave him a raw score of 28 and a standard score of 95, while scorer D gave him a raw score of 21 and a standard score of 84, a difference of 11 standard score units.

This discrepancy is not so large as for the Plan test, but also the results are not strictly comparable because the numbers of protocols are smaller, age and score range narrower, and motivation better on the part of the scorers. It illustrates a useful point that high correlation coefficients are not sufficient indications of inter scorer reliability and more needs to be known in terms of differences between scorers' means and the extreme cases.

C TESTEE STABILITY.

This is best achieved by giving the same children a parallel form of the test for in this way a practice effect can be avoided, but as there is no parallel form to this test, it was given at intervals of one week, one month and two months. An interval that is too short, such as one week, can produce scores which show a spuriously high correlation, because the children are recalling the responses that they made last time, on the other hand, a longer time interval of two months, at an age level when maximum development in the basic concepts is occurring, may produce a spuriously low result. As these tests were given and scored by the tester, contributing sources of unreliability, due to differences in administration and scoring, were reduced.

Test-Retest Reliability of the Plan Test

1. Interval of one week

This was done with a class of about 23 eight year olds in a girls' primary school. Using Spearman's rho a correlation of .96 was obtained. A product moment correlation was also calculated and the results are in Table 3.6.

TABLE 3.6

CORRELATIONS OF TEST-RETEST SCORES WITH ONE WEEK INTERVAL

| Test | Mean | St. D. | Correlation |
|---|---|---|---|
| 1 | 12.26 | 7.64 | .96 |
| 2 | 12.86 | 7.53 | |

2. Interval of one month

This was done in a primary school with a class of first year boys and girls between 7 and 8 years. Seventeen pairs were obtained of both the Plan and the Draw-a-Man test, the latter being used for comparison. The results are in Table 3.7.

TABLE 3.7

CORRELATION OF TEST-RETEST SCORES IN PLAN AND DRAW-A-MAN TEST WITH ONE MONTH'S INTERVAL

| | Test | Mean | S.D. | Correlation |
|---|---|---|---|---|
| Plan | | | | |
| | 1 | 6.65 | 5.76 | |
| | 2 | 8.41 | 6.47 | .79 |
| Man | | | | |
| | 1 | 23.18 | 6.81 | |
| | 2 | 22.29 | 6.18 | .70 |

The average Plan score showed a gain over the one month interval, while the Man score showed little change. Both correlations were about the same.

3. Interval of two months

These results were obtained from two classes of eight year olds in a mixed primary school as a side result of an investigation into the effects of teaching on the Plan score. The results of both the control class and experimental class, who had a lesson in plan drawing between their first and second test, can be seen in Table 3.7.

TABLE 3.7

CORRELATIONS BETWEEN TEST-RETEST WITH INTERVAL OF TWO MONTHS. THE EXPERIMENTAL GROUP WERE INSTRUCTED IN PLAN DRAWING.

| | CONTROL | EXPERIMENTAL |
|---|---|---|
| BOYS | .85 | .97 |
| GIRLS | .75 | .14 |
| BOYS & GIRLS | .79 | .61 |

4. Interval of three months

These results were obtained from the same school as the previous results and were a by product of another investigation (Table 3.8).

TABLE 3.8

CORRELATIONS BETWEEN TEST-RETEST WITH THREE MONTHS INTERVAL

| N = 18 | M | S.D. | r |
|---|---|---|---|
| AGE | 8y 11.6m | 3.5m | |
| PLAN | | | |
| Sept.22 | 9.857 | 7.226 | .79 |
| Jan. | 15.142 | 10.333 | |
| VOCABULARY | | | |
| Sept. 23 | 38.521 | 9.963 | .96 |
| Jan. | 42.130 | 8.901 | |

Here it is possible to contrast the reliability of the Plan test with the Crichton vocabulary test. As can be seen from the means, there was less change in the vocabulary, and its coefficient was higher than the Plan The numbers of children changing their scores can be seen in Table 3.9. This shows that there was a much greater change on the Plan test than the vocabulary test.

TABLE 3.9

PERCENTAGES OF CHILDREN SHOWING DIFFERENT AMOUNTS OF CHANGE ON THE PLAN AND VOCABULARY TESTS.

| RAW SCORE | PLAN | | VOCABULARY | |
|---|---|---|---|---|
| CHANGE | N | % | N | % |
| 0 | 6 | 29 | 0 | 0 |
| 1 | 4 | 19 | 0 | 0 |
| 2-5 | 4 | 19 | 22 | 96 |
| 6-10 | 3 | 14 | 0 | 0 |
| 11+ | 4 | 19 | 1 | 4 |

Discussion

The results tended to fall into two groups the first one with only one week interval between test and retest, which produced a correlation of .96 and the others with intervals of one, two and three months which all produced lower correlations.

In the first group the high correlation of .96 suggests that the girls were remembering a previously produced response. Many of the pupils had identical scores and only one showed an increase of 6.

In the second group most had identical scores again, but one showed an increase of 12 points which suggests some development of spatial concepts in the meantime. The Man that these children drew was also scored and produced a test-retest correlation of a similar magnitude at .70. Harris (1963) quotes correlations in the .60 and .70 range for children's scores with intervals as much as three months. Strumpfer and Miene (1968) found test-retest coefficients of .73 for Man scales after an interval of four months.

The results in the third group where instruction has been given suggest that differences between boys and girls are masked when the two sexes are grouped together. There was no statistical difference between the means of the experimental and control group to indicate a learning effect and the correlation of boys and girls test scores together were .75 in keeping with the control group. Divided into boys and girls, the sample produced different results, for the boys' control group had a correlation of .85 between test and retest and the experimental group had one of .97, as high as the .96 found in a one week interval with girls. The girls control group, on the other hand, had a correlation of .75, but for the experimental group it was only .14. This suggests that teaching does have an effect on some girls' scores. Only 2 out of 13 boys had an increased score of 10 points in the experimental group, whereas 7 girls out of 21 had an increased score of more than 10 points and one as many as 26 points. The possible reason for this is more fully discussed later. (Chapter XI) Here it need only be said that it is possible that boys' scores are more reliable than girls' scores, for even in the control group, the girls' correlation of .75 is lower than that of the boys of .85.

The results in the fourth group are interesting because it provides a comparison with a vocabulary test. The correlation coefficients are lower for the Plan than the vocabulary test and examination of the accompanying differences in changes of the means and different distributions of the percentages of change amongst the children suggests the reason. The greatest change in rate of increase of vocabulary in children comes before the age of 5yrs. By the age of 8yrs the increase has slowed down. This is reflected in the small differences between the vocabulary means. In the case of the Plan test, the greatest change in the concepts of horizontality are just taking place. This is reflected in the large change in the mean score and the distribution of the increases. The latter indicate that while 48% show little or no change, 19% have large changes.

D TRANSFERABILITY

The opportunity arose to give the Plan test to some children in north and south London.

In the north they lived in the residential area of Barnet and had been used by Dalton (1968) as a control group for children whose mothers had been treated with progesterone in pregnancy. In order to assess the effect of progesterone on intellectual development, both groups of children were given a battery of tests including verbal reasoning, non-verbal, arithmetic-maths and the Plan test. The results can be seen in Table 3.10. They indicate that the group is of good average intelligence and that the mean of the Plan test is correspondingly higher than the original Bucks. standardization sample, while the standard deviation is the same.

TABLE 3.10

PRODUCT MOMENT CORRELATIONS, MEANS AND S.D. OF THE PLAN AND OTHER TESTS ON 27 CHILDREN IN EDMONTON, LONDON, MEAN AGE 11.9y S.D. .59y

| | | 1 | 2 | 3 | 4 | M | S.D. |
|---|---|---|---|---|---|---|---|
| 1 | VERBAL | | .60 | .74 | .35 | 108.14 | 15.50 |
| 2 | NON VERBAL | | | .69 | .35 | 106.22 | 12.09 |
| 3 | ARITH-MATHS | | | | .24 | 104.70 | 12.40 |
| 4 | PLAN | | | | | 105.70 | 15.55 |

In South London a class of 29 children in Streatham was used by Butterfield (1970) to investigate the association of personality and cognitive ability. Among the tests used were the BG, DAM, Schonell GWRT, Plan and a verbal reasoning test. The results in terms of raw scores and standard scores, where available, can be seen in Table 3.11.

TABLE 3.11

MEANS AND SD OF STREATHAM SAMPLE COMPARED WITH STANDARDIZATION SAMPLES

| | STREATHAM | | STANDARDIZATION SAMPLE | |
|---|---|---|---|---|
| N = 29 | M | SD | M | SD |
| AGE | 10y 10.97m | 3.729m | | |
| BG | 1.451 | 1.435 | 1.5 | 1.5 |
| DAM (RS) | 36.448 | 6.780 | Not Known | |
| (SS) | 97.793 | 12.07 | 100.0 | 15.0 |
| PLAN (RS) | 21.517 | 8.286 | 20.5 | 7.592 |
| (SS) | 98.241 | 17.423 | 100.0 | 15.0 |
| GWRT | 50.571 | 18.406 | 55 | |
| VERBAL REASONING | 31.423 | 21.206 | Not Known | |

TABLE 3.12

CORRELATIONS OF PLAN WITH OTHER TESTS

| | |
|---|---|
| BG | -.49 |
| DAM (RS) | .68 |
| (SS) | .45 |
| GWRT | .41 |
| VERBAL REASONING | .49 |

When these sample means are compared where possible with their standardization means, it can be seen that they are similar, suggesting that although this sample is small it may be representative of children of average ability. The DAM sample scores were not available because only mean scores for boys and girls separately are given in the manual and the verbal reasoning test with a closed one.

The correlations with the Plan test can be seen in Table 3.12. That of the Plan and DAM are the same as in the standardization sample (Thorstad, 1965), and that of the Plan and verbal reasoning test similar to that of the Edmonton sample.

It is not known, however, at what geographical point a line would have to be drawn, beyond which the test would not be reliable clinically, for similarity between standardization sample and the sample from which the clinic patient came could not be assumed.

It is doubtful, for instance, if it would be a reliable test in Sicily. There I only had the opportunity of obtaining plans from two boys, one

FIG. 3.1. A drawing of a plan of his house and a man by a Sicilian boy aged 9yrs of possibly above average ability.

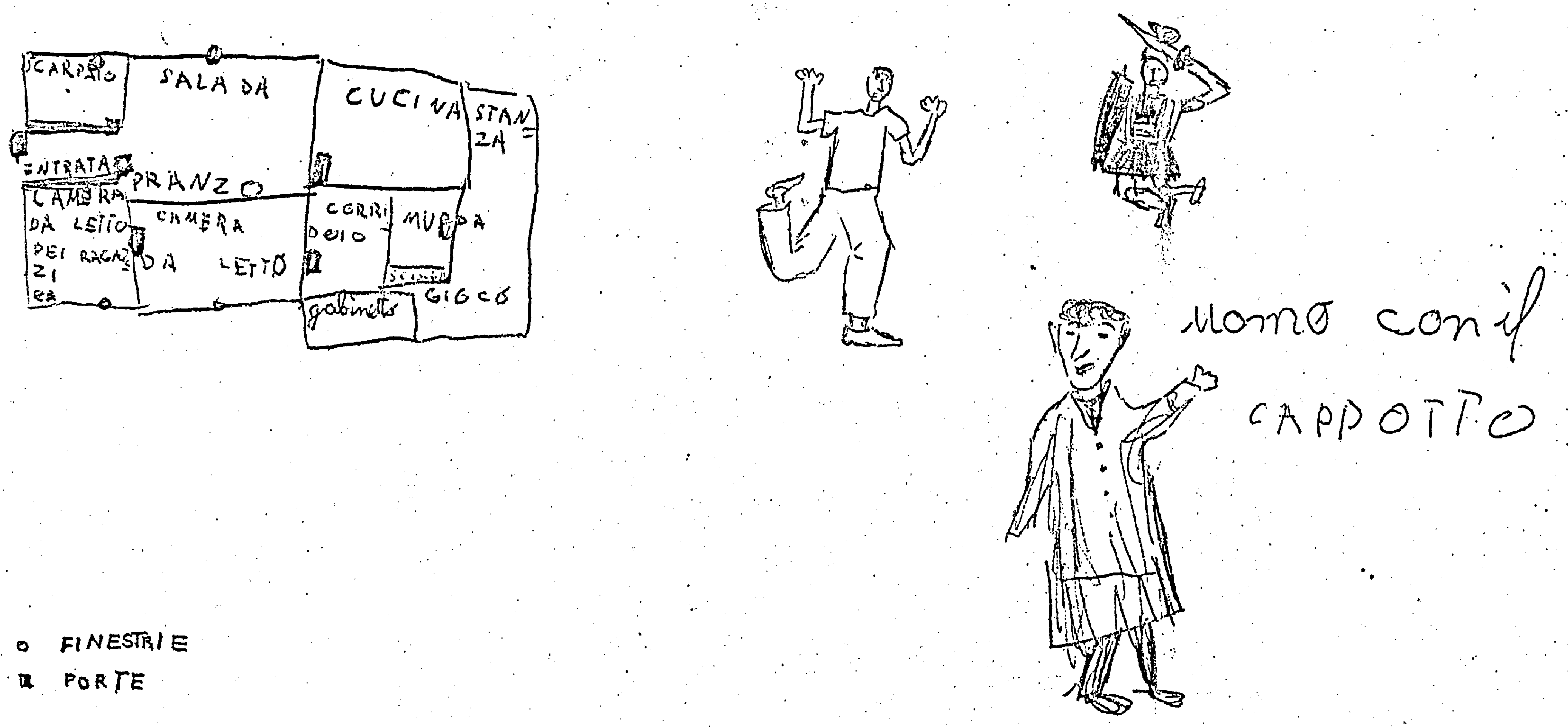


FIG. 3.2. A drawing of a plan of his house and a man by a Sicilian boy aged 12yrs of possibly average ability

nine year old boy of possibly above average ability and one twelve year old boy of possibly average ability. The first boy produced a horizontal plan which obtained a score of 125, which might have been expected in England. The other boy drew a vertical plan, which scored well below average and was typical of an eight year old. His drawing of a man was also at the same level. This would have suggested a spatial disability in England, but possibly not in Sicily. (Figs. 3.1 and 3.2)

Very early in the initial standardization, it was obvious that children from India and the West Indies could not be included for their drawings of the man and the plan were several years behind their English contemporaries. This is perhaps in line with Vernon's (1969) findings in the West Indies and other findings among the Negro population in the USA that the spatial ability of Negro children tends to be lower than that of the white children at the moment.

SUMMARY

1. The split half reliability coefficient indicated that the odd and even items were samples of the same universe of possible items.

2. Scorers reliability coefficients were all high and there was little difference between the mean scores, but as with other tests of this type, depending on the scorer's judgement, there were occasional lapses, which resulted in a large difference in standard scores. As such a difference can influence clinical diagnosis, it emphasises the clinician's responsibility to check scores and always be aware of the possibility of scorer unreliability, where making inferences from test results.

3. The stability of the test appears to be high at .96 over a week's interval, but then falls to .79 for intervals between one and three months. This suggests that the former was enhanced by memory and the latter figure the more realistic. There were indications that it was higher for boys than girls and these sex differences should be further explored.

There are no prescribed limits for stability coefficients, the Plan can only be compared with other tests in use. In these groups the reliability for the Plan was lower than that for a vocabulary test, but about the same for another vizuo-motor test (DAM). It is possible that the Plan is showing the lowest stability coefficient used with 8 year old children than with any other age group because the children are showing maximum conceptual change at this stage.

4. Transferability of the test is appropriate in the London area, for although the groups were small there was enough information about them to

render the findings meaningful. This suggests that the test is likely to be reliable in other parts of England. Just how far the transferability would extend geographically would depend on the external differences in the stimuli and the internal differences in abilities of the subjects.

PART TWO : RELATIONSHIP OF PLAN TEST TO GENERAL DEVELOPMENT

# CHAPTER IV

## CONCEPTUAL DEVELOPMENT OF SPACE AS REVEALED IN THE ITEMS OF THE PLAN TEST

### INTRODUCTION

When constructing this test, the principal means of validating the test items was by selecting those items which showed a steady increase with age. This was an entirely empirical method arising from the initial observation that 6 year old children drew pictures of houses when asked to draw a plan and only at the age of 10 years did most of them draw plans horizontally. Moreover when the items had been selected and the total scores found for standardization purposes, it was found that they increased until 13 years and then levelled off. Thus the striking feature was that it took seven years for this skill to develop, despite all the opportunity the children had to observe the house they lived in and the lessons they must have been given in plan drawing first in the primary school and then in the secondary school.

Although this information was obtained from a cross section sample, experience with other developmental tests suggests that the sequence of correct items seen in this sample would probably be duplicated in a longitudinal sample and with minor modifications in individual children. This feature at once suggests that the plan test is measuring some aspect of concept development in children, not just something that has been taught. However, when one turns to the literature very little can be found on this particular skill in any form.

A map has some of the attributes of a plan in that it necessitates a view in a plane at an angle of $90^{\circ}$, but with regard to roads does not incorporate the complexities of portraying a three dimensional structure. Money has published "A Standardized Road Map Test of Direction Sense" (1965) for subjects from 7 to 18 years which covers some of the same developmental period as the plan. As its name suggests it is testing children's sense of direction in so far as this involves knowing which way a road turns even though the subject's body is not in line with the direction of advance. However, this sense of direction is only indirectly incorporated into plan drawing. Children can be heard saying to themselves, "The kitchen is on this side and the living room on that", they do not have to attach the labels left and right which is essential to Money's test. In fact one pair of twins drew mirror images of the same house showing one of them was wrong, but their plan score was not penalized because accurate left-right naming is not scored.

Neurologists and psychologists studying the effects of parietal damage have found that plan drawing is affected (Critchley, 1953) but, being interested in the pathological aspects, have assumed that the average adult can draw a plan of his house correctly. They have not investigated the development of the necessary concepts in children.

Piaget only has investigated plan drawing, although limited to a model village and not the interior of a house. He has looked at it from the developmental point of view, producing extensive results and a theoretical framework.

He considers that the capacity to draw a plan of a model village is the co-ordination of schemes built up in the concrete operational stage, in which conservation in these infra-logical systems is achieved by means of reciprocity in projective and euclidean space leading eventually to a three dimensional grid based on horizontal and vertical co-ordinates. In a series of experiments given in "The Children's Conception of Space" (1956), he illustrates how children's concepts change from intellectual to visual realism, between the ages of 5 and 11 years. He shows how changes in the concept of projective space are seen in children's ability to use and portray perspective between the ages of 7 and 11 years. During this period they become increasingly capable of knowing what shape a geometric solid would have to someone with a viewpoint other than their own, what shape it would have if sectioned and what shape its shadow would cast. They knew how to draw railway lines and tree lined roads from any point of view. They are also increasingly able to conserve positions in space irrespective of the viewpoint by realising the relativity of terms such as left-right and in front-behind. He considers these concepts of projective space are eventually amalgamated with systems of horizontal and vertical space to form a concept of euclidean space, incorporating not only the conservation of proportions of objects themselves, but also the distance between objects. This is then a truly operational scheme in which conservation is achieved by reciprocity of relations.

The development of these concepts and their final amalgamation is seen in the topographical experiment in which children are asked to draw a model village from view points of $45^{o}$ and $90^{o}$. In this task Piaget found that from 4 to 7 years the children drew the required objects along the edge of the paper with no indication of depth. From 7 to 10 years a system of reference was gradually built up. The drawings now showed depth, distinguishing foreground from background so making full use of the paper. The children also began to clearly distinguish the drawings of the houses from different points of view and at an angle of $90^{o}$, the roofs were drawn as rectangles with a line down the middle as a ridge, instead of side elevations. Positions of objects were also stabilized and adjustments of right-left, in front-behind, were made in accommodating different view points.

Above 10 years the children began to take account of the distances between objects, use more than one reference point simultaneously and reduce the size of the objects proportionally. Thus it was not until this last stage that children were able to achieve conservation in their drawings by taking account of systematic viewpoints, implying a euclidean co-ordinate system within which they were able to place objects so that their size and the distance between them retained the correct proportions.

That this limitation in representation in younger children was not just due to difficulty in depicting the model was illustrated in Brown's experiment in 1969, in which he showed children three photographs of a farm and they had to arrange the toys accordingly. Under 4 years the arrangement was random, between 4 and 5 years the toys were arranged in a mirror image, between 4½ and 6 years a rough reproduction of the arrangement was made, over 6 years the children began to arrange the toys round the sides of the paper and finally between 8 and 9 years they achieved a systematic correspondence using all the space.

Although drawing a plan of a house is not exactly the same task as drawing a plan of a model village, it would seem to have some common features in that both involve the conceptualization of a three dimensional grid in order to conserve the positions of left-right, in front-behind and on top and underneath. At the same time a house may also be regarded as a paralleliped of which a plan is a horizontal section. Children's verbalization while they are still only able to draw vertical sections reveal that they are often aware of the inadequacy of their solutions for they only show the house from one point of view, while a plan should incorporate all points of view.

As the improvement in plan drawing occurs between the ages of 6 and 13 years, it would seem to exemplify in Piaget's terms the cognitive development seen in the concrete operational stage in infra-logical systems in which several systems are brought to bear simultaneously on one object.

AIM: To see what aspects of plan drawing, as exemplified in the items, are consistent with Piaget's findings at the concrete operational stage.

METHOD

1. Find the age at which 50% of children succeed on each item from the graphs. Also look at the age levels for boys and girls

separately, as the results in the item selection and standardization indicate that the boys are usually ahead of the girls.

2. Arrange the items in order of their age levels and use Spearman's rho to see if there is a significant relationship between the item order in boys and girls.

3. Group together those items which seem to be testing the same aspect of plan drawing ability with a view to discussing their characteristics in relationship to Piaget's findings and theory.

RESULTS

1. The age levels at which 50% of boys, girls and both together succeeded in passing each item can be seen in Table 4.1. They ranged from 6.9 years to 13.8 years, a spread of 7 years. Most of the girls levels were higher than the boys and in four items, 21, 27, 37 and 38 they failed to attain the criterion.

2. When the orders of the boys and girls items were examined their correlation was found to be rho .95 indicating that they were similar even though the girls were usually older before they passed each item successfully.

3. The items were then placed in four groups as given in Table 4.2, Group I Vertical Items had the youngest age range of 6.9 to 7.8 years, GROUP IV Proportions had the oldest age range 10.8 to 13.8 years and GROUP II Initial horizontal items and GROUP III Items measuring the delineation of internal space, occupied parallel age ranges within 8.0 to 12.9 years.

I VERTICAL ITEMS (1 to 6)

These were grouped together because the content was similar, all being concerned with a vertical representation of a plan. They were unlike the other groups in that there is no difference between the boys and girls age levels.

II INITIAL HORIZONTAL ITEMS (7, 16, 24, 30 and 34)

Only the initial horizontal items of rooms, doors, windows and staircase were considered. Items 7, 24 and 30 showed an increasing ability to take a horizontal section of a paralleliped. The near cube-like shape of a room (7) is easiest, followed by a door (24) which is much thinner and lastly a window (30) which is thinner still and also transparent. The staircase (16) at 9.1 years came midway and caused more difficulty than a room owing to the slope of the upper surface. There was no

TABLE 4.1

AGES AT WHICH 50% OF CHILDREN PASS EACH ITEM

Item definitions as for Fourth and Final Scoring System

| | ITEM | AGES IN YEARS Boys | Girls | Both |
|---|---|---|---|---|
| 1 | Roof absent | 6.9 | 6.9 | 6.9 |
| 2 | Chimney " | 6.9 | 6.9 | 6.9 |
| 3 | Upstairs " | 7.0 | 7.0 | 7.0 |
| 4 | Plan of outside wall absent | 6.9 | 6.9 | 6.9 |
| 5 | Floor indicated | 7.7 | 7.6 | 7.7 |
| 6 | Depth " | 7.8 | 7.5 | 7.7 |
| 7 | Rooms horizontal | 8.0 | 8.1 | 8.1 |
| 8 | All rooms connected | 8.3 | 8.7 | 8.6 |
| 9 | All walls common | 8.6 | 9.2 | 8.7 |
| 10 | Outer Wall I | 8.5 | 9.2 | 8.7 |
| 11 | Outer Wall II | 9.0 | 11.0 | 9.9 |
| 12 | Rooms : Proportion | 11.0 | 11.0 | 11.0 |
| 13 | Hall I | 8.8 | 10.2 | 9.2 |
| 14 | Hall II | 9.1 | 12.0 | 10.8 |
| 15 | Hall : Proportions | 12.0 | 13.2 | 12.9 |
| 16 | Horizontal stairs | 8.8 | 9.2 | 9.1 |
| 17 | Staircase I | 9.2 | 13.6 | 11.0 |
| 18 | " II | 10.8 | 13.8 | 13.4 |
| 19 | Staircase Proportion | 12.5 | 13.8 | 13.2 |
| 20 | Treads I | 9.2 | 12.4 | 11.2 |
| 21 | " II | 14.5 | - | 14.8 |
| 22 | Doors : Number I | 8.3 | 9.0 | 8.7 |
| 23 | " " II | 9.2 | 10.8 | 10.7 |
| 24 | " : Type I | 9.0 | 10.6 | 9.5 |
| 25 | " " II | 9.2 | 13.0 | 10.9 |
| 26 | " " III | 13.1 | 15.0 | 13.2 |
| 27 | Doors : Proportion | 13.6 | - | - |
| 28 | Windows : Number I | 8.8 | 9.4 | 8.9 |
| 29 | " " II | 9.3 | 10.3 | 10.2 |
| 30 | " Type I | 9.2 | 11.6 | 9.8 |
| 31 | " " II | 10.9 | 13.0 | 11.1 |
| 32 | " " III | 13.1 | 13.2 | 13.1 |
| 33 | No unaccounted for space | 10.8 | 12.9 | 11.0 |
| 34 | No vertical walls | 8.8 | 8.8 | 8.8 |
| 35 | Proportion : Number correct I | 10.8 | 10.8 | 10.8 |
| 36 | " " " II | 12.0 | 13.0 | 12.7 |
| 37 | " " " III | 13.8 | - | - |
| 38 | " " " IV | 13.8 | - | - |
| 39 | Quality of drawing I | 9.4 | 10.8 | 10.5 |
| 40 | " " II | 13.4 | 13.8 | 12.5 |

TABLE 4.2

Items grouped according to content showing the order of ages at which 50% of the children pass successfully.

I VERTICAL ITEMS

| | | Boys | Girls | Both |
|---|---|---|---|---|
| 1 | Roof absent | 6.9 | 6.9 | 6.9 |
| 2 | Chimney absent | 6.9 | 6.9 | 6.9 |
| 3 | Upstairs absent | 7.0 | 7.0 | 7.0 |
| 4 | Plan of outside wall absent | 6.9 | 6.9 | 6.9 |
| 5 | Floor indicated | 7.7 | 7.6 | 7.7 |
| 6 | Depth indicated | 7.8 | 7.5 | 7.7 |

II INITIAL HORIZONTAL ITEMS OF DIFFERENT FEATURES

| | | Boys | Girls | Both |
|---|---|---|---|---|
| 7 | Rooms horizontal | 8.0 | 8.1 | 8.1 |
| 34 | No vertical walls | 8.8 | 8.8 | 8.8 |
| 16 | Stairs horizontal | 8.8 | 9.2 | 9.1 |
| 24 | Doors horizontal | 9.0 | 10.6 | 9.5 |
| 30 | Windows horizontal | 9.2 | 11.6 | 9.8 |

III ITEMS MEASURING THE DELINEATION OF INTERNAL SPACE

| | | Boys | Girls | Both |
|---|---|---|---|---|
| 8 | All rooms connected | 8.3 | 8.7 | 8.6 |
| 10 | Outer wall $\frac{3}{4}$ correct | 8.3 | 9.2 | 8.7 |
| 9 | All walls common | 8.6 | 9.2 | 8.7 |
| 11 | Outer wall intact | 9.0 | 11.0 | 9.9 |
| 33 | No unaccounted for space | 10.8 | 12.9 | 11.0 |

IV PROPORTIONS

| | | Boys | Girls | Both |
|---|---|---|---|---|
| 35 | One proportion correct | 10.8 | 10.8 | 10.8 |
| 12 | Rooms correct | 11.0 | 11.0 | 11.0 |
| 36 | Two proportions correct | 12.0 | 13.0 | 12.7 |
| 15 | Hall correct | 12.0 | 13.2 | 12.9 |
| 19 | Staircase correct | 12.5 | 13.8 | 13.2 |
| 27 | Doors correct | 13.6 | - | - |
| 37 | Three proportions correct | 13.8 | - | - |
| 38 | Four proportions correct | 13.8 | - | - |

Only items that seemed to illustrate the experimental findings about the development of children's conception of space given in the introduction have been used. Thus items such as number of doors and windows and quality of lines have been omitted. Where there is a series of items related to one object in a plan, such as stairs, only the first in the series, indicating the major conceptual change, has been used.

difference between boys and girls age levels of items 7 and 34 room and vertical walls, but stairs, doors and windows showed an increasing age discrepancy with boys .4 year, 1.6 year and 2.4 years ahead respectively. It seemed therefore that although boys and girls achieved the concept of horizontality about the same time with regard to rooms, the boys generalized it much more quickly to stairs, doors and windows.

III ITEMS MEASURING THE INCREASING DELINEATION OF INTERNAL SPACE (8, 9, 10, 11 and 33)

It took 2.4 years from 8.6 to 11.0 years before 50% of children ceased to have unaccounted for space. It was eliminated first from between the rooms and last from round the staircase.

Even when children could draw horizontal rooms they were vague about how they fitted together. They often joined the rooms together with a hall (Fig. 4.1) because that was how they remembered proceeding from room to room or put the drawing in one encircling outer wall as in Fig. 4.2.

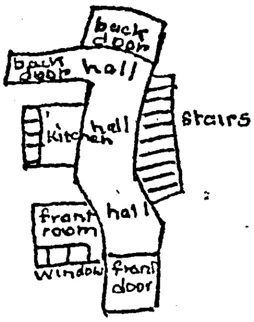



Fig.4.1 A plan with connected rooms, but walls not common by a girl aged 10y 3m

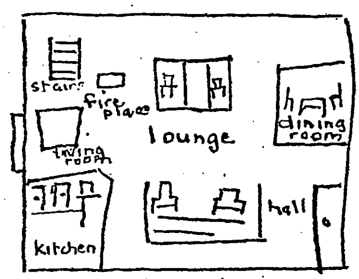



Fig.4.2 A plan showing isolated rooms within an encircling wall by a girl aged 9y 6m

They found the area round the staircase particularly confusing and often did not portray the staircase and the hall where they walked as adjoining. They were also vague about the wall at this point and it was often the last wall to remain vertical. (Fig 4.3).

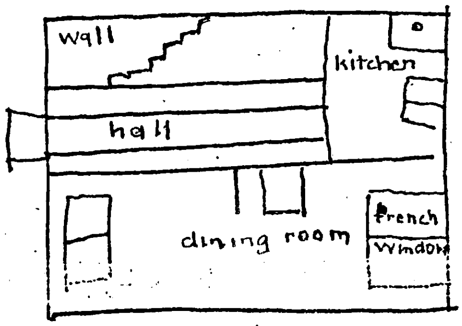



Fig. 4.3. A typical plan of an 8 year old
"The hall is where you go down to the kitchen"

IV PROPORTIONS (12, 15, 19, 27, 35, 36, 37, 38)

The proportions were the last group of items to be scored correctly by 50% of the children. The items followed the same order as for horizontality, rooms, hall, staircase and doors. Although 50% of both boys and girls obtained one proportion correct at 10.8 years, the boys generalized more quickly than girls, who never achieved the criterion on 27, 37 and 38. These items on proportion were never done completely correctly even by 15 year old children. They achieved about an 80% success with rooms and hall, but staircase and doors remained at about 50% and 40% respectively.

DISCUSSION

I VERTICAL ITEMS

These items would seem to exemplify how the children change from Piaget's ego-centric pre-operational stage to the beginnings of the concrete operational stage in which a concept of projective space eventually leads to the conservation of left-right and in front-behind.

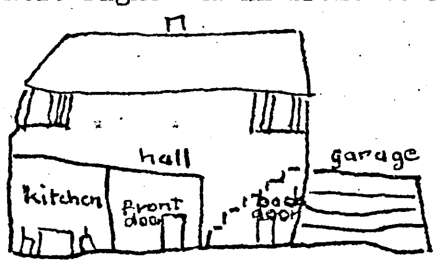



Fig.4.4 A drawing incorporating external and internal features of a house by a boy of 6y 10m

The plan that the 6 year old draws such as in Fig.4.4 still belongs to the pre-operational stage of topological geometry in which he only portrays the relations of proximity, separation, enclosure and continuity. Despite the instructions he draws the chimney on the roof, the roof on the house and the windows and the door inside the outline of the house. In an attempt to indicate the rooms in the house as requested he sometimes puts in a rectangle representing a room and some stairs, leaving it very uncertain to what extent the plane of the outside still exists. This solution has something in common with children's drawings of a section of a paralleliped or cylinder found in Stage II by Piaget's experiments in which the cross section is incorporated within the usual outline (Fig. 4.5).

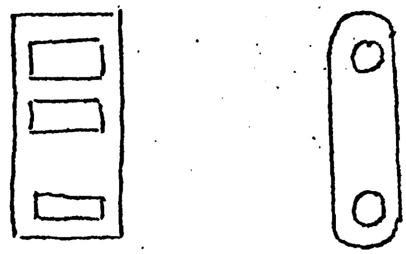


Fig. 4.5 Transverse sections of a paralleliped and a cylinder by a boy of 6 years (Piaget and Inhelder, 1956).

At this stage children have still not accepted the discipline and rigorous exclusiveness of one ego-centric view point and are still at the stage of Luquet's (1929) intellectual realism in which they draw what they know and not what they see.

Gradually between the age of 7 and 8 years they are able to undertake an imaginative decomposition of the vertical section of the house leaving out the chimney, the roof and the upstairs and draw an interior picture usually of the hall and stairs. At first it shows no recession, but towards the end of the eighth year they begin to indicate depth, first by drawing in the floor and later by showing rooms behind one another (Figs.4.6 and 4.7).

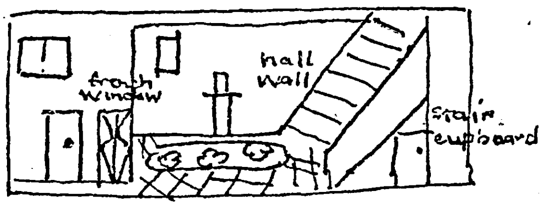



Fig.4. Depth indicates as in a picture by a boy of 6y 11m.

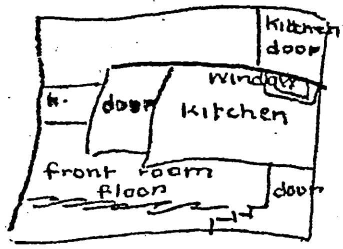


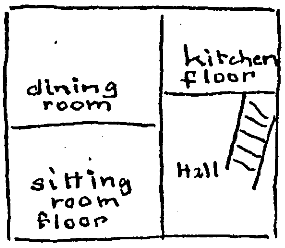

Fig.4.7. Depth indicated by drawing rooms behind each other by a boy of 7y 8m.

This is the age when the children in Brown's experiment begin to place toys round three sides of the paper when trying to copy the arrangement in a photograph and in the reverse situation in Piaget's experiment of drawing a model village do not just draw all the objects along the bottom edge of the paper, but begin to use more of the inner space.

In the other Piaget experiments on projective space children's concepts of perspective are clarifying at Stage III usually between the ages of 7.0 and 8.6 years. They are beginning to be able to imagine different viewpoints and sections of solids and know what shape shadow they will project. Recognition would seem to precede execution for drawings of roads and railways showing the convergence of parallel lines are only just emerging.

When their capacity to draw a picture of the ground floor of their house at about an angle of $45^{o}$ is established they produce a solution to the problem as in Fig. 4.8 and 4.9

An example of a child's drawing at an angle of 45°.



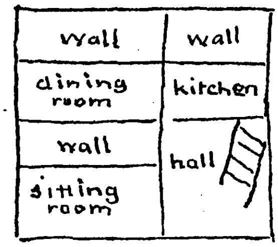
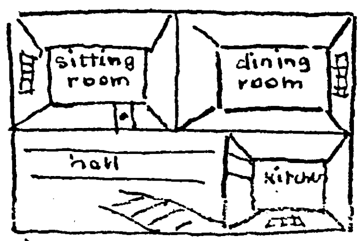




Fig. 4.8. Before enquiry        Fig. 4.9 After enquiry

Such drawings as Fig. 4.8 always need a careful enquiry because it can be assumed that the enclosed space is horizontal, whereas it is really an amalgamation of floor and wall. If pressed to indicate which is floor and which is wall, children put in lines as in Figure 4.9

In the above drawings they have conserved the positions of left-right but not in front-behind. What seems to cause them disquiet is that they realize they cannot simultaneously show the plane surface of both sides of a wall. This can only be achieved by taking a view point of 90° and leads to the successful passing of item 7 Horizontal rooms. At this stage they would appear to be taking into account for the first time the three dimensional attribute of space. Some at first take successive viewpoints over each room (Fig 4.10) but most seem to proceed to the better solution of Figure 4.11.



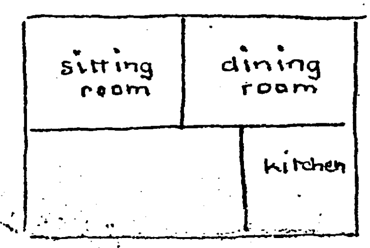




Fig.4.10. Successive 90° viewpoints  Fig.4.11. A horizontal plane of viewpoints.

Even so they do not immediately generalize this new solution to stairs, doors and windows, which are discussed in Group II nor do they solve the problem of what happens between the objects they are focussing on, which is discussed in Group III.

II INITIAL HORIZONTAL ITEMS (7, 16, 24 and 30)

Achievement with these items would seem to relate to Piaget's work on projective space, projection of shadows and geometric sections, in which success comes first at 8.0 years with simple solids and continues through to 12.0 years with more complex ones. In the plan all the solids are simple parallelipeds, although of decreasing width, but they differ from the solids used in Piaget's experiment in that they are all larger than the child and rarely come within one vizual span. They are also not so abstract for they have connotations of everyday use. A door is something to go through and knobs are usually drawn; stairs are something to ascend and the step like symbol is used frequently; while windows are something to look through and are not therefore treated as a solid. One child refused to draw in the kitchen window because it was opaque and he could not see through it.

These items exemplify Piaget's concept of horizontal décalage in which it takes time before an operational scheme is generalized to all possible stimuli.

III ITEMS MEASURING THE INCREASE IN DELINEATION OF INTERNAL SPACE (8,9,10, 11 and 33)

What may be happening in plan drawing at this stage is that the child is taking a series of individual viewpoints of 90°, one over each room, shown in Fig. 4.12. When they begin to realize that one wall is common to two rooms, that it is only a divider of a larger space, then they see the spaces between as illogical and eliminate them.

It is not only a three dimensional room they see as separate at 8.0 years. In Piaget's work on euclidean space the parallels in the scissor like shape of Fig. 4.13a are not conserved immediately, but are copied as in Fig. 4.13b the child focussing on each diamond shape separately.

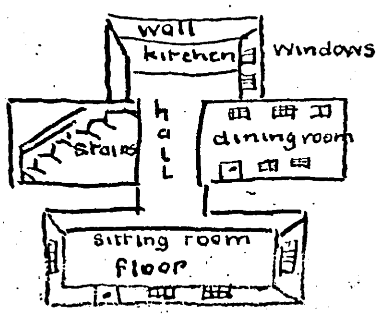



Fig.4.12. A plan with walls not common by a boy of 10y 1m

(a)

(b)

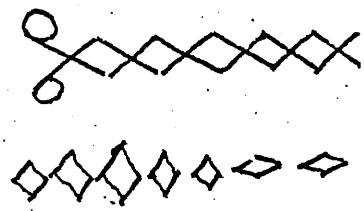


Fig.4.13. A childs copy of the Nuremburg scissors

Likewise Vernon (1962) cites Gesell's and Rupp's work showing that children cannot at first see the dual functions of the lines in a honeycomb, but see the shapes as separate entities. Thus it might be that any different shape in a complex figure is seen on its own at first and only later in relationship to the whole, illustrating the part-whole aspect, Piaget's infra-logical system.

When a child does eventually see walls as common and no unaccounted for space between them then it implies a series of viewpoints in any direction in a plane at right angles to the floor, involving a system of co-ordinates. This may be similar in three dimensional space to what happens in two dimensional space. The author has observed that it used to be difficult to teach 8.0 year old children how to draw a line parallel to another one, for they had difficulty in conceptualizing the line as a series of points all the same distance from the given line. Piaget in an extension of this task, locating a point that implied the intersection of two parallel lines, found that it was not achieved until 10 years.

For all viewpoints to be accommodated in three dimensional space of which a plan is one, it is possible that a child has to establish a conceptual grid of horizontal and vertical co-ordinates. Such a grid was hypothesized by Piaget when he found that between the ages of 8.0 and 9.0 years children were giving evidence of vertical and horizontal concepts when masts of boats, trees on mountains and a plumb line in a jar were drawn vertically and water in a tilted jar was drawn horizontally. This is a period when children are making fast progress in plan drawing, so that ability to draw all items horizontally and eliminate unaccounted for space may be a product of the co-ordination between projective and euclidean concepts of space, enabling him to form a three dimensional grid of vertical and horizontal space.

IV PROPORTIONS

Ability to incorporate proportion in plan drawing is the last group of items to receive attention, improving from 10.8 years to 13.8 years at the 50% level, but never achieving a 100% success, which suggests that the average adult may be no better. The staircase and doors are the weakest.

Piaget and Inhelder (1956) have one study on the perceptual comparison of proportions in which children have to compare and draw a rectangle 1.5 cm x 3.0 cm with a series whose width is 4 cm but whose length varies. They were also required to draw one in proportion. Between 5 and 6 years children tended to choose and draw rectangles which were longer than the stimulus, between 7 and 9 years the perceptual estimates were better than the drawings, while over 10 years construction was better than perceptual judgement because children began to understand the nature of proportion. This suggests that perception of proportion before 10 years tends to be intuitive, possibly relying on spatial judgement and only becomes part of a logical scheme later.

In their study of plan drawing of the model village, as in the case of area and volume, children first attend to proportion of the object in houses at 7 years, but do not begin to notice the proportional distance between objects until 11 years. This seems another example of the figure ground problem as seen in the Kohs' Blocks test, in which, when the blocks are increased from 4 to 9, children cease to attend to the whole red and white design, but see the red section as a figure on a white background.

In the plan drawings it would seem that children first see the rooms as objects in a large undifferentiated space encompassed by four outer walls. Two per cent have proportions of rooms correct at 7.2 years and the numbers increase rapidly until 61% at 11.2 years. The more difficult items hall, staircase and doors come later. The doors may exemplify the rule of the proportions of spaces following that of objects for when the child ceases to draw a picture of a door they next represent the door frame, that is a space in between walls. It is this which is credited in item 27 and when the 50% who eventually include the door as in an architect's plan at the age of 13.5 years it is always of the same width as the door frame.

Proportions therefore would seem to be one of the last concrete operational schemes to appear.

SUMMARY

When the items of the Plan test are grouped as above they would seem to indicate three stages that children go through in the seven years which elapse between the vertical pictures of houses at six years and the horizontal and mainly correct plans at thirteen.

Stage I when children are in the process of passing from vertical to horizontal representations of rooms.

Stage II when children are generalizing the concept of horizontality to other parallelipeds and eliminating spaces

Stage III when the concept of proportion is applied to parallelipeds in the same order and finally to spaces in between objects.

These stages occur over the same time span as those found by Piaget when investigating children's conception of projective and euclidean space. He ascribes these concepts to the infra-logical system of the concrete operational stage and considers that they illustrate the acquirement of knowledge through the biologically adaptive processes of assimilation and accommodation. It was therefore considered useful to look at the changes seen in plan drawing in the light of the same theory to see what further testable hypotheses might be produced.

# C H A P T E R V

## ASSOCIATION OF CHILDREN'S ABILITY TO CONCEPTUALIZE A 3 DIMENSIONAL SPATIAL SYSTEM OF REFERENCE AND THEIR ABILITY TO DRAW A PLAN

### INTRODUCTION

In order to test a child's conception of space as a euclidean grid of intersecting horizontal and vertical co-ordinates, it was decided to use two of Piaget's tasks from 'A Child's Conception of Space' (1956), horizontality of a water level and verticality of a plumb line, one from 'The Child's Conception of Geometry' (Piaget, Inhelder and Szeminska, 1960) a geometric locus, and the drawing of a line parallel to a given one. The last task was thought to be of the same type but easier than the geometric locus, because it only needed a measurement in one direction and because it was known to be difficult for eight year old children even when demonstrated.

### SAMPLE

A primary school was chosen in Buckinghamshire, because it was known to have a normal distribution of verbal reasoning scores among 10 and 11 year old children taking the secondary selection test.

When looking for concomitant variations in abilities in children, it is necessary to use children at the proper level of concept development. If they are too immature, the tasks are too hard and nobody can do them, if they are too mature, the tasks are too easy and everybody can do them. In either case there is no discrimination in the tasks and therefore no association, which is a [illegible] of the sampling. As the main change from vertical to horizontal plans occurred in the main sample between 7 and 9 yrs. that would seem to be the principal period of change. In a normal population it is the period of change, which may give interesting information about any association between different conceptual developments, as opposed to investigations where different clinical groups are used, when it is more useful to choose a stage when the concept should have developed in all children.

From Piaget's work in Switzerland on horizontal and vertical concepts, it seemed that most children achieved these by the age of 9 yrs. Mycock's, (1969) work in England with 60 children, whose average age was 9 y 6 m, also showed that 90% of them accomplished the tasks correctly. The locus of a point from a corner was a little more difficult according to Piaget; and children were nearer to 10 yrs. before achieving it while the ability to draw a line parallel to another was known to present difficulties to 8 yr. olds.

From this information it was decided to use 8 yr. old children in the investigation, as likely to be at an age when the association between developing concepts could be seen most clearly. The whole of the age group consisting of 40 boys and 40 girls was therefore tested.

MATERIALS

1. Paper, pencils and rubbers for drawing the plan.
2. a. Jar with water, and a jar with a plumb line; both standing upright.
   b. Paper with diagrams of 4 empty jars, 2 upright and 2 tilted at $45^{\circ}$
3. Paper with one horizontal line and a dot 2" from the top left hand corner.
4. The Crichton Vocabulary Scale (Raven, 1950).

PROCEDURE

The children were first tested as a group in their own class rooms and later individually in a small room nearby.

A. Group Testing

Children were asked to draw a plan and a man; the dual task being given in order to stop copying. The procedure and instructions were exactly the same as for the main sample.

B. Individual Testing

1. Piaget Tests

The children were first given the three Piaget tests and the one of drawing parallel lines, henceforth referred to as the Piaget tasks. As some practice effect could be expected, the four tasks were given in a random order.

The instructions for the tests were as follows:

a. Show the child the jar of water, then point to the outline of the tilted jar on the paper and say "If this was a jar of water like this one here (Point again to the jar of water) show me where the water would come if the jar was tilted... Draw it in with your pencil".

b. Show the child the jar with the plumb line hanging down, then point to the outline of the second tilted jar on the paper and say, "If this jar contained a plumb line like this one here, (Point to the jar with the plumb line) show me where the plumb line would come if the jar was tilted... Draw it in with your pencil".

c. Show the child the line on the paper and say, "Draw me another line 2" away with the ruler". Check that he can measure 2".

d. Show the child the dot in the top left hand corner and say, "Put a dot in the other corner exactly the same distance away from the corner as this one is.

2. Verbal Questionnaire

For procedure and results see Chapter VII.

3. The Crichton Vocabulary Scale

This was chosen because it was anticipated that success on the other tasks would be partially associated with general intellectual ability. Vocabulary always has a high correlation with any other intelligence test and it has the advantage that it is not loaded with spatial ability as the other tests probably are.

It was given according to the set instructions.

SCORING

1. The Plan was scored as in the Fourth and Final Scoring System
2. The Man was scored on Harris's adaptation of the Goodenough System.
3. The Crichton Vocabulary Scale was scored according to Raven's instructions.
4. The Questionnaire answers were classified according to the criteria in Chapter VII.
5. The Piaget tests were scored in the following manner, first using a simple pass and fail criterion then the developmental stages as found by Piaget:

| a. Horizontality | Score |
|---|---|
| Surface of the water represented by a straight line | 1 |
| The straight line drawn at an angle other than parallel to the bottom of the jar | 2 |
| The straight line drawn horizontally, ie parallel to the bottom of the page. | 3 |

| b. Verticality | |
|---|---|
| Plumb line hanging straight | 1 |
| Plumb line hanging at an angle but not correct | 2 |
| Plumb line hanging at the correct angle at $90^{\circ}$ to the bottom of the paper. | 3 |

| | | Score |
|---|---|---|
| c. | Parallel line | |
| | A line drawn with the ruler approximately parallel with the given line, but no measurement made | 1 |
| | Attempting to measure the distance of 2" from the first line, but drawing a line at right angles | 2 |
| | Measuring the distance correctly and then using one measurement to draw a second line parallel to the first | 3 |
| | Measuring the distance correctly from two points in order to get the line parallel | 4 |
| d. | Locating a point in a 2 dimensional space | |
| | Approximately correct placing of the dot using only a visual estimate | 1 |
| | Using a ruler to measure an oblique line from the corner | 2 |
| | Using a ruler to measure an oblique line from the corner and the distance from one of the sides | 3 |
| | Using the ruler to measure the distance from both of the sides | 4 |

RESULTS

The results of the boys and girls were treated separately because the boys were nearly one year ahead of the girls in the standardization sample and it was thought that different interactions between tests may be revealed. The group consisted of 40 boys and 40 girls from 8 to 9 years, average age being 8 y 7.m. for both. Their scores on the Plan test were approximately the same as in the standardization sample.

The Piaget tasks were first scored according to simple pass or fail criteria and if a line which was within 10$^{\circ}$ of being correct was accepted as correct in the vertical and horizontal scores. The number of children succeeding on the tasks are shown in Table 5.1. The plans are scored as being vertical or horizontal, based on item 7.

TABLE 5.1

NUMBER OF CHILDREN SUCCEEDING ON ITEM 7 OF THE PLAN TEST AND THE PIAGET TASKS, EXPRESSED AS PERCENTAGES.

| | PLAN ITEM 7 | | PIAGET TASKS a | | b | | c | | d | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % |
| BOYS | 23 | 58 | 22 | 55 | 30 | 75 | 23 | 58 | 2 | 5 |
| GIRLS | 20 | 50 | 13 | 33 | 21 | 53 | 20 | 50 | 0 | 0 |
| Order of Difficulty | 3.5 | | 2 | | 5 | | 3.5 | | 1 | |

The results show that the age group was appropriately chosen because about half the group succeeded on all tasks, except d, which was too difficult. This means that the concepts were being formed and that it would be useful to look for associations between these and the ability to draw a plan horizontally.

The boys performed better on all of them as expected, but the order of difficulty as defined by the number of children passing was the same for both sexes, ( Table 5.1. ).

An attempt was made to compare the results of the water (a) and plumb line (b) task with those of Beard, (1964) by finding the average scores using the 3 point criteria. (Table 5.2.).

TABLE 5.2

AVERAGE SCORES FOR PIAGET TASKS

| | a | b | c | d |
|---|---|---|---|---|
| BOYS | 1.92 | 2.05 | 2.25 | 1.60 |
| GIRLS | 1.82 | 2.22 | 1.98 | 1.18 |

But they are not easy to compare because her age range is six months higher, 8y 5m to 9y 4m, and she used a 5 point scale. Beard's results are in Table 5.3.

TABLE 5.3

Beard's Results 1964

| | NUMBER | | HORIZONTAL WATER AVERAGE SCORE | | VERTICAL PLUMB LINE AVERAGE SCORE | |
|---|---|---|---|---|---|---|
| AGE | BOYS | GIRLS | BOYS | GIRLS | BOYS | GIRLS |
| 6y5m-8y4m | 29 | 11 | 1.6 | 1.2 | 2.6 | 1.7 |
| 8y5m-9y4m | 25 | 19 | 1.9 | 1.7 | 3.2 | 2.8 |

Taking the difficulties of comparison into account, the direction seems to be generally the same, boys better than girls, vertical task scores higher than horizontal scores, although the overall scores might be lower in Beard's sample.

ASSOCIATION TESTED BY CHI-SQUARE

The association between drawing a plan horizontally and success on the tasks a, b and c was tested by chi-squared. The results are in Table 5.4.

TABLE 5.4

ASSOCIATION BETWEEN HORIZONTALITY IN THE PLAN AND ITEMS ON THE PIAGET TESTS.

a. Horizontality of water level and Plan.

BOYS

| Water | PLAN: Horizontal | PLAN: Vertical |
|---|---|---|
| Hor. | 17 | 5 |
| Not Hor. | 6 | 12 |

Chi-square 6.126 P.05

GIRLS

| Water | PLAN: Horizontal | PLAN: Vertical |
|---|---|---|
| Hor. | 11 | 2 |
| Not Hor. | 9 | 18 |

Chi-square 7.296 P.01

b. Verticality of plumb line and horizontality of plan.

BOYS

| PLUMB LINE | PLAN: Horizontal | PLAN: Vertical |
|---|---|---|
| Vertical | 20 | 10 |
| Not Vertical | 3 | 7 |

Chi-square 2.762 P.1

GIRLS

| PLUMB LINE | PLAN: Horizontal | PLAN: Vertical |
|---|---|---|
| Vertical | 14 | 7 |
| Not Vertical | 6 | 13 |

Chi-square 3.609 P.05

c. Parallel lines and horizontal plan

BOYS

| Parallel Lines | PLAN: Horizontal | PLAN: Vertical |
|---|---|---|
| Correct | 16 | 7 |
| Incorrect | 7 | 10 |

Chi-square 2.166 P.10

GIRLS

| Parallel Lines | PLAN: Horizontal | PLAN: Vertical |
|---|---|---|
| Correct | 15 | 5 |
| Incorrect | 5 | 15 |

Chi-square 8.100 P.01

There was a significant association between horizontality on the plan and all the tests, but the highest was with Task a, the water level. On this and on Task c, parallel lines, the association in girls was higher than in boys. There was no association with Task d, locating a point in a corner, because it was too difficult.

As no unequivocal relationship was revealed between the plan and individual tasks, association between the Plan and different combinations of tasks was tested also using chi-squared, to see if there was a more significant relationship between those.

a. A horizontal plan and both a and b correct, either a and b correct and neither a and b correct.

b. A horizontal plan and number of tasks correct.

c. A horizontal plan and either 0 tasks correct or 1 to 4 tasks correct.

d. A horizontal plan and either 0 and 1 correct or 2 and 4 correct.

Knowing that success can be achieved in a variety of ways, it might be expected that if one concept was not available to help solve the problem, then another one would be. The results are in Table 5.5.

TABLE 5.5

ASSOCIATIONS BETWEEN HORIZONTALITY IN THE PLAN AND DIFFERENT COMBINATIONS OF THE PIAGET TESTS.

a. Association between horizontality and horizontal and vertical tasks correct, either correct and neither correct.

| | BOYS PLAN | | GIRLS PLAN | |
|---|---|---|---|---|
| | Horizontal | Vertical | Horizontal | Vertical |
| Horizontal and Vertical | 15 | 4 | 8 | 2 |
| Either Hor. or vert. correct | 7 | 7 | 9 | 5 |
| Neither correct | 1 | 6 | 3 | 13 |
| Chi-square | 9.391 | P.01 | Chi-square 10.982 | P.005 |

b. Association between horizontal plan and number of tasks correct.

BOYS PLAN

| | H | V |
|---|---|---|
| 4 | 1 | 2 |
| 3 | 10 | 2 |
| 2 | 9 | 3 |
| 1 | 3 | 7 |
| 0 | 0 | 4 |

GIRLS PLAN

| | H | V |
|---|---|---|
| 4 | 0 | 0 |
| 3 | 6 | 2 |
| 2 | 8 | 1 |
| 1 | 6 | 6 |
| 0 | 0 | 11 |

Chi-square 13.331 P.01 Chi-square 12.9444 P.02

c. Association between horizontal plan and gaining either 0 or 1-4 correct. (The Fisher Exact Probability Test)*

BOYS

| | H | V |
|---|---|---|
| 1-4 | 23 | 13 |
| 0 | 0 | 4 |

GIRLS

| | H | V |
|---|---|---|
| 1-4 | 20 | 9 |
| 0 | 0 | 11 |

P 0.05 P 0.01

d. Association between horizontal plan and gaining either 0 or 1, or 2, 3 or 4 correct. (The Fisher Exact Probability Test)*

BOYS

| | H | V |
|---|---|---|
| 2-4 | 21 | 6 |
| 0-1 | 2 | 11 |

GIRLS

| | H | V |
|---|---|---|
| 1-4 | 20 | 9 |
| 0 | 0 | 11 |

P 0.01 P 0.01

The results show that there is a closer association between success on the Plan and combinations of these tasks. Again a closer association is seen with the girls, except for the boys in (b). Particularly important are (b) and (c), which show that no child drew a horizontal plan, who did not have at least one other task correct.

However, as it is possible that the association could be explained by intelligence, the coefficient of correlation of the vocabulary test, as an estimate of general ability, and the Plan test was found.

* 'Tables for Fisher's Exact Probability Test' given by R. Langley in 'Practical Statistics', Pan Books (1968).

ASSOCIATION TESTED BY PRODUCT-MOMENT CORRELATION OF TESTS WITH VOCABULARY

The scoring was done as follows:-

1. Plans were scored
   a. On the 40 items of the full scoring system.
   b. 10 items pertaining to horizontality, 7, 16, 20, 21, 24, 25, 26, 30, 31 and 34.

2. Piaget items were scored according to the system mentioned earlier, total being 14.

The results are shown in Table 5.6

TABLE 5.6

PRODUCT MOMENT CORRELATION

| BOYS | | 1 | 2 | 3 | 4 | 5 | 6 | MEAN | S.D. |
|---|---|---|---|---|---|---|---|---|---|
| Vocabulary | 1 | | | | | | | 37.670 | 8.595 |
| Piaget Tasks | 2 | .538 | | | | | | 7.825 | 2.354 |
| Plan on Full Score | 3 | .601 | .537 | | | | | 12.775 | 8.676 |
| Plan on Horizontal scores | 4 | .583 | .508 | .949 | | | | 2.700 | 2.925 |
| DAM | 5 | .461 | .166 | .372 | .373 | | | 26.325 | 7.403 |
| Age in months | 6 | .266 | .368 | .185 | .202 | .195 | | 103.475 | 3.24 |

| GIRLS | | 1 | 2 | 3 | 4 | 5 | 6 | MEAN | S.D. |
|---|---|---|---|---|---|---|---|---|---|
| Vocabulary | 1 | | | | | | | 39.60 | 9.30 |
| Piaget Tasks | 2 | .550 | | | | | | 6.95 | 1.92 |
| Plan on Full Score | 3 | .343 | .618 | | | | | 10.27 | 7.22 |
| Plan on Horizontal scores | 4 | .263 | .567 | .904 | | | | 1.60 | 2.07 |
| DAM | 5 | .400 | .402 | .349 | .263 | | | 28.63 | 7.50 |
| Age in months | 6 | .181 | .030 | .020 | .057 | .263 | | 102.85 | 3.43 |

P .05 = 0.300 P .01 = 0.394

Some of the correlations are as expected from other studies. The vocabulary test as a measure of general intelligence tends to correlate at the .5 level, as it does here with the Piaget tasks and the Plan scores 3 and 4 in the boys. The correlation score of .4 for vocabulary and DAM is the same as studies quoted by Harris, (1963). The correlation of the Plan and DAM of .37 for boys and .35 for girls is about the same as found by the writer in this age group of the standardization sample. (Thorstad, 1965).

The correlation of all tests with age was low, or non-significant. The correlation with the Plan full score (3) and horizontal scores (4) was high at .9 in both boys and girls and suggests that this horizontal scoring system might be substituted for the full one without much loss.

The most relevant for this study are however the correlations between vocabulary, Piaget tasks and Plans 3 and 4, which were all statistically significant.

The correlations of the Piaget tasks and the Plan 3 and 4 were moderately high at .5 and .6 for boys and girls respectively. A sex difference, however, was apparent in the correlations of the vocabulary and Plan (3) Boys .6 and Girls .3, and Plan (4) in the same direction Boys .5 and Girls .3.

Using the formula $rxy.z = \dfrac{rxy - rxz.ryz}{\sqrt{(1 - r^2xz)\ (1-r^2yz)}}$

the effect of the vocabulary was partialled out of the Plan (3) and Piaget scores leaving a correlation of Boys .32 and Girls .54. Thus as expected, general intelligence, as measured by vocabulary, could explain some of the association between the ability to draw a Plan and the Piaget tasks.

Also as expected from the 2x2 tables of the chi-square the ability to draw a plan is more closely connected to general intelligence, whatever that means, in the boys and more closely to the Piaget tasks in the case of the girls.

ANALYSIS OF COVARIANCE

Having established that there was an association between the ability to draw a Plan and the Piaget tasks even when the effect of vocabulary is controlled, the problem was approached from another direction by using analysis of covariance.

Still keeping the boys and girls separate, they were divided into two groups, those drawing a plan vertically and those drawing a plan horizontally. Their scores on the Piaget tasks were then tested for homogeneity. As it was known that the scores were affected by vocabulary, an analysis of covariance was used to remove this effect. (Table 5.7).

TABLE 5.7

ANALYSIS OF COVARIANCE TO TEST THE HOMOGENEITY OF PIAGET TASK SCORES IN TWO GROUPS OF CHILDREN, DRAWING THE PLAN VERTICALLY AND HORIZONTALLY.

BOYS

SUMS OF SQUARES AND PRODUCTS

| SOURCE | Ss VOCABULARY | SP | Ss PIAGET | df |
|---|---|---|---|---|
| BETWEEN | 1044.6 | 248.35 | 56.19 | 1 |
| RESIDUAL | 190.5 | 143.20 | 165.61 | 38 |
| TOTAL | 2955.1 | 391.55 | 221.80 | 39 |

ANALYSIS OF VARIANCE ON ADJUSTED SCORES

| SOURCE | Ss | df | Variance | F | P |
|---|---|---|---|---|---|
| BETWEEN | 56.14 | 1 | 56.14 | 12.81 | .001 |
| RESIDUAL | 165.53 | 38 | 4.36 | | |
| TOTAL | 221.67 | 39 | | | |

GIRLS

SUMS OF SQUARES AND PRODUCTS

| SOURCE | Ss VOCABULARY | SP | Ss PIAGET | df |
|---|---|---|---|---|
| BETWEEN | 415.77 | 142.36 | 48.74 | 1 |
| RESIDUAL | 3045.83 | 178.84 | 99.16 | 38 |
| TOTAL | 3461.60 | 321.20 | 147.90 | 39 |

ANALYSIS OF VARIANCE ON ADJUSTED STORES

| SOURCE | Ss | df | Variance | F | P |
|---|---|---|---|---|---|
| BETWEEN | 48.706 | 1 | 48.706 | 18.67 | .001 |
| RESIDUAL | 99.102 | 38 | 2.608 | | |
| TOTAL | 147.808 | 39 | | | |

The variance ratio indicates that the Piaget scores in the two groups are not homogeneous, but are significantly different, even when the effect of general intelligence is removed.

DISCUSSION

Although this group of 80 children was small, the available measures show that the abilities of these children in these tests were similar to the national average for this age group. Not only were the means and standard deviations similar to the original standardization samples of the Plan, DAM and vocabulary scores, but also the inter relationships between the tests were in a similar range to those found in other studies. This implies that the findings in this group are likely to be applicable to other groups, if of a similar constitution.

The findings showed that there was a significant association between both Plan scores and the Piaget Tasks, whether taken singly or in combinations. There was, however, also a significant association with intelligence, as measured by the vocabulary test and both the Plan and the Piaget Tasks. This might have explained the association between the Plan and Piaget tasks, but the partial-correlation and the analysis of co-variance showed that there was still a significant association, even when the effects of intelligence were controlled. This was higher for the girls than the boys.

The hypothesis that all children who can draw a horizontal plan had a 3 dimensional conception of space, as measured by their ability to put in horizontal water lines and vertical plumb lines, was not supported. For this to be true it would have been expected that more children would have succeeded on Piaget's vertical and horizontal tasks than on the Plan, because as it is a developing concept linked with age, the higher incidence would have implied that the tasks were easier and that they developed before the Plan. It would also have implied that mere children would have drawn horizontal water and vertical plumb lines and a vertical plan than vice versa.

In fact, the percentages of success in both boys and girls showed that the vertical plumb line was the easiest task, the Plan and the parallel lines were the same, and the horizontal task was the most difficult (Table 5.1). This finding would be consistent with other known work that a young child can draw a vertical line before a horizontal one and the vertical line looks longer than a horizontal one in all cultures.

Moreover, in the easiest vertical task, there were more children who had the line correct and the Plan wrong than vice versa, which was in line with the hypothesis. On the other hand, in the case of the horizontal line, more children had the Plan correct and the water level wrong, which is opposite to the prediction from the hypothesis.

In the case of the parallel lines, there was exactly the same number of boys and girls who drew the line correctly and the Plan incorrectly as vice versa.

These findings suggest that the child might use his concept of the vertical and the implications of a parallel line in order to extend his view point, from an angle of 45°, as seen in the plans showing some depth, to the full 90° in the plans demonstrating horizontally.

This implies that he would be working with concepts found in projective space, rather than euclidean space, involving a full inference system of horizontal and vertical co-ordinates. In fact tasks such as the Plan may eventually strengthen the concept of horizontally leading to the full 3 dimensional co-ordinate system. This might fully emerge at a time when the multiplication of relationships in the 2 dimensional plane is understood and the failure of 95% of the children on this task of locating a point in the corner of a page show how far behind this is.

Translating these findings in terms of Piaget's theme about the self-reflecting nature of intelligence, which provides its means of development, it looks as though children learn to draw a plan by a logical extension of view points to include all cases, even when never seen. Thus they first use the familiar view of 0° to the ground (Fig.5.1) gradually getting higher to 45°, drawing in some of the floor (Fig.5.2). Then they become aware of the lack of conservation of view points and that their plan does not satisfy view points from other directions. They verbalize their concern in terms of not being able to portray fully the rooms behind. They seem to solve their problem by ultimately taking a view point at 90° to the ground (Fig.5.3). At this point either a knowledge of sections of parallelepipeds and/or the implications of parallel lines might help. This results in a horizontal plan.

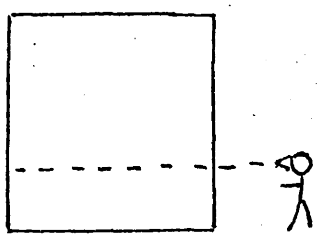


Fig.5.1. Viewpoint 0°

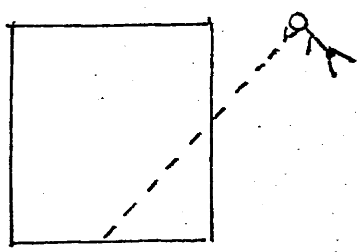


Fig.5.2. Viewpoint 45°

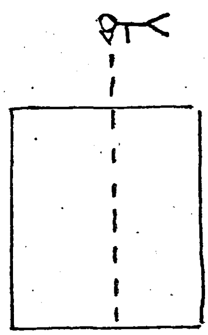


Fig.5.3. Viewpoint 90°

The ability to draw a plan horizontally, put in a water line horizontally and do other tasks of a like nature, may eventually lead to a general concept of horizontality, which is applied systematically when the problem requires it. This in turn might lead to a fully conceptualized 3 dimensional grid after a 2 dimensional grid is fully understood.

The hypothesis that children who can draw a horizontal plan have conceptualized space in terms of a 3 dimensional grid was not upheld. A hypothesis that all children who can draw a plan horizontally have a well-developed projective conceptualization of space may have fitted these findings more adequately.

# CHAPTER VI

## COMMONALITY IN 3 DIMENSIONAL AND 2 DIMENSIONAL SPACE

### INTRODUCTION

#### Observation

From Chapter IV on the developmental stages of plan drawing in children, it can be seen that once horizontality is achieved the ability to draw all the plan correctly does not appear simultaneously as might be expected. As can be seen from Table 6.1 items 8 and 9 Connectedness of rooms and Commonality of walls follow later.

TABLE 6.1

AGES AT WHICH ITEMS APPEARED CORRECTLY IN 25% TO 100% OF PLANS

| | ITEMS | 25% | 50% | 75% | 100% |
|---|---|---|---|---|---|
| 7 | HORIZONTAL PLAN | 7.7 yrs | 8.1 yrs | 9.0 yrs | 11.3 yrs |
| 8 | CONNECTEDNESS OF ROOMS | 7.9 yrs | 8.6 yrs | 9.3 yrs | 11.7 yrs |
| 9 | COMMONALITY OF WALLS | 8.2 yrs | 8.7 yrs | 10.6 yrs | 13.7 yrs |

At the 25% level, appearing at the age of 7 to 8 years, there is only a difference of .5 yrs in these items, but at the 100% level of success, there is a difference of 2.4 years between item 7 at 11.3 years and item 9 at 13.7 years. From this it would seem that the younger child is when solving the horizontality problem the more likely he is to solve the problem of commonality as well. As the ability to solve these problems is connected with general intelligence, see Table 5.6, it may be supposed that in general the first 25% of children who solve the problems at 7 to 8 years are more intelligent than the last 25% of children who solve them at 11 to 14 years.

When children have been questioned about the spaces between the rooms, they have very occasionally seen the error and crossed out one of the walls. More of them have asserted that the whole space is filled with bricks and that it is a very thick wall. A few, on the other hand, have maintained that there is a space between the rooms, "Where ghosts are".

Thus it seems that even when a child can take a horizontal viewpoint in a room, he considers his memories of each room independently and is not able to see how the total space interrelates.

The same problem occurs with the outer wall, for children either do not see the need or are unable to conceptualize the relationship between the outside and the inside of the house. This does not show up in the drawings as clearly as commonality of walls, but is recorded by success or failure on items 10 and 11, three quarters of outer wall common with internal rooms and completely common. Some children with item 10 incorrect do not draw the outside wall at all, but if pressed to do so draw a separate line encircling the rooms as seen in Fig. 6.1.

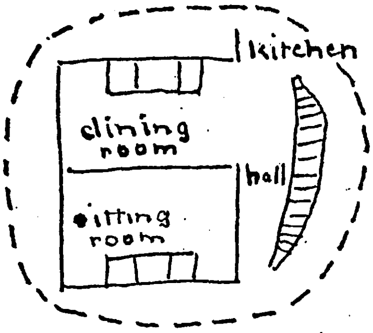
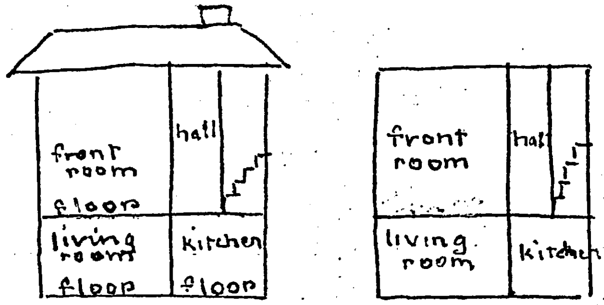



Fig 6.1. Separate outer wall represented by dashes




(a) (b)

Fig 6.2.(a)A version of a vertical house which may transform easily into a horizontal house (b)

When talking to children about the problem of drawing a plan, only one has ever mentioned visualizing the house from the outside in order to check on the arrangement of the rooms, and none of the 80 children in the Woodside study. This may be because the usual modern house is box like and the outer rectangular plan so self evident that it cannot be a point for discussion. It is possible that some children go from drawing a vertical 'plan' of a house to a horizontal plan still able to use the same rectangle for either without really having to think about it. (Fig 6.2). There was some evidence in the main sample that children who lived in houses with slightly more irregular outlines had to think about the problem and found it difficult. Only a detailed inquiry elucidates this point and as it was not done in the main sample, it is not clearly revealed in the scoring as is Commonality of walls.

THEORETICAL CONSIDERATIONS

The inability to solve the problem of the commonality of walls in horizontal plans is most evident in children between the ages of 7.7 to 10.2 years. According to Piaget, this is Stage II in the development of intelligence, of concrete operations, which began about the age of seven and goes through a process of structuring before finally developing into Stage III of formal operational thinking.

The criterion of this stage is the reversibility of the thought operations, for not only are they independent of the external world, to which they were tied in the sensory-motor period, but they are reversible in the logical sense. This first begins to appear between the ages of 5 and 6 and continues to be elaborated throughout the period. In the conservation of quantities it would appear that the child is able to apply this operation first to tangible substances such as beads and later to more hypothetical quantities such as weight and volume.

Reversibility is characterized by two forms:

(a) negation as expressed in the plasticine experiment in which a perceived change in form is cancelled by its corresponding negative thought operation.

(b) reciprocity, as expressed in the child's discovery that "being a foreigner" is a reciprocal relationship, or that left-right, before-behind spatial relationships are relative.

As already mentioned in Chapter V it is thought that the capacity to draw a house from a horizontal view point instead of the usual vertical one is an instance of reversibility in which all viewpoints are reciprocal. It is considered that the perception of walls as being common to two spaces (rooms) simultaneously also implies the conception of reciprocal spatial relations as implied in reversibility.

This ability to perceive reciprocal relationships can also be seen in two dimensional figures, as well as the three dimensional figure of a plan. According to Vernon, (1962) the perception of shapes by children under six or seven years is 'synthetic', for they perceive the wholes rather than the details. With a shape such as in Fig 6.3 the crosses are not correctly related till about 7 yrs, according to Gesell and Ames, (1946)

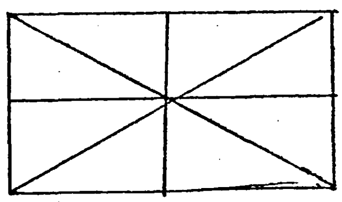
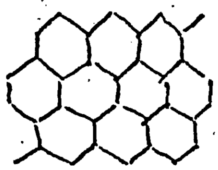


Fig 6.3. Shape with interior detail which was copied incorrectly by 7 yr olds.

Also children fail to relate the parts to the whole in the honeycomb pattern for Rupp (1923) found that young children reproduced the honeycomb pattern as in Fig. 6.4. It seemed that they saw the lines as boundaries of figures, concentrated on the figure and could not see how it related to the next one. Evidently they did not see it with the lines as the figure and the space as the background, as in the perception of wire netting.



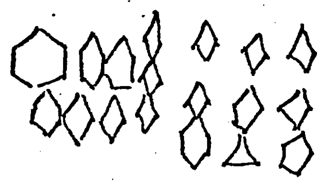


Fig 6.4. Childrens representation of a honeycomb pattern.

It was considered that the mistakes made by children in the honeycomb pattern may be an example of the failure of the process of reversibility, and that they could not see that one line belonged to two figures simultaneously, that is, they could not see the reciprocal relationship of a common line to two figures, just as in the same way that they could not see a common wall as having a reciprocal relationship to two rooms in a drawing of a three dimensional space.

It could be supposed that the inability to see walls as common may be just peculiar to the plan situation and may only reflect the child's lack of experience in never having seen two adjoining rooms simultaneously, such as in a half-built house. On the other hand, it may be a specific instance of the child failing to apply the general law of reciprocal relations.

The null hypothesis was then formulated that there would be no association between children's ability to perceive reciprocal relations in the three dimension situation (the plan) and a two dimensional situation (a honeycomb type pattern).

METHOD

A class of 28 children, who had already been tested on the Piaget type battery were chosen, but only 23 completed the tests given, 14 boys and 9 girls. The ages ranged from 8 yrs to 5 mths to 9 yrs 4 mths averaging at 8 yrs 11 mths.

The following tests were given, the Crichton Vocabulary test, the Plan test and the 'Honeycomb' test. The 'honeycomb' pattern, see Fig.6.5, was made more complex than the usual pattern, being based on an octagonal figure instead of a hexagonal, so that the task should not be too easy and some variation in scores could be obtained.

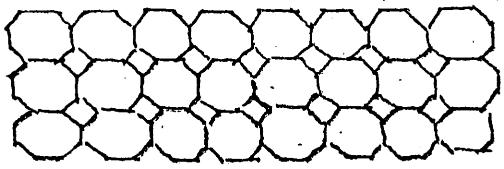


Fig. 6.5. 'Honeycomb pattern'

The Crichton test was chosen as a verbal measure of general intelligence, because it was quick to administer and provided a measure which was independent of spatial ability, on which the other two tests may be loaded. Although it had been administered four months previously, it was repeated because it was known from repeating the Plan test, how quickly children's intellectual abilities were maturing at this age.

The 'Honeycomb' and Plan tests were administered as a group test in the class room. In order to prevent copying, one child in each desk started with the 'Honeycomb' and the other with the Plan. Both were done on the same paper. A section of the 'Honeycomb' pattern had been printed on the top of the paper, the reproduction being required underneath, while the Plan was drawn on the other side.

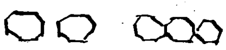
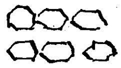
The Crichton Vocabulary test was administered later individually because some of the children were not able to read or write well enough for it to be administered as a group test.

TREATMENT OF RESULTS

A Scoring system for the Crichton Vocabulary Scale and the Plan was already available, but scores for the 'Honeycomb' test had to be devised from the experimental sample by sorting the 25 protocols into the following five categories which received scores from 1 to 5 as in Fig.6.6.

Fig. 6.6

Scoring Categories for the 'Honeycomb' Test, Derived Intuitively from Inspection

| Score | Criteria |
|---|---|
| 1 | Separate figures or a single row  |
| 2 | Two or more separate rows either horizontal or vertical  |
| 3 | Figures integrated, but only four or less correct  |
| 4 | Mainly correct with occasional errors |
| 5 | Well drawn and completely correct |

The results were then looked at from two points of view, the association between 'Honeycomb' and Plan scores, and for significant differences between average Plan scores when the sample is divided into two on the basis of correct and incorrect 'Honeycomb' reproductions. General characteristics of the sample were also examined to see how it compared with other samples, for as it is a small sample unusual characteristics could affect the result.

RESULTS

Association of 'Honeycomb', Plan and other Scores.

Each subject was given a category on the Plan test of either vertical or horizontal (Item 7) and a category of correct (Scores 4 and 5) or incorrect scores (1, 2 and 3) on the 'Honeycomb' test and chi-squared was calculated (Table 6.2).

TABLE 6.2

'HONEYCOMB'

| | | Correct | Incorrect |
|---|---|---|---|
| PLAN | Horizontal | 10 | 5 |
| | Vertical | 1 | 7 |

Chi-square 6.134 P = 0.02

This result does not support the null hypothesis and it was considered necessary to look at the scores in more detail. An important cause for this relationship could be general intelligence and therefore in order to partial out effects from this source it was decided to use the product-moment test of correlation, although the sample of 23 and the number of possible scores on the 'Honeycomb' is small.

Product moment correlations were calculated between scores on the Plan test, full score 0-40 and horizontal scores 0-10, the Crichton Vocabulary test, and the 'Honeycomb' test (Table 6.3).

TABLE 6.3

PRODUCT MOMENT CORRELATIONS OF PLAN FULL SCORES, PLAN HORIZONTAL SCORES, 'HONEYCOMB' AND VOCABULARY.

| | | 1 | 2 | 3 | 4 | Means | SD |
|---|---|---|---|---|---|---|---|
| Plan tot.sc. | 1 | | | | | 16.00 | 10.26 |
| Plan Hor.sc. | 2 | .95 | | | | 3.22 | 8.26 |
| Honeycomb | 3 | .77 | .69 | | | 2.96 | 1.52 |
| Vocabulary | 4 | .48 | .52 | .70 | | 42.13 | 8.90 |

The 'Honeycomb' correlations with the Plan full score and the Plan horizontal score were statistically significant. They also correlated with vocabulary. However when the effect of the vocabulary score was partialled out the resulting correlation of Plan and 'Honeycomb' scores was still significant (Table 6.4).

TABLE 6.4

PRODUCT MOMENT CORRELATIONS WITH THE EFFECT OF VOCABULARY PARTIALLED OUT.

| | PLAN Total | PLAN Horizontal |
|---|---|---|
| 'Honeycomb' | .69 | .68 |

Difference in Plan, Vocabulary and Age when the Sample is Divided into Two Groups According to Correct and Incorrect Scores on the 'Honeycomb' Pattern.

Further evidence of the relationship expressed by the correlation coefficient was looked for by dividing the sample into two groups, those scoring correctly (Scores 4 and 5) and incorrectly (Scores 1, 2 and 3) on the 'Honeycomb' test and looking at the difference between the means on the Plan and vocabulary tests. (Table 6.5).

TABLE 6.5

THE DIFFERENCE IN PLAN SCORES, VOCABULARY AND AGE BETWEEN CORRECT AND INCORRECT SCORERS ON THE 'HONEYCOMB' TEST.

| | 'HONEYCOMB' Correct M | 'HONEYCOMB' Incorrect M | t | P |
|---|---|---|---|---|
| Plan full Sc. | 24.545 | 8.16 | 6.06 | 0.001 |
| Plan Hor. Sc. | 5.58 | 0.92 | 5.02 | 0.001 |
| Vocabulary | 44.30 | 33.00 | 3.32 | 0.01 |
| Age | 8y11.73m | 8y11.50m | 0.15 | NS |

The means of the Plan full scores and the Plan horizontal scores showed a highly significant difference, while the vocabulary means were less statistically significant and age not at all. In order to remove what effects there were from vocabulary an analysis of covariance was calculated (Table 6.6).

TABLE 6.6

ANALYSIS OF COVARIANCE ON THE PLAN SCORES

| Source | SOS | df | MS | F | P |
|---|---|---|---|---|---|
| Between Columns | 970.123 | 1 | 970.123 | 23.223 | 0.001 |
| Error | 877.274 | 21 | 41.774 | | |
| Total | 1847.397 | 22 | | | |

This result showed that even when the effect of vocabulary was removed, the null hypothesis of there being no difference between scores on the Plan, when the sample is divided into those copying the 'Honeycomb' pattern correctly and incorrectly, was disproved.

DISCUSSION

All results show that the children who do well on the Plan test tend to do well on the 'Honeycomb' test even when the effects of general intelligence, as measured by vocabulary are removed. This lends support to the hypothesis that children who cannot conceptualize a dividing wall being common to both rooms, may not be experiencing a difficulty that is peculiar to 3D perception, but is also experienced in 2D situations, that is, the difficulty may be a generalized one of seeing the relationship between two complex adjoining figures whether 3D or 2D.

# CHAPTER VII

## CHILDRENS CAPACITY TO VERBALIZE ABOUT PLAN DRAWING

### INTRODUCTION

It might be assumed that if a child can make the first essential step in drawing a plan by representing the rooms horizontally, behaviourally showing that he is using a viewpoint on a horizontal plane parallel to the floor, then he understands the difference between a picture and a plan and can express the difference verbally. This however would be unwarranted without an enquiry for usually manipulation of visuo-spatial data precedes verbalization by years. On the SB the average child of 5 years can see when pairs of animals are the same and different, but he can not verbalize differences until 6 years. Annett (1959) considered that retardation in spatial relationships may have a marked effect on development of conceptual thinking such as contiguity and classification.

It is possible that a child might be able to conceptualize a plan and talk about it, but not draw it; in the same way that a child can recognize a circle at 2 years, differentiating it from a square and a triangle, but can not draw it until 3 years (SB, 1961). But there is also the possibility that the capacity to draw a plan and verbalize about it appears at the same time or even that verbalization, in some children at least, follows the ability to draw a plan.

As however it has been shown that the capacity to deal behaviourally with concrete material in space precedes the capacity to verbalize, it is here considered likely that children who have the ability to verbalize about essential aspects of plan drawing will have a higher mean score on the Plan test than those who do not have that ability.

### METHOD

This investigation was conducted on the same children and at the same time as "The association of childrens ability to conceptualize a 3 dimensional spatial system of reference and their ability to draw a Plan" in Chapter V.

As a free discussion about plan drawing had hitherto failed to elicit much verbalization from children, 4 questions were asked which needed only simple 'Yes/No' answers followed in each case by a question which required reasons. Two more questions were asked about previous experience in seeing or drawing a plan, the results of which are given in Chapter VIII

The questionnaire was given individually between the Piaget type tests and the Crichton Vocabulary. Questions 1-3 related to each child's own plans drawn in March, June and September, all of which showed increased scores between the first and third occasion of testing. Each child's personal plans had been chosen for discussion rather than a set of plans observing progression from vertical to horizontal information for they were more meaningful to them in terms of the actual house they were meant to represent. In this way it was hoped that the concreteness of the task would facilitate the production of insightful and appropriate comments. The fourth question was abstract and concerned the difference between a picture and a plan.

QUESTIONNAIRE

1a Did you find it easy or difficult to draw a plan?

b Why was it easy/difficult?

2a Show the child their own plans drawn at three monthly intervals and ask, "Which is the best?"

b Why is it the best?

3a Are you satisfied with it?

b How could it be improved?

4a Is there a difference between a plan and a picture?

b What is the difference in viewpoint between a plan and a picture? (If a child answers in terms of content, such as there is furniture in a picture and not in a plan add this further question).

If you took all the furniture out of this room, what would be the difference between drawing a plan of it or drawing a picture? What would be the most important difference?

RESULTS

1. CATEGORIZATION OF RESPONSES

On obtaining the replies to the questions it became apparent that the responses would need to be classified into three types:

A Responses which were incorrect to part (a) of each question and were followed by irrelevant reasons to the second part (b).

B Responses which were correct to part (a) of each question, but were followed by irrelevant reasons to part (b).

C Responses which were correct to part (a) and were followed by relevant reasons to part (b).

Examples of irrelevant and relevant reasons when the response to (a) was correct were as follows with plan score in brackets.

1b Why was it difficult?

B Irrelevant reasons

These were usually related to the execution of the task and included "Don't knows". "Because I never had a ruler" (5)

"To keep things straight" (7)

"If you do something wrong you would not like to show the teacher." (8)

C Relevant reasons

These centred round the difficulties of method and recall.

"I didn't know what shape. First I thought I should get it in a square. (18)

"I got a bit muddled up in the shapes of the house. (20)

"Have to get rooms the right width. (27)

"Difficult looking down" (30)

"I found it hard to memorize it" (27)

"Because you are not in the house" (18)

(A girl gave the longest answer, an example of verbosity).

"My house is ever so difficult. If you look into the window, it has got a piece of wood at the top and square at the bottom and looks out into the back garden. There's the living and the dining room and on the left the kitchen. From the dining room you have to go up some stairs. In the living room you can go right round in a circle from kitchen and dining room. When you go to the right, you go down into the kitchen and on the left is the back door" (11)

1b Why is it the best?

B Irrelevant reasons

Most of their reasons were concerned with the number of articles represented, the size of the plan and its execution.

"More things in it" (22)

"Because its bigger" (10)

"Spread out more and you can see it better" (18)

"I haven't got the writing squashed up" (24)

"Neater" (13)

C Relevant reasons

Many of the children referred to specific items on their plans which had improved.

"Hall is too wide. Stairs aren't correct" (27)

"Marked out rooms better" (19)

"Looks better in a square. Looked from outside" (18)
"I looked through here and this time I looked down" (15)
"Door was wrong this way because it doesn't take up so much room. Windows, they are at the side where they are, but these are in the middle of the room" (23)

3b How could it be improved?

B Irrelevant reasons

These were mainly concerned with execution
"Could be a bit smaller" (19)
"Make lines straighter" (22)
"Put in furniture" (22)

C Relevant reasons
These referred mainly to specific items
"The dining room is in the wrong place" (17)
"Not make room so big. Could make it a better shape" (12)
"Improve stairs. They go upwards above lounge" (15)

4b What is the difference in viewpoint between a plan and a picture?
B Irrelevant reasons
These often referred to the emptiness of a plan except for writing and the furniture and colours in a picture. (28)
"Nothing in it" (19)
"Plans marked with names. Pictures is just drawing"
"No pictures on the walls" (13)
"Put colours in a picture, but not in a plan" (13)
"There'd be writing inside the room, if its a plan" (6)
"Plan not coloured, a plan is labelled" (23)

C Relevant reasons
These are usually, but not always connected with the difference in viewpoint.
"Picture through here and a plan down" (15)
"When you make a plan you look down and when you do a picture you look that way" (22)
"Able to see it from the side not the top" (18)
"Don't have to concentrate so much on what you do. A picture is more like a room" (30)
"Windows in a different place" (17)

Most of the irrelevant reasons given to the first three questions were concerned with deficiencies in the drawing, such as crooked lines, while most of the relevant reasons were concerned with the shape, width, size and position of rooms. In question 4 the irrelevant reasons were concerned with the presence of furniture in a picture and names in a plan, while the relevant reasons were mostly concerned with the different viewpoints expressed in terms of looking down for plans and from the side for pictures.

2. TEST SCORES OF GROUPS A, B and C

Having divided the responses into the three categories A, B and C the means and standard deviations of the test scores and ages were found in the boys and girls groups separately (Tables 7.1 to 7.4) with the significance of difference between the groups in Tables 7.5 and 7.6.

QUESTIONS 1a and b

The increase in mean scores of the Plan test was in the expected direction in the girls' group with those in Group A saying the task was easy, scoring low, while those in Group C, who thought the task was difficult and could give relevant reasons scoring high (Table 7.1). The difference between the groups was significant at the .001 level (Table 7.5).

This finding was not entirely repeated in the boys' groups for whereas the boys in Group C also scored high, some boys who scored high said the task was easy, so raising the mean score of Group A. Thus this question revealed personality differences between the sexes.

TABLE 7.1

COMPARISON OF TEST SCORES BETWEEN CHILDREN WHO THOUGHT PLAN DRAWING A EASY; B DIFFICULT, BUT WITH IRRELEVANT REASONS; C DIFFICULT WITH RELEVANT REASONS.

| | A | | B | | C | |
|---|---|---|---|---|---|---|
| BOYS | (N = 16) | | (N = 7) | | (N = 17) | |
| | M | SD | M | SD | M | SD |
| Plan | 11.06 | 7.34 | 7.57 | 4.23 | 16.06 | 9.59 |
| Piaget | 7.87 | 2.89 | 6.71 | 1.48 | 8.11 | 1.78 |
| Vocabulary | 37.75 | 0.44 | 30.05 | 7.79 | 40.23 | 8.16 |
| Age | 8y 8.50m | 2.60 | 8y 6.28m | 3.25 | 8y 6.00m | 3.06 |
| GIRLS | (N = 13) | | (N = 8) | | (N = 19) | |
| Plan | 5.38 | 4.41 | 8.87 | 6.45 | 14.10 | 7.38 |
| Piaget | 5.92 | 1.66 | 7.25 | 2.12 | 7.42 | 1.77 |
| Vocabulary | 33.77 | 9.76 | 42.25 | 8.96 | 41.53 | 7.21 |
| Age | 8y 6.46 | 3.78 | 8y 7.12m | 3.04 | 8y 7.68 | 3.48 |

QUESTIONS 2a and b

Here the increase in mean scores was in the expected direction in both girls and boys, with children choosing correctly and giving relevant reasons scoring the highest (Table 7.2). The difference between the mean scores of Groups A and C was greater for girls at the .001 level than for the boys at the .05 level (Table 7.5).

TABLE 7.2

COMPARISON OF TEST SCORES BETWEEN CHILDREN WHO A CHOSE INCORRECTLY, B CHOSE CORRECTLY GIVING IRRELEVANT REASONS, C CHOSE CORRECTLY GIVING RELEVANT REASONS

| | A | | B | | C | |
|---|---|---|---|---|---|---|
| BOYS | N = 17 | | N = 14 | | N = 9 | |
| | M | SD | M | SD | M | SD |
| Plan | 10.17 | 9.19 | 12.35 | 8.34 | 17.44 | 5.46 |
| Piaget | 6.88 | 1.91 | 8.36 | 2.58 | 8.44 | 1.97 |
| Vocabulary | 34.41 | 9.03 | 40.42 | 5.67 | 39.22 | 10.63 |
| Age | 8y 6.11m | 3.08 | 8y 7.57m | 2.73 | 8y 8.00m | 3.46 |
| GIRLS | N = 12 | | N = 13 | | N = 15 | |
| | M | SD | M | SD | M | SD |
| Plan | 5.00 | 1.81 | 11.23 | 7.95 | 13.53 | 3.61 |
| Piaget | 5.67 | 1.67 | 7.08 | 1.71 | 7.73 | 1.79 |
| Vocabulary | 36.33 | 7.08 | 38.77 | 11.09 | 41.73 | 8.36 |
| Age | 8y 6.75m | 3.14 | 8y 7.61m | 4.75 | 8y 7.94m | 3.49 |

QUESTIONS 3a and b

Here the increase in the mean score was in the expected direction, but whereas the difference between Groups A and C was significant for girls at the 5% level, it was not significant for boys (Table 7.3). As in the response to Question 1a there was a sex difference related to personality, for whereas only 1 out of the 16 girls saying they were satisfied had a score over 20, 4 of the 16 boys had such high scores. Thus it seemed that if a boy scored high he was more likely to be satisfied with his drawing than a girl and therefore not be ready to talk about ways in which it could be improved (Table 7.3).

TABLE 7.3

COMPARISON OF TEST SCORES BETWEEN CHILDREN WHO WERE A SATISFIED WITH THEIR PLANS, B NOT SATISFIED BUT GIVING IRRELEVANT REASONS, C NOT SATISFIED AND GIVING RELEVANT REASONS.

| BOYS | A N = 16 M | SD | B N = 19 M | SD | C N = 5 M | SD |
|---|---|---|---|---|---|---|
| Plan | 10.86 | 9.15 | 13.26 | 8.89 | 15.40 | 2.70 |
| Piaget | 6.56 | 2.07 | 8.63 | 2.30 | 8.40 | 1.02 |
| Vocabulary | 35.50 | 9.64 | 39.05 | 8.50 | 38.60 | 5.31 |
| Age | 6.62 | 3.03 | 7.94 | 3.00 | 5.00 | 2.91 |

| GIRLS | N = 16 M | SD | N = 16 M | SD | N = 8 M | SD |
|---|---|---|---|---|---|---|
| Plan | 8.25 | 6.44 | 10.62 | 6.84 | 15.00 | 8.48 |
| Piaget | 7.00 | 2.10 | 6.56 | 1.75 | 7.37 | 1.85 |
| Vocabulary | 37.62 | 8.50 | 38.06 | 10.63 | 44.87 | 7.59 |
| Age | 8y 6.35m | 3.03 | 6.62 | 3.46 | 9.87 | 3.27 |

QUESTIONS 4a and b

Here there was an increase in the mean plan score in both boys and girls in the expected direction with those children giving relevant reasons scoring highest (Table 7.4). However like the response to Question 2 the difference between groups A and C was higher in the girls at .01 than in the boys at .05 (Table 7.5).

TABLE 7.4

COMPARISON OF TEST SCORED BETWEEN CHILDREN WHO THOUGHT THERE WAS A NO DIFFERENCE BETWEEN A PICTURE AND A PLAN, B A DIFFERENCE BUT GAVE AN IRRELEVANT REASON, C A DIFFERENCE AND GAVE RELEVANT REASON.

| BOYS | A N = 9 M | SD | B N = 25 M | SD | C N = 6 M | SD |
|---|---|---|---|---|---|---|
| Plan | 8.77 | 7.40 | 12.36 | 8.00 | 19.16 | 9.37 |
| Piaget | 7.44 | 2.33 | 7.64 | 2.48 | 7.82 | 3.23 |
| Vocabulary | 33.55 | 5.85 | 38.24 | 8.71 | 41.00 | 10.37 |
| Age | 8y 8.22m | 2.17 | 8y 6.76m | 2.90 | 8y 8.16m | 4.54 |

| GIRLS | N = 23 M | SD | N = 12 M | SD | N = 5 M | SD |
|---|---|---|---|---|---|---|
| Plan | 7.87 | 6.85 | 11.67 | 6.89 | 17.60 | 5.68 |
| Piaget | 6.13 | 1.60 | 7.17 | 1.95 | 9.20 | 0.84 |
| Vocabulary | 38.22 | 7.80 | 41.58 | 1.87 | 37.60 | 7.23 |
| Age | 8y 6.18m | 3.71 | 8y 8.50m | 2.78 | 8y 8.60 | 2.41 |

3. SIGNIFICANT DIFFERENCES BETWEEN GROUPS A, B and C

Table 7.5 indicates that those girls, who could give relevant reasons for finding plan drawing difficult and chose the best plan, who knew in what way their plan was still not satisfactory and were able to give relevant differences between a plan and a picture, had significantly higher mean scores than those who thought plan drawing was easy, failed to choose the best plan, thought their plan was satisfactory and thought there was no difference between a plan and a picture.

Although the same trend was present in the boys groups, groups A and C were only significantly different in Question 2 and 4. Questions 1 and 3 phrased in terms of difficulty and satisfaction did not produce the same differences, for although the mean scores in the C groups were as high as in the girls, those in the A groups were not so low.

TABLE 7.5

SIGNIFICANCE OF DIFFERENCE BETWEEN PLAN MEAN SCORED OF GROUPS AB, AC and BC

| | BOYS | | | | | | GIRLS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AB | | AC | | BC | | AB | | AC | | BC | |
| QUESTION | t | P | t | p | t | p | t | P | t | P | t | P |
| 1. Difficulty | 1.15 | NS | 1.67 | NS | 1.67 | NS | 1.48 | NS | 3.84 | .001 | 1.74 | NS |
| 2. Choice | 0.50 | NS | 2.17 | .05 | 1.61 | NS | 2.67 | .02 | 3.80 | .001 | 0.54 | NS |
| 3. Satisfaction | 0.78 | NS | 1.07 | NS | 0.52 | NS | 0.66 | NS | 2.19 | .05 | 1.60 | NS |
| 4. Difference | 0.49 | NS | 2.40 | .05 | 2.40 | .05 | 1.55 | NS | 2.96 | .01 | 1.69 | NS |

As Piaget and vocabulary scores were available for all these groups, it was possible to discover if there was any difference in their scores between Groups A and C, which might suggest an additional cause for the difference in verbalization apart from the children's ability to draw a plan. (Table 7.6).

Age can sometimes explain some of the difference between children's test scores, but in this study the groups only varied between 8y 5m and 8y 8m and then not in any particular direction

TABLE 7.6

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN SCORES OF PIAGET AND VOCABULARY TESTS IN GROUPS A AND C IN BOYS AND GIRLS

| BOYS | PIAGET A/C | | VOCABULARY A/C | |
|---|---|---|---|---|
| QUESTIONS | t | P | t | P |
| 1. Difficulty | 0.23 | NS | 0.86 | NS |
| 2. Choice | 1.95 | .1 | 1.34 | NS |
| 3. Satisfaction | 1.87 | .1 | 0.70 | NS |
| 4. Difference Plan/Picture | 0.25 | NS | 1.79 | NS |

| GIRLS | PIAGET A/C | | VOCABULARY A/C | |
|---|---|---|---|---|
| QUESTIONS | t | P | t | P |
| 1. Difficulty | 2.50 | .02 | 2.89 | .01 |
| 2. Choice | 3.13 | .01 | 1.78 | NS |
| 3. Satisfaction | 0.43 | NS | 1.02 | NS |
| 4. Difference Plan/Picture | 3.97 | .001 | 0.16 | NS |

Table 7.6 indicates that there was no statistically significant difference between A and C Groups in vocabulary for the boys, and only Question 1 about the task's difficulty produced a difference in the girls. Thus there is no indication that ability to talk about plans depended on vocabulary.

The results of the Piaget type tests were more interesting. Again in the boys there was no difference between the groups, but the girls did show a difference between Groups A and C in all questions, except that of Question 3 concerned with satisfaction. This suggests that ability to conceptualize a three dimensional spatial system of reference may have some relevance to their ability to verbalize about plan drawing.

## 4. UNEXPECTED FINDINGS WITHIN THE GROUPS.

Although there was a significant difference in mean Plan scores between Groups A and C, not all children in the A groups were drawing vertical plans and not all children in the C groups were drawing horizontal plans. The percentages are given in Table 7.7.

TABLE 7.7

NUMBERS OF CHILDREN IN GROUPS A, B AND C DRAWING AT LEAST HORIZONTAL ROOMS

| | BOYS GROUPS | | | | | | GIRLS GROUPS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | | B | | C | | A | | B | | C | |
| QUESTIONS | N | % | N | % | N | % | N | % | N | % | N | % |
| 1 | 9/16 | 56 | 2/7 | 29 | 14/17 | 82 | 2/13 | 15 | 4/8 | 50 | 15/19 | 79 |
| 2 | 7/17 | 41 | 8/14 | 57 | 8/9 | 89 | 1/12 | 8 | 9/13 | 69 | 11/15 | 73 |
| 3 | 6/16 | 38 | 12/19 | 63 | 5/5 | 100 | 7/16 | 44 | 8/16 | 50 | 6/8 | 75 |
| 4 | 2/9 | 22 | 16/25 | 64 | 5/6 | 83 | 8/23 | 35 | 8/12 | 67 | 5/5 | 100 |

As the previous evidence had suggested that the manipulation of visuo-spatial data preceded the ability to verbalize, it was to be expected that there were some children in groups A and B who drew horizontal plans and made high scores. What did not fit with expectations was to find children classified in the C groups, as giving relevant reasons and yet still drawing vertical plans.

Examination of the reasons given revealed the boys' reasons related to memory, such as:

"Only been in house a week"

"I didn't know where things were"

"Have to find everything out" (Q1)

"Thinking how to draw it" (Q1)

"Because I had a better look at my house" (Q2).

Just one boy giving a good relevant reason:

"When you have a plan you look down and when you have a picture you look that way" (Q4) might have been influenced by having seen and drawn a plan, although it had not helped him with the other questions for he had scored in Group A for those. Perhaps he just remembered somebody saying it without really understanding its significance.

The girl's answers referred more to absent or wrong items.

Q1 "You've got to put the rooms where they actually are and that's quite hard".
"You have to get right shape of hall and can't do ceiling".
"Didn't know how to do it".
"Doing stairs and all that".

Q2 "Didn't put a bathroom in (upstairs)".
"All things in the wrong place".
"I put the porch in".
"I haven't put a roof".

Q3 "Put hatch in there"
"Make stairs better".

Q4 All drew horizontal plans.

Three of them contained references to improvements in vertical plans in which the ceiling, the roof and the upstairs were omitted; which are justifiable having already been noted in the developmental stages and included in the scoring.

When initially categorizing the children in terms of irrelevant or relevant reasons, those concerned with the neatness of the execution and the "Don't knows" were categorized as irrelevant and the others as relevant. The relevant reasons therefore sometimes included ambiguous ones and probably those related to memorizing ought to have classed as irrelevant. Such misclassifications in that direction however do not invalidate the findings, because they have reduced the mean scores for the C groups and so reduced the difference between A and C, not increased it.

## CONCLUSIONS

The best questions to ask, which showed no personality differences between the sexes, were 2a and b with choice of the best plan and 4a and b concerned with the difference between a picture and a plan. The other questions 1a and b and 2a and b concerned with difficulty of plan drawing and satisfaction in the plans drawn revealed different attitudes. The girls, who had not solved the problem of a plan's horizontality thought plan drawing easy and those that had, thought it was difficult. Some of the boys reacted in this way too, but some, who had solved the problem, thought plan drawing was easy. The same differences occurred in the question on satisfaction, the girls were satisfied when they were drawing vertical plans and dissatisfied when they saw the nature of the problem and began to draw horizontal plans. Some boys also reacted similarly, but others said they were satisfied when they began to draw horizontal plans. So they were using different criteria for difficulty and satisfaction.

The findings in the girls groups and in the boys groups for questions 2 and 4 supported the expectation that the ability to verbalize was associated with high plan scores. There was also the additional finding that ability to verbalize was not associated with higher vocabulary scores, while in girls it was associated with higher Piaget scores, which are probably relevant to plan drawing and again underline the need for spatial understanding to precede verbalization.

There was no evidence that a child could conceptualize the task and talk about it but had not the skill to execute it. On the contrary many of the children who drew good horizontal plans could not make any essential statements and resorted to comments about neatness and size of execution. Thus this task seems to be another instance of the general finding that manipulation of visuo-spatial data precedes verbalization.

# CHAPTER VIII

## THE EFFECTS OF EXPERIENCE ON PLAN DRAWING

### INTRODUCTION

A possible criticism of the Plan Test is that a child's ability to draw a plan might be influenced by what he has seen or been taught at home or in school. As clinical standardized tests need to be reliable and valid in order to have any value, a test, which is open to the influence of some unquantifiable training, which may be given to some subjects but not others, would not be of any use. It was therefore important to investigate what effect previous experience had on plan drawing.

The aim of this investigation was to see if children who had seen and drawn plans had higher scores than those who had not.

### METHOD

The sample, procedure and tests used have already been described in Chapter VI. The only additional information given here and not imparted there is the responses to the following questions:-

1 (a) Have you ever seen a plan?
  (b) If so, where?

2 (a) Have you ever drawn a plan before?
  (b) If so, where?

### RESULTS

The results to questions 1 and 2 are given separately.

### QUESTION ONE

The children were divided into two groups depending upon their responses to question (a), those who had not seen a plan and those who had. The means and standard deviations of the Plan, Piaget and vocabulary tests were then found and tested for significant differences. The results are in Table 8.1.

TABLE 8.1

COMPARISON OF TEST SCORES BETWEEN CHILDREN WHO HAVE NOT SEEN AND SEEN A PLAN

| | Not seen | | Seen | | | |
|---|---|---|---|---|---|---|
| | N = 18 | | N = 22 | | | |
| BOYS | M | SD | M | SD | t | P |
| Plan | 11.11 | 8.13 | 18.77 | 8.39 | 0.98 | NS |
| Piaget | 7.5 | 1.86 | 8.09 | 2.83 | 0.78 | NS |
| Vocabulary | 34.61 | 8.78 | 39.82 | 8.66 | 1.85 | NS |
| Age | 8y 6.83m | 2.54 | 8y 7.23m | 3.75 | - | NS |
| | N = 20 | | N = 20 | | | |
| GIRLS | M | SD | M | SD | t | P |
| Plan | 7.55 | 5.73 | 12.90 | 7.63 | 2.46 | .05 |
| Piaget | 6.25 | 1.76 | 7.55 | 1.74 | 1.32 | NS |
| Vocabulary | 39.15 | 7.48 | 40.25 | 10.43 | 0.40 | NS |
| Age | 8y 7.60m | 3.19 | 8y 6.80m | 3.60 | - | NS |

Although the boys who had seen a plan scored higher than those who had not, the difference was not statistically significant. Moreover, even if it had been, the difference in vocabulary scores was also in the same direction and the greater intelligence, which such scores signify would have provided an alternative explanation to that of experience.

The girls' group on the other hand did show a statistically significant difference in the seen Plan scores, those who had seen a plan scoring higher. When possible alternative explanations were looked for such as age, vocabulary as indication of general intelligence, or Piaget scores as indication of a type of spatial activity, none were significantly different.

A chi-square test was then used to look at the relationships between children having seen a plan and whether or not they were at least able to represent the rooms horizontally. The results are in Table 8.2.

TABLE 8.2

THE ASSOCIATION BETWEEN CHILDREN'S ABILITY TO REPRESENT ROOMS HORIZONTALLY AND THEIR EXPERIENCE OF HAVING SEEN OR NOT SEEN A PLAN.

| | | BOYS | | GIRLS | |
|---|---|---|---|---|---|
| | | SEEN | NOT SEEN | SEEN | NOT SEEN |
| PLAN | HORIZONTAL | 12 | 10 | 12 | 8 |
| | VERTICAL | 10 | 8 | 8 | 12 |

Chi-Square .004 N S

Chi-Square 1.6 N S

As might have been expected there was no relationship in the boys' group between experience and their ability to make the conceptual change from vertical to horizontal representation. The association in the girls' group was higher, but it was not statistically significant.

Knowing that most of these children had recently had a lesson in plan drawing at school, their answers to the second part of the question were examined. Contrary to expectations nobody mentioned the lesson, but instead recalled experiences out of school (Table 8.3).

TABLE 8.3

CIRCUMSTANCES UNDER WHICH CHILDREN RECALLED HAVING SEEN A PLAN

| | Boys | Girls |
|---|---|---|
| Father's occupation: builder, surveyor, electrician, engineer, draughtsman | 4 | 4 |
| Grandfather's occupation: architect | 2 | 1 |
| Seen plans of own house when moving | 6 | 4 |
| Seen plans of alterations of own house | 1 | 4 |
| Seen plans on building sites at estate agents, station, zoo | 4 | 0 |
| Seen plans drawn by siblings | 1 | 4 |
| Seen plans in books | 3 | 2 |
| Did not remember where | 1 | 1 |
| | 22 | 20 |

As the children in this sample came from a mixed socio-economic background, it became evident that most of the children who could recall having seen a plan had seen it at home, either because their fathers were in the type of occupation which involved plans or because they had seen them when moving or alterations had been done to their houses. In either case it seemed that they were likely to come from higher socio-economic groups than those who had not seen a plan. It is possible, although not investigated, that those who had not seen a plan had fathers involved in manual occupations and lived in rented houses provided by the local authority.

The interesting fact remains that this experience does not appear to have influenced boys' ability to draw plans, but may have influenced the girls. Also in both groups it was the out of school experience, which was recalled not the lesson in school.

QUESTION TWO

The children were again divided into two groups depending upon their responses to question (a) those who had not drawn a plan and those who had. The means and standard deviations of the Plan, Piaget and vocabulary tests were then found and tested for significant differences (Table 8.4).

TABLE 8.4

COMPARISON OF TEST SCORES BETWEEN CHILDREN WHO HAVE NOT DRAWN AND DRAWN A PLAN

| | NOT DRAWN N = 30 | | DRAWN N = 10 | | | |
|---|---|---|---|---|---|---|
| BOYS | M | SD | M | SD | t | P |
| Plan | 11.67 | 8.37 | 15.30 | 7.76 | 1.18 | NS |
| Piaget | 7.97 | 3.14 | 8.4 | 1.62 | 0.44 | NS |
| Vocabulary | 36.63 | 8.19 | 40.5 | 9.02 | 1.23 | NS |
| Age | 8y 6.8m | 2.94 | 8y 7.8m | 4.01 | - | NS |
| GIRLS | N = 33 | | N = 7 | | | |
| | M | SD | M | SD | t | P |
| Plan | 10.82 | 7.50 | 8.43 | 5.15 | 1.11 | NS |
| Piaget | 7.06 | 1.71 | 6.14 | 2.04 | 1.21 | NS |
| Vocabulary | 40.94 | 8.79 | 36.43 | 11.72 | 1.12 | NS |
| Age | 8y 7.55m | 3.52 | 8y 5.43m | 2.38 | - | NS |

Whereas 50% of boys and girls had seen a plan, less than 25% had drawn one. There was no statistically significant difference in the Plan mean score between those who had drawn plans and those who had not. In the boys the age and all the test scores were slightly higher in the group that had drawn a plan, but in the girls' group the scores were actually lower.

CONCLUSIONS

The girls' plan scores may have been increased because they had already seen a plan at home, but seeing a plan had no effect on the boys' scores and drawing a plan previously had no effect on either boys' or girls' scores.

Children seemed to make more use of their experience at home than in school and recall it more frequently. It was evident, too, that children who lived in owner occupied houses and/or had fathers in an occupation involving plans were more likely to have seen them. But although this type of experience may have improved the girls' scores it did nothing for the boys.

Some of the children, who had seen and said that they had drawn plans could only draw vertical sections of houses, and could not give a verbal distinction between a plan and a picture. This raises the question as to what the term plan means to them. As they could not draw a plan, or verbalise the distinctive features, the only other way of trying to discover if they had any concept of a plan would have necessitated asking them to select a plan or picture from an array, but this was not done.

From these results it would seem that lessons on plan drawing in school are not recalled and are not likely to affect the plan score and render the test invalid. Home experience, too, has little effect on the boys, but it may have some effect on the girls' scores.

# CHAPTER IX

# THE EFFECT OF TEACHING CHILDREN TO DRAW A PLAN

## INTRODUCTION

### AIM

A clinical standardized test needs to be reliable and valid in order to have any value. If a score can be easily affected by some specific but unquantifiable training, which may be given to some subjects, but not others, then it is useless for no prediction or constructs may be inferred from it. A frequent criticism of the Plan test is that the scores may be affected by whatever teaching the subject has been exposed to, particularly in school. This experiment has been designed to test the hypothesis that teaching subjects to draw a plan does not increase the score on this test.

### STANDARDIZED TESTS

Standardized tests provide a scale against which the individual case can be measured and are an invaluable tool to professional psychologists working in the field. The cognitive tests fall into three types, intelligence, attainments and specific tests, usually testing a more circumscribed ability in the visuo-motor or auditory spheres. The plan comes into the last category and as such may reflect intelligence and maturation, but not specific teaching as required in attainments.

When intelligence tests came to be widely used it was often thought by testers, but not the constructors, that they were measuring some innate ability that depended solely on genetic endowment. Hebb (1949) drew attention to the fact that intelligence cannot develop in a vacuum and that the innate intelligence A can only manifest itself in behaviour as intelligence B through interacting with an environment. Vernon (1955) developed this model further by pointing out that intelligence tests cannot even measure this intelligence B, but only its interaction with the test, resulting in intelligence C.

This same model can usefully be applied to attainment and specific tests. Specific tests are entirely similar to intelligence tests in that the ability tested at C is the resultant interaction between innate ability and a generally facilitating environment. Attainment tests on the other hand require more interaction from the environment at point B, in the form of teaching.

Nevertheless attainment tests of reading, spelling and arithmetic retain their value clinically because all children in this culture are exposed to teaching and because this exposure needs to continue over a wide span of years. No child can attain the level of an average adult after one or two lessons, for learning is more dependent than is usually realised on maturation. A plan however, if it can be taught at all, could theoretically be taught in one lesson, providing that the child had the vizuo-motor skill of drawing straight lines and angles. Thus it could be more vulnerable to specific interaction with the environment at B, than are the basic attainments.

In contrast to attainment tests, it has always been held that it is not possible to teach abilities tested in intelligence tests. Any coaching on similar types of items only results in limited gains, much of which is due to a practice effect. Repetition alone can increase scores by 4.7 and 6.7 IQ points, as Vernon and Parry found in 1949 when re-testing British recruits, and Lloyd and Pidgeon (1961) found that practice given to European, African and Indian children, produced gains of 7.39, 6.95 and 5.65 respectively, while coaching gave additional gains of 3.21, 7.60 and 0.45. Thus it seems that there are only gains within limits and much of what might seem to come from coaching, actually comes from practice providing increased familiarity with the test situation.

Little work seems to have been done on the possibilities of teaching specific skills in perceptual, visuo-motor and auditory abilities. The Kohs' Blocks Design has been taught and shown significant gains. (Schubert 1967). The designs in the Marianne Frostig Developmental Test are incorporated into an educational scheme of work stretching over months. Not unexpectedly gains are reported. Nobody however, seems to have tried teaching the Bender Gestalt Visual Motor Test.

The most studies perhaps have been done on DAM. Goodenough (1926) had 37 children directly coached on the scoring items of the test. The coaching consisted of two half hour periods on successive days. The children were tested before training, after each half hour, four hours after the last period of teaching and one week later; the median scores respectively were 16.7 points, 19.2 points, 23.7 points, 22.5 points and 20.7 points. A comparison with the control showed that 70% of the children had gained at least one point, while 8% showed no gain and 22% showed a slight loss. Goodenough concluded that in the majority of cases specific training does affect the score, but there was no evidence that the kind of art training commonly given in school would have any effect.

Others have tried the effect of indirect teaching on the DAM scores. Mott (1945) investigated the effect of muscular activity in concept formation.

Here the children were given exercises emphasising parts of the body, "This is my hand, I used it". Drawings made immediately after showed that the exercised part was more likely to be drawn and more attention was paid to detail.

Harris (1950) investigated the effect of rhythmic exercises, not verbally emphasized, on the length of limbs in the DAM drawings of 48 boys and 56 girls, aged 6 to 7yrs. He found that the drawings made after exercise did not differ significantly from drawings made after no exercise with respect to mean length of limbs, body, angles of limbs or action; that intra child variance was less than intra group variance showing a consistency of drawing from each child; and that there was greater variety between individual children than there was between the groups.

The Plan is a cognitive test involving general intellectual ability. Like intelligence tests it might be expected to respond to teaching, but only within limits. However, intelligence tests are composed of many tasks, the Plan only one. Two criticisms can be made of the Plan test:

1. It is not a closed test, so can be and is taught in schools.
2. It may be affected by the teaching of related subjects such as special exercises in modern mathematics, in the primary school and technical drawing in the secondary school.

So far there have been no indications that the drawings have been affected in these ways.

1. If plans could be efficiently taught then quantitative and qualatative differences might have been expected to appear in the standardization sample.
   a. Unexpectedly high scores should have appeared in some places that break the pattern of gradually increasing scores with age. This was not found.
   b. If plans had any horizontal feature correct then all items, rooms, doors, windows and stairs might have been expected to be correct. This too was not found except in older and more intelligent children.
2. If the teaching of modern mathematics and technical drawing was going to have an effect on Plan drawing, then it might have been expected that children in the primary schools following the Nuffield mathmatics scheme would produce better Plan drawings than the others and that boys doing technical drawing in the secondary school would produce correct plans. Neither of these results was seen.

This finding is consistent with others in the literature. As the Plan loads on spatial ability (Chapter X), the following studies are relevant, for although some special tests are useful predictors of success in technical courses (Smith, 1960), training on the latter does not affect the former (Faubian et al, 1942; Churchill et al, 1942; Myers, 1957). One criticism can be made that these courses were all of a short duration. When McFie (1961) tested African youths after a 2 year technical training, he found that their scores on Block Design and Memory for Designs had improved. However, their upbringing had lacked toys and constructional games of a European culture and the improvement may in part have been due to a general facilitation of development plus the elimination of mistakes due to extrinsic factors.

More positively in the case of the Plan it may be stated that not only was there no qualitative or quantitative evidence of the effects of teaching, but the characteristics of the standardization sample and others suggested that the ability reflected mainly maturation and intelligence.

(a) Average scores in other normal samples were the same as in the standardization sample.

(b) Intelligence always affected the results. Grammar school scores were higher than those in secondary modern schools, in the standardization sample and when correlation coefficients were found between the Plan and intelligence scores in subsequent samples, they tended to be about .5.

(c) Average scores for girls were always lower than for boys, showing a consistent sex difference, which is often found in spatial tasks.

All these observations suggested that the Plan was testing concepts that owed more to maturation than exposure to teaching. As however, it is only a one task test, it is important that its susceptibility to teaching should be rigorously tested.

THEORETICAL BACKGROUND TO THE EXPERIMENTAL DESIGN

The aim of this experiment is to teach the drawing of a Plan as efficiently as possible, so that the possibilities of the children learning are maximised. It should, if possible be better than any teaching likely to be encountered in the normal process of schooling.

For that reason it is necessary to consider first of all what is to be taught, for that will determine when and how it is best taught and what the most efficient measure would be.

1. What is to be taught.

One type of material to be taught is best learned through an association type method, in which laws of simple S-R learning play an important role. The less meaning the content has and the more arbitrary the associations are, the greater is the efficiency of the laws established in S-R learning.

The other main type of learning involves restructuring of concepts that takes place through insight. This does not respond to the simple S-R laws of learning, but needs an experimental situation in which restructuring of the concepts is facilitated.

All evidence so far suggests that learning to draw a plan of a house involves the latter, for when a child changes from drawing a vertical to a horizontal plan, it is not just a new array of lines on the paper, but involves a new way of viewing the environment.

The work which has already been shown to be relevant to this is that of Piaget. An association between the concepts of verticality and horizontality has already been demonstrated in Chapter V. If this is correct, plan drawing, which begins in the average child at the age of 8 years, may be classed as an infra logical grouping, which belongs in the concrete operational stage. Using his terms, it would seem that the change from vertical to horizontal representation shows that biological adaptation has taken place, with the accent on accommodation rather than assimilation, resulting in a new cognitive integration, in which equilibrium is attained through decentration of the percept. In this new internalised system, representation of an infinite number of actions can take place internally without any change in the external world.

It therefore seems that what is to be learnt is that the conservation of all possible viewpoints can only be achieved, if the 3D space is represented horizontally via a co-ordinating grid of vertical and horizontal planes. In this way conservation is achieved because all viewpoints are reversible and the law of association is also satisfied in that all sequences of movements are possible

2. How it should be taught.

Since Plan drawing probably involves concept formation rather than S-R type of learning, the training will need to facilitate insight.

As the successful accomplishment is associated with other concepts, which might seem to be more fundamental, such as verticality and horizontality, it might be expected that most improvement might occur if these are taught rather than the task itself. However, the association is not so strong as to indicate that it is a necessary condition of learning. It is found in teaching that most improvements and skill usually come in teaching the skill itself, rather than from teaching supposedly more fundamental skills. This suggests that particularly as the effects of teaching plan drawing have not been explored at all, a direct teaching approach should be used at this stage; that is plan drawing itself should be the content of the teaching.

This decision was reinforced by Brainerd and Allen's review of training experiments in 1971a. They concluded that training in concepts at Piaget's concrete operational stage was not transferable, hence the presence of the décalages, but that training at the formal operational stage was. They attributed this to the finding that conservation at the concrete operational stage was achieved through inversion or negation,or reciprocity; whereas at the formal operational stage it could be achieved by their joint action. They tested out this hypothesis by demonstrating the generalisation of density conservation to liquid and solid volume conservation. (1971b).

Just how much training in conservation at the concrete operational stage is possible, may be debatable. Piaget himself was most interested in mapping out the whole range of cognitive development and the hypothetical structures involved in change, and has not himself studied how the acquisition of skills could be affected by teaching.

In Vernon's terms, Piaget explains acquisition of intelligence B by the interaction of innate ability with large quantities of generalised experience, which facilitate the cognitive operations, such as reversibility. Other workers however, tried to teach the conservation of substance and weight (Smedslund,1961), number (Wohlwill and Lowe,1962), discontinuous quantities (Feigenbaum and Sulkin, 1964) volume (Ball and Campbell, 1970). All used kindergarten children at the pre-operational stage and taught the experimental group in a variety of non verbal ways using a control group for comparison. In most cases the experimental group improved, but so did the control group, while in a few cases the experimental groups' scores were lower than those of the control group. From a review of the work, up to 1963 Flavell concluded that these kinds of concepts were not trainable.

The increase in the scores of the control group remains to be explained. It can be classed as a practice effect, which is commonly found in all learning tasks, but this does not clarify whether it is more due to the interaction of test and intelligence, i.e. intelligence C or whether it reflects an interaction at the level of intelligence B, suggesting a more fundamental conceptual change.

These experiments are therefore of limited use in providing an indication as to how insight into these concepts can be taught. It is worth noting however, that the successful teaching methods employed practical examples of how addition and subtraction of substances changed the quantity. These types of examples, which had been derived from children's explanations, who already had achieved the concept of conservation, were found to be more effective than examples based on adults' explanations. This suggested that when devising a method of teaching plan drawing, it would be useful to look at explanations given by children who were doing it correctly. When this was done many of the explanations were found to be idiosyncratic and involved talking about what was for them possibly the most emotionally significant parts of the house. Indications of the cognitive procedure were sparse. All of them attempted to visualise the house, but in many different ways; many imagined themselves going from room to room inside the house, a few tried to visualise the outside of the house as well, some thought of themselves looking down from the top, one thought of the foundations as it was being built, many of them were particularly worried about the stairs.

As a result of this information, it was decided to teach plan drawing by using a model of a house. This would have the advantage of being:

1. Present to their view, so that memory was not involved.
2. Simpler than any house.
3. A uniform experience for all the class, presenting the same problem to all
4. Able to be viewed from all angles behaviourably, not just imaginatively, so eliminating differences in the clarity of visual imagination.
5. Able to be demonstrated by the teacher drawing a plan of the model in full view of the class.
6. A full discussion of any query and as much verbal explanation as possible.

This contrasts with the usual method followed in school, in which the teacher first shows the class how to draw a plan of a desk, followed by a plan of the classroom, the school and often a house. The teacher demonstrates the plans on the blackboard. There is usually no check to see if the children know what aspect of the object they are drawing, it being assumed that they realize they are taking a viewpoint from above.

3. What type of measure.

In these infra logical tasks of Piaget related to objects, it is always possible to test a child's conservation behaviourally, as well as verbally. In all studies that have used both methods, it has been found that there are more correct behavioural responses than there are acceptable verbal explanations or justifications (Wohlwill and Lowe, 1962; Goldschmid, 1967; Goldschmid and Bentler, 1968; Rothenberg, 1969).

This was also found in the Woodside study (Chapter VII). Children, who could draw a plan horizontally, could not necessarily pick out the best plan from three, when some were vertical, or if they could, they often gave irrelevant reasons. They also often could not explain the difference in viewpoint between a plan and a picture.

It was therefore decided that when measuring the responses, a behavioural method should be used, because it would reveal the maximum change. The usual scoring system was therefore employed.

4. When it should be taught.

When studying the effects of teaching, it is essential that the concept to be tested should be taught to the correct age group. If the children are too young, little or no learning will take place; if the children are too old, no measurable improvement will show, because they already know how to solve the problem. So for all other studies in the acquirement of conservation of a concept have either chosen children within the age group when conservation is possible or at a lower stage (Smedslund, 1961; Wohlwill and Lowe, 1962; Feigenbaum and Sulkin, 1964). Often the upper age limit of the sample has been when 50% of the children have the concept without teaching.

From the standardization samples the great change in drawing a plan horizontally comes between the ages of 7y 6m, 8y 6m and 9y 6m, when children drawing plans horizontally increase from 14% to 58% and 82% respectively. This also coincides with an increase in children having the concept of horizontality and verticality according to Beard (1964.)

Such findings suggest that the optimal time for teaching, which should show the greatest improvement, might come between the ages of 7r 6m and 9y 6m. As the girls are about one year behind the boys, it is possible that the optimal year for boys might be 7y 0m to 7y 11m and for girls 8y 0m to 8y 11m.

SUMMARY

When examining what is to be taught, how and when it should be taught and how the effects of teaching should be measured, the following conclusions were drawn:

1. The task involved insight not just S-R association learning.
2. In Vernon's terms, it involved intentional manipulation of the environment, which should result in a change in intelligence B. However, a control group is essential for there are indications that practice alone can produce a change in scores, which might indicate only a change in intelligence C.
3. There was not enough evidence about the exact nature of the skill to warrant teaching supposed components, therefore the skill itself should be taught. Moreover Brainerd's review suggests that there may be no transfer of training from one type of conservation to another at the concrete operational stage.

4. Conversations with children on plan drawing about difficulties in visualizing their homes from all angles suggested that drawing a plan of a model might be a useful teaching aid.
5. Use the scoring system of a plan as a measure, because it reflects a behavioural response. This is easier for children than a verbal response and therefore more likely to show changes with teaching.
6. Both Piagetian studies and the standardisation sample indicate that children between the ages of 7y 0m and 9y 11m would show the greatest improvement with teaching with the proviso that it might differ for boys from girls.

By using these criteria it is hoped to maximise the effect of teaching, such that it would produce as great or greater change than any teaching children are likely to experience in school.

SAMPLE

Woodside Primary school in Buckinghamshire was used for this study, because the children showed a normal distribution of intelligence in the 11+ selection tests and other work already done showed that their scores on drawing a plan corresponded to the standardization sample.

Children in the first year were chosen because they had no experience of plan drawing in school. They were at the lower end of the age range 7r 0m to 9y 11m, when it was considered that teaching might result in an optimum change.

METHOD

Experimental Design

The children were divided into an experimental and control group. Both were to be tested, then one taught, both tested immediately after teaching and again after an 8 week interval.

As the first year was divided into two classes on the basis of the alphabetical order of their names, it was thought that they might be equal in age and ability. One was designated the control and one the experimental group.

Only children who were there on all testing occasions and lived in houses were included in the achieved sample. The losses due to living in flats and absences are shown in Table 9.1.

TABLE 9.1

COMPOSITION OF DESIGN SAMPLE

| SEX | CONTROL | | | | EXAMPLE | | | |
|---|---|---|---|---|---|---|---|---|
| | DESIGN SAMPLE | LOSS | FLAT | ABSENT | DESIGN SAMPLE | LOSS | FLAT | ABSENT |
| BOYS | 16 | 6 | 3 | 3 | 20 | 7 | 4 | 3 |
| GIRLS | 26 | 8 | 5 | 3 | 26 | 5 | 3 | 2 |

There are rather more girls in both groups, which did not matter because the results had to be treated separately. The average ages of both groups were about the same. (Table 9.2).

TABLE 9.2

COMPOSITION OF ACHIEVED SAMPLE: AGE AND SEX

| | CONTROL | | EXPERIMENTAL | |
|---|---|---|---|---|
| SEX | N | MEAN AGE | N | MEAN AGE |
| BOYS | 10 | 7y 10.4m | 13 | 7y 10.8m |
| GIRLS | 18 | 7y 8.3m | 21 | 7y 11.2m |

The sequence of testing and retesting was as follows :

1. Testing both groups, Friday 4th March, 9.00 a.m. - 12.00 noon.
2. Teach experimental group, Tuesday 9.00 a.m. - 12.00 noon.
3. Test both groups Tuesday, 1.30 p.m. - 3.30 p.m.
4. Test both groups Friday 13th May.

TEACHING

The children in this school were usually taught in small groups, but although this would have been possibly the best method, it would have had to be spread out over too long a period, so would have been difficult to control and inconvenient for the class.

A class method of teaching was therefore used, followed by individual teaching.

1. The task was given and children were invited to explain how it could be done. Some came out and drew diagrams on the blackboard.
2. A model of a house was then produced, from which it was possible to remove the top floor. The insides of two rooms and hall with staircase were then shown. (Figs.9.1 and 9.2)

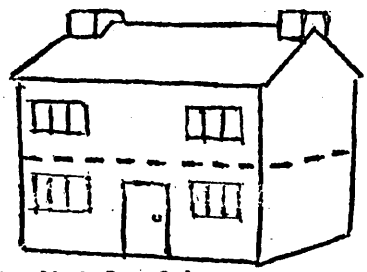


Fig. 9.1 Model of house.

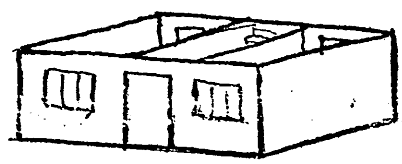


Fig. 9.2 Upstairs of house removed.

It was then demonstrated how it would be possible to draw a plan of the model by placing it with the 'floor' of the model against the blackboard and drawing a line round the perimeter. The position of other walls, stairs, doors and windows were then added. The different parts were labelled and discussed with the class.

3. Each child then made his own model of the ground floor of a two roomed house made out of a shoe-box with the help of the teacher, assistant teacher and tester, being given individually.
4. When the model was completed, the children placed it on their drawing papers, drew round the base and added other features and labels. The total time taken, including a 15 minute break in the middle of the morning, was 2 hours.
5. The children were then asked to draw a plan of their own house.

RESULTS

As the numbers in the boys' groups were small, the difference between the control and experimental groups were first assessed by putting together the boys and girls scores. The means and standard deviations are shown in Table 9.3

TABLE 9.3

DIFFERENCES BETWEEN MEAN SCORES OF CONTROL AND EXPERIMENTAL GROUPS

| | CONTROL N = 28 | | EXPERIMENTAL N = 34 | | | |
|---|---|---|---|---|---|---|
| TEST | MEAN | S.D | MEAN | S.D | t | P |
| 1 | 7.464 | 6.977 | 7.205 | 5.840 | 0.259 | NS |
| 2 | - | - | 10.323 | 8.397 | - | - |
| 3 | 10.892 | 8.020 | 11.352 | 8.609 | 0.460 | NS |

There was no significant difference between the initial mean scores of the two groups, indicating that the assumption that there would be no difference in ability in plan drawing between the two classes was correct.

It had not been possible to test the control group when the experimental group were tested for the second time immediately after teaching, so that only the scores of the third testing, two months later, can be compared. These show no statistical difference between experimental and control groups, suggesting that teaching had no effect.

However, the experimental group showed some increase and inspection showed that it was chiefly due to the improvement in a few individual girls' scores. A product moment correlation between scores on test 1 and test 3 was therefore calculated on boys and girls separately (Table 9.4)

TABLE 9.4

CORRELATIONS BETWEEN TEST AND RETEST SCORES

| | CONTROL GROUP | | | | EXPERIMENTAL GROUP | | |
|---|---|---|---|---|---|---|---|
| | BOYS | | | | BOYS | | |
| TESTS | 1 | 2 | 3 | TESTS | 1 | 2 | 3 |
| 1 | | - | .851 | 1 | | .972 | .974 |
| 2 | - | | - | 2 | .271 | | .979 |
| 3 | .75 | - | | 3 | .140 | .771 | |
| | GIRLS | | | | GIRLS | | |

All the boys' test scores were statistically significantly correlated and teaching has made little, if any, difference to the order of their ability. It has, however, made a great difference to the girls' scores, and once the change took place it seems to have been maintained.

Differences between the control and experimental means in the boys and girls groups separately were then examined, but again no significant differences were found (Table 9.5)

TABLE 9.5

DIFFERENCES BETWEEN MEANS OF BOYS AND GIRLS SEPARATELY

| | CONTROL | | EXPERIMENTAL | | | |
|---|---|---|---|---|---|---|
| BOYS | N = 10 | | | N = 13 | | |
| TEST | MEAN | S.D | MEAN | S.D | 't' | P |
| 1 | 9.60 | 6.44 | 9.69 | 8.36 | .09 | NS |
| 2 | - | - | 12.30 | 10.18 | - | - |
| 3 | 12.50 | 7.95 | 11.15 | 9.32 | 1.35 | NS |
| GIRLS | N = 18 | | | N = 21 | | |
| 1 | 6.28 | 6.98 | 5.67 | 2.40 | 0.61 | NS |
| 2 | - | - | 9.09 | 6.79 | - | - |
| 3 | 10.00 | 7.92 | 11.48 | 8.13 | 1.48 | NS |

Nor was any statistically significant difference found when the mean differences between 1st and 3rd testing was found in boys and girls separately (Table 9.6)

TABLE 9.6

MEAN DIFFERENCE BETWEEN TEST 1 and 3

| | CONTROL | | EXPERIMENTAL | | | |
|---|---|---|---|---|---|---|
| | N | M | N | M | t | P |
| BOYS | 10 | 2.90 | 13 | 1.46 | 1.01 | NS |
| GIRLS | 18 | 3.72 | 21 | 5.72 | 0.88 | NS |

The girls experimental group had improved more than the boys, but was not significantly different from the control group because that had improved too.

DISCUSSION

These findings supported the null hypothesis that there was no difference in boys' scores between the experimental and control groups, which would seem to indicate that teaching had no effect on their ability to draw plans.

However, the same cannot be said for the girls. Like the boys there was no statistically significant difference between the experimental and control groups, but the mean scores of both had improved on the 3rd test. One-third of the girls showed large differences, although the others hardly changed. This indicated that some girls could make use of a facilitating experience and it did not need to be teaching, exposure to practice was sufficient in a few cases.*

Fortunately it is not very probable that they would ever have quite such an intensive lesson as the experimental group had this time and also nothing is known of the long term effects of the teaching. It is not know if this improvement will be retained indefinitely and if so would it be cumulative or would those without teaching eventually achieve the same standard.

Clinically, when testing a child, it would be important to ask if they have seen a plan and if they have been taught how to draw a plan and if so when? However, the test would still be useful, even if the child had been taught for clinicians are interested in scores which fall below that of general intelligence. Any teaching would increase a score not decrease it. This means that although a deficiency would be obscured, a false deficiency would not be created.

* See Chapter XI for a further discussion about sex differences in plan drawing

# CHAPTER X

## SPATIAL ABILITY AND ABILITY TO DRAW A PLAN

### INTRODUCTION

Factors derived from a battery of tests depend on the sample tested, the content and number of tests, and the method of analysis.

A. Sample:

1. A normal sample should be chosen, or if this is not possible, findings from abnormal groups should not be assumed to be characteristic of normal ones. On occasion, findings from groups with a known abnormality could be illuminating.
2. The appearance of a factor can depend on age, as Slater and Drew showed with regard to the spatial factor not appearing in 11 year old children, although it can be consistently found in adults.
3. The more homogeneous the group is in age and general ability, the more differences in specific abilities is revealed. Spearman and Thurstone evolved different theories of intellectual structure not only because the methods of analyses differed, but also because their samples differed.

B. Content

1. A factor cannot be found if it is not contained in the test battery and there is no means of being sure that all possible facets of intelligence are represented in the tests.
2. The content of the tests affects the correlation matrix and there needs to be at least two tests with similar content in order to get a high correlation. Often tests are used just on subjective judgement alone, based on a name or type of content and this can be misleading. A spatial test can be presented in a verbal form and a test of 'g' by the use of diagrams. Moreover, even if the factor loading is known from previous work, the factor term may be ambiguous, such as the use of spatial symbols 'K' and 'k', and lead to the wrong choice of tests.

C. Method of Analysis

A factor analysis cannot produce factors that are not present, but there is no unique solution to a particular correlation matrix and there is no completely objective way of determining what analysis suits the data best. Thurstone has attempted one in his theory of Simple Structure but this assumed that there was no general factor and was made to fit his theory that scores on all tasks could be explained in terms of a few primary mental abilities.

Direct factorial solutions always produce one general factor, Pearson's Principal Component, Burt's Simple Summation, Holzinger's Bi-factor, Hotelling's Principal Factor and Thurstone's Centroid method. In all except Holzinger's the group factors account for a diminishing amount of the variance. This leads inevitably to a hierarchical model of intellectual ability and fits Burt's classical type of definition of the characteristics of abilities.

A multiple-factor solution that can follow a direct solution is an outcome of orthogonal or oblique rotations. This precludes the finding of a general factor for the common variance is spread evenly among the common factors instead of being extracted in the first factor. Such a method produces a solution which conforms to Thurstone's criteria of 'Simple Structure' and his theory of primary mental abilities. As oblique rotations inevitably results in correlated factors, a general factor can be found in a second order analysis, but it has quite a different psychological implication to Spearman's 'g'.

Summary of General Principles of Selection of Content of Test Battery, Sample and Type of Analysis.

A. Sample.

1. Select a normal sample that is not likely to be affected by specific disabilities.
2. Select as age range in which desired factor is likely to be present.
3. Take an average ability range.

B. Content of Test Battery.

1. Select tests with known factor loadings in order to attempt to cover the intended range of abilities and provide the required factor structure.
2. Have at least three tests purporting to represent a desired dimension (Child, 1970).

C. Analysis.

1. Use several methods, orthogonal, rotated and oblique to look for all possible factors in a sample and to examine robustness of factor.
2. Use a criterion for numbers of factors to be selected in order to reduce possible effect of unique variances.
3. Use a criterion for assessing significance of factor loading.

D. Identification.

The only method of identifying a factor known so far is by inspection, which involves looking at the test which loads highest on the factor, comparing its performance with that in other studies, subjectively deciding what cognitive ability it is likely to be using and name the factor accordingly.

METHOD

As the test results had to be obtained from a clinic population, it was not possible to follow the above criteria entirely.

A. Sample Selection

1. This was not a normal sample, but children who had been referred for learning or emotional problems to an urban clinic; 61 boys and 29 girls for educational, and 110 boys and 46 girls for psychiatric assessment. As sex and type of disability might cause different interactions, each group was looked at separately before being put together.
2. The children's ages ranged from 7 to 15 years averaging at 9y 2m. As spatial ability is more clearly found in children over 10 yrs. such an age range was extracted from the largest group, emotionally disturbed boys, and looked at separately.

B. Content of Battery

It was not possible to compose a battery especially for the Plan test, only to select from tests used regularly for educational and psychiatric referrals. Tests selected were subtests from the WISC: Information, Comprehension, Arithmetic, Similarities, Vocabulary, Digit Span, Picture Completion, Picture Arrangement, Block Design, Object Assembly and Coding; Visuo Motor tests: DAM and BG; Attainment tests: Schonell's Word Graded Reading Test, Schonell's Spelling A and Vernon's Arithmetic-Mathematics Test.

Information about factor loadings of the WISC subtests came from Maxwell's, Gault's and Cohen's factor analysis of the WISC standardization sample. Although not strictly comparable because they differed in battery content and type of analysis, some findings were similar at the 10½ year level, which is the most relevant for the sample.

In the direct solution 'g' is always the first factor extracted followed by a verbal factor to which the above subtests IN, CO, AR, SI, VO always contribute; a spatial factor on which BD and OA load and a memory factor which receives contributions from DS . The spatial factor in this test is always consistently present from the mean age of 7½ years and is found invariably in the BD and OA.

The factor content of the two visuo-motor tests BG and DAM was not known, because they do not seem to have been included in any factorial study of clinical tests. They were used here because it was thought possible the BG would load on the spatial factor since it, like the BD, shows lower scores and qualitative differences in subjects with known brain damage. They both also like the Plan test, reflect cognitive development and show great changes through the 5y to 11y age range. In the standardization sample the Plan had correlations of .2 to .5 with the DAM scores.

Attainment tests of reading, spelling and arithmetic were included because Vernon has found them to load on a verbal-education factor. It was thought they would provide a rather specific loading which would help to distinguish the verbal from the 'g' factor in the WISC and provide an orthogonal factor to the spatial one. Also, while it is known that arithmetic tests load heavily on 'g' at this age, the provision of two arithmetic tests would enable a numerical factor to appear, if there was one.

Thus it was expected that all tests would reveal a 'g' factor, at least seven a verbal factor, two and possibly four a spatial factor and two a numerical factor. Had a battery of tests been specifically compiled for this task, the number of tests purporting to load on each factor would have been kept equal and NFER spatial tests requiring visualisation of three dimensional objects would have been chosen.

C. Analysis.

The scores were analysed by the computer at Bedford College. A direct solution was used initially in which the principal axes were extracted successively until the variance explained by the last axis was less than one. This would produce a general factor and bi-polar factors. The principal axes were then rotated to approximate simple structure using Kaiser's Varimax procedure, the communalities being the same before and after rotation.

D. Identification of Factors.

This was done by considering only statistically significant loadings and using the WISC verbal tests to identify a verbal factor and the BD and OA to identifying a spatial factor (Gault, 1954; Maxwell, 1959; Cohen, 1959), the BG and DAM to identify a visuo-motor factor and the attainment tests an educational factor

RESULTS

A. Sample

From the means of the scores there was evidence both for cognitive normality and abornality in the groups.

The WISC verbal, performance and full scale IQs were above the American norms, but consistent with a normal London sample (Jones, 1962). Standard deviations were also appropriate. (Table 10.1).

TABLE 10.1

| Educational | BOYS N = 61 M | SD | GIRLS N = 29 M | SD |
|---|---|---|---|---|
| VERBAL | 107.49 | 13.53 | 107.93 | 13.12 |
| PERFORMANCE | 107.18 | 13.13 | 105.83 | 16.53 |
| FULL SCALE | 107.74 | 12.51 | 107.07 | 14.53 |
| AGE | 10y 10.30m | 21.41m | 10y 3.79m | 21.31m |

| Psychiatric | BOYS N = 110 M | SD | GIRLS N = 46 M | SD |
|---|---|---|---|---|
| VERBAL | 108.40 | 16.62 | 105.70 | 13.68 |
| PERFORMANCE | 106.95 | 14.63 | 100.17 | 15.44 |
| FULL SCALE | 108.25 | 15.23 | 103.09 | 14.06 |
| AGE | 10y 11.43m | 26.63m | 10y 11.04m | 24.48m |

There was no evidence of severe learning difficulties in any group except the Boys Educational referrals. The spelling means were low, but the test used is known to be about one year too difficult for most of the age range (Table 10.2).

There was evidence of a learning disorder in the Boys Educational referrals. They scored low on the WISC sub-tests AR, DS and CO and attainments. That particular WISC pattern has been found in children with the syndrome of Specific Dyslexia. Vizuo-motor functioning was immature in all four samples for both the DAM and BG means were lower than their normative samples (Table 10.2).

B. Factor Structure

As this sample was abnormal in some aspects, although normal in others, it was considered necessary to examine each matrix separately before using the matrix of the total sample to describe factor components of the Plan test.

The results of the Principle axes solution were similar in all groups. Factor I took up most of the variance and could be identified as 'g', Factor II took up much less variance and was bi-polar, spatial and

## ABBREVIATIONS OF TESTS USED

| | |
|---|---|
| WISC | |
| Information | IN |
| Comprehension | CO |
| Arithmetic | AR |
| Similarities | SI |
| Vocabulary | VO |
| Digit Span | DS |
| Picture Completion | PC |
| Picture Arrangement | PA |
| Block Design | BD |
| Object Assembly | OA |
| Coding | COD |
| VISUO-MOTOR | |
| Bender Gestalt | BG |
| Draw-a-Man | DAM |
| Plan | PLAN |
| ATTAINMENTS | |
| Reading | READ |
| Spelling | SPELL |
| Arithmetic | ARITH |

TABLE 10.2

MEANS AND STANDARD DEVIATIONS OF TEST SCORES IN EDUCATIONAL AND PSYCHIATRIC CHILD REFERRALS

| | EDUCATIONAL | | PSYCHIATRIC | | TOTAL |
|---|---|---|---|---|---|
| | BOYS | GIRLS | BOYS | GIRLS | |
| N | 61 | 29 | 110 | 46 | 246 |
| WISC | | | | | |
| In Means | 10.49 | 10.41 | 11.51 | 10.57 | 10.95 |
| SD | 2.79 | 2.83 | 3.50 | 3.12 | 3.23 |
| CO Means | 11.34 | 10.72 | 11.08 | 10.83 | 11.06 |
| SD | 3.05 | 3.20 | 3.45 | 3.04 | 3.26 |
| AR Means | 9.91 | 10.91 | 10.65 | 10.42 | 10.46 |
| SD | 3.10 | 2.92 | 3.75 | 3.10 | 3.40 |
| SI Means | 12.36 | 11.90 | 11.80 | 11.72 | 11.93 |
| SD | 3.19 | 3.04 | 3.59 | 2.62 | 3.27 |
| VO Means | 11.70 | 11.90 | 12.01 | 11.89 | 11.80 |
| SD | 2.50 | 2.19 | 2.91 | 2.74 | 2.71 |
| DS Means | 8.88 | 10.14 | 10.82 | 9.49 | 9.98 |
| SD | 2.84 | 2.54 | 6.40 | 2.32 | 4.69 |
| PC Means | 11.80 | 10.41 | 11.43 | 10.80 | 11.28 |
| SD | 3.08 | 3.31 | 3.56 | 3.99 | 3.54 |
| PA Means | 10.48 | 9.68 | 10.15 | 8.96 | 9.95 |
| SD | 2.63 | 3.04 | 2.58 | 2.49 | 2.68 |
| BD Means | 12.20 | 10.83 | 12.08 | 10.17 | 11.61 |
| SD | 2.72 | 3.68 | 3.13 | 2.69 | 3.13 |
| OA Means | 11.79 | 11.83 | 11.68 | 9.61 | 11.34 |
| SD | 3.34 | 3.20 | 3.09 | 3.35 | 3.32 |
| CO Means | 8.90 | 11.41 | 9.36 | 10.41 | 9.69 |
| SD | 2.61 | 2.76 | 2.98 | 2.70 | 2.93 |
| Visuo-Motor | | | | | |
| BG Means | 88.00 | 93.17 | 89.12 | 92.54 | 89.82 |
| SD | 19.23 | 19.98 | 19.49 | 18.25 | 19.36 |
| DAM Means | 94.15 | 95.70 | 96.48 | 94.83 | 95.39 |
| SD | 16.80 | 17.48 | 17.47 | 16.49 | 17.12 |
| PLAN Means | 89.78 | 96.31 | 89.21 | 88.85 | 90.12 |
| SD | 15.11 | 15.12 | 16.59 | 12.68 | 15.55 |
| Attainments | | | | | |
| Read. Means | 92.00 | 97.59 | 100.69 | 101.02 | 98.21 |
| SD | 21.16 | 19.55 | 22.08 | 19.44 | 21.41 |
| Spell Means | 81.51 | 91.17 | 89.58 | 94.22 | 88.63 |
| SD | 18.23 | 18.22 | 19.14 | 17.79 | 19.08 |
| Arith Means | 89.40 | 92.34 | 95.08 | 91.15 | 92.62 |
| SD | 19.31 | 16.09 | 20.54 | 17.98 | 19.43 |

educational. Factor III was scarcely significant and was found in verbal, spatial and visuo-motor tests. There was no numerical factor.

In the rotated Varimax solution the 'g' factor disappeared. The factors differed much more in the different groups, in the order of appearance, in the factor combinations and the amount of the total variance they accounted for. It was therefore decided to select the factor matrix in which the Plan and the identification tests for the different abilities had the highest communalities, and also the one which explained the largest percentage of the test variance (Table 10.3).

TABLE 10.3

COMMUNALITIES OF THE IDENTIFICATION TESTS IN DIFFERENT SAMPLES OF CHILDREN

| | | EDUCATIONAL | | PSYCHIATRIC | | | TOTAL |
|---|---|---|---|---|---|---|---|
| | TEST | GIRLS | BOYS | GIRLS | BOYS | BOYS 10+YRS | |
| VERBAL | VO | 78 | 40 | 65 | 63 | 61 | 66 |
| SPATIAL | BD | 77 | 92 | 47 | 44 | 42 | 64 |
| VS-MTR | BG | 69 | 41 | 54 | 76 | 31 | 25 |
| MEMORY | DS | 77 | 24 | 20 | 12 | 11 | 71 |
| EDUCATIONAL | READ | 96 | 72 | 79 | 69 | 64 | 77 |
| | PLAN | 49 | 26 | 24 | 27 | 57 | 22 |
| TOTAL PERCENTAGE VARIANCE OF ALL TESTS | | 69 | 48 | 52 | 49 | 52 | 48 |

Although the matrix using the whole sample of 245 children might have been expected to produce the most satisfactory structure, the total percentage variance accounted for was one of the lowest and so was the communality of the Plan test. This was probably because there is possibly a sex difference in the factor structure of tests done by boys and girls and also between children with psychiatric and learning disorders.

The most satisfactory matrix came from the Girls Educational sample. It had the highest test communalities and accounted for the highest percentage variance. It also happens to be the one which, according to the test means and clinic judgement is nearest to a 'normal' sample. In addition it has produced four factors, which is another characteristic of a normal sample. This factor structure will therefore be given in detail (Tables 10.4 and 10.5)

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TABLE 10.4

PRODUCT MOMENT CORRELATIONS

BOYS PSYCHIATRIC

| | IN | CO | AR | SI | VO | DS | PC | PA | BD | OA | CO | BG | DAM | PLAN | READ | SPELL | ARITH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IN | | 49xxx | 61xxx | 52xxx | 66xxx | 34xx | 27x | 23 | 33xx | 16 | 37xx | 15 | 05 | 53xxx | 64xxx | 66xxx | 69xxx |
| CO | 64xx | | 47xx | 52xxx | 60xxx | 25x | 23 | 26x | 26x | 18 | 14 | 15 | 25 | 34xx | 31xx | 35xx | 49xxx |
| AR | 77xxx | 53xx | | 48xx | 41xx | 14 | 13 | 27 | 42xx | 21 | 51xxx | 01 | 13 | 29x | 56xxx | 65xxx | 83xxx |
| SI | 41x | 41x | 30 | | 64xxx | 20 | 30x | 10 | 07 | 03 | 30x | 13 | 01 | 19 | 43xx | 46xxx | 56xxx |
| VO | 77xxx | 57xx | 69xx | 44x | | 25x | 33xx | 30x | 20 | 10 | 30x | 22 | 02 | 44xx | 64xxx | 59xxx | 56xxx |
| DS | 25 | 04 | 27 | 34 | 26 | | 14 | 06 | 13 | 03 | 19 | 13 | 00 | 17 | 25x | 26x | 18 |
| PC | 32 | 13 | 26 | 38x | 35 | 53xx | | 20 | 30x | 38xx | 43xx | 02 | 54xx | 22 | 15 | 07 | 26x |
| PA | 35 | 24 | 26 | 41x | 41x | 08 | 38x | | 29x | 36xx | 26x | 13 | 60xxx | 43xx | 22 | 13 | 22 |
| BD | 39x | 31 | 53xx | 58xx | 41x | 32 | 47xx | 66xxx | | 48xxx | 39xx | 17 | 43x | 54xxx | 16 | 25x | 46xxx |
| OA | 26 | 11 | 41 | 49xx | 27 | 46x | 58xx | 50xx | 60xx | | 23x | 18 | 62xxx | 39xx | 01 | 05 | 15 |
| COD | 40x | 41x | 42x | 36 | 41x | 02 | 04 | 16 | 43x | 34 | | 02 | 26 | 19 | 24x | 30x | 5xxx |
| BG | 53x | 34 | 75xx | 49x | 49x | 48x | 40 | 19 | 71xx | 54x | 41 | | 07 | 29 | 25 | 24 | 27 |
| DAM | 43x | 30 | 43 | 37 | 22 | 15 | 16 | 33 | 46xx | 51x | 64 | 42 | | 28 | 01 | 04 | 09 |
| PLAN | 39x | 39x | 61xx | 26 | 49x | 11 | 21 | 48xx | 54xx | 32 | 28 | 60xx | 32 | | 31xx | 33xx | 37xx |
| READ | 50xx | 26 | 69xx | 30 | 49xx | 31 | 01 | 07 | 21 | 24 | 47xx | 56x | 50x | 21 | | 87xxx | 61xxx |
| SPELL | 53xx | 22 | 64xx | 31 | 57xx | 34 | 09 | 03 | 26 | 25 | 46x | 60xx | 48x | 28 | 95xxx | | 72xxx |
| ARITH | 65xxx | 49xx | 81xxx | 52xx | 61xx | 22 | 28 | 14 | 54x | 44x | 58xx | 75xx | 51 | 45x | 76xxx | 73xxx | |

GIRLS EDUCATIONAL

P 0.05 x     P 0.1 xx     P 0.01 xxx

TABLE 10.5

VARIMAX FACTOR MATRICES

| | BOYS | PSYCHIATRIC | 10+YRS | | GIRLS | EDUCATIONAL | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N = 71 | | | | N = 29 | | | |
| TEST | $h^2$ | I | II | III | $h^2$ | I | II | III | IV |
| IN | 69 | 80 xx | 17 | 17 | 75 | 29 xx | 61 xx | 51 xx | 19 |
| CO | 36 | 52 xx | 27 xx | 14 | 48 | 17 | 39 xx | 54 xx | -01 |
| AR | 68 | 77 xx | 24 x | -18 | 80 | 32 xx | 75 xx | 36 xx | 09 |
| SI | 43 | 66 xx | 03 | 01 | 43 | 57 xx | 30 xx | 13 | -02 |
| VO | 61 | 71 xx | 16 | 28 xx | 78 | 31 xx | 56 xx | 55 xx | 27 |
| DS | 11 | 32 xx | 04 | -08 | 77 | 53 xx | 24 x | -36 xx | 55 xx |
| PC | 32 | 22 x | 51 xx | -12 | 60 | 70 xx | 01 | 03 | 33 xx |
| PA | 40 | 14 | 57 xx | 23 x | 63 | 66 xx | -08 | 40 xx | -18 |
| BD | 42 | 27 xx | 59 xx | 08 | 77 | 79 xx | 26 xx | 19 | -19 |
| OA | 55 | 00 | 74 xx | -11 | 71 | 80 xx | 21 x | -14 | -09 |
| CO | 39 | 44 xx | 37 xx | -25 xx | 53 | 23 x | 56 xx | 10 | -39 xx |
| BG | 33 | 17 | -01 | 53 xx | 69 | 55 xx | 62 xx | 07 | 07 |
| DAM | 77 | -09 | 87 xx | -07 | 61 | 40 xx | 51 xx | -04 | -43 xx |
| PLAN | 57 | 33 xx | 50 xx | 46 xx | 49 | 37 xx | 31 xx | 47 xx | -20 x |
| READ | 64 | 76 xx | 01 | 24 x | 96 | 01 | 97 xx | -16 | 03 |
| SPELL | 73 | 84 xx | -04 | 18 | 85 | 09 | 91 xx | -11 | 08 |
| ARITH. | 78 | 87 xx | 22 x | 00 | 81 | 34 xx | 82 xx | 16 | -04 |
| VARIANCE | | 5.03 | 2.85 | .90 | | 3.88 | 5.13 | 1.65 | 1.00 |

x P.05 xx P.01

The other sample which is also of interest, since it has the highest communality of the plan, is the Boys Psychiatric group of over 10 years, for it is above this age that the spatial factor can be identified most easily (Table 10.4).

Having chosen the most suitable factor solutions by the criteria above, it can now be seen that this battery of tests does not entirely provide matrices which conform to Thurstone's theory of 'simple structure' so that the factors are not unique.

However, they do group together in commonly formed pairs. In the Boys Psychiatric sample Factor I can be identified as verbal and educational. Factor II as spatial and visuo-motor and Factor III as visuo-motor. In the Girls Educational sample Factor I can be identified as mainly spatial, but also visuo-motor and verbal, Factor II as verbal, educational and visuo-motor, Factor III as verbal and Factor IV as memory. The verbal and memory components are more pervasive than in the boy's group.

C. Factor Loading of the Plan test

The boys' matrix provides a higher communality for the Plan test and also a clearer factor structure. On this the Plan loads highest on spatial and visuo-motor factors, but it also loads significantly on the verbal educational factor. On the girls' matrix the Plan loads significantly on all three factors, verbal, spatial and visuo-motor. It is the only test in the boy's group to do this and only the WISC, IN and VO do this in the girl's group.

DISCUSSION

The loading of the Plan test on spatial and visuo-motor factors had been expected from introspection into the nature of the task taken in conjunction with the findings in the literature, what was surprising was its loading on a verbal factor. It is therefore necessary to consider to what extent this can be considered a general characteristic, which can be found in other populations or to what extent it is only characteristic of these populations.

When assessing the possibility of generalizing these results, it is necessary to consider the samples used. Of all the samples, both the test findings and clinical judgement point to the Girls Educational sample as being the most normal. It is therefore possible that these factors would be found in other girls' samples covering this particular age range in girls. It is also possible that the loadings might change, if the age of the sample was from 12yrs. or 14yrs. upwards, when the loading on spatial ability might increase.

The Boys Psychiatric sample did have a more appropriate age range of 10 to 15 yrs, when spatial ability is more commonly found. However this cannot be considered a normal sample for all had a psychiatric disorder and their Plan scores were significantly lower than their general intellectual ability. The correlations of the Plan scores with the two spatial tests BD and OA at .32 and .12 respectively were also lower than those of the Boys Educational at .45 and .27 and the Girls Educational at .54 and .32. This suggests that the underlying psychological processes, which are involved in plan drawing, may not be the same in this group as in a normal group, where the correlations might be higher.

Finally, the battery of tests used was not entirely satisfactory and imposed constraints on the findings. Smith (1964) emphasised that the essence of spatial ability is the capacity to visualise and manipulate 2D and 3D space. The BD and OA only test this to a limited extent and there are more appropriate tests available. Since it is recommended that there should be at least three tests of each factor that is hoped to be found, then there should have been at least three tests with known spatial loadings and fewer tests with verbal loadings, particularly the more ambiguous ones in the WISC, which Cohen labels Verbal Comprehension II : CO and PC.

Taking all these facts into consideration, it is considered that the Plan might well load on verbal, spatial and visuo-motor factors in other groups with these particular characteristics of sex age and type of disorder, but that these findings cannot be safely generalized to a normal sample, particularly if the age range was higher. It would be interesting to put the Plan test into a more appropriate battery of tests given to a normal population of an age range of 15 to 30 years.

# CHAPTER XI

## DIFFERENCES BETWEEN BOYS AND GIRLS IN PLAN DRAWING

### AIM

Differences between boys' and girls' ability to draw plans were not anticipated, hence the selection of just about 200 children per age group. It was however found to such a marked extent in the item analysis that it was necessary to standardize them separately. In all subsequent studies some degree of difference was always present suggesting that plan drawing may be tapping some basic psychological difference of children that ought to be investigated. In this chapter it is proposed to look at well attested cognitive differences between boys and girls to see if they show any relationship to the findings of the Plan test and if so consider possible explanatory theories.

### COGNITIVE DIFFERENCES BETWEEN GIRLS AND BOYS

Tests can be constructed and given to populations so that no group factors emerge, all the variance being accounted for by general ability and error. However when an appropriate battery of tests is given to a carefully selected population of the right age and ability, then whatever type of factor analysis is used a factor of general ability emerges, plus those of verbal and spatial ability. (Emmett, 1949; Vernon, 1950). Using factor loading as a criterion where possible, otherwise just the face validity of the test, a brief summary is given of the type of verbal and spatial tests, which reveal different abilities in boys and girls.

#### Verbal Ability

The most obvious test material for this would appear to be vocabulary, but in fact vocabulary tests always show a high correlation with general reasoning, and either show no sex difference (MacNemar, 1942) or show either female superiority (McCarthy, 1930; Wechsler, 1958) or male superiority (Dunsdon and Frazer-Roberts 1957).

Where verbal tests have been constructed to test general reasoning using vocabulary and grammatical structure that is well within the ability range of the testees, there is also no sex difference (Gainer, 1962; Miele, 1958; Edmonds, 1964; Havighurst and Breeze, 1947).

Sex differences appear greatest showing female superiority on verbal tasks that are not just a medium for reasoning, but are the essence of the skill itself such as articulation, fluency and reading. Girls are ahead of boys in all verbal development up to 5 or 6 yrs.

McCarthy (1930) showed that girls used simple sentences earlier, gave a higher mean number of words, used a greater number of different words per response, were more grammatically advanced, used adjectives and conjunctions earlier and made a lower number of incomprehensible utterances. Davis's study in 1937 gave the same result for girls of $5\frac{1}{2}$, $6\frac{1}{2}$ and $9\frac{1}{2}$ years. They were superior in articulation, word usage, and length, complexity and grammatical correctness of sentences. Later they read sooner, read more books (Terman, 1925) and throughout their school years did better in grammar and the mechanics of spelling and reading (Norman, Clark and Bessemer, 1962). In contrast boys form about 75% of backward readers. (Rutter et al, 1970). Yedinack (1949) found that of 40 2nd grade children selected for articulation and reading problems, 75% and 67% respectively were boys and of the 27 who had both reading and articulation problems 78% were boys.

It is in these more specific aspects of language where the sex difference is seen at its greatest, girls doing better than boys. This is seen particularly in spelling where many studies illustrate their superiority throughout their school career (Clark, 1959; Heilman, 1933; Haggard, 1957). Wesman's comprehensive study of 1949 illustrates the difference between the sexes very well for when he used the Differential Aptitude Test on 10 yr. olds the girls did better at the clerical, spelling and sentences test, while the boys did better on space relations and mechanical reasoning. There were no differences on the verbal and numerical tests. Later at college (Osborne and Sanders, 1954) found that women obtained significantly higher marks in literature and fine art.

Spatial Ability

As when verbal tests are found to be a measure of general reasoning ability, so tests can be devised using shapes as a medium and still found to be testing mainly the same ability, such as Raven's Matrices (Smith, 1964). Such tests are standardized on combined population of boys and girls, presumably because there is no sex difference, and when they are included in a battery of test, load on the 'g' factor.

The best tests to show a spatial factor are those in which complexity is involved. Not the complexity of a great number of details requiring analytic treatment, such as Raven's Matrices, but according to Smith 1964, one where "... the complexity is of a kind which compels the subject to rely on the perception of the configuration as a whole". El Koussy (1955) in his paper summarizing other attributes of such tests said that the content might be two or three-dimensional and static or dynamic, and that the process required could be visualisation and/or manipulation.

Not many of these spatial tests are used for girls because they have usually been constructed as vocational guidance tests for boys and men, but where they are, such as Alexander's Passalong test, it has been necessary to construct separate norms. In one investigation, however, done by Smith (1952) with 11 year old pupils, he examined the problem of measuring spatial ability in order to select for Technical Education. There he found a group factor in tests requiring the ability to form and retain the impression of a shape, in which the boys did significantly better than the girls. It also correlated with practical geometry and engineering drawing, but not with hand work.

Smith (1964) attributes the lower performance of girls to their inferior visualising ability. This may account for Taylor's finding (1960) that when an NIIP Memory for Designs Test was marked for proportion, the boys were better, while when it was marked for detail the girls were marginally better. Presumably the proportion score would load more highly on the spatial factor. When Stafford (1961) gave a series of spatial visualisation tasks to parents and children, he found the usual male superiority, the means for fathers and boys being 10.2 and 11.9, while those for mothers and daughters were 6.3 and 9.6. Also when the SB block counting test is given to children in which some of the blocks are hidden, the boys always do better (McNemar, 1942).

Certainly tests involving space-visualisation factors given to male and female college students by Barratt (1955) were done significantly better by the men than by the women; and these included Thurstone's flag and figure tests which are known to have a visualisation factor. Qualitatively too the men were found to have several different types of spatial factors, whereas the women had a more general undifferentiated one. This difference in the appearance of a spatial factor is also seen at a younger age. Mellone (1944) found that boys did better at block counting and mazes and that they showed a spatial factor as well as general and educational ones, while the girls did not.

When Emmett (1949) tested 4000 girls and 4000 boys between the ages of 10 yrs. and 11 y 6 m on the Moray House Space Tests, he found that boys were significantly better, particularly in those tests involving 3D even more than 2D. While Havinghurst and Breese (1947), when giving the Primary Mental Abilities test to 13 year old children found that the boys excelled in spatial tests and the girls in number, word fluency, reading and memory. Satterly (1968) gave arithmetic, vocabulary, reading, visual, haptic-perceptual, drawing and spatial tasks to 200 children 7 yrs. to 11 yrs., and found that there was a marked sex difference in tests with a spatial component. He found the boys were better at drawing the physical world, drawing which required re-orientation within 3D of space, discrimination between viewpoints and pictorial depth perception.

Other tests in which a spatial factor may be expected are in the tests devised by Piaget in order to explore the child's conception of space. This was looked for in a battery of tests, including spatial and logical, given to 50 nine year old children by Mycock (1969). Detailed results were not given but it was not surprising that a general factor was first found, followed by one due to age and last of all a spatial factor of a specific kind involving perception of similarity of triangles. No significant difference was found between boys and girls. In view of the previous evidence this finding is surprising and suggests that the usual kind of psychological ability involved in spatial perception, as suggested by Smith and El Koussy was not tested. In contrast to this, Beard (1964) in a group of 6 to 11 year olds, found that there was a sex difference in the two Piaget tasks measuring horizontality and verticality, although she does not say if they are statistically significant. However, although Fogelman (1970) talks about tests of spatial concepts when quoting Beard's results, he does not cite any studies that have actually revealed this factor.

Orientation is also probably another aspect of spatial ability although it has not yet been validated as such in a battery of tests. In geographic orientation in the blind McReynolds (1954) found there was no sex difference in ability to point to local and distant places. Yet when Lord (1941) studied spatial orientation in younger children, he found that boys were more able to point to cardinal compass points and distant localities, indicate local towns, draw maps and maintain sense of direction when travelling in a car.

Visuo-Motor Ability.

Visuo-motor ability is often lower in boys than girls at 5 yrs. (Sapir, 1966) but this disappears later and when Keogh (1971) asked 75 boys and 63 girls aged between 8 and 9 yrs. to copy ten simple geometric shapes, she found no difference in their drawing ability, as might be expected. When, however, they were asked to walk the patterns on the floor, the boys did better, and improved more when the conditions were more structured. Qualitative differences were also apparent in that the boys made more precise angles, indicated more clearly when the patterns were completed and were more accurate in starting and stopping; whereas the girls walked more hesitantly, made rounded corners, imprecise angles, did not indicate stopping and starting so clearly and made incomplete patterns.

Porteus (1918) had earlier found that boys did significantly better on his maze and that their scores tended to be higher than their SB age whereas the girls were about the same. Similar items on the SB produced the same result, for McNemar (1942) found that boys were better at Orientation from 9 to 17yrs and Plan of search from 13 to 18yrs.

Where the whole body is related to some outside object and needs reassessment of angle and speed such as ball throwing, boys did better from the age of $3\frac{1}{2}$ yrs. onwards, but where children have to relate to objects such as clothes, where left-right, inside-outside matter, such as dressing, then girls are superior according to Gesell (1940).

Memory

In most studies on memory, there is no sex difference, such as in the immediate repetition of numbers in the Digit Symbols subtests of the WISC and WAIS (Miele, 1958; Gainer, 1962). If there is a difference, number memory (Duggan, 1950) and quantitative memory, populations, distances (Sommer, 1958) favours boys. While object and word memory (Duggan, 1950) and memory for people's names favours girls (Witryol and Kaess, 1957). This later is usually attributed to the greater interest shown in people by girls, whereas it is probably influenced by the greater association learning seen in the Coding subtest of the WISC and WAIS.

Perceptual Speed

Where subjects are required to pick out certain simple shapes from others in a row such as letters or numbers, as in the Minnesota Vocational Test for Clerical Workers (Schneidler and Patterson, 1942) and in the DAT clerical test (Wesman, 1949) or match simple shapes as in the Coding sub test of the WISC or the Digit Symbol sub test of the WAIS (Wechsler, 1958; Norman, 1958; Miele, 1958; Gainer, 1961) girls and women as a group are better than boys and men. The tasks are always simple in themselves and the score depends on the speed of execution.

Perceptual Analysis

When, however, subjects need to analyse the shapes, then boys and men do better. Witkin (1949, 1950) has shown that women do less well on the Gottschaldt Figures, and Embedded figures test, also Wechsler 1958 has found the same on the Picture Completion test. The difference is not great and is small in comparison to other sex variations, but it is found in children and adults and over a wide area (Witkin, Dyk, Faterson and Goodenough, 1962)

Witkin has also found that men are more flexible in being able to pay more attention to the channel of information which provides the most reliable information, so giving them more field independence. When information from visual and labyrinth clues conflicts, as in tests with a rod and frame, men as a group are superior. Likewise when visual cues conflict with auditory cues and the sound has had to be localized, men are also better.

A THEORETICAL EXPLANATION

Until the 18th Century, differences in all kinds of behaviour were popularly regarded as being innate and were explained in terms of the attributes of the class to which the individual belonged. It fitted in with religious teaching and the class system. With Rousseau arguments were martialled to support the effect of the environment on behaviour and by 1890 William James was advancing the instinct versus habit dichotomy, which has been revived in a modified form by the ethologists, such as Lorenz (1965) and psychologists, such as Burt (1966) and Jensén (1970). In its extreme form the explanation of behaviour in terms of innate abilities implies that the differences in behaviour are explained by anatomical or physiological differences brought about by different genes, while the explanation in terms of acquired habits implies that there are no anatomical or physiological differences and that all behaviour differences can be explained by differences in the environment in which the organism has been reared.

Present advocates of the former type of explanation are Gray and Buffery (1971) for they see sex differences in emotional and cognitive behaviour which are common to other mammalian species as being "of essentially biological origin, that is to say they are specified in the gene pool of our species".

They quote Bruell (1969) "if within species we encounter, anatomical, physiological or behavioural differences between sexes, we have prima facia evidence for workings of evolutionary forces, sexual dimorphism is always a product of natural selection".

They then go on to cite similar behaviour differences seen in the animal kingdom. "Both in the laboratory rats and in man there is clear evidence that males are superior to females at the performance of tasks which involve perception and the use of spatial relationships or locomotion in a spatially complex environment"; wild male rodents have a longer home range than females (Brown, 1966), patrolling of the home range increases dispersion through scent-masking or defence, thus forming part of agonist behaviour (Wynne Edwards, 1962), aimed object throwing is a predominantly male occupation in chimpanzees and forms a part of intra-specific agonistic behaviour, (Van Lawick-Goodall, 1968) and problems solving in man, which demands visualisation is also better in males (Smith, 1964).

At the human level they noted that :

1. Sex difference in aggression arises out of the male role in establishing dominance hierarchies, a role essentially unchanged in mammalian evolution.

2. Sex difference in fearfulness arises out of the role played by the female in establishing hierarchies in primates.

3. Sex difference in spatial ability is connected with dominance and protective role, allied to territory.

4. Sex difference in linguistic ability is due to the mothering role and need for communication.

5. Normally there is an overlap between structures in the frontal neo cortex, subserving verbal control of behaviour and those involved in submissive and fearful behaviour.

6. All points 1 to 5 being a consequence of division in male and female reproductive roles.

Buffery and Gray (1971) consider that there may be a neural basis of sex differences in emotional and verbal behaviour. Gray (1971b) suggests that the neural structures responsible for aggressive and fearful behaviour are separate,(even incompatible),seen independently in psychology and physiology. In psychological work aversion stimuli are known to cause fight or flight, that is an aggressive and dominant response versus a fearful and submissive one; while in physiology aggression involves the amygdala, stria terminalis, medial hypothalamus dorsal longitudinal bundle of Schütz and the grey matter of the mid brain (Olds and Olds, 1965) and fear involves structures in the frontal cortex, medial septal area and hippocampus. Psychiatrically women are more prone to phobias than men and are more neurotic and introversive on the Maudsley Personality Inventory, suggesting that they have a more highly reactive inhibitory system, which results in neuroticism and introversion; while men are more prone to extraversion and instability, which can take the form of aggression entailing delinquency.

In this paper Gray does not actually state that the sex difference in spatial ability is due to a neuro-physiological difference in the same way that he has done with differences in emotion and verbal ability, but in an article in The Times in 1971 he implies it. There he says "There is in fact good reason to believe that the sex difference in vizuo-spatial abilities is under the control of the sex chromosomes" and that it is due to a recessive gene, which is carried on the X-chromosome. He has come to this conclusion because when visuo-spatial tests have been given to families then "the correlation between mother and son is quite high, that between father and son zero, and the correlation between father and daughter is higher than that between mother and daughter", (Stafford, 1961).

When considering the ontogeny of the sex differences Buffery and Gray (1972) hypothesized that lateralization occurs earlier in the female than the male brain and that its results are seen in the emotional and cognitive behaviour of mammals. The earlier dominance of the left hemisphere in girls is seen in the earlier maturation of speech and language placing an emphasis on the verbal mediation of behaviour, which the boys with more slowly developing left hemisphere make more use of the spatial and perceptual skills associated with the right hemisphere.

The results of the Plan test will now be examined in relation to the other general findings in cognitive differences and Gray and Buffery's theory assessed as a possible explanation.

## SEX DIFFERENCES IN THE PLAN TEST

The difference between boys and girls results will now be reviewed looking first of all at the total scores and items in the standardization sample, (Chapters I and II), then at the differences in plan drawing in relation to a three dimensional spatial system of reference and the verbal comments made by the same children (Chapters VI and VII), the differences in the use of experience provided by adults (Chapters VIII and IX) and lastly the differing effects of emotional disturbance (Chapter XIII).

### Differences in Total Scores and Items

All the age groups of the standardization sample showed statistically significant differences between the boys' and girls' mean scores except the 7 and 13 year olds (Table 2.1). This superiority of the boys' ability was seen in all but one of the other studies suggesting that it might be a general finding at least in England.

The cause of these results was sought by studying the success rate of boys and girls on individual items. It was found that the 7 year olds showed no sex difference in their ability to dismember a house vertically (Items 1 to 6), but that although the boys and girls achieved the concept of representing rooms horizontally about the same time, the boys generalized this concept to other parallelepipeds more quickly (Table 4.2). At the same time the girls were also slower in their ability to delineate internal space. These two findings were the principal reasons that the girls' total scores lagged behind the boys' until the age of 13 years, when the lead was reduced.

This aspect of concept development has been shown to relate to a child's increasing effective capacity to understand space in terms of a three dimensional euclidean grid, possibly through his increasing facility with projective space. (Chapter V). Sex differences in favour of boys have been found (Beard, 1964) and Mycock (1969) found some evidence for a spatial factor in this type of ability. However, although Plan drawing involves visualisation of 3D space (Smith, 1964), this type of conceptual development takes place in an age group below 11 yrs when spatial factors are elusive. Also it is necessary to remember that when the Plan test was examined it was found to load on verbal and vizuo-motor factors as well as spatial ones. If it is hoped to explain the sex difference in Plan scores by the spatial component of the test, this type of change in the concept of horizontality between the ages of 7 and 10 years does not entirely support it.

A more likely group of items to load on a spatial factor and to show a sex difference with boys again superior is that relating to proportion. This accounts for the large difference in the total score appearing again at 14 years and might well also be found in adults. Other results have shown boys to score higher than girls in proportion (Taylor, 1960) and it might be one of the essentials of some types of spatial ability.

Differences in Attitude to Plan Drawing

Inspection of individual results revealed that the girls seemed to need to score higher on the vocabulary and Piaget tasks to obtain a Plan score equivalent to boys. No boys with a standard score on the vocabulary test of 110 failed to succeed on item 7, while 2 girls with vocabulary scores over 120 and 3/4 Piaget items correct failed. It seemed that the girls had the necessary abilities for the task but for some reason were not making use of them. (Chapter V).

A more confident attitude in boys was seen in their response to the Questionnaire I in Chapter VII. While drawing Plans vertically most girls said the task was easy, those who drew them horizontally seemed to understand the problem better said it was difficult and could give an acceptable reason. Some of the boys' responses followed this pattern too, but more said it was easy, and were not prepared to talk about the problem, although their plans were still not perfect. (Table 7.1).

When it came to deciding if there was a difference between a plan and a picture more boys said there was, but more of the girls making the correct response could elaborate the differences verbally, although there was no statistically significant difference (Table 11.1).

TABLE 11.1

| QUESTION 4a : IS THERE A DIFFERENCE BETWEEN A PICTURE AND A PLAN | | | QUESTION 4b : WHAT IS THE DIFFERENCE | | |
|---|---|---|---|---|---|
| RESPONSE | BOYS | GIRLS | REASON | BOYS | GIRLS |
| YES | 31 | 17 | CORRECT | 6 | 5 |
| NO | 9 | 23 | INCORRECT | 25 | 12 |
| Chi-square 10.205 P 0.01 | | | Chi-square 0.628 NS | | |

The Difference Between Boys and Girls Use of Experience With Adults

There was no relationship between boys having seen a plan and their Plan score, but the girls who had seen plans, usually at home, scored higher (Table 8.1). Drawing a Plan previously also made no statistically significant difference, but this time the girls scores were lower and it was the boys, who tended to be higher (Table 8.4).

When it came to being taught, the experience may have ~~even~~ confused the boys, because their mean score was lower than the controls, while the girls' mean score became as high as the boys'. The improvement of the girls was not statistically significantly better than the control group, but it was noteworthy that while no boy showed a large increase in score, one-third of the girls did as though they had all the necessary skills to solve the problem before, but were only able to put them together when the possibility had been demonstrated by an adult.

Differing Effects of Emotional Disturbance

In the study relating to the N scale on the NJMI to achievement, emotional instability appeared to disrupt reading ability in boys and plan drawing ability in girls. (Table 13.5).

When psychiatric referrals without a learning disorder are looked at in those children with Plans scoring more than 15 points below their IQs, then it is found that there is an association of the symptoms of temper tantrums in boys and a tendency to fears in girls. (Table 11.2). No other symptoms showed a sex difference in occurrence.

TABLE 11.2

DIFFERENCE OF SYMPTOM INCIDENCE IN BOYS AND GIRLS WITH PLANS > 15 POINTS BELOW IQ SCORES

| | BOYS | GIRLS | CR | P |
|---|---|---|---|---|
| N | 31 | 16 | | |
| TEMPER TANTRUMS | 10 | 0 | 2.576 | 0.05 |
| FEARS | 4 | 5 | 1.525 | NS |

DISCUSSION

The sex differences in total scores and individual items found persistently in the Plan test might seem to illustrate other similar findings which may be thought of as component skills, such as the male's superior ability in orientation, mazes, perceptual analysis, memory for space, capacity to more accurately transfer 2D designs to walking in 3D space, and lastly and possibly the most essential the capacity to visualise and manipulate 3D images.

A theory such as Gray and Buffery's of innate differences would seem to be the most appropriate. The test has been found to load on spatial and visuo-motor factors and the items on proportion are probably assisting this. The results from the emotionally disturbed children are also interesting, as the disturbance reveals more temper tantrums and greater tendency to aggression and destructiveness in boys, and a greater incidence of fears in girls.

There are however other findings which do not support their theory. The items 1 to 6 show no sex difference and those related to the Piagetian concepts of horizontality and verticality have not yet been found to load on a spatial factor. Also although there was a sex difference in the ability to generalize the concept of horizontality from rooms to other parallelepipeds, it could be associated to personality rather than specific cognitive differences, for this lack of generalization was also seen in emotionally disturbed boys (Chapter XIII).

Moreover the effect of personality on cognitive ability can be seen in the girls' different attitude to plan drawing for once they understood what was needed they were more self critical than the boys. They also seemed to need more general intelligence before drawing a plan horizontally and it only needed the presence of an adult, a parent at home a teacher at school, to enable them to have the confidence in collecting their knowledge together and putting it into action. Only in this way can be explained the superior results of some girls who have seen plans or the greater improvement in girls who have been taught to draw one.

Connolly's theory accounting for the interaction between nature and nurture is perhaps more applicable to sex differences seen in plan drawing. In his paper on "The evolution and ontogeny of behaviour" (1971) he describes how complex the model needs to be. He points out that "the problem of development is one of understanding what changing integrations underlie the successive functional stages which are characteristic of a given species" and that the developmental contributions of the two complexes, maturation and experience defined in Schneirla's terms (1966) must be viewed as fused at all stages of ontogenesis".

He gives examples from zoology and ethology, but they can equally well be given from psychological findings in man. At the chemical level there is the condition of phenylketonuria in children in which brain cells cease to grow and are destroyed, so effectively preventing almost all interaction in the developing organism. Then at the proprioceptive level in the hierarchical integration of reflexes, often specific anatomical damage as in cerebral palsied children is followed by the malfunctioning of basic reflex symptoms, so preventing normal movement, which in turn hinders normal experience of the environment and as a chain reaction impedes cognitive development. More elaborate are the effects of emotional maturation on personality, cognitive styles and the responses that are evoked from the social environment.

It is possible that small primary cognitive and emotional differences between boys and girls so interact together that they determine how and what shall be learnt, so that aggression linked with 'spatial' ability and fears with verbal ability may be a general observation, but not so firmly neurologically determined as Gray and Buffery's theory suggests. On the other hand the emotional components in the reaction to the environment may lead to different styles of acquiring knowledge.

Moore (1967) in his longitudinal study of the first eight years of language and intelligence considers that boys develop cognitive skills through object manipulation and girls through verbally mediated social interaction. Fogelman (1970) found that when 7 yr. old children were taught about the conservation of a solid, the boys improved most when they were allowed to actively handle the plasticine and find out for themselves, while the girls did best if they passively watched the teacher doing the demonstration.

Pederson and Bell (1970) in their study of sex differences in preschool children also noticed that boys manipulated physical objects such as blocks and toys much more than girls. They also found that boys walked more, were more aggressive to peers and showed a passive non-conformity to adults; while girls spent more time on an activity, manipulated clay and dough more, spent longer on passive motion in a glider or swing, imitated adults' posture more and followed games.

Connolly's theory takes into account the same cognitive and emotional differences found between boys and girls as does that of Gray and Buffery, the essential difference lies in how originally slight differences in spatial ability may be increased by personality differences. It would also imply that such differences could possibly be reduced by the correct learning experience. Of the two theories, the results of the Plan test support the interaction theory of Connolly rather than the more static theory of Gray and Buffery for only the former can explain the great changes that can be made by a few girls when taught.

PART THREE : PLAN DRAWING IN CHILDREN SHOWING SIGNS OF ORGAN OR PSYCHOLOGICAL PATHOLOGY.

# CHAPTER XII

## SKILL OF PLAN DRAWING AND ITS CEREBRAL REPRESENTATION AS REVEALED BY NEUROLOGICAL DYSFUNCTION

### INTRODUCTION

Organic evolution is characterized by differentiation of structure and specialisation of function, man being the most complex organism to emerge. Within man himself the most complex organ is the brain. From the discredited mapping of function based on faculty psychology, investigation has proceeded more soundly by neurologists such as Broca in the middle of the 19th century followed by others such as Hughlings Jackson, Head and Sherrington. Although exact localization of function has never really been claimed, there has always been a tendency to infer it from their diagrams. In contrast to this view, the psychologist, Lashley, in the 1930's demonstrated with rats that the amount of brain tissue removed had more effect on learning than the location, and pursued a theory of equipotentiality.

In the 1940's another psychologist, Hebb, proposed a neurophyschological theory of learning involving a 'cell assembly', a diffuse structure comprising cells in the cortex and diencephalon (and also perhaps in the basal ganglion of the cerebrum) capable of forming a series constituting a "phase sequence". He still, however, used the term localization of function.

Although it has been possible to localize some function in the primary, sensory and motor areas, this only accounts for a small part of the area of the cerebral cortex and at least three-quarters has nothing to do with these functions, but contains systems for more complex behavioural processes according to Luria (1973). Since damage in many parts can produce a similar result, but there is a tendency for the likelihood to be greater in some areas than others, Critchley (1953) has suggested that the term 'specialization' of function rather than 'localization' may be more appropriate, as it is open to explanation along the line of gradients. This takes into account that neurological dysfunction can occur both by direct loss of tissue concerned and also by reason of release phenomena.

At the present time, it is considered that the more posterior lesions produce greater intellectual defect than anterior ones and that left hemisphere lesions are more likely to produce language, ideo motor and apraxic defects and right hemisphere lesions, agnosic, apraxic, vizuo-spatial and route finding defects.

As yet these skills have mainly been expressed in medical terms derived from clinical observation. A more useful way of categorizing them may be in terms of abilities found in factor analysis. Thurstone's (1941) model of Primary Factors could be used, in which 'g' is a second order factor and corresponds to the intercorrelation of the others, the high intercorrelations being simply the tendency for cerebral regions subserving different intellectual functions to be proportionately developed in any one individual (Piercy 1964). McFie (1972) prefers to use Burt's hierarchical classification of intellectual factors, genus, species, proprium and accidens, in which genus is general intelligence represented by the total activity of the brain; species the two main forms of intelligence, verbal and non verbal, corresponding to the left and right hemispheres; proprium the different skills within each main factor, and accidens, the individual differences. It can be said that this is no more than a more sophisticatedly expressed faculty psychology, but the comparison is not justified, since factors are objectively defined and not susceptible to endless subjective proliferation as were faculties.

However, these theories are as yet entirely hypothetical for many clinical findings are equivocal and factor analytic studies incorporate few clinical tests. Spatial ability in particular is difficult to localize and has only been studied intensively since World War II. From the early work of McFie, Piercy and Zangwill (1950), Critchley (1953) and others done on a few well studied patients, it would seem that it was functionally organized within the parietal lobes of both hemispheres with a predominance in the right. Typical tests used were copying designs with pencil and paper, assembling other designs with matchsticks, drawing maps, plans, people and bicycles, and assembling blocks to make a pattern. Only the last, Kohs' Blocks, has definitely been found to load on a spatial factor; the others may as yet be better termed visual-motor tasks until their factorial composition is known.

By 1964, Piercy, in summarizing the research up to date, remarked on the qualitative differences between the visuo-motor deficits associated with left and right lesions, for which right hemisphere lesions were associated with unilateral neglect of space and failure on spatial tests not involving manual performance, left hemisphere lesions were associated with left/right disorientation. He considered the possibility that the former may be due to agnosia and the latter to apraxia, but dismissed it because it was not supported by an experiment by Piercy and Smyth (1962), though this was not surprising since the test they used, Raven's Progressive Matrices, loads mainly on general reasoning and not spatial ability, as they thought.

An early study of Piercy, Hécaen and Ajuriaguerra (1960) is cited by Piercy that out of 403 unselected cases of unilateral cerebral lesions that "constructional apraxis" was twice as common with right-sided lesions (22%) as with left-sides lesions (11%). Later McFie (1972), having reviewed studies of patients by McFie and Zangwill (1960) and experiments done by Warrington and James (1967) considered that "they lent support to the impression that the disorder in the left hemisphere patients was one of manipulation, whereas in the right hemisphere cases it was perception".

Warrington (1966) following up a qualitative difference noticed in cases with right and left lesions, found in a group of 62 patients, that those with right hemisphere lesions have difficulty in incorporating spatial information leading to disproportion and faulty articulation of parts, while those with left hemisphere lesions had difficulty in planning the drawing process leading to simplified versions of the model. As proportion is found to load on a spatial factor, this might indicate that the right hemisphere may be more necessary for a spatial task than the left hemisphere.

Critchley (1953) found that spatial defects in drawing maps or plans could occur without constructional apraxia. He considered that "The features which suggest spatial disorganization include a tendency to confuse the three-dimensions of space". Thus a patient with right parietal softening who is told to draw a plan of the ground floor of his house introduced chimneys or roof tops into his sketch (Fig 12.1)

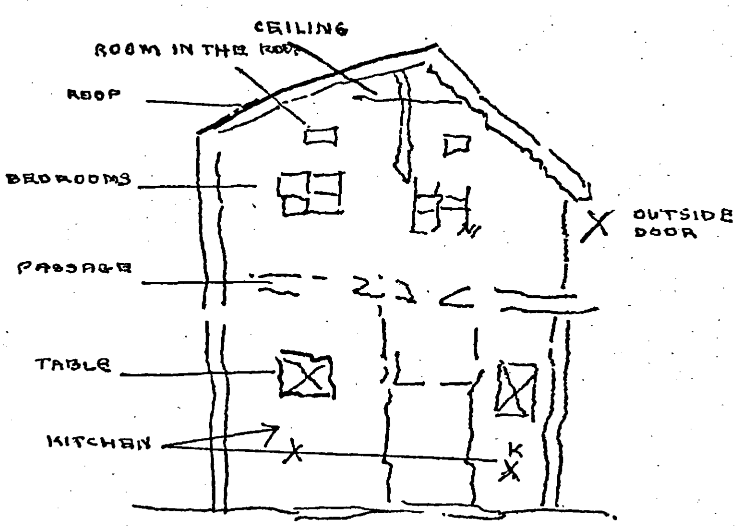



Fig. 12.1. Confusion of dimensions revealed in a patient's drawing of a plan of a house.

Such a drawing is about that of a 7 year old and would obtain a standard score of 90 at that age and well below 76 at 13 yrs. While Critchley considered the drawing abnormal, it might be useful to consider it as evidence of functional regression. (Abercrombie 1964).

McFie, Piercy and Zangwill (1950) looked at eight cases with gross vizuo-spatial disorders in whom the lesion was exclusively or predominantly right sided. Five had defects in plan drawing, one was a master printer with a right fronto parietal tumour. A neurological examination showed that there was left homonymous hemianopia and that his left arm and leg were slightly spastic with exaggerated tendon reflexes and a left plantar extensor response. A psychological examination showed no general intellectual loss, dyscalculia or dysphasia, but gross defects in Kohs' Blocks, assembling a Manikin, an inability to copy designs and draw objects from memory. He could count discrete blocks, but not when in a solid cube and the horizontal in co-ordination of space tilted left and upwards. His drawing of a plan of his house is illustrated below together with Zangwill's correct drawing. (Fig. 12.2 (a) and (b)).

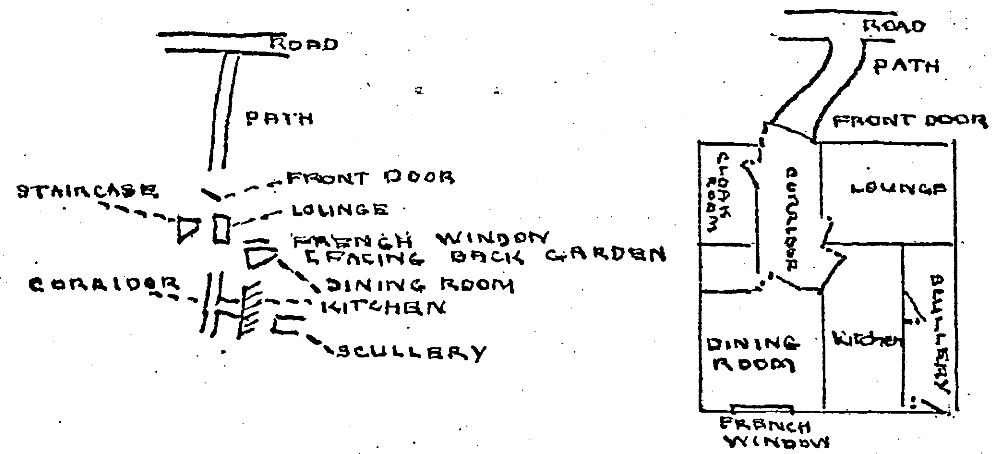



Fig. 12.2 (a) Ground plan of house by patient (b) Plan of house by Zangwill

This plan obtains a raw score of 14, which is average for an $8\frac{1}{2}$ yr. old. It shows a more sophisticated representation of a door than is usual at that age, which may be a remnant of a higher level of skill, and possibly gross disorientation, for both back and front face the same way. It also shows a typical lack of ability to put the rooms together and a preoccupation with the interior, so that the outer wall is not considered, which is typical of 8 yr. old plans. It is, however, at a higher age level than the example given by Critchley.

A rather easier task, the plan of a ward was given to a patient described by Humphrey and Zangwill in 1952. (Fig 12.3.). The patient was a left handed man except that he wrote with his right hand. He had a right occipital penetrating brain injury. The symptoms were associated with both hemispheres, left homonymous hemianopia, cortical sensory loss, motor disability, mixed dysphasia, dressing dyspraxia, right/left confusion, constructional dyspraxia and disturbed spatial orientation.

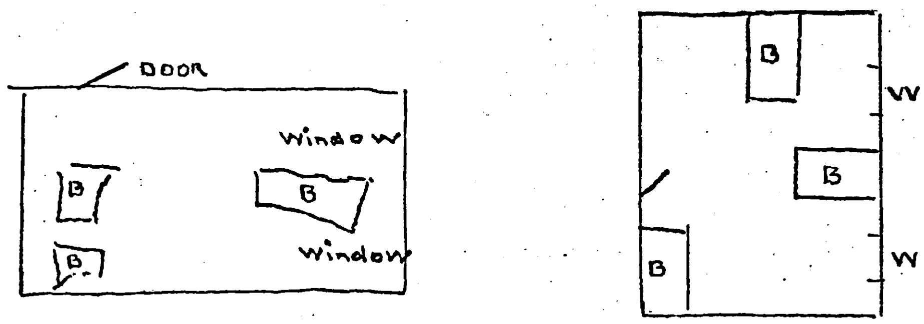



Fig 12.3 (a) Patient's plan of ward (b) Actual ward plan

When he drew the plan of his ward six weeks after his admission, it showed that he was able to draw it entirely horizontally including the beds, but some parts were wrongly interrelated. As he was mainly left-handed, it is possible that dominance was not well established and that functional transfer was possible to the left hemisphere. Continued dysphasia suggests that the right occipital-parietal was involved with language. If so, it is possible that the main area for spatial understanding was in the left parietal occipital, resulting in a plan where the major problem of how to interpret three-dimensional space horizontally was solved, but spatial disorientation remained.

Only very tentative conclusions may be drawn from these three cases with regard to what light they throw on which part of the brain is involved in the function of plan drawing. Difficulties of evaluation arise because:

1. The degree of previous intellectual functioning is not known. As Stark (1961) has said, "the effect of localized brain damage is best seen in subjects of good educational background". In these cases only the printer case may be assumed to have been average in plan drawing; Critchley's case might never have been able to draw a plan.

2. Degree of previous lateralization of function would affect present incapacity. Humphrey and Zangwill's case shows the least disruption in functioning, but this may be because his previous achievement level was high or because his main spatial function was in the left hemisphere and therefore not affected.
3. Area of present damage is also important. Of these three cases the least affected is the last one with the circumscribed injury, while the other two are affecting large areas of the cortex and probably subcortical structures.
4. Exactly what ability is impaired is also ambiguous. The last two cases have faulty disorientation, but have partially solved the problem of the horizontal two-dimensional.

However, it is worth considering the disabilities evident in these plans with other disabilities mentioned previously. In general, the conclusion seems to be that injury to the left hemisphere results in apraxia due to a disorder in manipulation, while an injury to the right hemisphere results in agnosia due to a disorder in perception particularly affecting 3D tasks. The conceptualization of a plan required 3D visualisation of a high order, but only a low order visuo-motor ability. This is exemplified in developmental terms by average children needing to be 9 yrs. before they can mentally manipulate 3D space, while being able to draw rectangles at 4 yrs. Thus defective plan drawing in patients with right parietal damage seems consistent with other findings and may be caused by difficulty in 3D visualisation. As this was thought by Smith (1964) to be an aspect of spatial ability, it would suggest that an intact, non-dominant, usually right hemisphere would be necessary for this factor to appear

To attempt to discover if these clinical observations could be substantiated, it would be necessary to investigate plan drawing in adult patients of at least average intelligence with left and right parietal damage keeping the sexes separate. Ideally, the damage should be as circumscribed as possible and cortical rather than involving the basal ganglia. A control group matched for age, sex and ability would also be needed.

As yet it has not been possible to assemble such a group of adults, but a sample of hemiplegic children was available. Unfortunately, such a sample suffers from two disadvantages in comparison with brain-damaged adults; the damage, although confined to one hemisphere always involves sub-cortical structures and because it is damage to a developing organism affects the way in which it develops through faulty information feedback. The result is that these children not only show a persistent disorder of movement and posture, but also a deficiency in a wide variety of vizuo-motor and perceptual tasks. This suggests that the cortical specialization might not be the same as in adults with normal development.

This difference is illustrated in a study of Fitzhugh et al (1962), when the effect of the difference between left and right hemisphere lesions on verbal and performance ability on the Wechsler Adult Intelligence Scale was studied. As expected it was found that patients with left hemisphere lesions had a mean verbal IQs of 82 and performance IQs of 91, while those with right hemisphere lesions had a mean verbal IQ of 94 and a performance IQ of 79 and those with diffuse damage showed no difference. These results came from patients with current lesions and is consistent with verbal specialization being in the left hemisphere and performance specialization concerned with pictures and blocks in the right. When they looked at patients with chronic lesions, the scores were lower and there was no significant difference.

In child hemiplegic groups a below average score is usually obtained on the WISC with no difference between verbal and performance scales, which is comparable to the previous findings in adults with chronic lesions. When reviewing the literature, however, Abercrombie (1964) found evidence for perceptual and visuo-motor disorders in both groups of hemiplegic children.

Wedell's findings in 1960 were an exception to this for when he looked at the visual perception of cerebral palsied children, he found that in carefully matched groups of spastics with bi-lateral, left unilateral, right unilateral, athetoids and a control group that perceptual impairment was not a general concomitant of cerebral palsy, but mainly associated with bilateral and left-sided spasticity. The tests which distinguished these groups from the controls were the Manikin and Matching test, while the tests which distinguish the left and right hemiplegics were the Matching and Bricks test. This study differed from most in that IQ was controlled and therefore it was possible to remove the effect of general intelligence.

## SUMMARY

Work done with adults in plan drawing suggests that right parietal lesions impairs plan drawing. It also indicates that 3D and 2D tasks requiring visualisation are also impaired. Children with congenital lesions resulting in cerebral palsy do not generally show the same specialization of function as in adults, but as a group show a variety of disorders including vizuo-motor and spatial irrespective to side of damage. Only Wedell has shown a difference in the type if impairment seen in left and right hemiplegics.

Nevertheless since lesions in adults can produce marked changes in plan drawing, it was considered useful to look for effects of neurological impairment in cerebral palsied children's drawings. Hemiplegic children were chosen because the area of damage was more limited to one hemisphere, although it cannot be assumed.

In addition, as the Plan test has been found to load on spatial and visuo-motor factors in physically normal children, more might be known about the interaction of abilities, if other tests probably loading on these factors are also given.

A study was therefore designed to investigate:

1. The effectiveness of the Plan test in
   a. Differentiating hemiplegics from normal children.
   b. Differentiating left and right hemiplegics from normal children.
   c. Differentiating left from right hemiplegics.
2. The effectiveness of the other tests in differentiating left and right hemiplegic children.
3. To what extent findings from this battery of tests replicated other studies of hemiplegic children and adults.
4. How ability on the Plan test related to ability on the other tests.

METHOD

A. Subjects

A group of 7 left hemiplegic and a group of 8 right hemiplegic children were selected from a physically handicapped school. Children were omitted if they had other complicating CNS conditions such as epilepsy or hydrocephalus, if they were below 8 yrs., as scoring on the Plan test is ineffective with mentally retarded children below this age, and if either the verbal or performance IQ scores were off the scale. The resulting numbers were so small that it was not possible to divide the sexes as would have been preferred. All except two had congenital hemiplegia and they, one an accident and one post-encephalitic, had the trauma when very young. All had effective use of one hand and arm, although some degree of hypertonia was often present elsewhere.

These children were matched for sex, age, and IQ with children mostly from an ESN school. The IQ was assessed on the WISC FS in the case of the hemiplegic children and on the SB in the case of the control group. In the former the scores were contemporary, whereas in the latter there was often an interval of about one year, between the SB and the Plan score.

B. Tests

Tests were chosen to give an estimate of general intelligence and provide numerous tasks in which visuo-motor and spatial ability may be required. Those involving intricate motor movements were avoided. Only tests standardized on children were used for as the groups were so small and the right and left hemiplegics were not matched for age and sex, it was essential to discount these effects by using standardized scores rather than raw scores.

Bender Motor Gestalt Test (BG)

This is a test which shows quantitative and qualitive changes when done by neurologically impaired adults and children (Bender, 1938; Parsons et al, 1971; Koppitz, 1963). It is also associated with ability to do the Plan test (Chapter X). The Koppitz scoring was used.

Draw-A-Man (DAM)

Difficulty in drawing a man has been noted in brain-damaged adults in studies already mentioned. Harris (1963) also cites similar findings, Freed and Pastor (1951) found patients drawings to improve after thalatomy, Fingert, Kagan and Schilder (1939) noted a steady improvement in Goodenough scores after shock therapy. Here Harris's scoring system was used, giving standard scores from 3.0yrs to 15.0yrs.

Map Test

Left-right disorientation has been found in adults with left hemisphere damage (McFie, Piercy & Zangwill, 1950). Development of left/right discrimination in the childs own body occurs between the ages of 5 and 9 yrs. and in a person facing the child by 12 years. The Map Test, in which left-right discrimination takes place in four directions, is more difficult and discriminates children up to 18 yrs., when they reach the adult level. This type of error has been found more prevelant in adults with Turner's Syndrome, who also have a defect in perceptual organization. Money therefore thought it likely that it would be valuable in examining patients with known or suspected brain damage (Money, 1965).

It was also thought possible that children's scores on this test, would offer some association with those on the Plan Test.

Frostig Developmental Test of Visual Perception

Standardized at yearly intervals from 3-0 to 9-0 yrs., it contains five subtests involving: I Eye-motor co-ordination (EMC), II Figure-ground perception (FGP), III Form constancy (FC), IV Position in Space (PS), V Spatial Relationships (SR).

Frostig, Lefever and Whittlesey (1961) found that children with known learning difficulties, many of whom were "neurologically handicapped" showed a greater scatter of subtest scores and had a lower verbal score than normal children. Abercrombie and Jonckheere (1964) found that a group of cerebral palsied children had lower scores than non-brain damaged children on this test and that hemiplegics did worse than athetoids on all the tests except IEMC. It was decided to use the subtest scores separately in this study, although it has been found by Ward (1970) that one factor accounts for most of the variance, except for the 8-0 to 9-0 year olds, when a second bi-polar factor emerges, separating tests IV and V, loading on 'k', from I, II and III, involving discrimination and perceptual ability. This later appearance of a spatial factor is consistent with findings on spatial factors generally.

Hiskey - Nebraska (Hiskey, 1966)

This is a performance test devised for deaf children and also standardized on hearing children. Three of the subtests, Paper Folding (PF), Block Patterns (BP) and Puzzle Blocks (PB) may load on a spatial factor. Both the block tests are three-dimensional and may have some affinity with plan drawing. It has also been found that McFie, Piercy and Zangwill's patients failed on block counting when in a solid block. Wedell (1960) too found that in the Bricks test, involving copying models in bricks, was impaired in left hemiplegics.

Wechsler Intelligence Scale for Children (WISC)

This test was used to provide a Full Scale IQ so that the hemiplegic group could be matched in intelligence with the control group. It was also thought useful to look at the sub-test scores since Wechsler (1958) had found deteriorated adults lower on the 'Don't Hold Tests', Digit Span (DS), Similarities (S) Digit Symbol and Block Design (BD). When reviewing the literature in adults, McFie (1972) had found Block Design (BD) impaired in right parietal-temporal-occipital patients, Picture Arrangement (PA) in patients with right temporal lesions; Similarities (SI) Vocabulary (VO) and Digit Span (DS) in patients with left temporal lesions and Arithmetic (AR) and Block Design (BD) in those with left parietal lesions.

C. Treatment of Results.

In order to eliminate the effect of age, raw scores were interpreted where possible in terms of standard scores as in the WISC, DAM and Plan. Otherwise age levels were assessed and the scores given as quotients as in the Map, Frostig and Nebraska tests.

RESULTS

1a. There was no significant difference in age, IQ or Plan scores between the hemiplegic and control groups, although the Plan mean score in the hemiplegic group was lower (Table 12.1).

TABLE 12.1.

AGE, IQ AND PLAN SCORES IN HEMIPLEGIC AND CONTROL GROUPS

| | M | SD | t | P |
|---|---|---|---|---|
| AGE | | | | |
| HEMIPLEGIC | 12y. 1.4m | 7.15 | 0.112 | NS |
| CONTROL | 12y. 2.5m | 7.15 | | |
| IQ | | | | |
| HEMIPLEGIC | 76.93 | 3.04 | 0.015 | NS |
| CONTROL | 77.00 | 3.04 | | |
| PLAN | | | | |
| HEMIPLEGIC | 75.93 | 3.95 | 0.644 | NS |
| CONTROL. | 78.93 | 3.95 | | |

1b. When the hemiplegic group was divided into left and right hemiplegics, there was no difference between them and their control groups in mean age and IQ scores, although the right hemiplegic group tended to have a lower mean Plan score than its control (Table 12.2.).

TABLE 12.2.

AGE, IQ AND PLAN SCORES IN LEFT AND RIGHT HEMIPLEGIC AND CONTROL SCORES

| | M | SD | t | P |
|---|---|---|---|---|
| AGE | | | | |
| LEFT HEMIPLEGIC | 11y. 4.29m | 6.562 | 0.446 | NS |
| CONTROL | 11y. 8.43m | 6.562 | | |
| RIGHT HEMIPLEGIC | 12y.13.7m | 12.09 | 0.095 | NS |
| CONTROL | 12y. 5.4m | 12.09 | | |
| IQ | | | | |
| LEFT HEMIPLEGIC | 81.71 | 5.01 | 0.100 | NS |
| CONTROL | 81.00 | 5.01 | | |
| RIGHT HEMIPLEGIC | 72.75 | 3.37 | 0.57 | NS |
| CONTROL | 75.50 | 3.37 | | |
| PLAN | | | | |
| LEFT HEMIPLEGIC | 82.00 | 6.25 | 0.113 | NS |
| CONTROL | 81.00 | 6.25 | | |
| RIGHT HEMIPLEGIC | 69.00 | 4.85 | -1.112 | NS |
| CONTROL | 77.12 | 4.85 | | |

1c. When the left hemiplegics were compared with the right hemiplegics, there was no significant difference in age and IQ, but the .1 level of significance was reached in the Plan scores, the right hemiplegics gaining lower scores. (Table 12.3).

TABLE 12.3

AGE, IQ AND PLAN SCORES IN LEFT AND RIGHT HEMIPLEGIC GROUPS

| | M | SD | t | P |
|---|---|---|---|---|
| AGE | | | | |
| LEFT HEMIPLEGIC | 11y. 4.3m | 10.28 | 1.214 | NS |
| RIGHT HEMIPLEGIC | 12y. 3.7m | 19.61 | | |
| IQ | | | | |
| LEFT HEMIPLEGIC | 81.71 | 4.50 | 1.455 | NS |
| RIGHT HEMIPLEGIC | 72.75 | 4.21 | | |
| PLAN | | | | |
| LEFT HEMIPLEGIC | 82.00 | 4.59 | 2.02 | .1 |
| RIGHT HEMIPLEGIC | 69.50 | 4.23 | | |

2. The effectiveness of the other tests in differentiating left and right hemiplegic children was looked at by comparing the difference on test scores between each group and the difference between each test score from the WISC FS IQ in each group separately.

a. Differences between test scores in left and right hemiplegic groups.

The right hemiplegic children scored lower than the left hemiplegic children on all the tests, but only two showed a statistically significant difference, the Frostig II FGP at the .01 level and the WISC PA at the .02 level. (Table 12.4.).

Tests which did not differentiate at all having $P > .5$ were the Map, Frostig I EMC, Nebraska BPa, WISC CO, AR, PC and BD

b. Differences between WISC FS IQs and other test scores in left and right hemiplegic groups separately.

As hemiplegic children score lower on tests involving visuo-motor ability (Abercrombie, 1963) 't' tests were done to see if any of the tests were significantly lower than the mean WISC FS IQs in either the LH or RH groups. (Table 12.6).

TABLE 12.5

ANALYSIS OF VARIANCE RESULTS

PLAN

| SOURCE | Ss | df | Variance | F | P |
|---|---|---|---|---|---|
| BETWEEN | 583.334 | 1 | 583.334 | 4.081 | 0.1 |
| RESIDUAL | 1858.000 | 13 | 142.923 | | |
| TOTAL | 2441.331 | | | | |

FROSTIG II FGP

| SOURCE | Ss | df | Variance | F | P |
|---|---|---|---|---|---|
| BETWEEN | 1221.556 | 1 | 1221.556 | 18.020 | 0.01 |
| RESIDUAL | 745.675 | 11 | 67.788 | | |
| TOTAL | 1967.231 | | | | |

NEBRASKA PF

| SOURCE | Ss | df | Variance | F | P |
|---|---|---|---|---|---|
| BETWEEN | 1512.900 | 1 | 1512.900 | 4.056 | 0.1 |
| RESIDUAL | 2984.000 | 8 | 373.000 | | |
| TOTAL | 4496.900 | | | | |

WISC PA

| SOURCE | Ss | df | Variance | F | P |
|---|---|---|---|---|---|
| BETWEEN | 45.268 | 1 | 45.268 | 7.474 | 0.05 |
| RESIDUAL | 78.740 | 13 | 6.057 | | |
| TOTAL | 124.000 | 14 | | | |

TABLE 12.4

DIFFERENCE OF TEST SCORES IN LEFT AND RIGHT HEMIPLEGIC GROUPS

| TEST | N | LT. HEM. | RT. HEM. | t | P |
|---|---|---|---|---|---|
| BG | 12 | 62.00 | 49.86 | 1.52 | NS |
| DAM | 11 | 80.00 | 69.83 | 1.77 | NS |
| MAP | 10 | 83.60 | 78.57 | 0.45 | NS |
| PLAN | 13 | 82.00 | 69.50 | 2.02 | .1 |
| FROSTIG | | | | | |
| I EMC | 11 | 70.60 | 63.25 | 0.75 | NS |
| II FGP | 11 | 64.75 | 45.88 | 3.62 | .01 |
| III FC | 11 | 70.00 | 52.25 | 2.68 | NS |
| IV PS | 11 | 64.60 | 56.62 | 1.20 | NS |
| V SR | 11 | 71.50 | 59.50 | 1.91 | .1 |
| NEBRASKA | | | | | |
| PF | 8 | 81.40 | 56.8 | 2.01 | .1 |
| BP | 8 | 85.40 | 75.40 | 0.60 | NS |
| PB | 8 | 82.80 | 66.20 | 1.06 | NS |
| WISC | | | | | |
| IN | 13 | 7.00 | 5.37 | 1.17 | NS |
| CO | 13 | 6.71 | 6.75 | 0.03 | NS |
| AR | 13 | 6.14 | 6.75 | 0.42 | NS |
| SI | 13 | 10.57 | 7.87 | 1.43 | NS |
| VO | 13 | 8.00 | 6.37 | 1.00 | NS |
| DS | 13 | 6.83 | 5.60 | 0.83 | NS |
| PC | 13 | 6.28 | 5.75 | 0.39 | NS |
| PA | 13 | 7.86 | 4.37 | 2.74 | .02 |
| BD | 13 | 7.71 | 7.25 | 0.38 | NS |
| OA | 13 | 8.57 | 5.62 | 1.31 | NS |
| CO | 13 | 6.14 | 7.57 | 0.79 | NS |
| VER | 13 | 85.28 | 76.75 | 1.29 | NS |
| PER | 13 | 81.43 | 73.50 | 1.07 | NS |
| FS | 13 | 81.71 | 72.75 | 1.45 | NS |

An analysis of variance confirmed these results (Table 12.5)

TABLE 12.5

ANALYSIS OF VARIANCE RESULTS

| TEST | F RATIO | P |
|---|---|---|
| PLAN | 4.08 | .1 |
| FROSTIG II FGP | 18.02 | .01 |
| NEBRASKA PF | 4.06 | .1 |
| WISC PA | 7.47 | .05 |

TABLE 12.6

DIFFERENCES BETWEEN WISC FS IQs AND OTHER TEST SCORES

| | LEFT HEMIPLEGICS | | | | | RIGHT HEMIPLEGICS | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | N | M | SD | t | P | N | M | SD | t | P |
| BG | 7 | 19.71 | 16.19 | 3.22 | .01 | 7 | 22.29 | 11.97 | 4.98 | .002 |
| DAM | 7 | 1.71 | 10.79 | 0.42 | NS | 6 | 1.17 | 11.72 | 0.24 | NS |
| PLAN | 7 | 0.29 | 11.97 | 0.06 | NS | 8 | 3.12 | 9.63 | 0.92 | NS |
| MAP | 5 | 2.40 | 7.83 | 0.69 | NS | 5 | 6.43 | 27.32 | 0.62 | NS |
| FROSTIG | | | | | | | | | | |
| I EMC | 5 | 16.40 | 22.72 | 1.51 | NS | 8 | 9.50 | 16.42 | 1.64 | NS |
| II FGP | 5 | 19.60 | 11.87 | 3.64 | .01 | 8 | 26.87 | 9.33 | 8.15 | .001 |
| III FC | 5 | 15.60 | 7.83 | 4.45 | .01 | 8 | 20.50 | 18.88 | 3.07 | .01 |
| IV PS | 5 | 21.40 | 14.95 | 3.20 | .05 | 8 | 16.12 | 14.28 | 3.19 | .01 |
| V SR | 5 | 14.80 | 18.86 | 1.75 | NS | 8 | 13.00 | 11.88 | 3.99 | .01 |
| NEBRASKA | | | | | | | | | | |
| PF | 5 | 4.60 | 17.02 | 0.60 | NS | 5 | 12.00 | 10.56 | 2.54 | .05 |
| BP | 5 | 0.60 | 21.94 | 0.06 | NS | 5 | 6.60 | 23.52 | 0.63 | NS |
| PB | 5 | 3.80 | 19.73 | 0.43 | NS | 5 | 2.60 | 19.28 | 0.30 | NS |

The tests showing the largest differences were the visuo-motor tests, where a figure had to be copied or dealt with in some way, such as the BG and Frostig II, III, IV and V. The tests which showed no difference were the Frostig I a simple test of eye motor co-ordination, DAM and PLAN requiring some conceptual thinking, the MAP requiring orientation and the Nebraska BP and PB probably loading on a spatial factor.

As the test differences were greater in the right hemiplegics they were examined, but none of the differences were found to be stabistically significant.

3. Product-moment correlations, using raw scores, were found to examine the amount of association between the Plan and the other tests (Table 12.7). It was then seen that a high correlation in one group was often accompanied by a low correlation in the other, although the only ones to be significantly different were the DAM and OA being higher in the left hemiplegics and WISC SI, VO and VER being higher in the right hemiplegics at the .01 level of confidence.

Product-moment correlations between the BG, DAM, WISC VER and PER and the other tests were then calculated to see if they showed the same pattern of associations as the Plan, but this was not found. (Table 12.7.).

TABLE 12.7

PRODUCT-MOMENT CORRELATIONS OF BG, DAM, PLAN AND WISC Ver AND Per WITH THE OTHER TESTS IN LEFT AND RIGHT HEMIPLEGICS.

| | BG | | DAM | | PLAN | | WISC Ver | | WISC Per | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LH | RH | LH | RH | LH | RH | LH | RH | LH | RH |
| BG | - | - | 81xx | 21 | 57 | 08 | 37 | -07 | 61 | 53 |
| DAM | 82xx | 21 | - | - | 85xx | -14 | 39 | -03 | 76x | 44 |
| MAP | 77x | 58 | -35 | -23 | -04 | -04 | 74 | -12 | 57 | -04 |
| PLAN | 57 | 08 | 85xx | 14 | - | - | 17 | 83xx | 78x | -05 |
| FROSTIG | | | | | | | | | | |
| I | 27 | 13 | 14 | 01 | -00 | 03 | 76x | 11 | -28 | 79xx |
| II | 09 | 40 | -21 | 22 | -19 | 23 | 59 | 12 | -27 | 79xx |
| III | 42 | 11 | 46 | 28 | 35 | 57 | -77x | 38 | 62 | 48 |
| IV | 49 | 59 | 74 | -19 | 73 | 21 | -40 | 03 | 17 | 42 |
| V | -32 | 55 | -01 | 14 | 23 | 19 | -76x | -01 | 54 | 55 |
| NEBRASKA | | | | | | | | | | |
| PF | 28 | 35 | 65 | 59 | 76x | 63 | 01 | 55 | 92xx | 59 |
| BP | 56 | 79x | 80x | -11 | 73 | 26 | 29 | 23 | 45 | 68 |
| PB | 26 | 10 | 57 | -10 | 79x | -07 | -03 | 13 | 91xx | 66 |
| WISC | | | | | | | | | | |
| IN | 32 | 44 | 19 | 52 | -06 | 44 | 84xx | 61 | 16 | -25 |
| CO | 54 | -07 | 79x | 05 | 57 | 57 | 68 | 82xx | 80x | -01 |
| AR | 43 | -09 | 43 | 26 | 16 | 58 | 98xxx | 86xx | 48 | 24 |
| SI | -09 | -23 | 02 | 09 | -12 | 85xxx | 73x | 87xx | 11 | 10 |
| VO | 41 | -15 | 36 | 09 | 35 | 86xxx | 67x | 90xx | 81xx | 08 |
| DS | 11 | 80x | 16 | 05 | -02 | 42 | 92xx | 77x | 41 | 13 |
| PC | 04 | -27 | 48 | 33 | 59 | 03 | 56 | 52 | 73x | 32 |
| PA | 31 | 79xx | 18 | 12 | -03 | -20 | 50 | 15 | 52 | 75x |
| BD | 27 | 16 | 47 | 43 | 74x | -18 | 35 | -01 | 63 | 89xx |
| OA | 75x | 61 | 87xx | 65 | 89xx | -55 | 93xxx | -55 | 36 | 59 |
| COD | 67x | 67x | 63 | 21 | 69x | 24 | 91xxx | 53 | 41 | 52 |
| VER | 37 | -07 | 39 | 03 | 17 | 83xx | - | - | 67 | 47 |
| PER | 61 | 53 | 76x | 44 | 78x | -05 | 67 | 47 | - | - |

Statistical Significance P = .05x P = .01xx P = .001 xxx

It was also decided to look at tests which showed significant correlations in left and right hemiplegics. (Table 12.8).

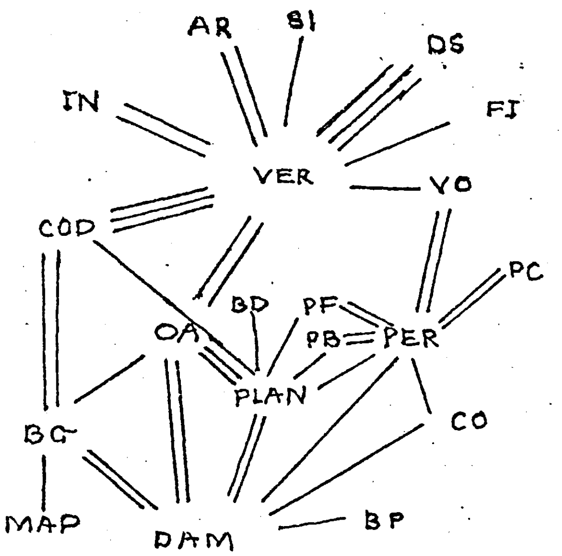
TABLE 12.8

TESTS SHOWING STATISTICALLY SIGNIFICANT CORRELATIONS IN LEFT AND RIGHT HEMIPLEGICS

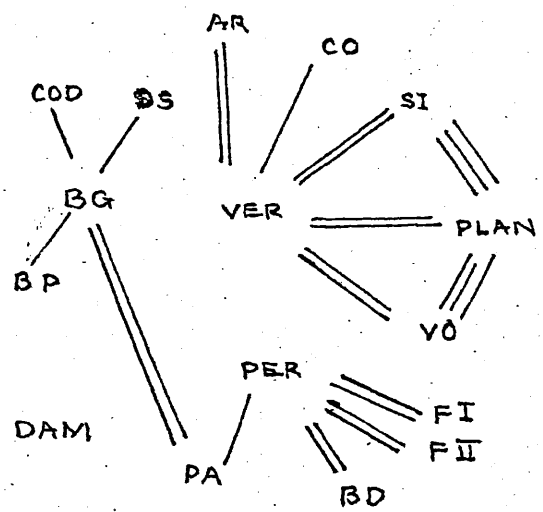
| LEFT HEMIPLEGICS | | | | | RIGHT HEMIPLEGICS | | | | |
|---|---|---|---|---|---|---|---|---|---|
| BG | DAM | PLAN | WISC | | BG | DAM | PLAN | WISC | |
| | | | VER. | PER. | | | | VER. | PER. |
| DAMxx | BGxx | DAMxx | FIx | DAMx | BPx | - | SIxxx | PLANxx | FIxx |
| MAPx | PLANxx | PFx | INxx | PLANx | DSx | - | VOxxx | COx | FIIxx |
| OAx | BPx | PBx | ARxxx | PFxx | PAxx | - | VERxx | ARxx | PAx |
| CODx | COx | BDx | SIx | PBxx | CODx | | | SIxx | BDxx |
| | OAxx | OAxx | VOx | COx | | | | VOxx | |
| | PERx | CODx | DSxxx | VOxxx | | | | DSx | |
| | | | OAxxx | PCxx | | | | | |
| | | | CODxxx | | | | | | |

DIAGRAMS ILLUSTRATING THE ASSOCIATION IN TABLE 12.8

LEFT HEMIPLEGICS




RIGHT HEMIPLEGICS




The table clearly reveals that more test scores correlate significantly in the left hemiplegics than the right hemiplegics. The diagram below Table 12.8 illustrates the associations. From this it can be seen that tests measuring verbal, spatial and visuo-motor ability are inter-correlated in LH but separate in RH. This difference in correlations in the two groups is also accompanied by a tendency for the scores in the LH group to be higher than in the RH group.

These groups are small, but if the findings could be replicated in larger samples, the hypothesis could be made that the greater the possibility of intercorrelation between verbal, spatial and visuo-motor abilities, the higher the score on tasks, which require a combination. The Plan test could be taken as an example. In a previous study, the Plan has been found to load on verbal, spatial and visuo-motor factors varying in emphasis according to the pathology of the sample, the sex and the age. In these hemiplegic groups, the Plan did not correlate with all these tests as in the physically 'normal' groups, instead, the Plan scores in LH group correlated with spatial (WISC OA and BD) and visuo-motor test DAM while in the RH group it correlated with verbal tests (WISC SI, VO and VER). It is possible that in order to attain at least an average score, it is necessary to have a greater interaction between verbal, spatial and vizuo-motor systems than is evident in either of the hemiplegic groups.

## DISCUSSION

The tests will now be grouped together and discussed according to whether or not they were effective in revealing any specific differences between the hemiplegic and non-hemiplegic groups and/or between the right and left hemiplegic groups.

## TESTS REVEALING NO DIFFERENCES

### Plan

Although instances have been given of plan drawing being affected in adults with right parietal damage, there was no statistically significant difference in Plan scores between hemiplegic and normal children, nor between right and left hemiplegic children. In contrast to the adults, the right hemiplegic children, implying left hemisphere damage, had the lower scores.

Neither the hemiplegic nor the control children had Plan scores which differed significantly from their own mean WISC FS IQs in contrast to the educational and psychiatric groups where the Plan score was significantly lower.

### DAM

Like the Plan, the mean scores of the DAM showed no significant difference between right and left hemiplegics, nor did they differ from their own mean WISC FS IQs. Such was the age range and hence variety in drawing that inspection did not reveal any qualitative differences, such as Warrington had found in adults with left and right lesions. Drawing a man did not produce the lower score in left hemiplegics that Wedell had found when he used the Collins-Driver test in which a Manikin had been assembled.

Map

Although adults with left parietal lesions may show left-right confusion and Money's MAP test is an extension of this, these groups of left and right hemiplegic children showed no difference in their mean scores. This suggests that the usual hemisphere specialization does not occur when the damage is prenatal or perinatal. Moreover, whereas this disability can occur in adults, when general reasoning ability appears intact, in this group of hemiplegic children there was no difference between their MAP scores and WISC IQs. Thus it would seem that this test would not diagnose brain damage primarily of the type causing a motor dysfunction as found in spastic hemiplegia.

Hiskey - Nebraska

Block Patterns and Puzzle Blocks.

Since adult patients with right parietal damage had been found to have difficulty in counting blocks in the solid and Wedell had found that left hemiplegic children made more errors in copying a brick model, some difference was expected between left and right hemiplegic groups, but there was no difference at all in the Block Patterns or Puzzle Blocks, nor were the scores significantly lower than their WISC IQs.

WISC

There was no difference between WISC Verbal and Performance IQs according to which hemisphere was damaged, which is unlike the usual findings in adults with recent trauma. Instead the lack of difference is consistent with other studies done with children (Abercrombie, 1963) and with adults with chronic lesions. This suggests that the usual specialization which occurs in the intact brain of the left hemisphere usually being dominant for language skills and the right hemisphere predominant for spatial skills does not occur in brains which have been damaged at birth or before.

Also when the subtest scores were examined individually no differences were found except in the PA which will be discussed later. This contrasts with McFie's finding in 1960 when he demonstrated an association in adult patients with localized lesions in left temporal lobe and impairment on the SI and VO and lesions in the left parietal with impairment on the AR and BD subtests. Such findings at once indicates the limitations of conclusions about specialization that can be drawn in this study for although autopsies of severely incapacitated cerebral palsy children usually show more extensive damage than just the pyramidal and extra pyramidal tracts, it cannot be assumed in all cases. It is possible that these children showed no difference on these tests because there was no temporal or parietal damage, not because of the lack of left versus right hemisphere specialization.

TESTS REVEALING SOME DIFFERENCES

Bender Gestalt

Both groups scored significantly lower on the BG than on the WISC FS, particularly the right hemiplegics. Such a result would seem to support other findings that the BG is sensitive to brain damage, both in adults and children (Parsons et al, 1971 and Hanvik, 1953) but it does not support adult findings with regard to lateralization for results suggest that the ability to copy geometric figures is a right hemisphere specialization (Hirschenfang 1960; Bogen, 1969).

Frostig

Frostig II FGP was the most effective test in differentiating left from right hemiplegics and the scores in both groups were also significantly lower than their WISC FS IQs. Both left and right hemiplegics had significantly lower scores on tests III FC and IV PS compared with their WISC FS IQs, although they did not differ significantly from each other. It was noticeable that test I EMC, which measured mainly simple visuo-motor errors showed neither a difference between the hemiplegic groups nor between its scores and WISC FS IQs. This shows that the disability on the other tests is the result of the deficiency at a higher level of integration and cannot be explained by a lower level visuo-motor deficiency.

WISC Picture Arrangement

McFie (1960) had found that adult patients with right frontal and temporal lesions had impaired scores on the WISC PA. Here it was the right hemiplegic children, implying left hemisphere damage, whose scores were both significantly lower than those of the left hemiplegic children and lower than their own WISC FS IQ. It was the only subtest of the WISC to show these differences.

CONCLUSION

The Plan test did not distinguish between the hemiplegic groups, nor did either group perform particularly badly on it, when compared with general intelligence as measured by the WISC. However, few of the other tests showed any patterns of weakness, which characterise the scores of adults with hemisphere damage either, which in turn suggests that this particular group of hemiplegic children did not show the left/right hemisphere specialization for verbal and spatial abilities which is found in adult brains. Thus it seems that such tests can only be used to investigate specialization, when there has been normal development and the trauma had occurred to the fully developed brain of the adult. Vigotsky (1960) makes the point that a lesion in a child's brain interferes with the relationship between fundamental systems in the cortex and interferes with all future development of higher cortical areas, whereas a lesion in the same region in adult life affects lower zones. This might explain the lack of hemisphere specialization, which has occurred in these hemiplegic children.

During this study one interesting observation was made which may indicate a useful technique of investigation. When a diagram was drawn illustrating the correlations between tests, it could be seen that the left hemiplegic children with presumably superior left hemisphere function showed a more involved correlation matrix between verbal, spatial and visuo-motor functions than right hemiplegic children, where these factorially dissimilar tests showed no inter relationship (Table 12.8). It may be asked therefore if the left hemisphere has a great facility interrelating the verbal and spatial systems and if so, if this is why this group scores higher on most of the tests, resulting in a higher measure of intelligence.

If such a result was repeatable on a larger group then it might be asked if the left hemisphere is more efficient than the right in using spatial material processed either in its own or opposite hemisphere. Beaumont and Dimond (1973) concluded that "presentation to the left or to both hemispheres leads to bilateral learning, while presentation to the right hemisphere alone results only in learning in that hemisphere".

# C H A P T E R XIII

## PLAN DRAWING IN MALADJUSTED CHILDREN

### AIM

In this Chapter it is proposed to look at what evidence there is that :

1. Maladjusted children score lower on this test than those not diagnosed as maladjusted and if this is found to be the case, then to see
2. If there is a qualitative difference as well as a quantitative one
3. If there is any indication as to what might be the causal connection between poor plan drawing if found and maladjustment.

The evidence that has been assembled here to try and throw some light on the above questions suffers from not being the result of a planned, coherent study in which hypotheses have been precisely defined and rigorously tested, but is instead a collection of results from divers sources. This has entailed different definitions of maladjustment and different batteries of tests, so that findings from one sample cannot be directly related to another sample. Moreover the samples are so small that although the results are interesting, they cannot in themselves be other than suggestions of future lines of more adequate research.

### INTRODUCTION

A. Origin and use of the Term Maladjusted.

The term maladjusted is of recent origin. Until the twentieth century deviant children were described as lazy, bad or mad, causal factors often being ascribed to the magical properties of religion. Improvement came when measures were devised, which could help to differentiate between the types of problems suffered by children. One measure, that of general intelligence received quick acceptance and spread widely from its first inception in a practical form by Binet and Simon in Paris in 1908. This enabled children who could learn academic skills to be differentiated from those who could not. Hinshelwood (1917) further aided the academic slow learner from being accused of laziness by his concept of word blindness. Concurrent with this work on the cognitive capacity of children, Freud was investigating the relationship between emotional causes and neurotic disorders, which took concepts of personality beyond the purely descriptive stage. The environment too was not forgotten and in studies of delinquency causal factors were being suggested by Burt and others. Wickman (1928) attempted to determine the incidence of behaviour problems seen in school children and found the teachers' judgements related mainly to discipline within the classroom. It brought out clearly the difference between maladjustment with reference to lack of social conformity, which now comes under the description of anti-social behaviour, and maladjustment as used by the clinician, which was derived from work with neurosis in adults and psychodynamic conflicts in children and for which terms such as mental ill health or emotional disturbance are frequently used. From the 1920s this term maladjusted has been used by administrators enabling special educational provision to be made for such pupils who do not fit in to ordinary schools for personality reasons. It is not therefore a clinical term.

However, it has the advantage of encompassing both 'anti-social and 'emotional disturbance', with their important different implications in diagnosis, prognosis and management. For this reason it has been used here.

B. Identification of Maladjustment in Children.

A variety of measures of maladjustment has been used in the studies reported here, A Children's Behaviour Questionnaire for completion by teachers (Rutter, 1967), The Rotter Incomplete Sentences Blank: College Form (Rotter and Rafferty, 1950), The New Junior Maudsley Inventory (Furneaux and Gibson, 1966) and referral to a Child Guidance Clinic.

1. A Children's Behaviour Questionnaire.

This was devised for a survey on the Isle of Wight. It followed Wickman's procedure by involving teachers, but differed in that the items have been derived from psychiatric findings of children attending clinics. The scale is short and quick to complete, extends over a wide age range (7-13 years), is applicable to boys and girls, has good retest reliability inter-raters reliability and discriminative power between clinic and non-clinic children and differentiates between anti-social and neurotic children. While an overall total score of more than 9 out of a possible 52 occurs in about 11% of boys and 3½% of girls of the normal population, about 80% of boys and 60% of girls obtain that score in a clinic population. Of the clinic children it was found that in about 90% of anti-social children and 80% of neurotic children the questionnaire and clinical diagnosis were in agreement.

2. The Rotter Incomplete Sentences Blank: High School Form.

While the Children's Behaviour Questionnaire is derived from objective observation of the child's behaviour, this measure of maladjustment is derived from the subject's introspective statements about himself through a sentence completion technique, which was something in common with both projective and word association techniques. However, there is no real pressure for immediate association, as in word association techniques and the method of analysis is often more similar to that of the Thematic Apperception Test. The items have been derived from a test used in the USA army during the war and have now been adapted for college and high school use. Although intended to be used clinically by the psychiatrist or psychologist as an aid in structuring his interview advantageously, it is also possible to obtain a total score which is supposed to relate to degree of maladjustment.

The use of the total score has been validated for both sexes against judgements made by college instructors and attendance for personal counselling by vocational advisors; normative data was also obtained from Ohio State University. The means for groups of well adjusted females were 121 and 127, and for well adjusted males 119 and 127, while maladjusted females scored 137 and males 133. Students selected as being specifically maladjusted scored a mean of 155 (females) and 149 (males). Clinically this completion task is useful in identifying areas of conflict, but just how valid it is as a measure of maladjustment has not yet been evaluated against psychiatrive criteria either in the USA or here. Moreover, it is questionable how justifiable the measure would be on children in this country when the validation was done on college students in the USA.

3. The New Junior Maudsley Inventory.

As its name indicates this personality test is in the form of an inventory, which is completed by the subject. It differs from the Rotter Sentence Completion in that the responses are forced into categories of same or different instead of being open ended. Like the Maudsley Personality Inventory for adults, from which it was derived, it described personality in terms of the continuous, orthogonal traits, extroversion and neuroticism and unlike the original incorporates a lie scale. These traits however are more general than just descriptions of response patterns and result in a categorization of a personality type (Eysenck, 1953).

The original adult test had been the result of a major study during the Second World War on nearly 10,000 normal and neurotic soldiers, taking behavioural, physical and clinical measures and submitting them to a factor analysis from which were derived the bi-polar orthognal measures of personality mentioned above. The extraverts were described as flexible, gregarious, easy going, carefree, optimistic and sometimes impulsive, while the introverts were more rigid, solitary and shy. Unstable extraverts when neurotic showed a tendency to hysterical conversion symptoms, while neurotic introverts tended to dysthymia, showing symptoms of anxiety and depression. Such typologies at that time were linked to the body build and personality types of Kretchmer (1925) and Sheldon (1943). Later another biological explanation was used, that of individual differences in excitatory and inhibitory response patterns of the nervous system. Eysenck sought to demonstrate that those who generated weak excitatory potential slowly and strong reactive inhibition quickly had an extraverted type of personality and those who generated strong excitatory potential quickly and weak inhibition slowly had an introverted type of personality.

The NJMI however does not have the same amount of research behind it. The justification for the independence of the two personality dimensions of extraversion and neuroticism lies with their zero correlation with each other as cited in the manual. The items though similar in type to the adult scale are expressed in a more concrete form and were selected from a pool of items already collected by Pintner (1938). When the NJMI and EPI were given to the same children the mean correlations of the two E and N scales were between .42 and .52. The test norms have been derived from the JMPI, which is a similar test, but without the lie scale. On the latter the N score decreased steadily at the rate of 1 point for every 20 month between 11 and 16 years, while the E score did not change.

In recent years work has been done on the relationship of the E and N personality dimensions to academic achievement. Throughout all the studies there has been a tendency for stable children to be best in verbal reasoning and attainments, but whereas extraverted children did better until about the age of 13 years, afterwards, at school and university, there is a tendency for the introverted to succeed more. A useful summary of these changes is given by Elliot (1972). Many of the studies he cites were large, such as 3,000 13 year old Aberdeen children (Entwistle and Cunningham,1968) and 4,000 11 year old Staffordshire children (Eysenck and Cookson,1969). Entwistle (1972) concluded that although ability, sex, geographical area and teaching may affect the relationship between academic achievement and personality, nevertheless there is now considerable agreement as to the effect of age so "that stable extraverts tend to be successful in primary schools, while introverts, and possibly even neurotic introverts, predominate among outstanding students".

4. Referral to a Child Guidance Clinic in London

Children were referred by doctors, educational psychologists and parents for a psychiatric assessment. They and their parents were interviewed by a psychiatrist, an educational psychologist and a social worker. After the interviews the symptoms, history and diagnosis were classified according to the Item sheet in Appendix II. The diagnoses used was similar to those advocated by the WHO Seminar of Psychiatric Disorders in 1969

C. Maladjustment and Spatial and Visuo Motor Abilities in Adults.

General intelligence seems to function independently of personality factors. Some types of brain damage, which disorganise some types of cognitive functioning does not produce personality changes and some brain damage which produces personality changes is not accompanied by changes in all aspects of cognitive functioning (Luria, 1973). Yet perception and some types of visuo-motor ability can reflect transient change in mood and more permanent changes in personality such as found with the Rorschach test and Porteus Maze test.

An association between spatial ability and neuroticism has been noted by some research workers. Vernon and Parry (1949) found that "Army recruits picked out by psychiatrists as lacking in combatancy or questionable in emotional stability did particularly badly in the Squares Test". Eysenck et al (1957) also found that normal adults did better than neurotics and psychotics on Thurstone's closure factor A, which loads spatially. Smith (1964) looking at these results and many others concluded that superior spatial relative to verbal ability was associated with emotional stability, perseverance, reflectiveness, independence, freedom from neuroticism and masculine attitudes and interests. He noted how the Porteus Maze test provided a better measure of social competency than the SB implying planning ability and foresight (Porteus, 1945).

Smith however has assumed that it is a spatial test, although other evidence suggests otherwise. Young children of five can accomplish simple mazes (WISC) before a spatial factor can be identified. In brain damaged adults spatial tests are affected by damage to the parietal lobes, Smith on the other hand states "the Maze Test devised by Porteus has been found to provide a measure of abilities characteristic of the frontal lobes". In particular it seems to assess ability to plan and freedom from impulsiveness. Petrie (1949) observed 20 patients before and after prefrontal leucotomy and reported a decrease in intelligence, a decrease in neuroticism and a movement from introversion to extroversion. Moreover Crown (1951) cited by Smith in his summary of other investigations into changes associated with preferential leucotomy found that Kohs' Blocks and Alexander's Passalong Test, both spatial tests, often showed a slight rise after leucotomy. Thus the fall in the Maze scores seems more likely to be due to personality variables associated with prefrontal trauma rather than to poorer spatial ability which is often associated with parietal damage.

One seeming inconsistent finding on the Porteus Maze test was that delinquents, by definition socially maladjusted, did as well on this test as the normal population. However Porteus noted that their errors were of a rather different type and when he introduced his Q score in 1942 it was possible to distinguish them from the normal population for it focused on the style of response rather than the intellectual capacity needed.

As the Porteus Maze test takes some time to administer, Gibson (1965) devised a Spiral Maze which takes less than 2 minutes to administer and is solely measuring the qualitative aspect of the task. This too was found to be successful in discriminating normal and delinquent populations. Apart from the Porteus Maze results, Gibson had also noted other examples of psychomotor performance being associated with emotional adjustment, which he cites in his manual. Davis (1948) had found an association between psychomotor performance and both neurotic syndromes and accident proneness in pilot trainees. Venables (1955) also found that a small group of industrial employees discharged for dishonesty gave different psychomotor responses to the other employees. In a larger sample of RAF candidates Anthony (1960) found that abnormal psychomotor performance was predictive of later being convicted of an offence.

D. Maladjustment and Spatial and Visuo-Motor Abilities in Children.

Jastak by 1934 had noted in the USA the variability of psychometric performances in mental diagnosis, finding that grossly maladjusted children tended to obtain higher scores in the vocabulary tests than in the performance tests, while normal subjects tended to have similar scores in both types of tests. In England, Bradford in 1948 in a symposium on the selection of pupils for different types of secondary schools stated that a relative weakness in performance tests was characteristic of many failures in the 11+ exam and poor pass degrees at University level.

However, the term performance tests is ambiguous and needs to be more precisely defined. When McHugh (1963) looked at the verbal and performance IQs on the WISC of 28 11 year old children with neurotic disturbance paired with 28 12 year old children with a conduct disorder, expecting to find the mean verbal IQ in the first group higher than the mean performance IQ and the reverse in the second group, he found that there was no difference.

This may have been because the WISC Performance in contradiction to its name loads heavily on verbal as well as spatial factors or because the numbers were too small or the children too young, since a spatial factor is only just beginning to appear at this age. In order to look at the interaction between neurotic disturbance and spatial ability, it would be necessary to use tests which load principally on a spatial factor and choose an age group when it can be expected to appear.

Visuo-motor ability by contrast can be identified from about the age of three years and its association with academic achievement, neurological dysfunction and emotional disturbance has been extensively studied. The results on two such tests Bender Gestalt and Draw-a-Man will be mentioned here.

1. Bender Gestalt Test

In children below 11 years the most consistent results comes from a visuo-motor test the Bender Gestalt. In a large sample of 8 to 9 year olds Brenner and Gillman (1968) found that failure on this test, using the Koppitz scoring was associated with under achievement in school and failure in the 11+ selection test a year later. In a younger age group of 150 5½ year old children Wedell (1969), using the Keogh and Smith scoring, found that low scorers on the Bender Gestalt were also poor in handwriting and spelling, but not in pencil copying 1 year 5 months later.

The attention paid to the association between visuo-motor dysfunction and academic failure is comparatively recent. When Bender (1938) devised the test, she had been concerned with its maturational aspects and the visuo-motor malfunctioning revealed in psychotic and brain damaged adults. She also particularly emphasised the test's ability to reflect the subject's integrative capacity, showing how it takes time to operate when the cards are shown in a tachistoscope to normal subjects and how the function, although disrupted with cerebral trauma treatment often improves with time afterwards.

Koppitz's studies have been on children and she has looked more at the diagnostic function of the test rather than the possible integrative mechanisms involved. In the manual (1964) she records how when 136 children aged 5-10 years with no known emotional problems were paired for sex and age with emotionally disturbed children that the scores on the Bender Gestalt discriminated between the two groups at P 0.001, the emotionally disturbed children scoring lower. She also found that when the test was given to 384 children aged 5 to 10 years, 103 having been medically diagnosed as brain injured and 281 with no known history, that the Bender scores of the brain injured were statistically significantly lower at each year level.

These results are encouraging, pointing to the diagnostic value of the test in distinguishing emotionally disturbed and brain injured children from normals by their lower scores, but they also reveal the weaknesses of the total score for diagnostic purposes for it does not distinguish between emotionally disturbed and brain injured children, nor does it differentiate them from young and intellectually retarded children.

In order to increase its diagnostic significance, Koppitz looked at the individual items in the light of previous research findings on adults and found that particularly at 9 years certain types of error, such as distortion, disproportion, rotation, integration and perseveration were found more frequently in the brain injured than non brain injured. She considered that the validity of the test as a diagnosis for brain injury was greatly enhanced when the total Bender score was examined for individual scoring items associated with neurological impairment. In this way low scores due to neurological dysfunction could be distinguished from those due to slow maturation.

In order to be able to use the test to measure emotional disturbance, Koppitz tried out eleven emotional indications, which were quite independent of the basic scoring system. These she used to score protocols from 55, emotionally disturbed children aged 5 to 6 years matched with 55 control protocols and from 81 emotionally disturbed children, aged from 8 to 10 years matched with their controls. In the younger age groups she found wavy line, overwork and expansion distinguished the two groups, while in the older group, confused order, small size, second attempt and expansion distinguished the emotionally disturbed from their controls. She also found that the emotionally disturbed children scored from 0 to 6 of the 11 indicators, but the control group's maximum was 6. Two thirds of all the children with two or less emotional indicators were well adjusted, while two thirds of those with three or more were emotionally disturbed.

However, although she has developed these qualitative scales to identify possible emotional disturbance and/or neurological dysfunction, she warns against using these criteria alone and only advocates their use together with information from other tests and the aetiology. She is also impressed by the low total scores obtained by both groups and considers that children with immature or malfunctioning vizual-motor perception are more susceptible to inadequacies in their social and emotional experiences than the average more integrated child.

2. Draw-A-Man Test

This test was originally devised by Goodenough as a means of measuring intellectual maturity, but when it was used in conjunction with better validated tests for intellectual ability, such as the WISC, in Child Guidance populations, it was noted that the DAM score was lower than the WISC (Des Lauriers, 1947; Hanvik, 1953; Lehman et al, 1971). Vane (1962) tried to select features other than scoring items, which would differentiate well adjusted from poorly adjusted children. As with the Bender, it was found that such items varied with age, for which grotesque, no body, no mouth distinguished the well and poorly adjusted at 5y 9m; no body, no mouth and no arms distinguished those who were only six months older. Koppitz (1966) took 30 different items and examined their appearance in human figures drawn by 76 clinic children aged from 5 to 12 years and matched for age and sex with non clinic children. The items which differentiated the two groups successfully were poor integration, shading on body, slanting figure, 2" or less in size, 9" or more in size, short arms hands cut off, and no neck.

Unlike the Bender, the effects of neurological dysfunction in children on their ability to draw a human figure has not been carefully investigated. Abercrombie (1964) gives illustrations of poor drawings by cerebral palsied children of varying ages and ability, but most of them are characteristic of immaturity rather than an abnormal visuo-motor function. In the results of 13 hemiplegic children given in Chapter XII, the DAM score, although below average was not significantly lower than the WISC score.

Perhaps one possible difference between the DAM drawn by a cerebral palsied child and one by a child with no known neurological deficit is that the former when young often do drawings of the head, body and legs drawn separately, a feature which has also been noted in brain damaged adults.

3. The Plan Test.

The factor analysis study (Chapter X) suggests that the Plan test loads on verbal, spatial and visuo-motor factors. Since there is no indication that low scores on verbal and spatial tests are characteristic of maladjusted children, while there is evidence that such children score lower on visuo-motor tests, it was considered useful to examine the Plan score in conjunction with scores on the BG and DAM in populations that have been defined as maladjusted on one of the four measures given in Section B.

Studies

The first two studies described here are based on test scores taken from pilot investigations done by trainee educational psychologists at the Child Guidance Training Centre, which were mainly concerned with the association of neuroticism and academic achievement. For the sake of brevity only those aspects of the studies which were relevant to Plan drawing will be given here. The third study was done by the author on material available in the clinic, but again was not purposely designed.

I. AN INVESTIGATION INTO THE EFFECTIVENESS OF THE AMERICAN ROTTER INCOMPLETE SENTENCES BLANK AS A MEASURE OF MALADJUSTMENT IN ENGLISH SCHOOL CHILDREN AS VALIDATED AGAINST THE RUTTER CHILDREN'S BEHAVIOUR QUESTIONNAIRE AND THEIR RELATIONSHIP TO THE PLAN SCORES (Denman, 1971)

Sample

The children came from the third year in a primary school in southwest London. Unfortunately owing to administrative problems it was only possible to test 27 children (12 boys and 15 girls) out of the possible sample of 60. This was further reduced in this present paper to 9 boys and 12 girls, as only those living in houses were used. Although it is usually preferable to keep boys and girls separate in investigations which may reflect sex differences, it was not advisable in this case because the numbers involved were so small.

The children came mainly from working class homes and many were considered to have emotional problems. Three of the 21 children attended a Child Guidance Clinic and four others were considered to be very disturbed.

Tests

Only group tests were used to reduce time of administration. They included the following:-

| | | |
|---|---|---|
| 1. | INTELLIGENCE : | Non-Verbal BD (NFER) |
| 2. | ATTAINMENT : | The Staffordshire Test of Computation (Hebron 1958) |
| 3. | VISUO-MOTOR : | Plan test |
| 4. | MALADJUSTMENT: | Rotter Incomplete Sentences Blank |
| | | A Children's Behaviour Questionnaire for Completion by Teachers |

RESULTS

1. The group scored lower on the non-verbal test in comparison with the standardization norm, but unlike clinic samples the average score on the Plan test was higher than the general ability test and very near the standardization average. (Table 13.1)

TABLE 13.1

TEST PARAMETERS OF THE SAMPLE

| | M | SD |
|---|---|---|
| AGE | 9y 9m | 3.9m |
| NV | 89.33 | 13.56 |
| ARITHMETIC | 26.00 | 5.51 |
| PLAN | 97.66 | 16.56 |
| ROTTER | 113.52 | 13.82 |
| RUTTER TOTAL | 15.04 | 9.34 |
| RUTTER NEUROTIC | 3.00 | 2.40 |
| RUTTER ANTISOCIAL | 4.24 | 4.31 |

The mean and scatter on the Rotter test was lower than those of the college students on which the test was evaluated and much lower than the maladjusted group.

The 78% of boys and 58% of girls scoring 9 or more on the Rutter Scale was far higher than the 11% and 3.5% in the normal sample, although in the same direction regarding sex differences. As the percentages are similar to those of the Maudsley Clinic sample (68.0% boys and 69.1% for girls) it supports that the headmaster's assessment that the children had more emotional problems than usual, but also raises the question of the scorer's reliability.

2. The association between the Plan and NV score was higher than for any other general cognitive test as yet found. The correlations of the NV, Arithmetic and Plan test were all high suggesting that they were assessing some common ability (Table 13.2).

TABLE 13.2

PRODUCT-MOMENT CORRELATIONS BETWEEN TEST AND RATING SCORES

| | NV | ARITHMETIC | PLAN | ROTTER | RUTTER N | RUTTER A | RUTTER TOTAL |
|---|---|---|---|---|---|---|---|
| NV | | 61xx | 80xxx | 28 | 23 | -43x | -26 |
| ARITHMETIC | | | 62xx | 37 | 08 | -60xx | -48x |
| PLAN | | | | 58xx | -10 | -30 | -24 |
| ROTTER | | | | | 19 | 19 | 16 |
| RUTTER TOTAL | | | | | | | |
| " NEUROTIC | | | | | | -03 | - |
| " ANTISOCIAL | | | | | | | - |

P = 0.05 x P = 0.01 xx P = 0.001 xxx

There was no significant correlation between the Rotter and Rutter scores, indicating that in this small sample at least they were not assessing the same personality variables.

There was a significant correlation between the Arithmetic and Plan, and the Rotter questionnaire, but both were positive and therefore not in the expected direction. There was no significant correlation between the Plan and Rutter questionnaire, but at least it was in the expected negative direction. The highest correlation was with the antisocial items nearing the P = 0.05 level of confidence. The most interesting finding was the significant negative correlation of the antisocial scale with the NV and Arithmetic.

As there was the expected negative relationship between cognitive and the Rutter scores the sample was divided as to whether a child's score was above (A) or below (B) the sample mean and the difference between the means on the other test scores was examined. (Table 13.3).

TABLE 13.3

TEST MEANS OF CHILDREN SCORING ABOVE (A) OR BELOW (B) THE RUTTER QUESTIONNAIRE MEANS

| | TOTAL A(N=11) | SCORE B (N = 10) | t | P |
|---|---|---|---|---|
| NV | 85.90 | 93.10 | -1.20 | NS |
| ARITHMETIC | 23.90 | 28.30 | -1.90 | NS |
| PLAN | 94.45 | 101.20 | -0.91 | NS |
| ROTTER | 115.54 | 111.30 | 0.67 | NS |
| | NEUROTIC | SCORE | | |
| | A | B | | |
| NV | 92.00 | 87.53 | 0.71 | NS |
| ARITHMETIC | 26.61 | 25.61 | 0.38 | NS |
| PLAN | 97.12 | 97.76 | -0.08 | NS |
| ROTTER | 117.25 | 111.23 | 0.91 | NS |
| | ANTISOCIAL | SCORE | | |
| | A | B | | |
| NV | 84.33 | 93.08 | -1.47 | NS |
| ARITHMETIC | 22.88 | 28.41 | -2.51 | 0.05 |
| PLAN | 92.22 | 101.75 | -1.30 | NS |
| ROTTER | 117.22 | 110.75 | 1.04 | NS |

The means of the NV, Arithmetic, and Plan tests all differed in the expected directions on the Rutter total and antisocial scores, but only the Arithmetic mean showed a statistically significant difference in the latter.

CONCLUSIONS

1. The Rotter Incomplete Sentences Blank was not effective in measuring maladjustment, as defined by the Rutter scale, in 10 year old London children, although the mean was lower than the maladjusted sample mean in the USA. Moreover its correlations with the cognitive tests were all positive, which is the opposite to what is usually found.

2. The antisocial aspects of maladjustment would appear to disrupt the

ability to learn arithmetic, but not neuroticism as measured by the Rutter scale.

3. The antisocial, though not the neurotic aspects of maladjustment was associated with lower Plan scores, but below the P = 0.05 level of confidence.

II. AN INVESTIGATION INTO THE ASSOCIATION OF VISUO-MOTOR TEST SCORES WITH PERSONALITY MEASURES (BUTTERFIELD, 1970)

Sample

A class of 39 10-year old primary school children in South London were given a battery of standardized group tests. Only the scores of the 15 boys and 16 girls who were present for all tests were used.

Tests

| | | |
|---|---|---|
| 1. INTELLIGENCE | : | Verbal Reasoning (NFER) |
| 2. ATTAINMENT | : | Word Graded Reading Test (Schonell, 1938) |
| 3. VISUO-MOTOR | : | BG |
| | | DAM |
| | | PLAN |
| 4. PERSONALITY | : | NJMI |

RESULTS

1. The test parameters of this sample are given in Table 13.4

The means and distributions of the cognitive and visuo-motor test scores were similar to their normative samples except for the girls scoring higher on the Plan test.

On the personality test the mean extraversion score was lower and the mean neuroticism score was higher than in the standardization sample, although only the girls' scores showed a statistically significant difference.

2. Product moment correlations were found between the test scores (Table 13.5).

TABLE 13.4

MEANS AND STANDARD DEVIATIONS OF TEST SCORES IN THIS SAMPLE COMPARED WITH THEIR STANDARDIZATION SAMPLES.

| | SOUTH LONDON | | | STANDARDIZATION SAMPLE | | | | |
|---|---|---|---|---|---|---|---|---|
| BOYS | N | M | SD | N | M | SD | t | P |
| AGE | 15 | 10y 11m | 4.03m | | 10.00y to 11.00y | | | |
| VERBAL REASONING | 15 | 34.18 | 27.73 | - | - | - | - | - |
| WGRT | 15 | 47.13 | 23.31 | | 55 | - | - | - |
| DAM | 15 | 35.40 | 8.03 | 75 | 36.00 | 10.32 | - | - |
| St. Sc. | 15 | 99.53 | 12.48 | 75 | 100.00 | 15.00 | - | - |
| BG | 15 | 1.66 | 1.66 | 19 | 1.4 | - | - | - |
| PLAN | 15 | 21.00 | 9.72 | 92 | 22.95 | 8.37 | .71 | NS |
| St. Sc. | 15 | 94.20 | 19.10 | 92 | 100.00 | 15.00 | - | - |
| NJMI E | 15 | 10.86 | 3.05 | 90 | 12.51 | 2.72 | 1.91 | NS |
| N | 15 | 9.06 | 3.08 | 90 | 7.96 | 3.35 | 1.27 | NS |
| L | 15 | 7.73 | 2.84 | 90 | 9.06 | 4.07 | 1.54 | NS |

| | SOUTH LONDON | | | STANDARDIZATION SAMPLE | | | | |
|---|---|---|---|---|---|---|---|---|
| GIRLS | N | M | SD | N | M | SD | t | P |
| AGE | 16 | 10y 10m | 3.49m | .1 | 10.00y to 11.00y | | - | - |
| VERBAL REASONING | 16 | 39.93 | 15.57 | | - | | - | - |
| WGRT | 16 | 52.56 | 6.97 | | 55 | - | - | - |
| DAM | 16 | 37.06 | 5.62 | 75 | 37.10 | 9.27 | - | NS |
| St. Sc. | 16 | 97.31 | 11.47 | 75 | 100.00 | 15.00 | - | - |
| BG | 16 | 1.20 | 1.10 | 12 | 1.5 | - | - | - |
| PLAN | 16 | 22.12 | 6.01 | 96 | 18.19 | 8.15 | 2.24 | .05 |
| St. Sc. | 16 | 103.00 | 13.60 | 96 | 100.00 | 15.00 | - | - |
| NJMI E | 16 | 9.12 | 2.30 | 71 | 12.14 | 2.61 | 4.57 | .001 |
| N | 16 | 10.75 | 3.05 | 71 | 7.45 | 3.00 | 3.83 | .001 |
| L | 16 | 8.31 | 2.55 | 71 | 11.21 | 3.27 | 4.32 | .001 |

TABLE 13.5

PRODUCT MOMENT CORRELATIONS

Boys above and girls below the diagonal

| | BOYS | | | | | N J M I | | |
|---|---|---|---|---|---|---|---|---|
| | VR | WGRT | DAM | BG | PLAN | E | N | L |
| VR | | 85xx | 60xx | -55x | 67xx | 21 | -19 | -18 |
| WGRT | 52x | | 56x | -72xx | 30 | -18 | -61xx | -22 |
| DAM | 42 | 20 | | -47 | 57x | -12 | -24 | -46 |
| BG | -31 | -42 | -36 | | -42 | 27 | 47 | -01 |
| PLAN | 25 | 25 | 63xx | -57x | | 16 | -28 | -46 |
| NGMI E | 00 | -15 | 05 | 15 | 01 | | | -38 |
| N | -17 | -12 | -31 | 21 | -54x | | | -15 |
| L | 04 | -04 | -24 | 16 | -11 | -56x | -50x | |

GIRLS

x P =0.05 (0.483)    xx P = 0.01 (0.605)

The cognitive test of verbal reasoning correlated highly with all tests except those of personality. The same test correlated with reading in the girls' group but not significantly with the others. The BG shows a negative correlation because the score is based on the number of errors. The Plan correlated at a statistically significant level with the other visuo-motor tests in boys and girls. There was no relationship between extraversion and verbal reasoning as has been found in other studies of children of this age. (Child, 1964).

There was a relationship between neuroticism and low Plan scores in girls and a high error score in the BG and a low reading score in the boys.

3. In order to clarify further the relationship between the Plan, E and N scores the same procedure as adopted by Child was used. The scores of each child were placed in one of four quadrants depending upon whether his E and N scores were above or below their respective means. Children with average scores were omitted. The means and standard deviations are given in Table 13.6.

TABLE 13.6

TEST MEANS AND STANDARD DEVIATIONS IN THE QUADRANTS GENERATED BY THE ORTHOGONAL CONTINUUMS OF NEUROTICISM AND EXTRAVERSION.

NEUROTICISM

| | N = 7 | | | | | N = 4 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VR | WGRT | DAM | BG | PLAN | VR | WGRT | DAM | BG | PLAN |
| M | 28.00 | 45.00 | 93.00 | 2.29 | 96.28 | 31.20 | 48.16 | 104.20 | 0.60 | 94.80 |
| SD | 13.55 | 16.43 | 10.34 | 2.13 | 12.86 | 16.30 | 12.81 | 18.20 | 0.89 | 22.78 |
| EXTRAVERSION | | | | | | | | | | INTROVERSION |
| | N = 8 | | | | | N = 3 | | | | |
| | VR | WGRT | DAM | BG | PLAN | VR | WGRT | DAM | BG | PLAN |
| M | 31.82 | 59.37 | 106.50 | 1.00 | 112.50 | 25.33 | 55.33 | 92.33 | 0.67 | 90.00 |
| SD | 0.62 | 17.43 | 9.13 | 1.06 | 9.58 | 11.59 | 3.06 | 2.52 | 0.57 | 18.13 |

STABILITY

The stable extraverts had the highest mean scores as in other studies, but the numbers were too small in some of the quadrants to evaluate statistically.

4. The difference in test scores were then found when subjects were divided into "Neurotic" and "Stable" groups, depending upon their score on that scale being at least 1 point above or below the mean for the group. (Table 13.7(a))

TABLE 13.7(a)

DIFFERENCE IN TEST SCORES BETWEEN NEUROTIC AND STABLE GROUPS

| | NEUROTIC | STABLE | | |
|---|---|---|---|---|
| | N = 14 | N = 12 | | |
| TESTS | M | M | t | P |
| VR | 24.71 | 43.58 | -2.37 | 0.05 |
| WGRT | 44.35 | 57.60 | -2.35 | 0.05 |
| BG | 2.00 | 1.00 | 1.88 | NS |
| DAM | 34.71 | 38.58 | -1.67 | NS |
| PLAN | 18.07 | 25.35 | -1.52 | 0.05 |
| EXTRAVERSION | 23.82 | 19.33 | 1.37 | NS |

All the scores were lower in the neurotic group, but only the VR, WGRT and Plan significantly so.

The same method of differentiating Extraverts from Introverts was then used on the scale of Extraversion (Table 13.7(b))

TABLE 13.7(b)

DIFFERENCE IN THE TEST SCORES BETWEEN EXTRAVERTS AND INTROVERT

| BOYS & GIRLS | | EXTRAVERT | | INTROVERT | | |
|---|---|---|---|---|---|---|
| | N | M | N | M | t | P |
| TESTS | 17 | | 9 | | | |
| VR | | 35.76 | | 27.77 | 0.83 | NS |
| GWRT | | 48.70 | | 54.55 | 0.78 | NS |
| BG | | 1.65 | | 0.78 | 1.61 | NS |
| DAM | | 36.29 | | 37.22 | 0.31 | NS |
| PLAN | | 23.82 | | 19.33 | 1.39 | NS |

This time there was no difference between the two groups except that there was a tendency for introverts to do best on the BG and extraverts on the Plan test.

Had such a result been statistically significant it might be thought that extraverts were more successful in thinking about things as well as people, as Burt suggests, and therefore do better on the Plan; while the introvert may be more successful on the BG test because he is not so impulsive.

CONCLUSIONS

Owing to small numbers and sex differences the conclusions can only be tentative.

1. Intelligence as measured by verbal reasoning showed little relationship with personality measures in individuals, although as a group the stable children scored higher.
2. Attainment as seen in reading ability was related to emotional stability and the group of stable children scored higher than the "neurotic" group.

3. The Plan scores were significantly associated with those of the other visuo-motor tests, BG and DAM.
4. Extraversion showed little relationship with other scores, but neuroticism was negatively associated with reading achievement in boys and Plan drawing in girls.

III. AN INVESTIGATION OF A PSYCHIATRIC POPULATION TO SEE IF THE PLAN TOTAL SCORES ARE LOWER AND/OR DIFFER QUALITATIVELY FROM A NON CLINIC POPULATION: AND TO SEE IF LOWER SCORES ARE ASSOCIATED WITH ANY PARTICULAR SYNDROME OF SYMPTOMS, INCIDENTS IN THE HISTORY, TYPE OF PARENTS OR DIAGNOSIS.

SAMPLE

This was the psychiatric sample which had already been used to look at the factor structure of the Plan Test (Chapter X). It consisted of those children who had been referred to a London Child Guidance Clinic for a psychiatric assessment. Only children who live in houses have been included because the standard scores are not rated for flat dwellers. This has limited the numbers therefore and as children coming from the immediate vicinity mostly live in flats, they have been excluded. Most of the children in the sample lived in Barnet, many in the same type of houses as the children on whom the test was standardized in Buckinghamshire.

TESTS

| | | |
|---|---|---|
| 1. | INTELLIGENCE : | WISC |
| 2. | ATTAINMENT : | Word Graded Reading Test (Schonell 1938) |
| 3. | VISUO-MOTOR : | BG |
| | | DAM |
| | | PLAN |

METHOD

1. Scores on the Plan tests were examined for a quantitative difference by dividing the sample according to sex and then

(a) Ascertaining the general intellectual normality of the samples by comparing the WISC test results with a small London sample.

(b) Ascertaining if the Plan Standard Scores were statistically significantly lower than the Buckinghamshire standardization sample.

2. Scores on the Plan test were then examined for qualitative differences in their component items by

(a) Comparing total mean raw scores of each age group separately with those of the standardization sample.

(b) Finding the percentage occurrence of each item in the separate age groups and testing those showing large differences by the method of significance of difference between proportions.

As the same information was available for children referred to the clinic for a learning disorder, also used in the factor analysis (Chapter X), this sample was used to provide another contrast group.

3. The association of lower scores on the Plan with symptoms, incidents in the history, parents' personalities or diagnosis was examined by

(a) Dividing the psychiatric referrals into those with and without retardation in reading. This was considered advisable because there is evidence, both clinical (Vernon,1971) and epidemiological (Yule, 1973) that some children have a learning disorder, which results in reading retardation that is persistent throughout the child's school years despite remedial teaching. Since in many children this occurs independently of emotional disturbance, except that which the disability itself engenders, it was thought that when looking for the association of poor Plan drawing with psychiatric symptoms the results might well be confused if the two disorders were present.

There are various ways of assessing retardation in reading from the crude comparison of reading age to the chronological age, to the statistically sophisticated method of a discrepancy from a predicted reading score based on a regression equation involving the age and IQ. In this study a midway method was used, in which a reading quotient of more than 15 points below the WISC FS IQ was used to separate the retarded from the non-retarded reader.

(b) These groups were then divided again into A and B, A having children whose Plan standard score was more than 15 points below their WISC FS IQ and B having children whose Plan score was 15 points or less below their WISC FS IQ.

(c) An Item Sheet constructed by a working party in the clinic in 1963, was then used to check the files for incidence of symptoms, events in the histories, parental attitudes, personalities and psychopathologies and psychiatric diagnoses.

RESULTS

1. Quantitative differences in Total Scores on the Plan Test between Normal and Psychiatric Populations.

The test means and standard deviations are given in Table 13.8. The WISC means were about the same for boys and girls and similar to those found by Jones (1962) in a normal sample of London 10 year olds, which suggests they may be average for this area. On the attainment tests standardised in England more than 15 years ago, the reading was average and the spelling and arithmetic low average. The visuo-motor tests were all low average.

TABLE 13.8

TEST SCORES IN CHILD PSYCHIATRIC REFERRALS AGED 7-0 to 15-0 YEARS.

| | BOYS N = 110 | | GIRLS N = 46 | |
|---|---|---|---|---|
| | M | SD | M | SD |
| WISC V | 108.40 | 16.62 | 105.70 | 13.68 |
| P | 106.95 | 14.63 | 100.17 | 15.44 |
| FS | 108.25 | 15.23 | 105.09 | 14.06 |
| READING | 100.69 | 22.08 | 101.02 | 19.44 |
| SPELLING | 89.58 | 19.14 | 94.22 | 17.79 |
| ARITHMETIC | 95.08 | 20.54 | 91.15 | 17.98 |
| BG | 89.12 | 19.49 | 92.54 | 18.25 |
| DAM | 96.48 | 17.47 | 94.80 | 16.49 |
| PLAN | 89.21 | 16.59 | 88.85 | 12.68 |

The Plan means were lower than the other London sample means given in Table 13.9.

TABLE 13.9

PLAN MEAN SCORES IN SMALL LONDON SAMPLES

| | | | | IQ | | PLAN | |
|---|---|---|---|---|---|---|---|
| NORTH | AGE | N | TEST | M | SD | M | SD |
| BOYS | 11-0 to 12-9 | 26 | V | 108.461 | 12.678 | 99.346 | 12.858 |
| | | | NV | 110.709 | 7.69 | | |
| GIRLS | 10-8 to 12-8 | 28 | V | 112.642 | 13.166 | 109.357 | 14.274 |
| | | | NV | 108.259 | 12.038 | | |
| SOUTH | | | | | | | |
| BOYS | 10-7 to 11-5 | 15 | - | - | - | 94.20 | 19.10 |
| GIRLS | 10-7 to 11-7 | 16 | | - | - | 103.00 | 13.60 |
| SOUTH WEST | | | | | | | |
| BOYS AND GIRLS | 9-2 to 10-2 | 21 | NV | 89.33 | 13.36 | 97.66 | 16.56 |

They were also statistically significantly lower than those of the Buckinghamshire standardization sample. (Table 13.10.)

TABLE 13.10

PLAN MEANS OF THE PSYCHIATRIC SAMPLE COMPARED WITH STANDARDIZATION MEANS.

| | | PSYCHIATRIC SAMPLE | | STANDARDIZATION SAMPLE | | | |
|---|---|---|---|---|---|---|---|
| | N | M | SD | M | SD | t | P |
| BOYS | 110 | 89.21 | 16.59 | 100.00 | 15.00 | 4.931 | 0.001 |
| GIRLS | 46 | 88.85 | 12.68 | 100.00 | 15.00 | 4.837 | 0.001 |

These results therefore support the clinical impression that children referred to a clinic for psychiatric assessment and who are later found to have an emotional disorder are poorer at drawing plans of their own house than non-clinic children.

2. Qualitative Differences Between Normal and Psychiatric Populations in the Types of Successful Items.

In order to look at the difference of success rates on items between the psychiatric and standardization samples, it was necessary to consider each year separately owing to development changes. The girls' sample was too small to treat in this way and so were some of the year groups in the boys' sample, so that only the 9, 10 and 11 year groups in the boys' sample could eventually be used.

As a contrast group, the 9, 10 and 11 year old boys with learning disorder (backwardness in attainments), who had been referred to the same clinic for educational advice, were also looked at. The results of the WISC and Plan tests in both samples is given in Table 13.11.

TABLE 13.11

BOYS MEANS AND STANDARD DEVIATIONS OF WISC FS IQs AND PLAN STANDARD SCORES IN EDUCATIONAL AND PSYCHIATRIC REFERRALLS.

| | | EDUCATIONAL | | | PSYCHIATRIC | | |
|---|---|---|---|---|---|---|---|
| AGE | | N | WISC | PLAN | N | WISC | PLAN |
| 9-0 to 9-11 | MEAN | 10 | 115.00 | 99.500 | 17 | 111.176 | 87.235 |
| | SD | | 11.737 | 6.467 | | 17.101 | 10.202 |
| 10-0 to 10-11 | MEAN | 11 | 110.222 | 95.636 | 16 | 109.937 | 96.187 |
| | SD | | 7.396 | 12.541 | | 11.993 | 11.067 |
| 11-0 to 11-11 | MEAN | 18 | 104.722 | 88.944 | 19 | 114.263 | 87.526 |
| | SD | | 12.979 | 13.576 | | 16.017 | 16.260 |

These groups were all of good average intelligence except the 11 year old psychiatric referrals, which was higher than for the educational and psychiatric referrals as a whole. This might explain why some of the mean Plan scores were average, and higher than the means of the whole sample.

The Plan standard scores, however, were all about 15 points below the WISC means for each age group.

Thus when the raw scores of these children of good average intelligence were compared with the standardization sample, only the 11 year old educational referrals and 9 and 11 year old psychiatric referrals were significantly lower. (Table 13.12).

TABLE 13.12

BOYS MEANS, STANDARD DEVIATIONS AND SIGNIFICANCE OF DIFFERENCE BETWEEN EDUCATIONAL AND PSYCHIATRIC REFERRALS AND STANDARDIZATION SAMPLE

| | EDUCATIONAL REFERRALS | | | STANDARDIZATION SAMPLE | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | M | SD | N | M | SD | t | P |
| 9-0 to 9-11 | 10 | 22.300 | 3.945 | 87 | 21.651 | 8.460 | - | NS |
| 10-0 to 10-11 | 11 | 20.818 | 7.859 | 92 | 22.945 | 8.370 | - | NS |
| 11-0 to 11-11 | 18 | 20.666 | 8.268 | 87 | 27.333 | 9.336 | 4.492 | 0.001 |
| | PSYCHIATRIC REFERRALS | | | STANDARDIZATION SAMPLE | | | | |
| | N | M | SD | N | M | SD | t | P |
| 9-0 to 9-11 | 10 | 13.411 | 7.669 | 87 | 21.651 | 8.460 | 3.837 | 0.001 |
| 10-0 to 10-11 | 16 | 19.625 | 6.868 | 92 | 22.945 | 8.870 | 1.494 | NS |
| 11-0 to 11-11 | 19 | 19.947 | 5.260 | 87 | 27.333 | 9.336 | 3.880 | 0.001 |

The individual items of the three age groups, which were significantly lower than those in the standardization sample, were then examined individually for significant proportional differences (Table 13.13).

TABLE 13.13

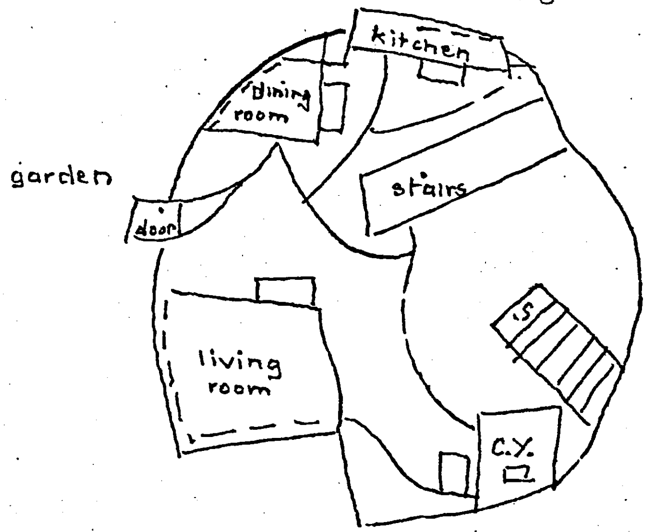
ITEMS SHOWING SIGNIFICANT DIFFERENCE IN SUCCESS RATES, BETWEEN BOYS IN THE STANDARDIZATION SAMPLE AND BOYS IN THE EDUCATIONAL AND PSYCHIATRIC REFERRALS.

| | SIGNIFICANT DIFFERENCE OF PROPORTIONS | | |
|---|---|---|---|
| | PSYCHIATRIC | | EDUCATIONAL |
| | 9-0 yrs. | 11-0 yrs. | 11-0 yrs |
| 10 Outer Wall I | 3.706 | 4.116 | NS |
| 11 Outer Wall II | 3.706 | 2.716 | 3.830 |
| 12 Proportions of Rooms | NS | NS | 2.007 |
| 13 Hall I | NS | NS | 4.348 |
| 14 Hall II | 2.707 | 4.022 | 3.944 |
| 15 Hall : Proportion | NS | NS | 3.211 |
| 16 Horizontal Stairs | 8.454 | 2.868 | NS |
| 17 Stairs I | 2.484 | 2.398 | NS |
| 18 Stairs II | 2.809 | 2.476 | NS |
| 19 Stairs : Proportion | NS | NS | NS |
| 20 Treads I | 2.976 | NS | NS |
| 21 Treads II | NS | NS | NS |
| 22 Doors : Number I | NS | NS | NS |
| 23 Doors : Number II | 3.045 | NS | 3.565 |
| 24 Doors : Type I | 2.865 | NS | NS |
| 25 Doors : Type II | 3.430 | NS | NS |
| 26 Doors : Type III | NS | NS | NS |
| 27 Doors : Proportion | NS | NS | NS |
| 28 Windows : Number I | NS | NS | 6.185 |
| 29 Windows : Number II | NS | 3.376 | 4.027 |
| 30 Windows : Type I | NS | NS | 3.730 |
| 31 Windows : Type II | NS | NS | NS |
| 32 Windows : Type III | NS | 4.520 | NS |
| 33 No Unaccounted for Space | NS | 5.670 | NS |
| 34 No Vertical Walls | NS | NS | NS |
| 35 Proportions I | NS | 2.211 | NS |
| 36 Proportions II | NS | NS | NS |
| 37 Proportions III | NS | NS | NS |
| 38 Proportions IV | NS | NS | NS |
| 39 Quality of Drawing I | 3.000 | 2.943 | 3.464 |
| 40 Quality of Drawing II | NS | NS | NS |

Statistically significant if > 3.000

There was no consistent pattern which appeared in all three groups. Effects of maturation probably explain differences in the psychiatric groups. Easy items 1 - 9 were passed by most and difficult items 36 - 38 were passed by few so that neither discriminate. The items which are vulnerable at any age are probably those on which the standardization sample children are just beginning to succeed. No such comparison is possible with the educational referrals since there is only one age group.

Two items 11 and 39 are failed most frequently in both educational and psychiatric samples. Item 11 is usually failed because children leave small gaps in the outer wall in the vicinity of the stairs. When this is brought to their attention, they frequently look anxious and confused, but very few can remedy the omission. It has seemed as though they had not yet accepted that the wall of a house does not have gaps, other than doors and windows. Again 39, Quality of Drawing, refers mainly to the outside wall. Failures occur because the child seems to be more concerned with the interior of the house and does not keep in mind that the whole is really concerned with sub-divisions of a rectangle. One psychiatric referral went to the extreme of drawing almost a circle (Fig. 13.1.).




Fis. 13.1. A plan of his house drawn by a boy of 9y 4m with a WISC FS IQ of 111.

Apart from these similarities between the psychiatric and educational referrals, there would also appear to be differences. Most of the items in which the psychiatric referrals score lower require the concept of horizontality, and these children are slower than normal to draw the stairs and windows horizontally. The educational referrals do less well on numbers of doors and windows (items 23, 28 and 29) but this would not appear to require conceptual understanding, but does require consistency of effort and systematic checking. A deficiency of such good work habits is often also seen in their school tasks.

3. Differences between Low Scorers and Very Low Scorers on the Plan Test in Terms of Symptoms, History, Parents' Personalities and Diagnoses.

When the psychiatric referrals were divided into backward and not-backward children, it was found that there were not enough girls to form a group backward in reading, so those who were backward were discarded. Each of the remaining three groups were then divided according to their Plan score, into groups A and B.

The items were scored by using the information in the case notes. The number of times an item occurred in each group, together with the equivalent percentage to aid comparisons, is given in the Appendix II. Although from inspection there appeared to be interesting differences between the backward and not-backward group and between the boys and the girls, they were not relevant to this study and not sufficient to justify keeping the groups separate. They were therefore amalgamated so that the total sample was just divided into groups A and B.

The test means of these groups can be seen in Table 13.14. The mean age and WISC IQ of Group A was higher than for Group B, while the mean Plan score was much lower. In Group A the mean difference between WISC and Plan was 28.760, but in group B only 3.275 indicating a statistically significant difference at the P 0.001 level.

TABLE 13.14

DIFFERENCES OF MEANS IN AGE, WISC FS, PLAN AND DISCREPANCY BETWEEN WISC AND PLAN SCORES OF GROUPS A AND B

| | A | B | | |
|---|---|---|---|---|
| | 61 | 41 | t | P |
| AGE IN MTHS. | 136.272 | 123.377 | 2.969 | 0.005 |
| WISC FS | 113.934 | 102.339 | 4.795 | 0.001 |
| PLAN | 85.592 | 99.792 | 6.583 | 0.001 |
| WISC-PLAN DIFF. | 28.760 | 3.275 | 14.126 | 0.001 |

Many of the items were scarcely used or showed no difference in occurrence. Only items in groups A and B, which seemed likely to show a statistically different incidence were tested. (Table 13.15).

TABLE 13.15

INCIDENCE OF SYMPTOMS, DEVELOPMENTAL FEATURES, TYPES OF PARENTS AND DIAGNOSES IN HISTORIES OF CHILDREN WHOSE PLAN SCORES WERE MORE THAN (A) OR LESS THAN (B) 15 POINTS BELOW THEIR WISC FS IQs.

| | INCIDENCE | | PROPORTIONS | | RATIO | P |
|---|---|---|---|---|---|---|
| SYMPTOMS | A N=61 | B N=41 | A | B | | |
| Temper Tantrums | 15 | 5 | .245 | .122 | 1.957 | 0.1 |
| Violent Aggression | 11 | 4 | .180 | .098 | 1.317 | NS |
| Depression | 10 | 2 | .163 | .048 | 2.129 | 0.05 |
| Fears | 9 | 1 | .147 | .024 | 2.277 | 0.05 |
| Eating Disturbance | 4 | 8 | .065 | .195 | 2.081 | 0.05 |
| Nightmares | 2 | 5 | .032 | .090 | 2.046 | 0.05 |
| DEVELOPMENT | | | | | | |
| Illness - 0-2 yrs. | 8 | 8 | .131 | .195 | 0.914 | NS |
| Illness - 2+ yrs. | 12 | 5 | .196 | .121 | 1.100 | NS |
| Motor Development | 5 | 7 | .082 | .122 | 0.719 | NS |
| Speech slow | 8 | 8 | .131 | .195 | 1.015 | NS |
| PARENTS | | | | | | |
| FATHER | | | | | | |
| Unrealistic Ambition | 5 | 0 | .081 | .000 | 1.910 | 0.1 |
| MOTHER | | | | | | |
| Personality Problem | 3 | 6 | .049 | .146 | 1.259 | NS |
| DIAGNOSIS | | | | | | |
| Reactive Behaviour Disorder | 9 | 12 | .144 | .292 | 1.870 | 0.1 |
| Neurotic Disorder | 40 | 20 | .655 | .487 | 1.787 | 0.1 |

(a) Symptoms

Those in Group A showed significantly more symptons of depression and fears, the latter most commonly in the girls. There was also a tendency for temper tantrums and aggression to appear more frequently in Group A, particularly in boys, but not at a statistically significant level. In the opposite direction, eating disturbance and nightmares occurred more frequently in Group B.

(b) Development

As neurological dysfunction has been found to be associated with difficulties in pregnancy, birth, prematurity and some childhood illness the differences in the occurrence of these items in Groups A and B were looked for, but none were found. Neither was there any difference between the two groups with regard to slow development in speech or motor control.

Likewise there was no difference between the two groups with regard to problems arising from mother-child interaction in feeding or toilet training, or in separations due to hospitalisation of the child, father or mother or due to the father or mother leaving the home temporarily or permanently. There was also no difference in the groups concerning the death of parents, grandparents or siblings.

(c) Parents

Group A tended to have more fathers who were unrealistically ambitious and Group B to have mothers with personality problems, but neither were statistically significant. There was no difference in the incidence of marital disharmony or divorce.

(d) Diagnosis

Group A tended to have a greater percentage of children diagnosed as having a neurotic disorder and group B a greater percentage diagnosed as having a reactive behaviour disorder, which confirmed clinical impressions that those scoring lower on the Plan test were more disturbed than those scoring higher, but when this was examined for statistical significance neither reached the 0.05 level of probability.

CONCLUSIONS

1. The boys with a learning disorder and boys and girls with emotional disturbance score lower on the Plan test than the Buckinghamshire standardization sample.
2. Boys of 9 and 11 years with emotional disturbance and boys of 11 years with a learning disorder have more difficulty in completing the outside wall of the house and making it a rectangle than the average boy, but whereas the former have problems in generalizing the concept of horizontality to the stairs, the latter fail to systematically check details, such as the correct number of doors and windows.
3. More of the children with the poorer plans were fearful and depressed and inclined to have temper tantrums, while those with average plans showed a greater incidence of eating disturbance and nightmares.
4. There was a tendency that was not quite significant for those with poorer plans to be more disturbed than those with average plans.
5. There was nothing in the histories to suggest that poor plan drawing was associated with either neurological dysfunction due to a prenatal, perinatal or postnatal trauma, or to slow motor development.

DISCUSSION

Returning to the aims set down at the beginning of the chapter, it is now evident that children who attended the Child Guidance Clinic for a psychiatric assessment scored lower on the Plan test than would have been expected from their intellectual level.

In a small sample of non-clinic children in Streatham, Plan scores were negatively associated with the Neuroticism scale of the NJMI in girls and low reading scores in boys, but not with Extraversion scale. When the individual items of the N scale are examined, it is apparent that many of them refer to feelings of worry, sadness and guilt, which may be summarised in the psychiatric term of depression. As these are found in the presenting symptoms of a Child Guidance population, it would seem that both categories are measuring something of the same trait in emotional disturbance and both are associated with lower Plan scores.

In contrast the neuroticism scale of the Rutter Questionnaire is probably not measuring the same trait, for it does not show a negative relationship with any of the tests. This is possibly because it includes symptoms of all nine diagnostic categories and does not have so many concerning feelings and personal relationships. Unexpectedly it is the anti-social scale that is related to low scores. Anti-social can be another term for delinquency, and Porteus found that delinquents had normal total scores on his maze test. I too can think of delinquent boys who have done well on the Plan, but they have been ones with no learning disorder and no other psychiatric symptoms. On the Rutter scale the anti-social items of restlessness, destructiveness, aggressiveness, bullying, disobedience, lying and stealing are also associated with the typical, if more acting-out symptoms of the Child Guidance population. It would therefore seem that while the NMPI picks out the more quiet, depressed, introspective, neurotic child, the Rutter anti-social scale picks out the angry, anxious, aggressive child. It would seem therefore that both scales should be used in a larger investigation into the effectiveness of low Plan scores revealing emotional disturbance in children.

Like the BG and the DAM, items on the Plan on which emotionally disturbed children score low varies with age. Between the ages of 8 and 12 years the clinical impression was confirmed that they seem to have difficulty in completing the outside wall, as though they do not or cannot juxtapose the memories of outside and inside the house, checking one with the other. They also fail to generalise their knowledge of three dimensional space from rooms to doors and stairs.

It ought to be mentioned here that children with learning disorders have similar problems in Plan drawing. They too score below what might be expected from their intellectual levels and have difficulty in completing the outer wall. They differ in that they generalise their concept of horizontality to all parallelipipeds as in the normal population, but fail to check numbers of doors and windows efficiently. Such lack of vigilance is also characteristic of their poor attainments, commonly referred to as carelessness. Thus in children with both emotional and learning disorders it would seem to be the style of working that is defective not the component skills.

The literature shows that low scores on visuo-motor tests particularly the BG are associated with neurological dysfunction. The Plan correlates with this test, but although neurological dysfunction in the parietal lobes produces poor plan drawing in adults, neurological dysfunction in CP children was not accompanied by low Plan scores. Moreover when the histories of the emotionally disturbed children were searched for the kind of prenatal, perinatal or post natal traumas that can produce neurological dysfunction, no association was found with low Plan scores.

Many of the studies of children with neurological dysfunction have focused on perceptual and spatial types of tests, which in adults have been found susceptible to post central damage. Such dysfunction has been found in some cerebral palsied children, but Abercrombie (1964) points out that a visuo-motor disorder does not necessarily imply a difficulty in spatial perception. She cites Vereeken (1961) who had studied constructive praxia in normal children up to 7 years and found it was characterised by

(1) reflective attitude and awareness, other spatial behaviour being on the level of prereflexive and spontaneous behaviour;

(2) voluntary exploration;

(3) voluntary activity;

(4) requiring spatial representation.

She illustrates the complexity of constructional skills by quoting a child's remark "Why can't I make my hand do what my eyes see".

The children with emotional and learning disorders studied here have no spatial difficulties as measured by the BD test, but they both had low scores on the BG and Plan. This suggests that the common element of both tests might be the integration of perceptual-spatial and motor skills and it is this skill which is vulnerable to a variety of causes, if the analysis of mistakes was only detailed enough to reveal.

Taking the apparently simple BG test Bender emphasised the integrative component in the test which takes place over time. "There is an innate tendency to experience gestalten ... not only as wholes ... but in the state of becoming .... which integrates the configuration not only in space but in time .... This pattern of action may be expected to vary in different maturation or growth levels and in psychological states organically or functionally determined". Thirty years later Koppitz and others are still finding that children with emotional and learning disorders and neurological dysfunction are scoring lower on this test than the normal child.

The Plan test would seem to be of the same type and though not so much affected by the neurological dysfunction of cerebral palsy, seems to be disrupted in children with emotional and learning disorders. Both fail to integrate consistently the outside and inside of their house and in addition the emotionally disordered fail to consistently apply the concept of horizontality to all items, while those with learning disorder fail to check consistently. This would seem to be a failure in programming and verifying which according to Luria (1973) is a function of the third unit of the brain located in the frontal lobe.

Such a disorder in programming and verification draws the attention away from the possible spatial function which is disrupted in adults by post central lesions to possible dysfunction in the frontal lobes. Even Critchley ended his chapter on disorder of spatial thought by citing Pollak's (1938) opinion that a frontal terminal component served for execution of direction and that "orientation in man was an automation which consisted of three components: a parieto - occipital; a vestibulo - labyrinthene; and a frontal one".

Luria's (1973) concept of brain function is the one which most aptly meets the observations made in this study. He conceives the brain as three functional units, one for regulating tone and mental states (sub cortical structures), one for receiving analysing and storing information (post central) and one for programming, regulating and verification (frontal); the last two also being organised hierarchically into primary, secondary and tertiary areas, of which the tertiary area including the prefrontal zone is last to develop phylogenetically and ontogenetically. The frontal lobe is particularly rich in two way connections with the post central cortex and all the sub cortical structures and is directly involved with consciousness, wakefulness, voluntary movement with its tonic background, mood, motivation and personality.

Apart from animal preparations, adults with limited lesions have produced most information about the function of the frontal lobes. Luria makes a distinction between lateral zone with its linked motor structures and medio basal zone with its links with the reticular formation and limbic structures. Lesions in the former give rise to disturbance of organization of movements and actions, to disintegration of motor programmes and to disturbance of the comparison of human motor behaviour and its original plan and lesions in the latter to generalised disinhibition with affective disorders in the form of lack of self control, violent emotional outbursts and changes in character.

Williams (1970) gives further examples of affective and personality changes after leucotomy. In adults orbital leucotomy was effective in removing symptoms of anxiety and depression, while cingulectomy was effective in removing the aggression and anxiety associated with obsessional disorders (Lewin, 1961) Pre-frontal leucotomy has also been found to increase extroversion on the MPI according to Petrie (1958). Using the "classical" blink conditioning Walter (1966) found that the expectancy wave, which is recorded over the frontal lobes, varied according to the type of mental disorder. Patients with chronic anxiety or phobic states did not habituate, the obsessionals sometimes increased in amplitude while psychopaths showed little reaction. Most became more adaptive after leucotomy.

Williams (1970) also draws attention to the inhibitory function of the brain. She quotes an anatomist "The main object of the synapse is not to assist transmission, but to block it" and goes on to say that the main function of the cortex may not only be to react to external stimuli, but to delay the response "until after a number of different sensory impressions have been processed". This has certainly been found in motor innervation which depends for its smooth function on the inhibitory action of the pyramidal and extrapyramidal systems as well as their excitation. Lesions may interrupt this inhibitory cortical action at any level, resulting in motor perseveration, acting out behaviour in the form of temper tantrums and aggression and/or impulsive problem solving.

This brief look at present theory about brain function has not been taken with the thought of finding neurological answers to psychological questions, but to see if concurrent findings in both realms of discourse might throw any light on what a poor Plan signifies and why it should appear in children with emotional and learning disorders.

Not much is known about the personalities of the children with a learning disorder but they do show a typical WISC subtest profile with low scores in subtests requiring long and short-term memory, arithmetical calculation and quick learning of association of symbols, all of which although not exactly the same as in adults are suggestive of a dysfunction programming verification and memory. Functions that in adults are associated with frontal lobes and limbic structures.

Children with emotional disorders are also poor in Plan drawing and are either depressed or show lack of control in their response to frustration and anxiety with temper tantrums or aggression. Again in adults such emotion is a function of the frontal lobe and limbic system particularly the amygdala.

If the Plan test was given to adults with parietal lesions confusion of verticality and horizontality or viewpoints might be expected, while those with a neurotic disorder are likely to have the same problem as children in being unable to concentrate on the task and integrate information from various systems producing the same lack of internal and external verification. The latter should improve with encouragement and experience,while the former would not.

# CHAPTER XIV

## VALIDITY

Validity refers to the extent a test measures what it was designed to measure and comprises the degree to which it represents, predicts and signifies that aspect of human behaviour, which is being assessed. It is not, therefore, a measure which can be found in the abstract, but only with reference to a particular aspect of the domain it is intended to measure. Basically this entails looking at the relationship between the test and other independently observable facts about the behaviour characteristics under consideration. In the 'Standards for Educational and Psychological Tests and Manuals' (1966) the procedures are classified under three principal categories; content, criterion - related and concurrent validity.

### CONTENT VALIDITY

This involves an examination of the test content to determine how it relates to the universe of items that the test situation claims to represent. It is built into the test at the stage of item validation, before even the test has been standardized. It ultimately determines the criterion related and construct validities.

Constructions of cognitive tests to be used over a wide age range used to employ age as a means of validating the items and automatically some association with intelligence was built in at this stage. Some personality tests have avoided this association by using different clinical groups to validate their items, but this is more possible with adults than children. Interpretation of the Rorschach test, for instance, in children cannot be made independently of a child's age and intelligence.

Although the Plan test was ultimately intended to assess the degree of emotional disturbance in a child, the protocols changed so much with age that the items had to be validated against this variable. Therefore the principal aim at this stage was to construct a test which measured the ability of normal children to draw a plan of their houses. Out of a possible universe of items in plan drawing, those items were selected which were used both by the majority of children and in their final form also appeared in architects' plans. As they were validated against an increasing percentage of success with age, automatically a positive association with intelligence was built into the test at this stage.

## CRITERION RELATED VALIDITY

Regarding criterion related validity it was hoped that the Plan test would have concurrent and predictive validity; concurrent validity as a screening test to reveal emotionally disturbed children in the school population and the degree of emotional disturbance in the clinic population, and predictive validity which would aid the prognosis of emotionally disturbed children and so refine the recommendations.

While obtaining the protocols for the standardization sample, enquiries about children drawing particularly poor plans revealed that most had behaviour or emotional problems and that some were attending or had attended Child Guidance Clinics. However, the test's effectiveness as a screening device has not been evaluated. An attempt was also made to look at the predictive validity of the test in relation to the effectiveness of psychotherapy in a Child Guidance Clinic population, for it was hypothesised that the child who drew the better plans would have the more resilient and better organized personalities and so would be able to make greater use of psychotherapy. Unfortunately, the records about the outcome of treatment were not sufficiently systematic and precise to give the required information in a form which could be used for such an investigation.

What can be reported here is the concurrent validity of the Plan test in relation to emotional disturbance, as defined by the neuroticism scale on the NMPI and from a psychiatric interview in a Child Guidance Clinic.

### Concurrent Validity

This was first assessed by comparing Plan standard scores obtained from child psychiatric populations, referred to Child Guidance Clinics, with the Buckinghamshire standardization sample. Although the use of raw scores would have been preferable, this was impossible because it would have been necessary to compare each year's age group individually and the few numbers of children in the bottom and top age groups precluded this. Scores from two clinics were used, one in Buckinghamshire, the other in North West London (Chapter XIII). The means of both were statistically significantly below the standardization means (Table 14.1.). The Buckinghamshire CGC Plan mean was lower than the London mean, probably because the mean WISC FS IQ was also lower at 96.26(SD 15.69).

TABLE 14.1

PLAN MEANS OF STANDARD SCORES OF PSYCHIATRIC SAMPLES COMPARED WITH STANDARDIZATION MEANS

| BUCKS | Psychiatric Sample | | | Standardization Sample | | | |
|---|---|---|---|---|---|---|---|
| | N | M | SD | M | SD | t | P |
| BOYS | 34 | 83.4 | 13.401 | 100.00 | 15.00 | 5.98 | 0.001 |
| NW LONDON | | | | | | | |
| BOYS | 110 | 89.21 | 16.59 | 100.00 | 15.00 | 4.93 | 0.001 |
| GIRLS | 46 | 88.85 | 12.68 | 100.00 | 15.00 | 4.84 | 0.001 |

A different criterion of neuroticism was used on a 10 year old group of 15 boys and 16 girls in South London (Chapter XIII). They had completed the NMPI and were divided into 'neurotic' and 'stable' groups, depending upon their N score being above or below 9, which is the mean N score for that age group as given in the manual. When the mean Plan raw and standard scores were computed for these two groups, those of the 'neurotic' group were found to be statistically significantly lower (Table 14.2).

TABLE 14.2

PLAN RAW SCORE MEANS OF 'NEUROTIC' AND 'STABLE' GROUPS (NMPI)

| RAW SCORES | Neurotic | | Stable | | | |
|---|---|---|---|---|---|---|
| | N | M | N | M | t | P |
| BOYS | 9 | 18.55 | 5 | 28.60 | 2.18 | 0.05 |
| GIRLS | 10 | 19.82 | 6 | 26.00 | 2.27 | 0.05 |
| BOTH | 19 | 19.21 | 11 | 27.18 | 3.11 | 0.01 |
| STANDARD SCORES | | | | | | |
| BOYS | 9 | 88.78 | 5 | 108.80 | 2.08 | 0.10 |
| GIRLS | 10 | 99.00 | 6 | 112.66 | 2.03 | 0.10 |
| BOTH | 19 | 94.16 | 11 | 110.91 | 2.91 | 0.01 |

Returning to the London psychiatric sample, differences of Plan scores were looked for in relation to severity of emotional disturbance. Since 90% of the children were diagnosed as having either a reactive or neurotic disorder, only these were considered for there were too few numbers in the other categories. According to the Item Sheet these disorders were defined as follows:

Reactive behaviour not amounting to neurosis or character disorder (i.e. a potentially reversible response to environmental stress, including inappropriate handling, traumatic occurrence etc.)

Neurotic disorder (a pattern of disordered behaviour which is more fixed, less reversible and manifested even in favourable circumstances).

These definitions implied that the children with a neurotic disorder were more emotionally disturbed than those with a reactive disorder. Plan means were therefore found of these groups and for comparison the non-clinic children of the North London sample (Chapter III) were used as a 'normal' contrast group. The term non-clinic is employed because it is likely that between 5% and 10% of this 'normal' group could belong to a clinic population. The mean scores of the three groups are in Table 14.3.

TABLE 14.3

PLAN STANDARD SCORE MEANS IN 'NON-CLINIC' CHILDREN AND CLINIC CHILDREN, REACTIVE AND NEUROTIC

| | AGE | N | M | SD |
|---|---|---|---|---|
| NON-CLINIC | 10-7 to 11-5 | 27 | 103.000 | 13.362 |
| CLINIC REACTIVE | 7-6 to 15-5 | 18 | 100.165 | 12.74 |
| CLINIC NEUROTIC | 7-6 to 15-5 | 72 | 90.569 | 12.93 |

DIFFERENCES BETWEEN MEANS

| | t | P |
|---|---|---|
| NON-CLINIC AND CLINIC REACTIVE | 1.127 | NS |
| NON-CLINIC AND CLINIC NEUROTIC | 4.363 | 0.001 |
| CLINIC REACTIVE AND NEUROTIC | 2.884 | 0.01 |

Despite the non-clinic sample probably containing some psychiatric cases, there was a statistically significant difference (P 0.001) between them and the clinic children with a neurotic disorder. There was no difference between the non-clinic and clinic children with a reactive disorder, although there was between clinic children with reactive and neurotic disorders.

However, the difference in mean Plan scores between the London and Buckinghamshire Child Guidance Clinics show how affected they are by general intelligence. Therefore the means of the discrepancies between IQ and Plan score in the different groups were also assessed. Again the difference between non-clinic and clinic reactive was barely significant, while the differences between non-clinic and neurotic, and reactive and neurotic were (Table 14.4).

In the same way the mean discrepancies between IQ and Plan score were compared in a non-clinic population from South London (Chapter XIII) with a Buckinghamshire Child Guidance Clinic population. These two samples were chosen because the mean IQs were similar. South London NV IQ 89.3 and Buckinghamshire WISC IQ 96.3. The mean discrepancies in the clinic population were again statistically significantly different at the P 0.001 level (Table 14.5).

TABLE 14.4

DIFFERENCE BETWEEN IQ AND PLAN SCORES IN NON-CLINIC CHILDREN AND CLINIC CHILDREN, REACTIVE AND NEUROTIC.

| NON CLINIC | | CLINIC REACTIVE | | | |
|---|---|---|---|---|---|
| N | M | N | M | t | P |
| 27 | 1.41 | 18 | -6.17 | 1.88 | 0.10 |
| **NON CLINIC** | | **CLINIC NEUROTIC** | | | |
| N | M | N | M | t | P |
| 27 | 1.47 | 72 | -20.972 | 6.01 | 0.001 |
| **CLINIC REACTIVE** | | **CLINIC NEUROTIC** | | | |
| N | M | N | M | t | P |
| 18 | -6.17 | 72 | -20.944 | 3.56 | 0.002 |

TABLE 14.5

DIFFERENCE BETWEEN IQ AND PLAN SCORES IN NON CLINIC ( SOUTH WEST LONDON) AND CLINIC (BUCKINGHAMSHIRE)

| NON-CLINIC | | | CLINIC | | | | |
|---|---|---|---|---|---|---|---|
| N | M | SD | N | M | SD | t | P |
| 21 | 8.27 | 10.05 | 34 | -12.79 | 14.43 | 6.26 | 0.001 |

Having established that a group of clinic children scored lower on the Plan test than non-clinic children, and showed greater discrepancies between their IQ and Plan scores, the distributions of scores and discrepancy scores was then looked at to discover what would be the most suitable out off point to identify clinic children.

Looking at Table 14.6 showing the distribution of scores in clinic and non-clinic samples, it would seem that one standard deviation above and below the mean would be the most suitable point to discriminate between clinic and non-clinic populations. A standard score of 115+ would include 27% of the non-clinic population and 4% of the clinic population; and a standard score of 84 or below would include 20% of the non-clinic population and 39% of the clinic population.

However, while the latter score might be a useful cut off point for identifying children in difficulty in the school population, either due to below average intelligence, a learning disorder or an emotional disorder, it is only of limited usefulness in a clinic population. A more useful clinical measure would be the cut off points of 0 and -15 on the discrepancy scores (Table 14.7).

TABLE 14.6.

PLAN SCORES IN NON-CLINIC AND CLINIC POPULATIONS

| | NON-CLINIC | | | | | CLINIC | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LONDON | | | | | | BUCKS | LONDON | | |
| | NORTH | SOUTH WEST | SOUTH | | TOTAL | TOTAL | | TOTAL | REACTIVE | NEUROTIC |
| N | 27 | 21 | 31 | | 79 | 124 | 34 | 90 | 18 | 72 |
| SCORES | | | 'Stable' | 'Neurotic' | | | | | | |
| 139–140 | 1 | | | | 1 | | | | | |
| 136–138 | | | | | | | | | | |
| 133–135 | | | | | | | | | | |
| 130–132 | | | | | | | | | | |
| 127–129 | | 1 | | | 1 | | | | | |
| 124–126 | 1 | 1 | 1 | | 3 | 1 | | 1 | 1 | |
| 121–123 | 3 | | 1 | 1 | 5 | | | | | |
| 118–120 | 2 | 1 | 1 | 1 | 5 | | | | | |
| 115–117 | 1 | 2 | 1 | 2 | 6 | 4 | 2 | 2 | | 2 |
| 112–114 | 2 | | 2 | | 4 | 5 | | 5 | 2 | 3 |
| 109–111 | 1 | | | 1 | 2 | 7 | 1 | 6 | 3 | 3 |
| 106–108 | 3 | 3 | 1 | | 7 | 4 | | 4 | 1 | 3 |
| 103–105 | 2 | | 2 | 2 | 6 | 2 | | 2 | | 2 |
| 100–102 | 3 | 1 | 1 | 2 | 7 | 5 | | 5 | 2 | 3 |
| 97– 99 | 3 | 2 | | | 5 | 10 | 2 | 8 | 1 | 7 |
| 94– 96 | | 1 | 1 | 1 | 3 | 9 | 1 | 8 | 1 | 7 |
| 91– 93 | 1 | | | 1 | 2 | 13 | 2 | 11 | 3 | 8 |
| 88– 90 | 1 | 1 | | | 2 | 8 | 3 | 5 | 1 | 4 |
| 85– 87 | | 3 | | 2 | 5 | 8 | 2 | 6 | | 6 |
| 82– 84 | | | | | | 11 | 3 | 8 | 1 | 7 |
| 79– 81 | | 2 | | 3 | 5 | 11 | 4 | 7 | 2 | 5 |
| 76– 78 | 2 | 1 | | | 3 | 7 | 5 | 2 | | 2 |
| 73– 75 | | 2 | | 2 | 4 | 5 | 2 | 3 | | 3 |
| 70– 72 | 1 | | | 2 | 3 | 7 | 4 | 3 | | 3 |
| 67– 69 | | | | | | 5 | 1 | 4 | | 4 |
| 64– 68 | | | | | | 2 | 2 | | | |

TABLE 14.7

DISCREPANCY BETWEEN IQ AND PLAN SCORES IN NON-CLINIC AND CLINIC POPULATIONS.

| | NON-CLINIC | | | CLINIC | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | LONDON NORTH | LONDON SOUTH WEST | TOTAL | TOTAL | BUCKS | NORTH WEST LONDON TOTAL | RE ACTIVE B | RE ACTIVE G | NEUR OTIC B | NEUR OTIC G |
| DISCREPANCY N | 27 | 21 | 48 | 124 | 34 | 90 | 14 | 4 | 47 | 25 |
| 60-64 | | | | | | | | | | |
| 55-59 | | | | | | | | | | |
| 50-54 | | | | | | | | | | |
| 45-49 | | | | | | | | | | |
| 40-44 | | | | | | | | | | |
| 35-39 | | | | | | | | | | |
| 30-34 | | | | | | | | | | |
| 25-29 | 2 | 2 | 4 | | | | | | | |
| 20-24 | | 2 | 2 | | | | | | | |
| 15-19 | 4 | 1 | 5 | 2 | | 2 | | | 1 | 1 |
| 10-14 | 5 | 4 | 9 | 1 | 1 | | | | | |
| 5- 9 | 4 | 4 | 8 | 8 | 4 | 4 | 2 | | 1 | 1 |
| 0- 4 | 1 | 3 | 4 | 2 | | 2 | | | 1 | 1 |
| 0- 0 | | 3 | 3 | 1 | | 1 | | | | 1 |
| 0- 4 | 1 | 1 | 2 | 16 | 3 | 13 | 6 | 3 | 1 | 3 |
| 5- 9 | 1 | 1 | 2 | 16 | 5 | 11 | 2 | 1 | 6 | 2 |
| 10-14 | 4 | | 4 | 10 | 6 | 4 | 1 | | 1 | 2 |
| -15-19 | 2 | | 2 | 14 | 5 | 9 | | | 4 | 5 |
| -20-24 | 2 | | 2 | 17 | 4 | 13 | 1 | | 9 | 3 |
| -25-29 | | | | 14 | 3 | 11 | 2 | | 8 | 1 |
| -30-34 | | | | 8 | 1 | 7 | | | 4 | 3 |
| -35-39 | 1 | | 1 | 5 | | 5 | | | 4 | 1 |
| -40-44 | | | | 4 | | 4 | | | 4 | |
| -45-49 | | | | 2 | 2 | | | | | |
| -50-54 | | | | 2 | | 2 | | | 1 | 1 |
| -55-59 | | | | 1 | | 1 | | | 1 | |
| -60-64 | | | | 1 | | 1 | | | 1 | |
| -65-69 | | | | | | | | | | |

A cut off point of 0 would identify 73% of the non-clinic children who showed a Plan score the same or higher than their IQ score and 89% of clinic children whose Plan score was 1 or more below their IQ score. Among the clinic children, a Plan score of 15 or more points below the IQ score would include 21% of boys with a reactive disorder and 77% of boys with a neurotic disorder.

CONSTRUCT VALIDITY

This aspect of validity tells something of what a test signifies or means. It gives some idea of how a subject functions and what traits are grouped together. It always involves, however simple, a theoretical model of a psychological process, which is verified by its degree of association with scores on another test. In the case of the Plan test the relevant findings in the investigations already cited will be given here.

The items themselves which comprise the test were validated against age and inevitably, as a result, intelligence. Thus in all the studies, the correlation is from .32 to .80, varying according to the type of test and score used, being highest with scores on a non-verbal test (Table 14.8). Thus a low score in itself may only indicate low intelligence, and only if the score is well below the IQ is a learning or psychiatric disorder a possibility (Table 14.8).

TABLE 14.8

PRODUCT MOMENT CORRELATIONS OF PLAN SCORES WITH INTELLIGENCE

| SOURCE | N | AGE | SEX | TEST | SCORE | CORRELATION |
|---|---|---|---|---|---|---|
| CLINIC | 285 | 7-0 to 15-0 | B & G | WISC V | Standard | .36 |
| | 285 | 7-0 to 15-0 | B & G | P | Standard | .37 |
| | 285 | 7-0 to 15-0 | B & G | FS | Standard | .41 |
| NORTH LONDON | 28 | 11-0 to 12-9 | Boys | Verbal | Standard | .39 |
| | 26 | 10-8 to 12-8 | Girls | Verbal | Standard | .40 |
| | 28 | 11-0 to 12-9 | Boys | Non-verbal | Standard | .57 |
| | 26 | 10-8 to 12-8 | Girls | Non-verbal | Standard | .47 |
| BUCKS | 40 | 8-0 to 9-0 | Boys | Vocabulary | Raw | .60 |
| | 40 | 8-0 to 9-0 | Girls | | Raw | .34 |
| SOUTH WEST LONDON | 21 | 9-2 to 10-2 | B & G | Non-verbal | Raw | .80 |

Although adults with parietal damage draw inadequate plans, there was no indication that low plan scores in children are associated with neurological dysfunction. Cerebral palsied children with hemiplegia did not draw plans which scored lower than their IQs. Nor was there any indication in the children referred for psychiatric assessment of an association of prenatal, perinatal or postnatal trauma or childhood illness with large discrepancies between the WISC and Plan score.

There was a positive association of the Plan and Rotter score of maladjustment, but the ISB did not have any psychiatric validation and showed a positive correlation with the other cognitive tests in the battery, so was probably not measuring maladjustment as usually defined.

The Plan score did correlate negatively with the Neuroticism score on the NJMI, which is defined as a trait indicating "the degree to which a person exhibits a tendency to worry unduly, to panic under conditions of stress" (Furneaux and Gibson, 1966). The correlation of -.57 for the girls was statistically significant, although not for the boys at -.28.

In children referred for psychiatric assessment, a Plan score of more than 15 points below the WISC FS IQ was associated with symptoms of fear and depression and a tendency to temper tantrums, and a diagnosis of neurotic rather than reactive disorder. The discrepancy score did not seem to be related to personality disorder or psychotic features, although there were very few cases in those categories.

# CHAPTER XV

## CONCLUSIONS

Children with emotional disturbance and neurological dysfunctions score lower in comparison to their intelligence on a visuo-motor test such as the Bender Gestalt. Some psychiatrists and some psychologists consider that emotional disturbance causes the visuo-motor disorder, while some consider that the emotional and visuo-motor disorder may have a common cause, or that a visuo-motor disorder may predispose a child to emotional disturbance.

Although this might seem only of academic interest, it has a clinical application in the diagnosis and prognosis of emotionally disturbed children, for where the diagnosis implies some constitutional determinant more accent is laid on management to alleviate the symptoms, while if the diagnosis implies a reactive or neurotic disturbance due to internalized emotional conflicts, then the condition is regarded as being potentially reversible and psychotherapy is the treatment of choice.

On discovering plan drawing as a test, it did seem possible that as neurological damage in the parietal lobes of adults impaired plan drawing that poor plan drawing in children might also indicate neurological dysfunction, although there was a logical flaw in the argument in that the same disability need not imply the same cause. Also findings from brain damaged adults after they have reached maturity cannot be equated with those of children before the functional units of their brains were fully developed. Nevertheless there seemed some possibility that a disability on the Plan drawing test may support the possibility of some type of neurological dysfunction.

Before this could be investigated a test had to be constructed out of the plan drawing task and it was considered advisable to look at what the test was testing. This proved to be verbal, visuo-motor and spatial ability, which in the 8 to 9 year olds at least seemed also related to children's capacity to deal with a 3D space and 2D figures. An unexpected finding was that the girls scored about one year lower than the boys, which was so persistent as to suggest a constitutional cause.

When applied to maladjusted children, while those selected by the Rotter and Rutter scales did not score low, the children scoring high on the Neuroticism scale of the NMP1 and those referred to clinics for psychiatric assessment, particularly those with a neurotic disorder, did score low.

Unexpectedly however hemiplegic children with known CNS impairment did not score lower than what might have been predicted from their general intelligence, although such a discrepancy appeared in other visuo-motor tests, the Bender Gestalt and Frostig. As their capacity to cope with spatial tests, such as the Block Design, Block Patterns and Puzzle Blocks, was also not impaired, it suggested that the parietal lobe of at least one hemisphere may have been functionally intact and that the low visuo-motor scores were more directly related to lesions in the frontal and sub-cortical areas

The persistence of the sex difference in plan drawing in all samples tested, however, still seemed to point to a constitutional cause, until it was found to disappear under certain conditions, for some girls scored higher when they had seen a plan at home, after they had drawn a plan in school or after they had had a lesson in plan drawing. They were also more aware of the faults in their drawings, more dissatisfied with them than the boys, who appeared more confident about their results. These findings suggest that the lower Plan scores in girls were not just a reflection of innate neurological differences, but rather due to an interaction between personality and possibly some innate difference.

Such an explanation had further support when the results of the boys with emotional disturbance were examined in detail. These boys had no disability on a spatial test and they were not much slower than normal in understanding the concept of horizontality in relation to rooms, but they did not generalise this concept to other parallelepipeds as quickly as the average boy of the standardization sample. They had also the problem of completing the outside wall of the house and clinically gave the impression that they were more concerned with the interior of the house than the exterior. A concern which was suggestive of their preoccupation with their own internal feelings rather than the objective, external environment. As with the sex difference in girls, such findings are suggestive of a functional rather than a neurological impairment, particularly as there was no association of possible neurological damage as a result of trauma or illness.

Thus the hypothesis that low Plan scores in emotionally disturbed children might indicate neurological dysfunction was not supported. The finding remains however that there is a relationship between low Plan scores and emotional disturbance in children that ought to be explored, although possibly the relationships could be more effectively investigated in adults. There the specialisation of functions has been more clearly delineated and focal lesions and functional disorders are more clearly differentiated. Thus it is possible that if the Plan test were to be given to a group adults with a neurotic or affective disorder and a group with a local lesion in the post central cortex quantitative and/or qualitative differences might be found.

# APPENDIX Ia

## THIRD SCORING SYSTEM

## PERCENTAGES OF CHILDREN SCORING EACH ITEM CORRECTLY

I MAIN STRUCTURE

| AGE | NUMBER OF CHILDREN | | | A VERTICAL | | | | B HORIZONTAL | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 49 | 66 | 115 | 44 | 62 | 106 | 92 | 5 | 4 | 9 | 8 |
| 7-6 to 7-11 | 37 | 48 | 85 | 27 | 32 | 59 | 69 | 10 | 16 | 26 | 31 |
| 8-0 to 8-5 | 49 | 51 | 100 | 23 | 23 | 46 | 46 | 28 | 28 | 54 | 54 |
| 8-6 to 8-11 | 65 | 70 | 135 | 20 | 30 | 50 | 38 | 45 | 40 | 85 | 62 |
| 9-0 to 9-5 | 41 | 57 | 98 | 4 | 15 | 21 | 19 | 37 | 42 | 79 | 81 |
| 9-6 to 9-11 | 49 | 45 | 94 | 5 | 8 | 13 | 16 | 44 | 37 | 81 | 86 |
| 10-0 to 10-5 | 51 | 54 | 105 | 3 | 11 | 14 | 10 | 48 | 43 | 91 | 90 |
| 10-6 to 10-11 | 42 | 47 | 89 | 2 | 6 | 8 | 9 | 40 | 41 | 81 | 91 |
| 11-0 to 11-5 | 59 | 19 | 78 | 0 | 0 | 0 | 0 | 59 | 19 | 78 | 100 |
| 11-6 to 11-11 | 22 | 19 | 41 | 0 | 0 | 0 | 0 | 22 | 19 | 41 | 100 |
| 12-0 to 12-5 | 29 | 28 | 57 | 1 | 2 | 3 | 5 | 28 | 26 | 54 | 95 |
| 12-6 to 12-11 | 19 | 25 | 44 | 0 | 0 | 0 | 0 | 19 | 25 | 44 | 100 |
| 13-0 to 13-5 | 23 | 25 | 48 | 0 | 0 | 0 | 0 | 23 | 25 | 48 | 100 |
| 13-6 to 13-11 | 16 | 25 | 41 | 0 | 0 | 0 | 0 | 16 | 25 | 41 | 100 |
| 14-0 to 14-5 | 31 | 26 | 57 | 0 | 0 | 0 | 0 | 31 | 26 | 57 | 100 |
| 14-6 to 14-11 | 27 | 36 | 63 | 0 | 0 | 0 | 0 | 27 | 36 | 63 | 100 |

A VERTICAL PLANS

| | a. Roof Absent | | | | b. Chimney Absent | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 28 | 40 | 68 | 58 | 27 | 42 | 69 | 60 |
| 7-6 to 7-11 | 25 | 41 | 66 | 78 | 25 | 39 | 64 | 76 |
| 8-0 to 8-5 | 43 | 48 | 91 | 91 | 44 | 45 | 89 | 91 |
| 8-6 to 8-11 | 63 | 66 | 129 | 96 | 54 | 68 | 122 | 91 |
| 9-0 to 9-5 | 40 | 55 | 95 | 96 | 39 | 55 | 95 | 96 |

c. Upstairs

| | 1 Present | | | | 2 Doubtful | | | | 3 Absent | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 23 | 29 | 52 | 45 | 7 | 2 | 9 | 8 | 19 | 35 | 54 | 47 |
| 7-6 to 7-11 | 17 | 14 | 31 | 36 | 1 | 3 | 4 | 5 | 19 | 31 | 50 | 59 |
| 8-0 to 8-5 | 8 | 7 | 15 | 15 | 1 | 3 | 4 | 4 | 40 | 41 | 81 | 81 |
| 8-6 to 8-11 | 5 | 6 | 11 | 8 | 0 | 5 | 5 | 4 | 60 | 59 | 119 | 88 |
| 9-0 to 9-5 | 3 | 3 | 6 | 6 | 0 | 1 | 1 | 1 | 38 | 53 | 81 | 93 |

d. Vertical Plane of Outside Wall Absent

| | 1 0% | | | | 2-4 25% - 75% | | | | 5 100% | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 11 | 22 | 33 | 29 | 4 | 7 | 11 | 9 | 34 | 37 | 71 | 62 |
| 7-6 to 7-11 | 5 | 8 | 13 | 15 | 5 | 0 | 5 | 6 | 27 | 40 | 67 | 79 |
| 8-0 to 8-5 | 1 | 2 | 3 | 3 | 2 | 0 | 2 | 2 | 46 | 49 | 95 | 95 |
| 8-6 to 8-11 | 2 | 1 | 8 | 2 | 0 | 1 | 1 | 1 | 43 | 68 | 131 | 97 |
| 9-0 to 9-5 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 41 | 56 | 97 | 98 |

e. Floor

| | 1 Absent | | | | 2 Named | | | | 3 Demarcated & Named | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 28 | 41 | 69 | 61 | 11 | 10 | 21 | 18 | 10 | 15 | 25 | 22 |
| 7-6 to 7-11 | 16 | 26 | 42 | 49 | 5 | 5 | 10 | 12 | 16 | 17 | 33 | 39 |
| 8-0 to 8-5 | 7 | 13 | 20 | 20 | 7 | 8 | 15 | 15 | 35 | 30 | 65 | 65 |
| 8-6 to 8-11 | 7 | 7 | 14 | 11 | 9 | 14 | 23 | 17 | 49 | 49 | 24 | 73 |
| 9-0 to 9-5 | 3 | 7 | 10 | 10 | 3 | 4 | 7 | 7 | 35 | 46 | 81 | 83 |

f. Depth

| | 1 No Depth | | | | 2 Some depth indicated | | | | 3 Depth indicated & room outlined | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 28 | 45 | 73 | 63 | 10 | 9 | 19 | 16 | 13 | 11 | 24 | 22 |
| 7-6 to 7-11 | 18 | 21 | 39 | 46 | 5 | 5 | 10 | 12 | 14 | 22 | 36 | 42 |
| 8-0 to 8-5 | 8 | 8 | 16 | 16 | 5 | 5 | 10 | 10 | 36 | 38 | 74 | 74 |
| 8-6 to 8-11 | 8 | 9 | 17 | 13 | 4 | 5 | 9 | 7 | 53 | 56 | 109 | 81 |
| 9-0 to 9-5 | 1 | 2 | 3 | 3 | 5 | 1 | 6 | 6 | 35 | 54 | 89 | 91 |

g. Outer Wall

| | 1 Enclosed in outer wall with a large area of space inside | | | | 2 Enclosed in outer wall with little or no unidentified space inside | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 6 | 6 | 5 | 9 | 10 | 19 | 17 |
| 7-6 to 7-11 | 0 | 4 | 4 | 5 | 14 | 15 | 29 | 34 |
| 8-0 to 8-5 | 2 | 4 | 6 | 6 | 33 | 34 | 67 | 67 |
| 8-6 to 8-11 | 0 | 2 | 2 | 1 | 52 | 48 | 100 | 79 |
| 9-0 to 9-5 | 0 | 1 | 1 | 1 | 35 | 45 | 80 | 81 |

A VERTICAL PLANS

Correct items found also in horizontal plans.

| | a. Roof Absent | | | | b. Chimney Absent | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 28 | 40 | 68 | 58 | 27 | 42 | 69 | 60 |
| 7-6 to 7-11 | 25 | 41 | 66 | 78 | 25 | 39 | 64 | 76 |
| 8-0 to 8-5 | 43 | 48 | 91 | 91 | 44 | 45 | 89 | 91 |
| 8-6 to 8-11 | 63 | 66 | 129 | 96 | 54 | 68 | 122 | 91 |
| 9-0 to 9-5 | 40 | 55 | 95 | 96 | 39 | 55 | 95 | 96 |
| 9-6 to 9-11 | 45 | 43 | 87 | 92 | 48 | 45 | 93 | 99 |
| 10-0 to 10-5 | 51 | 54 | 105 | 100 | 51 | 54 | 105 | 100 |
| 10-6 to 10-11 | 42 | 47 | 89 | 100 | 42 | 47 | 89 | 100 |
| 11-0 to 11-5 | 59 | 19 | 78 | 100 | 59 | 19 | 78 | 100 |
| 11-6 to 11-11 | 22 | 19 | 41 | 100 | 22 | 19 | 41 | 100 |
| 12-0 to 12-5 | 29 | 28 | 57 | 100 | 29 | 28 | 57 | 100 |
| 12-6 to 12-11 | 19 | 25 | 44 | 100 | 19 | 25 | 44 | 100 |
| 13-0 to 13-5 | 23 | 25 | 48 | 100 | 23 | 25 | 48 | 100 |
| 13-6 to 13-11 | 16 | 25 | 41 | 100 | 16 | 25 | 41 | 100 |
| 14-0 to 14-5 | 31 | 26 | 57 | 100 | 31 | 26 | 57 | 100 |
| 14-6 to 14-11 | 27 | 36 | 63 | 100 | 27 | 36 | 63 | 100 |

| | c3. Upstairs Absent | | | | d3. Plane of outside wall Absent | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 19 | 35 | 54 | 47 | 34 | 37 | 71 | 62 |
| 7-6 to 7-11 | 19 | 31 | 50 | 59 | 27 | 40 | 67 | 79 |
| 8-0 to 8-5 | 40 | 41 | 81 | 81 | 46 | 49 | 95 | 95 |
| 8-6 to 8-11 | 60 | 59 | 119 | 88 | 43 | 68 | 131 | 97 |
| 9-0 to 9-5 | 38 | 55 | 81 | 93 | 41 | 56 | 97 | 98 |
| 9-6 to 9-11 | 47 | 43 | 90 | 96 | 49 | 45 | 94 | 100 |
| 10-0 to 10-5 | 50 | 53 | 103 | 99 | 51 | 54 | 105 | 100 |
| 10-6 to 10-11 | 42 | 47 | 89 | 100 | 42 | 47 | 89 | 100 |
| 11-0 to 11-5 | 59 | 19 | 78 | 100 | 59 | 19 | 78 | 100 |
| 11-6 to 11-11 | 22 | 19 | 41 | 100 | 22 | 19 | 41 | 100 |
| 12-0 to 12-5 | 29 | 28 | 57 | 100 | 29 | 28 | 57 | 100 |
| 12-6 to 12-11 | 19 | 25 | 44 | 100 | 19 | 25 | 44 | 100 |
| 13-0 to 13-5 | 23 | 25 | 48 | 100 | 23 | 25 | 48 | 100 |
| 13-6 to 13-11 | 16 | 25 | 41 | 100 | 16 | 25 | 41 | 100 |
| 14-0 to 14-5 | 31 | 26 | 57 | 100 | 31 | 26 | 57 | 100 |
| 14-6 to 14-11 | 27 | 36 | 63 | 100 | 27 | 36 | 63 | 100 |

| | e2. Floor | | | | f3. Depth | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 11 | 10 | 21 | 18 | 13 | 11 | 24 | 22 |
| 7-6 to 7-11 | 5 | 5 | 10 | 12 | 14 | 22 | 36 | 42 |
| 8-0 to 8-5 | 7 | 8 | 15 | 15 | 36 | 38 | 74 | 74 |
| 8-6 to 8-11 | 9 | 14 | 23 | 17 | 53 | 56 | 109 | 81 |
| 9-0 to 9-5 | 3 | 4 | 7 | 7 | 35 | 54 | 89 | 91 |
| 9-6 to 9-11 | 47 | 40 | 87 | 92 | 49 | 42 | 91 | 97 |
| 10-0 to 10-5 | 49 | 45 | 94 | 89 | 49 | 51 | 100 | 95 |
| 10-6 to 10-11 | 42 | 44 | 86 | 97 | 42 | 45 | 87 | 98 |
| 11-0 to 11-5 | 59 | 19 | 78 | 100 | 59 | 19 | 78 | 100 |
| 11-6 to 11-11 | 22 | 19 | 41 | 100 | 22 | 19 | 41 | 100 |
| 12-0 to 12-5 | 28 | 28 | 56 | 98 | 29 | 27 | 56 | 98 |
| 12-6 to 12-11 | 19 | 25 | 44 | 100 | 19 | 25 | 44 | 100 |
| 13-0 to 13-5 | 23 | 25 | 48 | 100 | 23 | 25 | 48 | 100 |
| 13-6 to 13-11 | 16 | 25 | 41 | 100 | 16 | 25 | 41 | 100 |
| 14-0 to 14-5 | 31 | 26 | 57 | 100 | 31 | 26 | 57 | 100 |
| 14-6 to 14-11 | 25 | 38 | 63 | 100 | 25 | 38 | 63 | 100 |

B HORIZONTAL PLANS

a. Connectedness of Rooms

| | 1 No rooms connected | | | | 2 Some rooms connected | | | | 3 All rooms connected | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 34 | 4 | 8 | 7 |
| 7-6 to 7-11 | 3 | 3 | 7 | 7 | 1 | 2 | 3 | 4 | 6 | 13 | 19 | 22 |
| 8-0 to 8-5 | 2 | 9 | 11 | 11 | 0 | 1 | 1 | 1 | 24 | 18 | 42 | 42 |
| 8-6 to 8-11 | 2 | 2 | 3 | 3 | 1 | 0 | 1 | 1 | 36 | 36 | 72 | 50 |
| 9-0 to 9-5 | 0 | 2 | 2 | 2 | 0 | 1 | 1 | 1 | 35 | 39 | 74 | 75 |
| 9-6 to 9-11 | 0 | 1 | 1 | 1 | 0 | 2 | 2 | 2 | 41 | 33 | 74 | 79 |
| 10-0 to 10-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 46 | 91 | 86 |
| 10-6 to 10-11 | 2 | 0 | 2 | 3 | 3 | 1 | 4 | 4 | 35 | 38 | 73 | 82 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 45 | 19 | 64 | 82 |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 19 | 41 | 100 |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 28 | 26 | 54 | 95 |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 19 | 25 | 44 | 100 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 23 | 25 | 48 | 100 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 16 | 25 | 41 | 100 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 31 | 26 | 57 | 100 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 27 | 36 | 63 | 100 |

b. Commonality of Walls

| | 1 No common walls | | | | 2 One common wall | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 7-6 to 7-11 | 5 | 10 | 15 | 18 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 3 | 9 | 12 | 12 | 0 | 4 | 4 | 4 |
| 8-6 to 8-11 | 5 | 3 | 8 | 8 | 0 | 3 | 3 | 2 |
| 9-0 to 9-5 | 2 | 3 | 5 | 7 | 0 | 1 | 1 | 1 |
| 9-6 to 9-11 | 1 | 2 | 3 | 3 | 0 | 3 | 3 | 3 |
| 10-0 to 10-5 | 2 | 2 | 4 | 4 | 0 | 5 | 5 | 5 |
| 10-6 to 10-11 | 2 | 2 | 4 | 5 | 1 | 0 | 1 | 1 |
| 11-0 to 11-5 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 11-6 to 11-11 | 1 | 0 | 1 | 2 | 1 | 2 | 3 | 7 |
| 12-0 to 12-5 | 2 | 1 | 3 | 5 | 0 | 0 | 0 | 0 |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | 3 More than one wall common but incomplete | | | | 4 All walls common | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 4 | 3 | 7 | 6 |
| 7-6 to 7-11 | 1 | 2 | 3 | 4 | 4 | 6 | 10 | 12 |
| 8-0 to 8-5 | 2 | 3 | 5 | 5 | 21 | 12 | 33 | 33 |
| 8-6 to 8-11 | 4 | 0 | 4 | 3 | 30 | 32 | 62 | 47 |
| 9-0 to 9-5 | 2 | 12 | 14 | 14 | 31 | 26 | 57 | 57 |
| 9-6 to 9-11 | 4 | 3 | 7 | 7 | 36 | 28 | 64 | 64 |
| 10-0 to 10-5 | 4 | 4 | 8 | 8 | 42 | 35 | 77 | 77 |
| 10-6 to 10-11 | 3 | 1 | 4 | 4 | 33 | 36 | 69 | 77 |
| 11-0 to 11-5 | 0 | 2 | 2 | 3 | 44 | 19 | 63 | 81 |
| 11-6 to 11-11 | 1 | 0 | 1 | 2 | 20 | 17 | 37 | 90 |
| 12-0 to 12-5 | 0 | 2 | 2 | 4 | 26 | 22 | 48 | 84 |
| 12-6 to 12-11 | 0 | 3 | 3 | 7 | 19 | 21 | 40 | 91 |
| 13-0 to 13-5 | 0 | 3 | 3 | 6 | 23 | 22 | 45 | 94 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 16 | 25 | 41 | 100 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 31 | 26 | 57 | 100 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 25 | 35 | 60 | 100 |

c. Outer Wall

| | 1 No outer wall | | | | 2 Outer wall separate | | | | 3 Outer wall common to rooms but vertical | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 1 | 1 | 1 | 3 | 4 | 7 | 8 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 0 | 2 | 2 | 2 | 0 | 4 | 4 | 4 | 4 | 3 | 6 | 6 |
| 8-6 to 8-11 | 1 | 1 | 2 | 2 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 9-0 to 9-5 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 |
| 9-6 to 9-11 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 3 |
| 10-0 to 10-5 | 0 | 1 | 1 | 1 | 2 | 0 | 2 | 2 | 1 | 5 | 6 | 6 |
| 10-6 to 10-11 | 0 | 1 | 1 | 1 | 2 | 0 | 2 | 2 | 1 | 2 | 3 | 3 |
| 11-0 to 11-5 | 0 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 11-6 to 11-11 | 1 | 2 | 3 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-0 to 12-5 | 0 | 2 | 2 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | 4 25% or less common with interior | | | | 5 26% to 49% common with interior | | | | 6 50% common with interior | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 7-6 to 7-11 | 0 | 5 | 5 | 6 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 4 | 5 | 9 | 9 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| 8-6 to 8-11 | 0 | 1 | 1 | 1 | 3 | 1 | 4 | 3 | 0 | 3 | 3 | 2 |
| 9-0 to 9-5 | 1 | 3 | 4 | 4 | 0 | 5 | 5 | 5 | 0 | 3 | 3 | 3 |
| 9-6 to 9-11 | 1 | 3 | 4 | 4 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 |
| 10-0 to 10-5 | 1 | 3 | 4 | 4 | 0 | 2 | 2 | 2 | 0 | 1 | 1 | 1 |
| 10-6 to 10-11 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 3 | 0 | 1 | 1 | 1 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-6 to 11-11 | 1 | 0 | 3 | 2 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 |
| 12-0 to 12-5 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| 12-6 to 12-11 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 5 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | 7 51%-74% common with interior | | | | 8 75% common with interior | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 2 | 2 | 2 | 1 | 0 | 1 | 1 |
| 8-0 to 8-5 | 0 | 4 | 4 | 4 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 3 | 0 | 3 | 2 | 0 | 1 | 1 | 1 |
| 9-0 to 9-5 | 1 | 5 | 6 | 6 | 0 | 1 | 1 | 1 |
| 9-6 to 9-11 | 1 | 0 | 1 | 1 | 0 | 8 | 8 | 9 |
| 10-0 to 10-5 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 |
| 10-6 to 10-11 | 1 | 1 | 2 | 2 | 0 | 1 | 1 | 1 |
| 11-0 to 11-5 | 1 | 1 | 2 | 3 | 0 | 1 | 1 | 1 |
| 11-6 to 11-11 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-6 to 12-11 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | 9 76%-99% common with interior | | | | 10 100% common with interior | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 0 | 1 | 1 | 3 | 1 | 4 | 3 |
| 7-6 to 7-11 | 0 | 2 | 2 | 2 | 4 | 4 | 8 | 9 |
| 8-0 to 8-5 | 0 | 5 | 5 | 5 | 17 | 6 | 23 | 23 |
| 8-6 to 8-11 | 4 | 13 | 17 | 13 | 27 | 17 | 44 | 33 |
| 9-0 to 9-5 | 5 | 7 | 12 | 12 | 26 | 13 | 39 | 40 |
| 9-6 to 9-11 | 5 | 8 | 13 | 14 | 26 | 19 | 45 | 48 |
| 10-0 to 10-5 | 7 | 8 | 15 | 14 | 35 | 23 | 58 | 55 |
| 10-6 to 10-11 | 5 | 6 | 11 | 12 | 28 | 25 | 53 | 60 |
| 11-0 to 11-5 | 8 | 4 | 12 | 15 | 35 | 12 | 47 | 60 |
| 11-6 to 11-11 | 5 | 3 | 8 | 20 | 15 | 13 | 28 | 68 |
| 12-0 to 12-5 | 1 | 9 | 10 | 18 | 24 | 15 | 39 | 68 |
| 12-6 to 12-11 | 0 | 5 | 5 | 11 | 19 | 14 | 33 | 75 |
| 13-0 to 13-5 | 2 | 3 | 5 | 10 | 21 | 22 | 43 | 90 |
| 13-6 to 13-11 | 1 | 3 | 4 | 10 | 15 | 22 | 37 | 90 |
| 14-0 to 14-5 | 3 | 2 | 5 | 9 | 28 | 24 | 52 | 91 |
| 14-6 to 14-11 | 1 | 2 | 3 | 5 | 24 | 33 | 57 | 90 |

Amalgamating 4+5, 6+7 and 8+9

| | 4+5 1%-49% common with interior | | | | 6+7 50%-74% common with interior | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 2 |
| 7-6 to 7-11 | 0 | 6 | 6 | 7 | 0 | 2 | 2 | 2 |
| 8-0 to 8-5 | 5 | 5 | 10 | 10 | 0 | 5 | 5 | 5 |
| 8-6 to 8-11 | 3 | 2 | 5 | 4 | 3 | 3 | 6 | 4 |
| 9-0 to 9-5 | 1 | 8 | 9 | 9 | 1 | 8 | 9 | 9 |
| 9-6 to 9-11 | 1 | 6 | 7 | 7 | 1 | 0 | 1 | 1 |
| 10-0 to 10-5 | 1 | 5 | 6 | 6 | 1 | 2 | 3 | 3 |
| 10-6 to 10-11 | 1 | 2 | 3 | 3 | 1 | 2 | 3 | 3 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 3 |
| 11-6 to 11-11 | 2 | 1 | 3 | 7 | 1 | 0 | 1 | 2 |
| 12-0 to 12-5 | 2 | 0 | 2 | 4 | 0 | 0 | 0 | 0 |
| 12-6 to 12-11 | 0 | 1 | 1 | 2 | 0 | 3 | 3 | 7 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | 8+9 75%-99% common with interior | | | | 10 100% common with interior | | | | d. Proportions of rooms | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 0 | 1 | 1 | 3 | 1 | 4 | 3 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 1 | 2 | 3 | 4 | 4 | 4 | 8 | 9 | 1 | 0 | 1 | 1 |
| 8-0 to 8-5 | 0 | 5 | 5 | 5 | 17 | 6 | 23 | 23 | 2 | 1 | 3 | 3 |
| 8-6 to 8-11 | 4 | 14 | 18 | 13 | 27 | 17 | 44 | 33 | 12 | 2 | 14 | 10 |
| 9-0 to 9-5 | 5 | 8 | 13 | 13 | 26 | 13 | 39 | 39 | 8 | 7 | 15 | 15 |
| 9-6 to 9-11 | 5 | 16 | 21 | 22 | 26 | 19 | 45 | 48 | 21 | 9 | 30 | 32 |
| 10-0 to 10-5 | 8 | 9 | 17 | 16 | 35 | 23 | 58 | 54 | 14 | 15 | 29 | 28 |
| 10-6 to 10-11 | 5 | 7 | 12 | 13 | 28 | 25 | 53 | 60 | 19 | 20 | 39 | 44 |
| 11-0 to 11-5 | 8 | 5 | 13 | 17 | 35 | 12 | 47 | 60 | 32 | 7 | 39 | 50 |
| 11-6 to 11-11 | 5 | 3 | 8 | 20 | 15 | 13 | 28 | 68 | 13 | 12 | 25 | 60 |
| 12-0 to 12-5 | 1 | 9 | 10 | 18 | 24 | 15 | 39 | 68 | 18 | 17 | 35 | 61 |
| 12-6 to 12-11 | 0 | 5 | 5 | 11 | 19 | 14 | 33 | 75 | 14 | 17 | 31 | 70 |
| 13-0 to 13-5 | 2 | 3 | 5 | 10 | 21 | 22 | 43 | 90 | 19 | 18 | 37 | 77 |
| 13-6 to 13-11 | 1 | 3 | 4 | 10 | 15 | 22 | 37 | 90 | 9 | 16 | 39 | 68 |
| 14-0 to 14-5 | 3 | 2 | 5 | 9 | 28 | 24 | 52 | 91 | 23 | 16 | 25 | 61 |
| 14-6 to 14-11 | 1 | 2 | 3 | 5 | 24 | 33 | 57 | 90 | 23 | 13 | 36 | 57 |

e. Hall

| | 1 Present | | | | 2 One end wall correct | | | | 3 Any two walls correct | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 7-6 to 7-11 | 1 | 5 | 6 | 7 | 1 | 2 | 3 | 4 | 1 | 3 | 4 | 5 |
| 8-0 to 8-5 | 0 | 6 | 6 | 6 | 0 | 3 | 3 | 3 | 2 | 1 | 3 | 3 |
| 8-6 to 8-11 | 3 | 3 | 6 | 4 | 1 | 5 | 6 | 4 | 3 | 4 | 7 | 5 |
| 9-0 to 9-5 | 1 | 6 | 7 | 7 | 0 | 6 | 6 | 6 | 1 | 2 | 3 | 3 |
| 9-6 to 9-11 | 1 | 8 | 9 | 9 | 0 | 1 | 1 | 1 | 3 | 0 | 3 | 3 |
| 10-0 to 10-5 | 1 | 3 | 4 | 4 | 0 | 4 | 4 | 4 | 3 | 0 | 3 | 3 |
| 10-6 to 10-11 | 3 | 3 | 6 | 7 | 0 | 1 | 1 | 1 | 2 | 2 | 4 | 5 |
| 11-0 to 11-5 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 4 |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 8 |
| 12-0 to 12-5 | 0 | 1 | 1 | 2 | 1 | 0 | 1 | 2 | 2 | 1 | 3 | 6 |
| 12-6 to 12-11 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 5 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 5 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| | 4 Any three walls correct | | | | 5 Four walls correct | | | | f. Proportions of Hall | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 2 | 1 | 3 | 3 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 |
| 7-6 to 7-11 | 3 | 0 | 3 | 4 | 0 | 0 | 0 | 0 | 1 | 1 | .2 | 2 |
| 8-0 to 8-11 | 6 | 5 | 11 | 11 | 5 | 5 | 10 | 10 | 0 | 2 | 2 | 2 |
| 8-6 to 8-11 | 11 | 12 | 23 | 17 | 12 | 7 | 19 | 14 | 5 | 2 | 7 | 5 |
| 9-0 to 9-5 | 10 | 14 | 24 | 24 | 14 | 6 | 20 | 20 | 7 | 4 | 11 | 11 |
| 9-6 to 9-11 | 9 | 6 | 15 | 15 | 14 | 17 | 31 | 31 | 11 | 4 | 15 | 16 |
| 10-0 to 10-5 | 15 | 15 | 30 | 30 | 6 | 15 | 21 | 21 | 17 | 6 | 23 | 22 |
| 10-6 to 10-11 | 8 | 9 | 17 | 22 | 12 | 12 | 24 | 28 | 14 | 10 | 24 | 27 |
| 11-0 to 11-5 | 12 | 17 | 22 | 37 | 11 | 6 | 17 | 18 | 20 | 9 | 29 | 37 |
| 11-6 to 11-11 | 6 | 5 | 11 | 27 | 5 | 6 | 11 | 27 | 9 | 6 | 15 | 36 |
| 12-0 to 12-5 | 8 | 10 | 18 | 32 | 3 | 5 | 8 | 14 | 12 | 7 | 19 | 33 |
| 12-6 to 12-11 | 2 | 2 | 4 | 9 | 2 | 6 | 8 | 18 | 15 | 13 | 28 | 64 |
| 13-0 to 13-5 | 0 | 7 | 7 | 15 | 6 | 1 | 7 | 15 | 17 | 15 | 32 | 67 |
| 13-6 to 13-11 | 4 | 7 | 11 | 27 | 3 | 7 | 10 | 24 | 7 | 11 | 18 | 44 |
| 14-0 to 14-5 | 4 | 0 | 4 | 7 | 9 | 8 | 17 | 30 | 15 | 18 | 33 | 58 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 3 | 6 | 9 | 14 | 22 | 29 | 51 | 81 |

II STAIRS

| | A Vertical | | | | B Horizontality doubtful | | | | C Horizontal | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 46 | 64 | 40 | 91 | 0 | 1 | 1 | 1 | 3 | 1 | 4 | 3 |
| 7-6 to 7-11 | 29 | 41 | 70 | 81 | 3 | 0 | 3 | 5 | 5 | 7 | 12 | 16 |
| 8-0 to 8-5 | 30 | 42 | 72 | 71 | 3 | 1 | 4 | 4 | 16 | 8 | 24 | 23 |
| 8-6 to 8-11 | 35 | 34 | 69 | 41 | 5 | 1 | 6 | 4 | 21 | 21 | 43 | 27 |
| 9-0 to 9-5 | 7 | 22 | 29 | 33 | 4 | 3 | 7 | 7 | 28 | 31 | 59 | 65 |
| 9-6 to 9-11 | 10 | 17 | 27 | 32 | 4 | 1 | 5 | 6 | 32 | 26 | 58 | 68 |
| 10-0 to 10-5 | 9 | 20 | 29 | 28 | 4 | 4 | 8 | 7 | 38 | 29 | 67 | 65 |
| 10-6 to 10-11 | 8 | 13 | 21 | 24 | 2 | 8 | 10 | 11 | 27 | 13 | 40 | 45 |
| 11-0 to 11-5 | 2 | 5 | 7 | 9 | 6 | 2 | 9 | 12 | 38 | 11 | 49 | 63 |
| 11-6 to 11-11 | 7 | 7 | 14 | 34 | 1 | 3 | 4 | 10 | 16 | 11 | 27 | 66 |
| 12-0 to 12-5 | 3 | 1 | 14 | 25 | 3 | 3 | 6 | 20 | 22 | 14 | 36 | 64 |
| 12-6 to 12-11 | 0 | 2 | 2 | 5 | 0 | 6 | 6 | 14 | 19 | 17 | 36 | 82 |
| 13-0 to 13-5 | 2 | 2 | 3 | 8 | 1 | 0 | 1 | 2 | 20 | 23 | 43 | 90 |
| 13-6 to 13-11 | 1 | 1 | 2 | 5 | 0 | 2 | 2 | 5 | 15 | 22 | 37 | 90 |
| 14-0 to 14-5 | 3 | 2 | 5 | 9 | 1 | 0 | 1 | 2 | 27 | 24 | 51 | 89 |
| 14-6 to 14-11 | 3 | 3 | 6 | 10 | 1 | 2 | 3 | 8 | 23 | 31 | 54 | 86 |

A Vertical stairs

A Percentages based on total sample

B Percentages based on numbers of vertical stairs

| | 1a | | | A | B | 1b | | | A | B | 2a | | | A | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % |
| 7-0 to 7-5 | 0 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 4 | 5 | 9 | 8 | 8 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 4 | 4 |
| 8-0 to 8-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 3 | 4 |
| 8-6 to 8-11 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 0 | 2 | 2 | 3 |
| 9-0 to 9-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-6 to 9-11 | 0 | 1 | 1 | 1 | 4 | 0 | 1 | 1 | 1 | 4 | 2 | 1 | 3 | 3 | 11 |
| 10-0 to 10-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| 10-6 to 10-11 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 5 | 0 | 0 | 0 | 0 | 0 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 1 | 1 | 1 | |
| 11-6 to 11-11 | 2 | 3 | 5 | 12 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 1 | 0 | 1 | 2 | |
| 14-0 to 14-5 | 1 | 0 | 1 | 2 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-6 to 14-11 | 0 | 1 | 1 | 2 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |

| | 2b | | | A | B | 3a | | | A | B | 3b | | | A | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % |
| 7-0 to 7-5 | 3 | 15 | 18 | 15 | 16 | 0 | 2 | 2 | 2 | 2 | 25 | 20 | 45 | 39 | 40 |
| 7-6 to 7-11 | 4 | 7 | 11 | 13 | 16 | 0 | 3 | 3 | 4 | 4 | 14 | 22 | 36 | 42 | 51 |
| 8-0 to 8-5 | 4 | 8 | 12 | 12 | 17 | 1 | 2 | 3 | 3 | 4 | 14 | 19 | 33 | 33 | 48 |
| 8-6 to 8-11 | 5 | 10 | 15 | 11 | 22 | 0 | 0 | 0 | 0 | 0 | 14 | 20 | 34 | 25 | 51 |
| 9-0 to 9-5 | 2 | 6 | 8 | 8 | 27 | 1 | 0 | 1 | 1 | 3 | 6 | 8 | 14 | 14 | 47 |
| 9-6 to 9-11 | 1 | 2 | 3 | 3 | 11 | 0 | 0 | 0 | 0 | 0 | 4 | 7 | 11 | 12 | 41 |
| 10-0 to 10-5 | 1 | 4 | 5 | 5 | 17 | 0 | 0 | 0 | 0 | 0 | 6 | 9 | 15 | 14 | 50 |
| 10-6 to 10-11 | 0 | 3 | 3 | 3 | 14 | 0 | 0 | 0 | 0 | 0 | 3 | 7 | 10 | 11 | 48 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 1 | 3 | 4 | 5 | |
| 11-6 to 11-11 | 1 | 3 | 4 | 10 | | 0 | 0 | 0 | 0 | | 1 | 0 | 1 | 2 | |
| 12-0 to 12-5 | 0 | 3 | 3 | 5 | | 0 | 0 | 0 | 0 | | 0 | 7 | 7 | 12 | |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 1 | 1 | 2 | |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 2 | 2 | 4 | 8 | |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-0 to 14-5 | 0 | 1 | 1 | 2 | | 0 | 0 | 0 | 0 | | 1 | 0 | 1 | 2 | |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | | 1 | 0 | 1 | 2 | | 1 | 1 | 2 | 3 | |

| | 3c | | | A | B | 3d | | | A | B | 4a | | | A | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % |
| 7-0 to 7-5 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 7-6 to 7-11 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 8-6 to 8-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 2 | 3 |
| 9-0 to 9-5 | 0 | 2 | 2 | 2 | 7 | 0 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 |
| 9-6 to 9-11 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 4 | 0 | 0 | 0 | 0 | 0 |
| 10-0 to 10-5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 |
| 10-6 to 10-11 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 5 | 6 | 24 | 0 | 0 | 0 | 0 | 0 |
| 11-0 to 11-5 | 0 | 1 | 1 | 1 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 12-0 to 12-5 | 1 | 0 | 1 | 2 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | | 0 | 1 | 1 | 2 | | 0 | 0 | 0 | 0 | |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-0 to 14-5 | 0 | 1 | 1 | 2 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |

| | 4b | | | A | B | 4c | | | A | B | 4d | | | A | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % |
| 7-0 to 7-5 | 1 | 0 | 1 | 1 | 1 | 3 | 4 | 7 | 6 | 6 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 1 | 1 | 1 | 0 | 3 | 1 | 4 | 5 | 6 | 0 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 1 | 1 | 2 | 2 | 3 | 2 | 0 | 2 | 2 | 3 | 0 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 9-0 to 9-5 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 10 | 0 | 0 | 0 | 0 | 0 |
| 9-6 to 9-11 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 4 | 0 | 0 | 0 | 0 | 0 |
| 10-0 to 10-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 3 |
| 10-6 to 10-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | | 1 | 0 | 1 | 2 | | 2 | 0 | 2 | 5 | |
| 12-0 to 12-5 | 1 | 0 | 1 | 2 | | 0 | 0 | 0 | 0 | | 2 | 0 | 2 | 5 | |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 1 | 1 | 2 | |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-6 to 14-11 | 1 | 0 | 1 | 2 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |

| | 4e | | | A | B | 5a | | | A | B | 5b | | | A | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % |
| 7-0 to 7-5 | 0 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-0 to 9-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 9-6 to 9-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-0 to 10-5 | 0 | 1 | 1 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-6 to 10-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 11-6 to 11-11 | 0 | 1 | 1 | 2 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-0 to 14-5 | 1 | 0 | 1 | 2 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |

| | 6a | | | A | B | 6b | | | A | B | 6c | | | A | B |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 5 | 5 | 10 | 9 | 9 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 6 | 10 | 12 | 14 |
| 8-0 to 8-5 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 3 |
| 8-6 to 8-11 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 3 | 3 | 2 | 4 |
| 9-0 to 9-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-6 to 9-11 | 1 | 0 | 1 | 1 | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 7 |
| 10-0 to 10-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 5 | 6 | 6 | 20 |
| 10-6 to 10-11 | 0 | 2 | 2 | 2 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | | 0 | 1 | 1 | 2 | | 0 | 0 | 0 | 0 | |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |

| | 6d | | | A | B | 6e | | | A | B |
|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | % | B. | G. | TOT. | % | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 3 | 4 | 7 | 6 | 6 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 8-0 to 8-5 | 0 | 1 | 1 | 1 | 1 | 2 | 4 | 6 | 6 | 9 |
| 8-6 to 8-11 | 0 | 2 | 2 | 2 | 3 | 2 | 3 | 5 | 4 | 7 |
| 9-0 to 9-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-6 to 9-11 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 11 |
| 10-0 to 10-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-6 to 10-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | |

Amalgamating 4a+4c, 4d+4e and 6d+6e

| | 4a+4c | | 4d+4e | | 6d+6e | |
|---|---|---|---|---|---|---|
| | A | B | A | B | A | B |
| | % | % | % | % | % | % |
| 7-0 to 7-5 | 2 | 2 | 2 | 2 | 6 | 6 |
| 7-6 to 7-11 | 1 | 0 | 0 | 0 | 1 | 1 |
| 8-0 to 8-5 | 3 | 4 | 1 | 1 | 7 | 10 |
| 8-6 to 8-11 | 2 | 3 | 1 | 1 | 6 | 10 |
| 9-0 to 9-5 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-6 to 9-11 | 0 | 0 | 0 | 0 | 3 | 11 |
| 10-0 to 10-5 | 0 | 0 | 2 | 6 | 0 | 0 |
| 10-6 to 10-11 | 0 | 0 | 0 | 0 | 0 | 0 |

## C HORIZONTAL STAIRS

a. Outline of Staircase

| | 1a Outside house or in space | | | | 1b No outline | | | | 1c Minimal outline | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 8-0 to 8-5 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 3 | 4 | 4 |
| 8-6 to 8-11 | 0 | 6 | 6 | 4 | 3 | 1 | 4 | 3 | 1 | 2 | 3 | 2 |
| 9-0 to 9-5 | 1 | 5 | 6 | 6 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 |
| 9-6 to 9-11 | 0 | 8 | 8 | 9 | 0 | 0 | 0 | 0 | 4 | 1 | 5 | 6 |
| 10-0 to 10-5 | 2 | 5 | 7 | 7 | 0 | 0 | 0 | 0 | 3 | 2 | 5 | 3 |
| 10-6 to 10-11 | 2 | 1 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 3 | 5 | 5 |
| 11-0 to 11-5 | 1 | 1 | 2 | 3 | 0 | 2 | 2 | 3 | 3 | 0 | 3 | 4 |
| 11-6 to 11-11 | 1 | 1 | 2 | 4 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| 12-0 to 12-5 | 1 | 3 | 4 | 17 | 4 | 0 | 4 | 7 | 1 | 0 | 1 | 2 |
| 12-6 to 12-11 | 0 | 4 | 4 | 7 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 5 |
| 13-0 to 13-5 | 1 | 2 | 3 | 6 | 1 | 3 | 4 | 8 | 3 | 0 | 3 | 6 |
| 13-6 to 13-11 | 3 | 2 | 5 | 12 | 0 | 2 | 2 | 5 | 1 | 1 | 2 | 5 |
| 14-0 to 14-5 | 4 | 2 | 6 | 11 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 4 |
| 14-6 to 14-11 | 1 | 3 | 4 | 6 | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 2 |

| | 2a Outline wavery | | | | 2b Sides straight but incorrect | | | | 2c Sides curved | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 1 | 2 | 2 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 0 | 2 | 2 | 2 |
| 8-0 to 8-5 | 2 | 1 | 3 | 3 | 3 | 1 | 4 | 4 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 4 | 6 | 10 | 8 | 3 | 0 | 3 | 2 | 0 | 1 | 1 | 1 |
| 9-0 to 9-5 | 0 | 4 | 4 | 4 | 3 | 5 | 8 | 8 | 0 | 0 | 0 | 0 |
| 9-6 to 9-11 | 2 | 7 | 9 | 10 | 5 | 1 | 6 | 7 | 0 | 1 | 1 | 1 |
| 10-0 to 10-5 | 7 | 4 | 11 | 10 | 4 | 2 | 6 | 6 | 0 | 0 | 0 | 0 |
| 10-6 to 10-11 | 0 | 3 | 3 | 4 | 1 | 0 | 1 | 1 | 2 | 0 | 2 | 2 |
| 11-0 to 11-5 | 1 | 1 | 2 | 3 | 2 | 0 | 2 | 3 | 2 | 0 | 2 | 3 |
| 11-6 to 11-11 | 0 | 1 | 1 | 2 | 4 | 0 | 4 | 9 | 0 | 0 | 0 | 0 |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 5 | 0 | 0 | 0 | 0 |
| 12-6 to 12-11 | 2 | 0 | 2 | 5 | 1 | 1 | 2 | 5 | 0 | 1 | 1 | 2 |
| 13-0 to 13-5 | 1 | 1 | 2 | 4 | 1 | 3 | 5 | 8 | 0 | 1 | 1 | 2 |
| 13-6 to 13-11 | 1 | 1 | 2 | 5 | 1 | 2 | 3 | 7 | 0 | 0 | 0 | 0 |
| 14-0 to 14-5 | 0 | 2 | 2 | 4 | 1 | 3 | 4 | 7 | 2 | 0 | 2 | 4 |
| 14-6 to 14-11 | 1 | 2 | 3 | 5 | 2 | 0 | 2 | 3 | 0 | 1 | 1 | 2 |

| | 3 One side correct | | | | 4 Two sides correct | | | | 5a Upper limit correct | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 2 |
| 8-6 to 8-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 1 |
| 9-0 to 9-5 | 0 | 1 | 1 | 1 | 2 | 5 | 7 | 6 | 5 | 0 | 5 | 5 |
| 9-6 to 9-11 | 0 | 0 | 0 | 0 | 4 | 0 | 4 | 4 | 1 | 0 | 1 | 1 |
| 10-0 to 10-5 | 0 | 0 | 0 | 0 | 2 | 2 | 4 | 4 | 1 | 2 | 3 | 3 |
| 10-6 to 10-11 | 1 | 2 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 3 | 1 | 4 | 5 |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 4 | 2 | 1 | 3 | 5 |
| 12-6 to 12-11 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 |
| 13-6 to 13-11 | 0 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 1 | 1 | 2 |

| | 5b Lower limit correct | | | | 6 Three sides correct | | | | 7 Completely correct | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 7-6 to 7-11 | 0 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 2 | 3 | 3 |
| 8-0 to 8-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 8-6 to 8-11 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 10 | 8 | 18 | 14 |
| 9-0 to 9-5 | 1 | 5 | 6 | 6 | 0 | 0 | 0 | 0 | 22 | 5 | 27 | 28 |
| 9-6 to 9-11 | 5 | 3 | 8 | 9 | 0 | 0 | 0 | 0 | 15 | 7 | 22 | 23 |
| 10-0 to 10-5 | 5 | 6 | 11 | 10 | 0 | 0 | 0 | 0 | 22 | 11 | 33 | 32 |
| 10-6 to 10-11 | 4 | 1 | 5 | 6 | 1 | 0 | 1 | 1 | 22 | 21 | 43 | 48 |
| 11-0 to 11-5 | 6 | 4 | 10 | 13 | 0 | 0 | 0 | 0 | 31 | 6 | 37 | 47 |
| 11-6 to 11-11 | 5 | 4 | 9 | 20 | 0 | 0 | 0 | 0 | 10 | 9 | 19 | 45 |
| 12-0 to 12-5 | 1 | 3 | 4 | 7 | 0 | 0 | 0 | 0 | 15 | 9 | 24 | 42 |
| 12-6 to 12-11 | 2 | 8 | 10 | 23 | 0 | 0 | 0 | 0 | 19 | 8 | 27 | 61 |
| 13-0 to 13-5 | 3 | 3 | 6 | 13 | 0 | 1 | 1 | 2 | 17 | 26 | 33 | 69 |
| 13-6 to 13-11 | 2 | 4 | 6 | 15 | 1 | 1 | 2 | 5 | 9 | 11 | 20 | 49 |
| 14-0 to 14-5 | 1 | 3 | 4 | 7 | 0 | 0 | 0 | 0 | 25 | 16 | 41 | 72 |
| 14-6 to 14-11 | 3 | 7 | 10 | 16 | 0 | 0 | 0 | 0 | 23 | 20 | 43 | 68 |

b. Proportion of Staircase

| | B. | G. | TOT. | % |
|---|---|---|---|---|
| 7-0 to 7-5 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 1 | 1 | 1 |
| 8-0 to 8-5 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 4 | 2 | 6 | 4 |
| 9-0 to 9-5 | 7 | 1 | 8 | 8 |
| 9-6 to 9-11 | 4 | 2 | 6 | 6 |
| 10-0 to 10-5 | 8 | 6 | 14 | 13 |
| 10-6 to 10-11 | 9 | 8 | 17 | 19 |
| 11-0 to 11-5 | 13 | 4 | 17 | 22 |
| 11-6 to 11-11 | 6 | 4 | 10 | 22 |
| 12-0 to 12-5 | 7 | 2 | 9 | 16 |
| 12-6 to 12-11 | 8 | 6 | 14 | 32 |
| 13-0 to 13-5 | 7 | 8 | 15 | 31 |
| 13-6 to 13-11 | 3 | 4 | 7 | 17 |
| 14-0 to 14-5 | 7 | 4 | 11 | 19 |
| 14-6 to 14-11 | 8 | 5 | 13 | 21 |

c. Treads

| | 1a No treads | | | | 1b Diagonal lines | | | | 1c Inadequate symbol | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 1 | 4 | 5 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 2 | 4 | 6 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 2 | 3 | 5 | 10 | 1 | 0 | 1 | 2 | 2 | 0 | 2 | 4 |
| 9-0 to 9-5 | 7 | 4 | 11 | 12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-6 to 9-11 | 4 | 3 | 7 | 8 | 2 | 0 | 2 | 2 | 0 | 1 | 1 | 1 |
| 10-0 to 10-5 | 9 | 1 | 10 | 9 | 1 | 5 | 6 | 6 | 3 | 1 | 4 | 4 |
| 10-6 to 10-11 | 9 | 4 | 13 | 16 | 1 | 0 | 1 | 1 | 3 | 0 | 3 | 4 |
| 11-0 to 11-5 | 6 | 2 | 8 | 12 | 1 | 0 | 1 | 2 | 2 | 0 | 2 | 3 |
| 11-6 to 11-11 | 2 | 1 | 3 | 7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-0 to 12-5 | 3 | 6 | 9 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-6 to 12-11 | 3 | 2 | 5 | 8 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| 13-0 to 13-5 | 3 | 4 | 7 | 15 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| 13-6 to 13-11 | 2 | 7 | 9 | 22 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| 14-0 to 14-5 | 7 | 5 | 12 | 21 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| 14-6 to 14-11 | 5 | 12 | 17 | 27 | 0 | 0 | 0 | 0 | 1 | 2 | 3 | 2 |

| | 2a Only treads no sides | | | | 2b Pyramid | | | | 2c Correct but roughly drawn | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 2 | 0 | 2 | 2 | 2 | 2 | 4 | 4 | 1 | 0 | 1 | 1 |
| 8-6 to 8-11 | 2 | 2 | 4 | 3 | 1 | 4 | 5 | 4 | 2 | 0 | 2 | 4 |
| 9-0 to 9-5 | 0 | 0 | 0 | 0 | 1 | 3 | 4 | 4 | 4 | 4 | 8 | 8 |
| 9-6 to 9-11 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 7 | 2 | 9 | 10 |
| 10-0 to 10-5 | 0 | 0 | 0 | 0 | 2 | 1 | 3 | 3 | 4 | 11 | 15 | 13 |
| 10-6 to 10-11 | 0 | 0 | 0 | 0 | 2 | 3 | 5 | 6 | 4 | 6 | 10 | 11 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 3 | 7 | 2 | 9 | 12 |
| 11-6 to 11-11 | 1 | 0 | 1 | 2 | 1 | 2 | 3 | 7 | 1 | 2 | 3 | 7 |
| 12-0 to 12-5 | 2 | 1 | 3 | 5 | 1 | 1 | 2 | 4 | 6 | 0 | 6 | 11 |
| 12-6 to 12-11 | 1 | 2 | 3 | 5 | 0 | 0 | 0 | 0 | 2 | 1 | 3 | 7 |
| 13-0 to 13-5 | 0 | 3 | 3 | 6 | 1 | 1 | 2 | 4 | 3 | 1 | 4 | 8 |
| 13-6 to 13-11 | 2 | 3 | 5 | 12 | 2 | 0 | 2 | 5 | 0 | 1 | 1 | 2 |
| 14-0 to 14-5 | 1 | 1 | 2 | 4 | 1 | 2 | 3 | 5 | 2 | 3 | 5 | 9 |
| 14-6 to 14-11 | 1 | 0 | 1 | 2 | 0 | 1 | 1 | 2 | 3 | 2 | 5 | 8 |

| | 3a Treads too deep | | | | 3b Treads too shallow | | | | 3c Treads grouped | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 2 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 8-6 to 8-11 | 3 | 2 | 5 | 4 | 2 | 2 | 4 | 3 | 2 | 1 | 3 | 2 |
| 9-0 to 9-5 | 4 | 9 | 13 | 14 | 2 | 2 | 4 | 4 | 2 | 0 | 2 | 2 |
| 9-6 to 9-11 | 2 | 6 | 8 | 9 | 1 | 0 | 1 | 1 | 0 | 3 | 3 | 3 |
| 10-0 to 10-5 | 5 | 2 | 7 | 7 | 4 | 2 | 6 | 6 | 2 | 1 | 3 | 3 |
| 10-6 to 10-11 | 5 | 3 | 8 | 10 | 4 | 0 | 4 | 5 | 2 | 1 | 3 | 4 |
| 11-0 to 11-5 | 1 | 0 | 1 | 2 | 5 | 1 | 6 | 9 | 1 | 1 | 2 | 3 |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | 2 | 1 | 3 | 7 | 1 | 0 | 1 | 2 |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | 3 | 0 | 3 | 5 | 0 | 0 | 0 | 0 |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 2 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 2 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 5 | 1 | 0 | 1 | 2 |
| 14-0 to 14-5 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 2 | 2 | 0 | 2 | 4 |
| 14-6 to 14-11 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 3 | 0 | 0 | 0 | 0 |

| | 3+4 Treads almost correct | | | | 5-7 Treads correct | | | | 6 Proportion correct | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 8-0 to 8-5 | 4 | 2 | 6 | 6 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 4 | 8 | 12 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-0 to 9-5 | 8 | 9 | 17 | 18 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 9-6 to 9-11 | 16 | 8 | 22 | 24 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 |
| 10-0 to 10-5 | 7 | 4 | 11 | 10 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 10-6 to 10-11 | 7 | 3 | 10 | 12 | 1 | 2 | 3 | 4 | 4 | 0 | 4 | 4 |
| 11-0 to 11-5 | 7 | 2 | 9 | 14 | 0 | 2 | 2 | 3 | 2 | 0 | 2 | 3 |
| 11-6 to 11-11 | 6 | 4 | 10 | 24 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 2 |
| 12-0 to 12-5 | 4 | 3 | 7 | 12 | 1 | 1 | 2 | 4 | 1 | 1 | 2 | 4 |
| 12-6 to 12-11 | 4 | 7 | 11 | 25 | 4 | 3 | 7 | 11 | 4 | 3 | 7 | 16 |
| 13-0 to 13-5 | 2 | 5 | 7 | 15 | 8 | 1 | 9 | 19 | 8 | 1 | 9 | 19 |
| 13-6 to 13-11 | 4 | 3 | 7 | 17 | 4 | 1 | 5 | 15 | 4 | 1 | 5 | 12 |
| 14-0 to 14-5 | 6 | 8 | 14 | 25 | 3 | 1 | 4 | 7 | 3 | 1 | 4 | 7 |
| 14-6 to 14-11 | 8 | 6 | 14 | 22 | 3 | 3 | 6 | 10 | 3 | 3 | 6 | 10 |

d. Space Below Stairs Indicated

| | 1 Some space indicated | | | | 2 Space clearly indicated | | | | 3 At least some space indicated | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-0 to 9-5 | 2 | 0 | 2 | 2 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 2 |
| 9-6 to 9-11 | 2 | 1 | 3 | 3 | 1 | 0 | 1 | 1 | 3 | 1 | 4 | 4 |
| 10-0 to 10-5 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 2 | 0 | 2 | 2 |
| 10-6 to 10-11 | 1 | 3 | 4 | 5 | 2 | 0 | 2 | 2 | 3 | 3 | 6 | 7 |
| 11-0 to 11-5 | 4 | 1 | 5 | 6 | 0 | 0 | 0 | 0 | 4 | 1 | 5 | 6 |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 2 |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-6 to 12-11 | 4 | 1 | 5 | 11 | 1 | 0 | 1 | 2 | 5 | 1 | 6 | 14 |
| 13-0 to 13-5 | 1 | 4 | 5 | 10 | 1 | 1 | 2 | 4 | 2 | 5 | 7 | 15 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 | 0 | 1 | 1 | 2 |
| 14-0 to 14-5 | 5 | 4 | 9 | 16 | 5 | 0 | 5 | 9 | 10 | 4 | 14 | 25 |
| 14-6 to 14-11 | 2 | 7 | 9 | 14 | 3 | 2 | 5 | 8 | 5 | 9 | 14 | 22 |

III DOORS

a. Number of Doors

| | 1 One door | | | | 2 Two doors | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 2 | 1 | 3 | 3 | 0 | 1 | 1 | 1 |
| 7-6 to 7-11 | 0 | 2 | 2 | 2 | 2 | 1 | 3 | 3 |
| 8-0 to 8-5 | 3 | 4 | 7 | 7 | 8 | 1 | 9 | 9 |
| 8-6 to 8-11 | 4 | 3 | 7 | 5 | 5 | 8 | 13 | 10 |
| 9-0 to 9-5 | 0 | 4 | 4 | 4 | 4 | 1 | 5 | 5 |
| 9-5 to 9-11 | 3 | 2 | 5 | 5 | 2 | 3 | 5 | 5 |
| 10-0 to 10-5 | 3 | 0 | 3 | 3 | 0 | 0 | 0 | 0 |
| 10-6 to 10-11 | 0 | 12 | 12 | 13 | 5 | 3 | 8 | 9 |
| 11-0 to 11-5 | 0 | 1 | 1 | 2 | 1 | 1 | 2 | 3 |
| 11-6 to 11-11 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | 2 | 2 | 4 | 7 |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| 14-6 to 14-11 | 0 | 1 | 1 | 2 | 3 | 0 | 3 | 5 |

| | 3 Three doors | | | | 4 Access to all rooms | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 1 | 2 | 2 | 1 | 0 | 1 | 1 |
| 7-6 to 7-11 | 4 | 7 | 11 | 12 | 1 | 3 | 4 | 4 |
| 8-0 to 8-5 | 8 | 8 | 16 | 16 | 7 | 7 | 14 | 14 |
| 8-6 to 8-11 | 17 | 14 | 31 | 17 | 13 | 11 | 24 | 15 |
| 9-0 to 9-5 | 14 | 13 | 27 | 28 | 19 | 16 | 35 | 36 |
| 9-6 to 9-11 | 13 | 11 | 24 | 26 | 23 | 8 | 31 | 35 |
| 10-0 to 10-5 | 12 | 20 | 32 | 30 | 32 | 32 | 64 | 62 |
| 10-5 to 10-11 | 7 | 14 | 21 | 24 | 26 | 21 | 47 | 53 |
| 11-0 to 11-5 | 8 | 5 | 13 | 21 | 35 | 12 | 47 | 75 |
| 11-6 to 11-11 | 4 | 4 | 8 | 20 | 16 | 14 | 30 | 73 |
| 12-0 to 12-5 | 5 | 5 | 10 | 18 | 21 | 18 | 39 | 68 |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | 18 | 18 | 36 | 82 |
| 13-0 to 13-5 | 1 | 0 | 1 | 2 | 22 | 25 | 47 | 98 |
| 13-6 to 13-11 | 3 | 0 | 3 | 7 | 13 | 25 | 38 | 93 |
| 14-0 to 14-5 | 2 | 0 | 2 | 4 | 28 | 26 | 54 | 95 |
| 14-6 to 14-11 | 2 | 3 | 5 | 8 | 22 | 32 | 54 | 86 |

b. Types of Doors

| | 1 Vertical pictures of doors | | | | 2 Vertical pictures of door frames | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 44 | 65 | 109 | 95 | 1 | 0 | 1 | 1 |
| 7-6 to 7-11 | 24 | 39 | 63 | 74 | 0 | 1 | 1 | 1 |
| 8-0 to 8-5 | 24 | 34 | 58 | 58 | 4 | 5 | 9 | 9 |
| 8-6 to 8-11 | 29 | 47 | 76 | 56 | 0 | 2 | 2 | 1 |
| 9-0 to 9-5 | 14 | 40 | 54 | 55 | 4 | 2 | 6 | 6 |
| 9-6 to 9-11 | 13 | 21 | 34 | 36 | 3 | 4 | 7 | 7 |
| 10-0 to 10-5 | 10 | 26 | 36 | 34 | 4 | 4 | 8 | 8 |
| 10-6 to 10-11 | 6 | 17 | 23 | 26 | 2 | 0 | 2 | 2 |
| 11-0 to 11-5 | 1 | 3 | 4 | 5 | 1 | 1 | 2 | 3 |
| 11-6 to 11-11 | 6 | 6 | 12 | 29 | 1 | 2 | 3 | 7 |
| 12-0 to 12-5 | 5 | 10 | 15 | 26 | 0 | 1 | 1 | 2 |
| 12-6 to 12-11 | 1 | 8 | 9 | 20 | 1 | 2 | 3 | 7 |
| 13-0 to 13-5 | 3 | 3 | 6 | 13 | 1 | 1 | 2 | 4 |
| 13-6 to 13-11 | 2 | 1 | 3 | 7 | 0 | 0 | 0 | 0 |
| 14-0 to 14-5 | 1 | 1 | 2 | 4 | 0 | 1 | 1 | 2 |
| 14-6 to 14-11 | 3 | 1 | 4 | 6 | 0 | 1 | 1 | 2 |

| | 3 Some doors poor and some fair | | | | 4 All doors fair | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 7-6 to 7-11 | 0 | 1 | 1 | 1 | 3 | 3 | 6 | 7 |
| 8-0 to 8-5 | 3 | 2 | 5 | 5 | 9 | 5 | 14 | 14 |
| 8-6 to 8-11 | 5 | 3 | 8 | 6 | 10 | 7 | 17 | 13 |
| 9-0 to 9-5 | 1 | 3 | 4 | 4 | 4 | 7 | 11 | 11 |
| 9-6 to 9-11 | 2 | 2 | 4 | 4 | 8 | 8 | 16 | 17 |
| 10-0 to 10-5 | 3 | 2 | 5 | 5 | 11 | 12 | 23 | 22 |
| 10-6 to 10-11 | 0 | 1 | 1 | 1 | 13 | 11 | 24 | 27 |
| 11-0 to 11-5 | 1 | 2 | 3 | 4 | 11 | 7 | 13 | 23 |
| 11-6 to 11-11 | 0 | 1 | 1 | 2 | 2 | 5 | 7 | 17 |
| 12-0 to 12-5 | 0 | 1 | 1 | 2 | 2 | 6 | 8 | 14 |
| 12-6 to 12-11 | 0 | 2 | 2 | 5 | 3 | 1 | 4 | 9 |
| 13-0 to 13-5 | 1 | 1 | 2 | 4 | 1 | 0 | 1 | 2 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 2 | 3 | 5 | 12 |
| 14-0 to 14-5 | 0 | 1 | 1 | 2 | 2 | 1 | 3 | 5 |
| 14-6 to 14-11 | 1 | 4 | 5 | 8 | 2 | 7 | 9 | 14 |

| | 5 Doors nearly correct | | | | 6 All doors correct | | | | 5+6 All doors nearly correct |
|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 2 | 2 | 4 | 5 | 2 | 2 | 4 | 5 | 10 |
| 8-0 to 8-5 | 7 | 3 | 10 | 10 | 2 | 2 | 4 | 4 | 14 |
| 8-6 to 8-11 | 7 | 9 | 16 | 11 | 8 | 0 | 8 | 6 | 16 |
| 9-0 to 9-5 | 11 | 4 | 15 | 15 | 7 | 1 | 8 | 8 | 23 |
| 9-6 to 9-11 | 9 | 6 | 15 | 16 | 10 | 2 | 12 | 13 | 29 |
| 10-0 to 10-5 | 12 | 7 | 19 | 18 | 9 | 3 | 12 | 11 | 29 |
| 10-6 to 10-11 | 12 | 13 | 25 | 28 | 9 | 3 | 12 | 13 | 41 |
| 11-0 to 11-5 | 24 | 5 | 29 | 37 | 6 | 1 | 7 | 9 | 46 |
| 11-6 to 11-11 | 10 | 5 | 15 | 37 | 5 | 2 | 7 | 17 | 54 |
| 12-0 to 12-5 | 9 | 9 | 18 | 32 | 12 | 1 | 13 | 23 | 55 |
| 12-6 to 12-11 | 8 | 9 | 17 | 39 | 6 | 3 | 9 | 20 | 59 |
| 13-0 to 13-5 | 5 | 10 | 15 | 31 | 12 | 10 | 22 | 46 | 77 |
| 13-6 to 13-11 | 2 | 10 | 12 | 29 | 9 | 11 | 20 | 49 | 78 |
| 14-0 to 14-5 | 14 | 10 | 24 | 42 | 14 | 12 | 26 | 46 | 83 |
| 14-6 to 14-11 | 8 | 6 | 14 | 22 | 13 | 17 | 30 | 48 | 70 |

| | c. Proportions Satisfactory in Correct Doors | | | | Proportions Satisfactory in Doors Nearly Correct | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| 8-0 to 8-5 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 |
| 8-6 to 8-11 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 9-0 to 9-5 | 1 | 0 | 1 | 1 | 1 | 1 | 2 | 2 |
| 9-6 to 9-11 | 2 | 0 | 2 | 2 | 2 | 2 | 4 | 4 |
| 10-0 to 10-5 | 2 | 0 | 2 | 2 | 2 | 3 | 5 | 5 |
| 10-6 to 10-11 | 3 | 0 | 3 | 3 | 3 | 3 | 6 | 7 |
| 11-0 to 11-5 | 2 | 0 | 2 | 3 | 2 | 1 | 3 | 4 |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | 2 | 1 | 3 | 5 |
| 12-6 to 12-11 | 2 | 0 | 2 | 5 | 1 | 1 | 2 | 5 |
| 13-0 to 13-5 | 3 | 0 | 3 | 6 | 3 | 4 | 7 | 15 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 3 | 2 | 5 | 12 |
| 14-0 to 14-5 | 5 | 0 | 5 | 9 | 8 | 0 | 8 | 14 |
| 14-6 to 14-11 | 1 | 0 | 1 | 2 | 1 | 4 | 5 | 8 |

## IV WINDOWS

### A NUMBERS OF WINDOWS

| | 1 One Window | | | | 2 Two Windows | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 3 | 2 | 5 | 4 | 0 | 1 | 1 | 1 |
| 7-6 to 7-11 | 1 | 3 | 4 | 5 | 1 | 4 | 5 | 6 |
| 8-0 to 8-5 | 8 | 4 | 12 | 12 | 3 | 0 | 3 | 3 |
| 8-6 to 8-11 | 3 | 5 | 8 | 6 | 11 | 11 | 22 | 17 |
| 9-0 to 9-5 | 1 | 7 | 8 | 8 | 7 | 2 | 9 | 9 |
| 9-6 to 9-11 | 7 | 2 | 9 | 10 | 2 | 5 | 7 | 8 |
| 10-0 to 10-5 | 4 | 1 | 5 | 5 | 3 | 4 | 7 | 7 |
| 10-6 to 10-11 | 2 | 0 | 2 | 2 | 0 | 3 | 3 | 3 |
| 11-0 to 11-5 | 3 | 1 | 4 | 6 | 1 | 1 | 1 | 1 |
| 11-6 to 11-11 | 0 | 1 | 1 | 2 | 3 | 1 | 4 | 10 |
| 12-0 to 12-5 | 2 | 1 | 3 | 5 | 1 | 1 | 2 | 4 |
| 12-6 to 12-11 | 0 | 1 | 1 | 2 | 1 | 1 | 2 | 5 |
| 13-0 to 13-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13-6 to 13-11 | 0 | 0 | 0 | 0 | 1 | 1 | 5 | 5 |
| 14-0 to 14-5 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 2 |
| 14-6 to 14-11 | 0 | 1 | 1 | 2 | 2 | 1 | 3 | 5 |

| | 3 Three Windows | | | | 4 All Rooms with with Windows | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 1 | 0 | 1 | 1 | 3 | 1 | 4 | 5 |
| 8-0 to 8-5 | 5 | 6 | 11 | 11 | 7 | 5 | 12 | 12 |
| 8-6 to 8-11 | 9 | 7 | 16 | 12 | 11 | 12 | 23 | 17 |
| 9-0 to 9-5 | 8 | 7 | 15 | 15 | 19 | 17 | 36 | 37 |
| 9-6 to 9-11 | 10 | 1 | 11 | 12 | 22 | 20 | 42 | 45 |
| 10-0 to 10-5 | 4 | 1 | 5 | 5 | 32 | 33 | 65 | 62 |
| 10-6 to 10-11 | 5 | 1 | 6 | 6 | 29 | 31 | 60 | 64 |
| 11-0 to 11-5 | 4 | 2 | 6 | 8 | 38 | 14 | 52 | 67 |
| 11-6 to 11-11 | 1 | 2 | 3 | 7 | 17 | 14 | 31 | 76 |
| 12-0 to 12-5 | 1 | 2 | 3 | 3 | 24 | 19 | 43 | 75 |
| 12-6 to 12-11 | 0 | 4 | 4 | 9 | 18 | 18 | 36 | 82 |
| 13-0 to 13-5 | 1 | 0 | 1 | 2 | 22 | 25 | 47 | 98 |
| 13-6 to 13-11 | 3 | 2 | 5 | 12 | 12 | 21 | 33 | 80 |
| 14-0 to 14-5 | 0 | 0 | 0 | 0 | 29 | 26 | 55 | 96 |
| 14-6 to 14-11 | 1 | 2 | 3 | 5 | 24 | 32 | 56 | 89 |

B TYPES OF WINDOWS

| | 1 As a vertical picture | | | | 2 May be vertical or horizontal sections | | | | 3 Some poor and some fair | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 42 | 66 | 108 | 94 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 7-6 to 7-11 | 14 | 50 | 74 | 87 | 2 | 2 | 4 | 5 | 1 | 2 | 3 | 4 |
| 8-0 to 8-5 | 19 | 35 | 54 | 54 | 2 | 3 | 5 | 5 | 9 | 5 | 14 | 14 |
| 8-6 to 8-11 | 24 | 45 | 69 | 51 | 4 | 6 | 10 | 7 | 13 | 7 | 20 | 15 |
| 9-0 to 9-5 | 14 | 40 | 34 | 35 | 3 | 0 | 3 | 3 | 7 | 9 | 16 | 16 |
| 9-6 to 9-11 | 13 | 23 | 36 | 38 | 3 | 2 | 5 | 6 | 15 | 9 | 24 | 26 |
| 10-0 to 10-5 | 13 | 29 | 42 | 41 | 3 | 3 | 6 | 6 | 12 | 14 | 26 | 25 |
| 10-6 to 10-11 | 9 | 21 | 30 | 34 | 0 | 4 | 4 | 5 | 12 | 7 | 19 | 21 |
| 11-0 to 11-5 | 4 | 4 | 8 | 10 | 0 | 2 | 2 | 3 | 11 | 3 | 14 | 18 |
| 11-6 to 11-11 | 6 | 10 | 16 | 39 | 1 | 0 | 1 | 2 | 6 | 1 | 7 | 17 |
| 12-0 to 12-5 | 6 | 7 | 13 | 23 | 1 | 1 | 2 | 4 | 3 | 5 | 8 | 14 |
| 12-6 to 12-11 | 2 | 11 | 13 | 30 | 2 | 1 | 3 | 7 | 4 | 6 | 10 | 23 |
| 13-0 to 13-5 | 3 | 4 | 7 | 15 | 1 | 1 | 2 | 4 | 0 | 2 | 2 | 4 |
| 13-6 to 13-11 | 2 | 0 | 2 | 5 | 1 | 1 | 2 | 5 | 1 | 2 | 3 | 7 |
| 14-0 to 14-5 | 2 | 1 | 3 | 5 | 0 | 2 | 2 | 4 | 2 | 2 | 4 | 7 |
| 14-6 to 14-11 | 3 | 0 | 3 | 5 | 1 | 4 | 5 | 8 | 0 | 4 | 4 | 6 |

| | 4 All fair, often a symbol, mixed types | | | | 5 Nearly all correct | | | | 6 All correct | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 1 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 4 | 2 | 6 | 6 | 3 | 1 | 4 | 4 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 2 | 0 | 2 | 1 | 5 | 7 | 12 | 9 | 0 | 0 | 0 | 0 |
| 9-0 to 9-5 | 2 | 3 | 5 | 5 | 10 | 1 | 11 | 11 | 2 | 1 | 3 | 3 |
| 9-6 to 9-11 | 5 | 3 | 8 | 9 | 6 | 3 | 9 | 10 | 3 | 1 | 4 | 4 |
| 10-0 to 10-5 | 2 | 0 | 2 | 2 | 15 | 3 | 18 | 18 | 1 | 1 | 2 | 2 |
| 10-6 to 10-11 | 3 | 2 | 5 | 6 | 9 | 6 | 15 | 17 | 6 | 3 | 9 | 10 |
| 11-0 to 11-5 | 5 | 3 | 8 | 10 | 18 | 4 | 22 | 28 | 7 | 2 | 9 | 12 |
| 11-6 to 11-11 | 2 | 0 | 2 | 5 | 5 | 9 | 14 | 34 | 6 | 1 | 4 | 10 |
| 12-0 to 12-5 | 1 | 0 | 1 | 2 | 11 | 11 | 22 | 39 | 6 | 2 | 8 | 14 |
| 12-6 to 12-11 | 11 | 0 | 1 | 2 | 5 | 1 | 6 | 14 | 5 | 6 | 11 | 25 |
| 13-0 to 13-5 | 1 | 1 | 2 | 4 | 1 | 5 | 6 | 13 | 17 | 12 | 29 | 60 |
| 13-6 to 13-11 | 1 | 4 | 5 | 12 | 3 | 5 | 8 | 20 | 8 | 13 | 21 | 51 |
| 14-0 to 14-5 | 0 | 3 | 3 | 5 | 7 | 7 | 14 | 25 | 20 | 11 | 21 | 37 |
| 14-6 to 14-11 | 1 | 2 | 3 | 5 | 8 | 11 | 19 | 30 | 14 | 15 | 29 | 46 |

V UNACCOUNTED FOR SPACE AND VERTICAL WALLS

| | A No unaccounted for space | | | | B No vertical wall | | | | C No unaccounted for space or vertical wall | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 1 | 0 | 1 | 1 | 2 | 1 | 3 | 3 | 1 | 0 | 1 | 1 |
| 7-6 to 7-11 | 2 | 3 | 5 | 5 | 2 | 5 | 7 | 8 | 2 | 3 | 5 | 6 |
| 8-0 to 8-6 | 3 | 2 | 5 | 5 | 13 | 4 | 17 | 17 | 3 | 2 | 5 | 5 |
| 8-6 to 8-11 | 11 | 6 | 17 | 13 | 22 | 17 | 39 | 29 | 11 | 6 | 17 | 13 |
| 9-0 to 9-5 | 21 | 10 | 31 | 32 | 27 | 29 | 56 | 57 | 20 | 10 | 30 | 31 |
| 9-6 to 9-11 | 23 | 9 | 32 | 34 | 32 | 24 | 56 | 60 | 21 | 9 | 30 | 32 |
| 10-0 to 10-5 | 24 | 18 | 42 | 40 | 38 | 23 | 61 | 58 | 23 | 16 | 39 | 37 |
| 10-6 to 10-11 | 23 | 17 | 40 | 45 | 29 | 20 | 49 | 55 | 23 | 17 | 40 | 45 |
| 11-0 to 11-5 | 35 | 6 | 41 | 53 | 40 | 11 | 51 | 65 | 35 | 6 | 41 | 53 |
| 11-6 to 11-11 | 8 | 10 | 18 | 44 | 7 | 12 | 19 | 46 | 6 | 10 | 16 | 36 |
| 12-0 to 12-5 | 16 | 13 | 29 | 51 | 22 | 17 | 39 | 68 | 16 | 13 | 29 | 51 |
| 12-6 to 12-11 | 17 | 15 | 32 | 73 | 19 | 15 | 34 | 77 | 17 | 12 | 29 | 66 |
| 13-0 to 13-5 | 19 | 17 | 36 | 73 | 21 | 20 | 41 | 83 | 19 | 13 | 32 | 67 |
| 13-6 to 13-11 | 10 | 16 | 26 | 63 | 16 | 25 | 41 | 100 | 10 | 16 | 26 | 63 |
| 14-0 to 14-5 | 24 | 24 | 49 | 86 | 29 | 25 | 54 | 95 | 25 | 24 | 49 | 86 |
| 14-6 to 14-11 | 24 | 32 | 56 | 89 | 25 | 35 | 60 | 95 | 24 | 32 | 56 | 89 |

VI NUMBER OF PROPORTIONS CORRECT

| | 1 One correct | | | | 2 Two correct | | | | 3 Three correct | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 1 | 1 | 2 | 2 |
| 8-0 to 8-5 | 9 | 1 | 10 | 10 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 |
| 8-6 to 8-11 | 7 | 6 | 13 | 10 | 4 | 2 | 6 | 4 | 1 | 1 | 2 | 1 |
| 9-0 to 9-5 | 6 | 8 | 14 | 14 | 7 | 0 | 7 | 7 | 2 | 3 | 5 | 5 |
| 9-6 to 9-11 | 12 | 6 | 18 | 19 | 6 | 3 | 9 | 10 | 4 | 1 | 5 | 5 |
| 10-0 to 10-5 | 12 | 10 | 22 | 21 | 6 | 4 | 10 | 10 | 8 | 2 | 10 | 10 |
| 10-6 to 10-11 | 10 | 12 | 22 | 25 | 4 | 7 | 11 | 12 | 6 | 4 | 10 | 11 |
| 11-0 to 11-5 | 9 | 4 | 13 | 17 | 13 | 3 | 16 | 21 | 8 | 3 | 11 | 14 |
| 11-6 to 11-11 | 6 | 8 | 14 | 34 | 6 | 4 | 10 | 21 | 2 | 2 | 4 | 10 |
| 12-0 to 12-5 | 11 | 9 | 20 | 35 | 2 | 8 | 10 | 18 | 7 | 1 | 8 | 14 |
| 12-6 to 12-11 | 4 | 6 | 10 | 23 | 4 | 5 | 9 | 20 | 6 | 7 | 13 | 30 |
| 13-0 to 13-5 | 4 | 11 | 15 | 31 | 11 | 6 | 17 | 35 | 2 | 7 | 9 | 19 |
| 13-6 to 13-11 | 5 | 8 | 13 | 32 | 3 | 7 | 10 | 24 | 1 | 3 | 4 | 10 |
| 14-0 to 14-5 | 6 | 10 | 16 | 28 | 8 | 12 | 20 | 35 | 5 | 2 | 7 | 12 |

| | 4 Four correct | | | | 5 Five correct | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-0 to 9-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 9-6 to 9-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-0 to 10-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 10-6 to 10-11 | 3 | 0 | 3 | 3 | 0 | 0 | 0 | 0 |
| 11-0 to 11-5 | 2 | 0 | 2 | 3 | 0 | 0 | 0 | 0 |
| 11-6 to 11-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 12-0 to 12-5 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 |
| 12-6 to 12-11 | 2 | 1 | 3 | 7 | 1 | 0 | 1 | 2 |
| 13-0 to 13-5 | 1 | 0 | 1 | 2 | 4 | 1 | 5 | 10 |
| 13-6 to 13-11 | 2 | 1 | 3 | 7 | 1 | 0 | 1 | 2 |
| 14-0 to 14-5 | 4 | 0 | 4 | 7 | 1 | 0 | 1 | 2 |
| 14-6 to 14-11 | 2 | 0 | 2 | 3 | 1 | 1 | 2 | 3 |

VII DOUBLE LINES FOR WALLS

| | 1 Some walls with double lines | | | | 2 All walls with double lines | | | | 3 At least some with double lines | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 8-6 to 8-11 | 1 | 1 | 2 | 2 | 2 | 3 | 5 | 4 | 3 | 4 | 7 | 6 |
| 9-0 to 9-5 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 2 | 2 |
| 9-6 to 9-11 | 2 | 0 | 2 | 2 | 5 | 3 | 8 | 9 | 7 | 3 | 10 | 11 |
| 10-0 to 10-5 | 2 | 0 | 2 | 2 | 4 | 0 | 4 | 4 | 6 | 0 | 6 | 5 |
| 10-6 to 10-11 | 1 | 0 | 1 | 1 | 3 | 1 | 4 | 5 | 4 | 1 | 5 | 6 |
| 11-0 to 11-5 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 11-6 to 11-11 | 1 | 2 | 3 | 7 | 3 | 0 | 3 | 7 | 4 | 2 | 6 | 15 |
| 12-0 to 12-5 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 4 | 2 | 0 | 2 | 4 |
| 12-6 to 12-11 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | 1 | 0 | 1 | 2 |
| 13-0 to 13-5 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 |
| 13-6 to 13-11 | 1 | 1 | 2 | 5 | 2 | 0 | 2 | 5 | 3 | 1 | 4 | 10 |
| 14-0 to 14-5 | 3 | 1 | 4 | 7 | 2 | 0 | 2 | 4 | 5 | 1 | 6 | 11 |
| 14-6 to 14-11 | 1 | 1 | 2 | 3 | 1 | 0 | 1 | 2 | 2 | 1 | 3 | 5 |

## VIII QUALITY OF DRAWING

| | 1. Half lines straight 2 corners right angles | | | | 2. All lines straight and parallel | | | |
|---|---|---|---|---|---|---|---|---|
| | B. | G. | TOT. | % | B. | G. | TOT. | % |
| 7-0 to 7-5 | 3 | 0 | 3 | 3 | 0 | 0 | 0 | 0 |
| 7-6 to 7-11 | 3 | 0 | 3 | 3 | 0 | 0 | 0 | 0 |
| 8-0 to 8-5 | 8 | 8 | 16 | 16 | 0 | 0 | 0 | 0 |
| 8-6 to 8-11 | 16 | 7 | 23 | 17 | 0 | 0 | 0 | 0 |
| 9-0 to 9-5 | 18 | 8 | 26 | 27 | 1 | 0 | 1 | 1 |
| 9-6 to 9-11 | 30 | 9 | 39 | 41 | 2 | 0 | 2 | 3 |
| 10-0 to 10-5 | 34 | 14 | 48 | 46 | 1 | 3 | 4 | 4 |
| 10-6 to 10-11 | 27 | 22 | 49 | 55 | 3 | 3 | 6 | 7 |
| 11-0 to 11-5 | 47 | 17 | 64 | 86 | 4 | 0 | 4 | 5 |
| 11-6 to 11-11 | 17 | 13 | 30 | 73 | 1 | 1 | 2 | 5 |
| 12-0 to 12-5 | 25 | 14 | 39 | 68 | 1 | 2 | 3 | 5 |
| 12-6 to 12-11 | 18 | 13 | 31 | 70 | 1 | 7 | 8 | 18 |
| 13-0 to 13-5 | 21 | 22 | 43 | 90 | 7 | 9 | 16 | 33 |
| 13-6 to 13-11 | 14 | 24 | 38 | 93 | 3 | 12 | 15 | 37 |
| 14-0 to 14-5 | 29 | 22 | 51 | 89 | 16 | 8 | 24 | 42 |
| 14-6 to 14-11 | 25 | 31 | 56 | 89 | 10 | 6 | 16 | 25 |

# APPENDIX Ib

## THIRD SCORING SYSTEM

## MODES, MEDIANS, UPPER QUARTILES AND LOWER QUARTILES OF ITEMS

I MAIN STRUCTURE

A Vertical Plans

a. Roof absent

| Mode | Median | U.Q. | L.Q. |
|---|---|---|---|
| 8-9 | 8-4 | 8-11 | 7-9 |

b. Chimney absent

| Mode | Median | U.Q. | L.Q. |
|---|---|---|---|
| 9-3 | 8-4 | 8-11 | 7-9 |

c. Upstairs

| | Mode | | Median | | U.Q. | | L.Q. |
|---|---|---|---|---|---|---|---|
| 2 | 9-3 | 2 | 8-8 | 2 | 9-1 | 2 | 8-0 |
| 3 | 9-3 | 3 | 8-5 | 3 | 9-0 | 3 | 7-10 |
| 1 | 7-3 | 1 | 7-7 | 1 | 8-0 | 1 | 7-3 |

d. Plane of outside wall absent

| | Mode | | Median | | U.Q. | | L.Q. |
|---|---|---|---|---|---|---|---|
| 5 | 9-3 | 5 | 8-4 | 5 | 8-10 | 5 | 7-9 |
| 2-4 | 7-3 | 2-4 | 7-6 | 2-4 | 7-11 | 1 | 7-3 |
| 1 | 7-3 | 1 | 7-5 | 1 | 7-9 | 2-4 | 7-2 |

e. Floor

| | Mode | | Median | | U.Q. | | L.Q. |
|---|---|---|---|---|---|---|---|
| 3 | 9-3 | 3 | 8-7 | 3 | 9-0 | 3 | 8-0 |
| 2 | 7-3 | 2 | 8-1 | 2 | 8-8 | 2 | 7-5 |
| 1 | 7-3 | 1 | 7-7 | 1 | 8-0 | 1 | 7-3 |

f. Depth

| | Mode | | Median | | U.Q. | | L.Q. |
|---|---|---|---|---|---|---|---|
| 3 | 9-3 | 3 | 8-7 | 3 | 9-8 | 3 | 8-0 |
| 2 | 7-3 | 2 | 7-10 | 2 | 8-6 | 2 | 7-4 |
| 1 | 7-3 | 1 | 7-6 | 1 | 7-11 | 1 | 7-3 |

g. Outer wall

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 2 | 9-3 | 2 | 8-7 | 2 | 9-0 | 2 | 8-0 |
| 1 | 8-3 | 1 | 7-11 | 1 | 8-3 | 1 | 7-5 |

B Horizontal Plans

a. Connectedness of rooms

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 3 | 11-9 | 3 | 11-11 | 3 | 13-5 | 3 | 10-2 |
| 2 | 10-9 | 2 | 9-1 | 2 | 10-7 | 2 | 7-11 |
| 1 | 8-3 | 1 | 8-2 | 1 | 8-8 | 1 | 7-10 |

b. Commonality of walls

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 4 | 13-9 | 4 | 12-0 | 4 | 13-7 | 4 | 10-4 |
| 2+3 | 9-3 | 2+3 | 10-0 | 2+3 | 11-9 | 2+3 | 9-1 |
| 1 | 7-9 | 1 | 8-5 | 1 | 9-11 | 1 | 7-10 |

c. Outer wall

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 10 | 13-3 | 10 | 12-4 | 10 | 13-8 | 10 | 10-7 |
| 1 | 12-3 | 1 | 11-5 | 8+9 | 12-5 | 8+9 | 9-8 |
| 3 | 10-3 | 8+9 | 11-3 | 1 | 12-4 | 1 | 9-5 |
| 8+9 | 9-9 | 3 | 9-0 | 6+7 | 11-3 | 3 | 8-9 |
| 6+7 | 9-3 | 4+5 | 9-4 | 4+5 | 11-7 | 6+7 | 8-7 |
| 4+5 | 8-3 | 6+7 | 9-4 | 3 | 10-4 | 4+5 | 8-3 |
| 2 | 7-9 | 2 | 8-2 | 2 | 9-2 | 2 | 7-9 |

d. Proportion of rooms

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 1 | 13-3 | 1 | 12-7 | 1 | 14-5 | 1 | 11-2 |

e. Hall

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 5 | 14-0 | 4 | 11-2 | 5 | 13-1 | 5 | 9-10 |
| 4 | 12-3 | 3 | 11-1 | 4 | 12-4 | 4 | 9-9 |
| 3 | 11-9 | 5 | 11-0 | 3 | 11-11 | 3 | 9-0 |
| 1+2 | 9-3 | 1+2 | 9-3 | 1+2 | 9-7 | 1+2 | 8-1 |

f. Proportions of hall

| Mode | Median | U.Q. | L.Q. |
|---|---|---|---|
| 14-6 | 12-11 | 14-2 | 11-7 |

II STAIRS

Verticality versus Horizontality

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| C | 13-6 | C | 12-3 | C | 13-9 | C | 10-3 |
| B | 11-3 | B | 11-3 | B | 12-6 | B | 10-0 |
| A | 7-3 | A | 8-7 | A | 10-5 | A | 7-8 |

A Vertical Stairs

% based on total sample. Age range 7-0 to 14-11 yrs.

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 3d | 10-9 | 3d | 10-7 | 3d | 10-10 | 3d | 9-11 |
| 6d+c | 8-3 | 2b | 8-7 | 2b | 10-3 | (2b | 7-8 |
| (3b | 7-9 | 3b | 8-5 | 3b | 10-1 | (3b | 7-8 |
| (6c | 7-9 | 6d+c | 8-3 | 2a | 9-7 | 6c | 7-5 |
| (2b | 7-3 | 2a | 7-11 | 6c | 9-5 | 6d+e | 7-5 |
| (2a | 7-3 | 4c | 7-10 | 4c | 9-1 | (4c | 7-4 |
| (4c | 7-3 | 6c | 7-9 | 6d+c | 8-8 | (2a | 7-4 |

B Vertical Stairs

% based on numbers of vertical stairs. 7-0 to 10-11 yrs.

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 3d | 10-9 | 3d | 10-9 | 3d | 10-9 | 3d | 10-1 |
| 6c | 10-3 | 4d+c | 10-0 | 1b | 10-7 | 1b | 9-6 |
| 4d+c | 10-3 | 1b | 9-11 | 4d+c | 10-3 | 4d+c | 8-2 |
| 6d+c | 9-9 | 3c | 9-1 | 6c | 10-1 | 3c | 8-2 |
| 2d | 9-9 | 6d+c | 8-11 | 3b | 10-0 | 6d+c | 8-0 |
| 1b | 9-9 | 3b | 8-11 | 2a | 9-9 | 3b | 8-0 |
| 4c | 9-3 | 2b | 8-11 | 2b | 9-9 | 2b | 8-0 |
| 3c | 9-3 | 6c | 8-9 | 3c | 9-7 | 6c | 7-8 |
| 2b | 9-3 | 2a | 8-6 | 6d+c | 9-6 | 4a+b | 7-8 |
| 3b | 8-9 | 4c | 8-5 | 4c | 9-3 | 4c | 7-7 |
| 4a+b | 8-3 | 4a+b | 8-2 | 4a+b | 8-6 | 3a | 7-7 |
| 3a | 8-0 | 3a | 8-0 | 3a | 8-5 | 2a | 7-7 |

C Horizontal Stairs

a. Outline of staircase

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 7 | 14-3 | 1b | 12-11 | 2c | 14-1 | 1b | 11-4 |
| 2c | 14-3 | 7 | 12-7 | 7 | 13-10 | 5b | 11-1 |
| 1b | 13-3 | 1a | 12-7 | 1a | 13-8 | 7 | 11-0 |
| 5ab+6 | 12-9 | 2c | 12-7 | 5ab+6 | 13-6 | 5ab+6 | 10-9 |
| 5b | 12-6 | 5b | 12-6 | 5b | 13-6 | 2c | 10-6 |
| 2b | 11-9 | 2b | 11-9 | 1b | 13-5 | 1c | 9-10 |
| 5a | 11-3 | 1c | 11-5 | 2b | 13-4 | 1b | 9-8 |
| 1a | 11-3 | 5a | 11-3 | 1c | 13-3 | 2a | 9-5 |
| 2a | 10-0 | 5ab+6 | 11-1 | 2a | 13-0 | 5a | 9-5 |
| 1c | 9-9 | 2a | 10-4 | 5a | 12-4 | 4 | 9-5 |
| 4 | 9-3 | 4 | 10-2 | 4 | 12-2 | 1a | 9-3 |
| Proportion of staircase | | | | | | | |
| 8 | 13-3 | 8 | 12-4 | 8 | 13-5 | 8 | 11-0 |

b. Treads

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 1a | 14-9 | 7 | 13-2 | 1a | 13-11 | 7 | 12-6 |
| 3d | 14-3 | 1a | 12-4 | 7 | 13-10 | 1a | 10-4 |
| (7 | 13-3 | 3d | 11-10 | 3d | 13-8 | 2f | 10-2 |
| (3a | 13-3 | (3a | 11-3 | 3a | 13-4 | 3b | 10-1 |
| (3b | 11-3 | (3b | 11-3 | 2e | 13-0 | 3d | 9-11 |
| (2f | 11-3 | (2f | 11-3 | (2f | 12-10 | 2a-d | 9-10 |
| 2a-d | 10-3 | 2e | 10-10 | (3c | 12-10 | 3a | 9-7 |
| (3c | 8-9 | 3c | 10-8 | 3b | 12-5 | 3c | 9-4 |
| (2e | 8-9 | 2a-d | 10-3 | 2a-d | 10-9 | 2e | 8-10 |

c. Space below stairs indicated

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| (1 | 14-3 | 1 | 14-0 | 1 | 14-6 | 1 | 12-10 |
| (2 | 14-3 | 2 | 13-3 | 2 | 14-0 | 2 | 10-8 |

III DOORS

A Number of Doors

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 4 | 14-3 | 4 | 12-6 | 4 | 13-9 | 4 | 11-0 |
| 2 | 10-9 | (2 | 9-8 | 2 | 12-0 | 3 | 9-2 |
| 3 | 10-3 | (1 | 9-8 | 3 | 11-6 | 2 | 8-7 |
| 1 | 8-9 | 3 | 10-2 | 1 | 10-8 | 1 | 8-5 |

B Type of Doors

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 3 | 14-9 | 6 | 13-3 | 6 | 14-1 | 6 | 11-9 |
| 6 | 13-9 | 5 | 12-1 | 5 | 13-5 | 5 | 10-9 |
| 5 | 14-3 | 3 | 10-11 | 3 | 13-0 | 4 | 9-8 |
| 3 | 10-9 | 4 | 10-10 | 4 | 12-1 | 2 | 9-2 |
| 2 | 10-3 | 2 | 10-4 | 2 | 12-4 | 3 | 9-0 |
| 1 | 7-3 | 1 | 8-9 | 1 | 10-4 | 1 | 7-9 |

C Proportions Satisfactory in Correct Doors

| | | | |
|---|---|---|---|
| 14-3 | 12-11 | 14-1 | 10-10 |

IV WINDOWS

A Number of Windows

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 4 | 13-3 | 4 | 12-5 | 4 | 13-7 | 4 | 10-9 |
| 3 | 9-3 | 3 | 10-4 | 3 | 12-6 | 3 | 9-1 |
| 2 | 8-9 | 2 | 9-11 | 2 | 11-11 | 2 | 8-9 |
| 1 | 8-3 | 1 | 9-6 | 1 | 11-1 | 1 | 8-4 |

B Type of Windows

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 6 | 13-3 | 6 | 13-11 | 6 | 14-1 | 6 | 12-8 |
| 5 | 12-3 | 5 | 11-6 | 5 | 13-7 | 5 | 10-11 |
| 4 | 11-3 | 4 | 11-3 | 4 | 13-7 | 4 | 9-9 |
| 3 | 9-3 | 3 | 11-2 | 2 | 13-9 | 3 | 9-6 |
| 2 | 8-9 | 2 | 11-0 | 3 | 12-1 | 2 | 9-0 |
| 1 | 7-9 | 1 | 8-11 | 1 | 10-9 | 1 | 7-9 |

V Unaccounted for Space and Vertical Walls

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| (C | 14-9 | (C | 12-8 | C | 14-0 | (C | 11-0 |
| (A | 14-9 | (A | 12-7 | A | 13-11 | (A | 11-0 |
| C | 13-9 | B | 12-5 | B | 13-9 | B | 10-5 |

VI Number of Proportions Correct

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 4 | 14-0 | 4 | 13-3 | 4 | 14-1 | 5 | 13-1 |
| 5 | 13-3 | 5 | 13-4 | 2 | 14-0 | 4 | 12-6 |
| 2 | 13-3 | 3 | 13-2 | 5 | 13-11 | 2 | 11-4 |
| 3 | 12-9 | 2 | 12-10 | 3 | 13-7 | 3 | 11-3 |
| 1 | 12-3 | 1 | 12-2 | 1 | 13-7 | 1 | 10-7 |

VII Double Lines for Walls

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 1 | 11-9 | 1 | 11-6 | 1 | 13-9 | 1 | 10-0 |
| 2 | 9-9 | 2 | 11-5 | 2 | 12-8 | 1 | 9-10 |

VIII Quality of Drawing

| Mode | | Median | | U.Q. | | L.Q. | |
|---|---|---|---|---|---|---|---|
| 2 | 14-3 | 2 | 13-7 | 2 | 14-2 | 2 | 12-11 |
| 1 | 13-9 | 1 | 12-5 | 1 | 13-9 | 1 | 11-0 |

## APPENDIX II

INCIDENCE OF OCCURRENCE OF ITEMS FROM THE CHILD GUIDANCE TRAINING CENTRE ITEM SHEET

| | NOT RETARDED | | | | | | | | RETARDED | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GIRLS | | | | BOYS | | | | BOYS | | | |
| | A N = 16 | | B N = 17 | | A N = 31 | | B N = 16 | | A N = 14 | | B N = 8 | |
| | N | % | N | % | N | % | N | % | N | % | N | % |
| a. SYMPTOMS | | | | | | | | | | | | |
| Eating disturbance | 1 | 6 | 3 | 18 | 1 | 3 | 4 | 25 | 2 | 14 | 1 | 13 |
| Over weight | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Abdominal pains | 3 | 19 | 2 | 12 | 5 | 16 | 2 | 13 | 0 | 0 | 0 | 0 |
| Dizziness | 1 | 6 | 1 | 6 | 2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Nightmare, night terrors | 1 | 0 | 2 | 12 | 0 | 0 | 2 | 13 | 1 | 7 | 1 | 13 |
| Difficulty in sleeping | 1 | 6 | 1 | 6 | 5 | 16 | 4 | 25 | 3 | 21 | 1 | 13 |
| Nocturnal eneuresis | 3 | 19 | 0 | 0 | 4 | 13 | 3 | 19 | 2 | 14 | 2 | 25 |
| Eneuretic by day | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 6 | 3 | 21 | 0 | 0 |
| Encopresis | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 2 | 14 | 0 | 0 |
| Nail biting | 1 | 6 | 2 | 12 | 0 | 0 | 1 | 6 | 1 | 7 | 1 | 13 |
| Thumb sucking | 2 | 13 | 0 | 0 | 2 | 6 | 0 | 0 | 0 | 0 | 1 | 13 |
| Rocking, head banging | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 6 | 0 | 0 | 0 | 0 |
| Tics | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 2 | 14 | 0 | 0 |
| Poor speech | 2 | 12 | 1 | 6 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 0 |
| Hyperkinesis | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Messy, dirty | 1 | 6 | 0 | 0 | 2 | 6 | 2 | 13 | 1 | 7 | 0 | 0 |
| Clumsy | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Temper tantrums | 0 | 0 | 1 | 6 | 10 | 32 | 3 | 19 | 5 | 36 | 1 | 13 |
| Violent aggression | 2 | 13 | 2 | 12 | 6 | 19 | 2 | 13 | 3 | 21 | 0 | 0 |
| Destructiveness | 0 | 0 | 0 | 0 | 2 | 6 | 1 | 6 | 2 | 14 | 0 | 0 |
| Stealing | 1 | 6 | 0 | 0 | 6 | 9 | 5 | 31 | 3 | 21 | 2 | 25 |
| Lying | 0 | 0 | 0 | 0 | 3 | 10 | 2 | 13 | 3 | 21 | 1 | 13 |
| Truanting | 0 | 0 | 0 | 0 | 3 | 10 | 0 | 0 | 1 | 7 | 0 | 0 |
| School refusal | 1 | 6 | 2 | 12 | 5 | 16 | 4 | 25 | 1 | 7 | 1 | 13 |
| Fears | 5 | 31 | 0 | 0 | 4 | 13 | 1 | 6 | 0 | 0 | 0 | 0 |
| Anxiety symptoms | 0 | 0 | 0 | 0 | 2 | 6 | 1 | 6 | 0 | 0 | 0 | 0 |
| Obsessional symptoms | 0 | 0 | 0 | 0 | 2 | 6 | 1 | 6 | 1 | 7 | 0 | 0 |
| Depression symptoms | 2 | 13 | 1 | 6 | 7 | 23 | 0 | 0 | 1 | 7 | 1 | 13 |
| Poor academic progress | 3 | 19 | 2 | 10 | 0 | 0 | 3 | 19 | 6 | 43 | 6 | 75 |
| Does not mix | 3 | 19 | 2 | 0 | 1 | 3 | 3 | 19 | 4 | 29 | 0 | 0 |
| Withdrawn | 0 | 0 | 1 | 6 | 0 | 0 | 2 | 13 | 1 | 7 | 1 | 13 |

| | NOT RETARDED | | | | | | | | RETARDED | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GIRLS | | | | BOYS | | | | BOYS | | | |
| | A N = 16 | | B N = 17 | | A N = 31 | | B N = 16 | | A N = 14 | | B N = 8 | |
| | N | % | N | % | N | % | N | % | N | % | N | % |
| Antagonistic to parents | 2 | 13 | 4 | 24 | 2 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| Jealous of sibling | 0 | 0 | 2 | 12 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Poor concentration | 0 | 0 | 0 | 0 | 2 | 6 | 2 | 13 | 0 | 0 | 0 | 0 |
| Asthma | 0 | 0 | 0 | 0 | 1 | 3 | 2 | 13 | 0 | 0 | 0 | 0 |
| b. DEVELOPMENT | | | | | | | | | | | | |
| Difficult pregnancy | 1 | 6 | 2 | 12 | 3 | 10 | 2 | 13 | 3 | 21 | 1 | 13 |
| Difficult birth | 8 | 50 | 6 | 35 | 6 | 19 | 8 | 50 | 5 | 36 | 0 | 0 |
| Premature | 0 | 0 | 2 | 12 | 1 | 3 | 0 | 0 | 1 | 0 | 2 | 25 |
| Feeding difficulty | 4 | 25 | 4 | 24 | 2 | 6 | 3 | 19 | 1 | 7 | 2 | 25 |
| Cried at night | 2 | 13 | 1 | 6 | 0 | 0 | 1 | 6 | 1 | 7 | 0 | 0 |
| Toilet training difficulty | 2 | 13 | 1 | 6 | 4 | 13 | 4 | 25 | 2 | 14 | 2 | 25 |
| Poor balance | 0 | 0 | 2 | 12 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Motor dev. slow | 1 | 6 | 2 | 12 | 2 | 6 | 2 | 13 | 2 | 14 | 3 | 38 |
| Speech slow | 2 | 13 | 1 | 6 | 4 | 13 | 3 | 19 | 2 | 14 | 4 | 50 |
| Visual disorder | 2 | 13 | 0 | 0 | 1 | 3 | 1 | 6 | 0 | 0 | 1 | 13 |
| Illness 0 - 2 years | 1 | 6 | 4 | 24 | 5 | 16 | 3 | 19 | 2 | 14 | 1 | 13 |
| Illness 2+ years | 1 | 6 | 2 | 12 | 7 | 23 | 2 | 13 | 4 | 29 | 1 | 13 |
| Hospitalization child | 4 | 25 | 6 | 35 | 11 | 35 | 5 | 31 | 6 | 43 | 3 | 38 |
| Hospitalization mother | 5 | 31 | 5 | 29 | 10 | 32 | 8 | 50 | 2 | 14 | 1 | 13 |
| Hospitalization father | 0 | 0 | 1 | 6 | 2 | 6 | 1 | 6 | 0 | 0 | 0 | 0 |
| Mother away | 1 | 6 | 1 | 6 | 0 | 0 | 0 | 0 | 2 | 14 | 1 | 13 |
| Father away | 1 | 6 | 1 | 6 | 3 | 10 | 3 | 19 | 3 | 21 | 1 | 13 |
| Mother departed | 0 | 0 | 0 | 0 | 1 | 3 | 3 | 19 | 1 | 7 | 0 | 0 |
| Father departed | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 1 | 7 | 0 | 0 |
| Mother dead | 1 | 6 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Father dead | 0 | 0 | 1 | 6 | 1 | 3 | 0 | 0 | 2 | 14 | 0 | 0 |
| Sib dead | 1 | 6 | 1 | 6 | 1 | 3 | 2 | 13 | 2 | 14 | 0 | 0 |
| MGP dead | 0 | 0 | 1 | 6 | 1 | 3 | 3 | 19 | 0 | 6 | 0 | 0 |
| PGP dead | 1 | 0 | 0 | 0 | 2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |

| | NOT RETARDED | | | | | | | | RETARDED | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GIRLS | | | | BOYS | | | | BOYS | | | |
| | A | | B | | A | | B | | A | | B | |
| | N = 16 | | N = 17 | | N = 31 | | N = 16 | | N = 14 | | N = 8 | |
| | N | % | N | % | N | % | N | % | N | % | N | % |
| Fostered | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Adopted | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Illegitimate | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 0 | 0 |
| c. PARENTS | | | | | | | | | | | | |
| FATHER | | | | | | | | | | | | |
| Domineering | 3 | 19 | 0 | 0 | 1 | 3 | 4 | 25 | 1 | 7 | 0 | 0 |
| Rigid and restricting | 1 | 6 | 1 | 6 | 5 | 16 | 1 | 6 | 0 | 0 | 0 | 0 |
| Unrealistic ambition | 2 | 13 | 0 | 0 | 2 | 6 | 0 | 0 | 1 | 7 | 0 | 0 |
| Perfectionist | 2 | 13 | 1 | 6 | 3 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ambivalent to child | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 14 | 6 | 0 |
| Immature | 1 | 6 | 1 | 6 | 1 | 3 | 11 | 6 | 0 | 0 | 0 | 0 |
| Anxious | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Neurotic | 1 | 6 | 0 | 0 | 1 | 3 | 3 | 19 | 0 | 0 | 0 | 0 |
| Depressed | 0 | 0 | 0 | 0 | 2 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| Psychotic features | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| Personality Problem | 0 | 0 | 1 | 6 | 1 | 3 | 4 | 25 | 5 | 36 | 0 | 0 |
| Punishes excessively | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 1 | 7 | 0 | 0 |
| Disabled | 0 | 0 | 1 | 6 | 1 | 3 | 0 | 0 | 1 | 7 | 0 | 0 |
| Ill Health | 2 | 13 | 1 | 6 | 1 | 3 | 2 | 13 | 2 | 14 | 0 | 0 |
| Dead | 0 | 0 | 1 | 6 | 1 | 3 | 0 | 0 | 2 | 14 | 0 | 0 |
| MOTHER | | | | | | | | | | | | |
| Domineering | 3 | 19 | 0 | 0 | 1 | 3 | 1 | 6 | 2 | 14 | 1 | 13 |
| Rigid and restricting | 1 | 6 | 1 | 6 | 5 | 16 | 2 | 13 | 1 | 7 | 0 | 0 |
| Unrealistic ambition | 3 | 19 | 0 | 0 | 1 | 3 | 2 | 13 | 0 | 0 | 0 | 0 |
| Perfectionist | 0 | 0 | 2 | 12 | 1 | 3 | 0 | 0 | 1 | 7 | 0 | 0 |
| Ambivalent to child | 0 | 0 | 0 | 0 | 3 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |
| Lacks confidence | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 6 | 0 | 0 | 0 | 0 |
| Anxious | 0 | 0 | 2 | 12 | 3 | 10 | 2 | 13 | 2 | 14 | 0 | 0 |
| Depressive Reactive | 1 | 6 | 0 | 0 | 3 | 10 | 0 | 0 | 3 | 21 | 2 | 25 |
| Depressive Psychotic | 1 | 6 | 3 | 18 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 0 |
| Neurotic | 5 | 31 | 4 | 24 | 1 | 3 | 1 | 6 | 0 | 0 | 0 | 0 |
| Psychotic features | 0 | 0 | 1 | 6 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 0 |

| | NOT RETARDED | | | | | | | | RETARDED | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GIRLS | | | | BOYS | | | | BOYS | | | |
| | A | | B | | A | | B | | A | | B | |
| | N = 16 | | N = 17 | | N = 31 | | N = 16 | | N = 14 | | N = 8 | |
| | N | % | N | % | N | % | N | % | N | % | N | % |
| Personality problem | 1 | 6 | 1 | 6 | 0 | 0 | 3 | 19 | 2 | 14 | 2 | 26 |
| Ill health | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 0 | 0 |
| Dead | 1 | 6 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| MARITAL RELATIONS | | | | | | | | | | | | |
| DISHARMONY | 2 | 13 | 3 | 18 | 5 | 16 | 3 | 19 | 2 | 14 | 2 | 25 |
| DIVORCE | 1 | 6 | 2 | 12 | 4 | 13 | 1 | 6 | 4 | 29 | 1 | 13 |
| d. DIAGNOSIS | | | | | | | | | | | | |
| Reactive behaviour disorder | 1 | 6 | 3 | 18 | 5 | 16 | 6 | 38 | 3 | 21 | 3 | 38 |
| Neurotic disorder | 13 | 81 | 9 | 53 | 18 | 58 | 9 | 56 | 9 | 64 | 2 | 25 |
| Anxiety reaction | 1 | 6 | 1 | 6 | 11 | 35 | 5 | 31 | 1 | 7 | 1 | 13 |
| Obsessional disorder | 0 | 0 | 0 | 0 | 1 | 3 | 2 | 13 | 1 | 7 | 0 | 0 |
| Hysterical disorder | 2 | 13 | 1 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Personality disorder | 2 | 13 | 2 | 12 | 3 | 10 | 4 | 25 | 4 | 29 | 1 | 13 |
| Affective disorder | 1 | 6 | 4 | 24 | 2 | 6 | 2 | 13 | 3 | 21 | 1 | 13 |
| Syndrome of organic brain damage | 0 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 1 | 13 |
| Psychotic features | 0 | 0 | 1 | 6 | 1 | 3 | 1 | 6 | 1 | 7 | 0 | 0 |
| Conduct disorder | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Habit disorder | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 0 | 0 | 0 | 0 |
| Immature | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 1 | 13 |

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