

PREPARATION FOR THE WORKING OF
INTELLIGENCE TESTS

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By

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I. Introduction

Is it justifiable to prepare or 'coach' for intelligence tests? Is it worth while? The answer to both these questions is yes, though with certain very important reservations.

It is justifiable to prepare a child to take an intelligence test for two reasons. First of all, this kind of test may be strange to him and therefore throw him out of his stride at first, so it is only fair that he should become accustomed to working such tests. This reason is not so important as it used to be as by now most children will have had some experience of intelligence tests, certainly by the time they reach eleven years of age.

The second reason is that an intelligence test is a test of *capacity* through performance (evidently capacity cannot be assessed directly), so that it is important that a child should show as fully as possible the extent of his capacity. Hence it is only fair that he should have had a reasonable amount of practice in exercising his capacity in this field; and it is also fair because there are limits to a child's capacity and he cannot exceed these limits no matter how much practice he is given. He may sometimes obtain a few extra marks by chance, but very rarely indeed enough to make a significant difference to his assessment. Moreover, children's capacities vary very greatly, so that, even after practice, an intelligence test will differentiate between them as effectively and fairly as before. Differences in amount and efficiency of preparation may affect the result, but no test or examination is free from this difficulty. The point is that, after reasonable practice, the

child will then have a better chance of showing his real mettle.

The operative word is 'reasonable,' so now for the reservations. Intelligence test practice is abused if so much time is given to it that too little is left for the various educational activities in which a child ought properly to be engaged. This is quite wrong. Moreover, too much practice defeats its own end. Not only are there limits to improvement through practice, but too much of this often makes a child confused and 'stale,' so that he falls below his best.

It would be quite improper and unprofitable to attempt to 'defeat' intelligence tests—improper because the test is a serious attempt to assess a child's capacity so that the best can be done for him educationally: unprofitable because those who construct intelligence tests are so skilful, and the material at their disposal is so large in amount and so varied, that it would be quite impossible to anticipate all the possible varieties of question in type and content.

What this small book does is to set out, as fairly as possible, some of the best-known and most widely used types of group tests (only group tests are considered), and the different ways in which they are presented, so that children may become accustomed to tackling them and giving the right account of themselves. Many illustrative examples and practice exercises are provided such as help teachers and others to make up further exercises themselves.

Provided reasonable care is taken to avoid ambiguities and other obvious defects, the making up of practice exercises does not need the skill and experience required by professional test constructors who are concerned to produce a measuring instrument of high validity.

In the sequel some of the main types of test are considered in turn. The answers to the practice exercises will be found at the end of the book.

II. Classification Tests

IN working intelligence tests children have to spot the relations between things, or to find things which are related in some way which is given.

In a classification test a number of words are given naming things falling into the same kind of group. For example:

oak ash elm pine

which are all names of trees.

There are two ways of finding whether the children can see the relation. One—the commonest—is to introduce an extra word which does not fit and ask the children to underline this word. Thus:

oak ash elm potato pine

Here “potato” is the odd word which has to be underlined to score correct.

Here is a more difficult item—more difficult because it is more abstract:

pity hunger love anger pleasure

Here “hunger” is the odd word, as it does not name an emotional feeling like the others.

Another way of presenting a test of this kind is to make

the extra word the group-name, which has to be underlined.

The first example above would then be:

oak ash elm tree pine

and "tree" has to be underlined.

The second example would be:

pity emotion love anger pleasure

and "emotion" has to be underlined.

In devising test items of this kind by the first method care has to be taken to see that only one classification fits.

Thus:

cotton wool linen flax jute

Here we might take "wool" as the odd word because it is the only material named which comes from an animal. But we might also take "linen" as it is the only material named which is manufactured, the others being raw materials, so this item will not do as it stands. The second method avoids this difficulty.

Here are some practice items:

First Method. After giving an example like the above, with the simple direction "Underline the word that does not belong with the others."

1. plum apple daisy orange pear
2. fox sparrow tiger dog cat
3. square round oblong blue oval
4. cowardice courage bravery boldness pluck
5. here where whence there when

Second Method. An example with a direction such as "Underline the word which tells what sort of thing is named by the other words."

6. eagle bird sparrow magpie thrush
7. daisy rose flower violet lily
8. mother princess aunt woman queen
9. feeling joy pleasure sadness pain
10. car engine bicycle crane machine

Two points may be noted here. The first is that it is important to vary the position of the correct answer from one item to another. The second is that, on first trying the test items, it may be found that some children misunderstand the directions, however simple. Another form of words should then be sought and a second trial made. This applies to all tests, but in the case of the more difficult it may not be possible to bring even the simplest possible directions within the comprehension of the duller children; but, if this is so, these children would probably be unable to tackle the test items anyhow, so that it does not matter. The point is that the directions must be simple enough to be understood by those children who are capable of tackling some of the test items.

Preparation for classification tests may be aided by drawing up lists of words naming things of the same type.

III. Analogies Tests

IN an analogies test two things are given with a certain relation between them and the child has to spot two other things standing in the same relation. There are, therefore, two stages in the mental process: first the detection

of the nature of the relations between the two given things, and then the detection of two other things also standing in that relation. The analogies test is therefore one of the most penetrating of the tests capable of simple presentation. It is also penetrating because it makes a particularly direct demand on native intelligence, for, as we shall see, it does not lend itself readily to "coaching."

There are three main ways in which analogies tests can be presented. To take a simple example in illustration:

Cat is to kitten as dog is to puppy.

This may be presented as follows:

Cat is to kitten as dog is to
the child being required to write in the correct word.

Or:

Cat is to kitten as dog is to (cub animal puppy kennel)
the child being required to underline the correct word in the bracket.

Or:

Cat is to kitten — (cub animal puppy kennel dog)
the child being required to underline the *two* words in the bracket illustrating the same relationship as that of cat to kitten.

The third method is probably the most effective for test purposes, for not only, unlike the first method, can it be answered without any actual writing, but there are so many ways of choosing two words from the bracket that the chance of getting the two correct words by a lucky guess is small.

Suppose the child has tried this particular example, and the nature of the relationship involved is then explained

to him. If he is then faced with another test item based, say, on this:

Tall is to short as wide is to narrow
the previous explanation will be of little help to him, for the relationship involved, that of opposites, is quite different from the relationship in the previous item.

Hence it is not possible to do very much more in the way of preparation for analogies tests than accustoming the children to the setting and working of such tests.

Here are some practice items. They are presented by the third method, as this is the most effective, but evidently they could be adapted without difficulty to either of the two other methods. One or two examples should be given first, followed by some such simple direction as "Underline the TWO words in the bracket which are connected in the same sort of way as the two words outside the bracket."

11. father, son (uncle child aunt parent cousin)
12. foot, leg (arm walk face toe hand)
13. man, king (palace woman court queen ruler)
14. up, down (sky cloud before rain after)
15. sugar, sweet (lemon sour honey mustard treacle)
16. lemonade, bun (apple cake eat bite drink)
17. why, where (reason method room manner place)
18. better, good (ill bad cure care worse)
19. expect, remember (future present gift past regret)
20. real, true (lie false solid imaginary vision)

IV. Vocabulary Tests

ALTHOUGH the extent of a child's vocabulary depends to a certain extent on his home and social circumstances, it has long been recognized that it is also one of the best indications of native intelligence.

The simplest method of discovering extent of vocabulary by means of group tests is through the recognition of synonyms and antonyms—"sames" and "opposites."

Again, there are various ways of presenting the test. Sometimes a list like this is given:

long short—same opposite
wide narrow—same opposite
courage bravery—same opposite

the child being required to underline "same" or "opposite" in each case.

The main objection to this form of presentation is that, if children answer merely by guessing, they will on the average get half the answers right by chance. There are ways of allowing for this which will be mentioned shortly, but it is better to choose a different method. For example:

long—(narrow tall short thick)

the child being required to underline the word in the bracket opposite in meaning to the word outside. Or:

courage—(anger bravery love pity)

where the child has to underline the word in the bracket meaning the same as the word outside. Better still:

long narrow tall short thick

where the *two* words which are opposite have to be underlined. Or:

courage anger bravery love pity

where the two words meaning the same have to be underlined.

Here are some practice items set in the last form of presentation, though easily translated to the other forms if desired.

First, after some examples, there should be the direction "Underline the TWO words meaning the same as (or the opposite of) one another."

The first five examples involve synonyms and the last five antonyms.

21. short fast narrow quick quiet
22. end empty long finish find
23. bad bold equal evil envy
24. tilt taut inward incline trim
25. deep dense previous devious profound

26. long hot rough cold thick
27. warm near straight narrow wide
28. clean clever stark close stupid
29. rejoice repeat lament lavish refrain
30. opaque obtuse translate transparent obtrude

V. Mixed Sentences Tests

IN a mixed sentences test the words making a grammatical sentence are presented in the wrong order and the child has to discover the correct order. As a simple example:

The cat is on the mat

may be read "cats are larger than mice," which is true, or "mice are larger than cats," which is false.

VI. Directions Tests

IN order to give the correct answers in tests of this kind the child has to understand a statement in the form of more or less complicated directions. Thus:

If 6 is less than 9 and 4 is greater than 7 put O, but if not, put X

the answer being, of course, X.

A common method of setting directions tests, because of its simplicity, is through the letters of the alphabet. Usually these letters are set out in order across the page, followed by directions such as

Write down the letter which comes just before the letter which comes next but one after P.

There is not much to be said about the working of such tests except that children should become accustomed to studying each part of the directions given and then reading them carefully as a whole, for here again an indefinite amount of variation is possible.

In the practice items given below the first six are general, the remainder are in terms of the alphabet. It is not really necessary to give illustrative examples before tests of this kind. It is enough to say:

Now do what it says

or

Now answer these questions

In the case of alphabetical tests this simple direction should be preceded by

Here is the alphabet

followed by the letters of the alphabet in order across the page.

41. Write down the number which is the next even number but one after the number 4.
42. If iron and tin are metals write down X, if not, put NO.
43. If winter comes between autumn and spring write down Z, unless summer comes between winter and spring, in which case write P instead.
44. If 15 and 18 make 33 write down X, unless 9 and 24 also make 33 in which case write O instead.
45. Write down every letter which only occurs *once* in this sentence.
46. Cross out all the even numbers greater than 6 but less than 29 among these:
3 14 32 17 26 4 40 25 8 13
47. Write the letter of the alphabet which comes next but one after N.
48. Write the letter which comes midway between F and L.
49. Write the letter which comes before the letter which comes before S.
50. Write the letter which is the sixth letter before the letter coming midway between D and J.
51. Write the letter coming midway between the letter between D and F and the letter between R and T.
52. Write the letter just before the letter coming midway between the letter midway between L and V and the letter midway between H and N.

VII. Comprehension Tests

IN a comprehension test the child has to grasp the meaning of a passage which may vary in length from a single sentence, more or less simple or complicated, to a whole paragraph or series of paragraphs forming a continuous narrative. Here we shall only consider shorter passages as the principle is the same whatever the length of the passages, and larger passages can be readily constructed by a combination of shorter ones.

The child indicates his comprehension by filling in blanks in the sentences or by answering questions on them.

Thus, to take a very simple example:

An apple is a kind of fruit.

This may be presented in one of two ways. Either:

An apple is a kind of

The child being required to fill in the missing word, or:

An apple is a kind of fruit

followed by the question

What sort of thing is an apple?

the answer to be written down.

An objection in both these cases is that, not only has the child actually to write something, but, except in the simplest sentences, more than one word or answer may fit. Unexpected, but allowable, alternatives have a way of turning up when children actually work the test, and this complicates the marking.

Sometimes, therefore, the child is given a number of alternatives from which he has to pick one and underline it. Thus:

An apple is a kind of (metal flower fruit tree)
or, another example,

Lions and tigers are animals (playful, happy, good,
fierce)

Let us consider a more complicated example, based on the following passage, which is not, of course, shown to the children as it stands.

Yesterday John and Mary went to play in the park. It was a cold day, so they walked along briskly. When they reached the park they saw that the green grass had turned white with the frost. They met Jane and Bill, and all four of them played ball, throwing the ball from one to another. After that they played hide and seek. Jane hid first while John, Mary, and Bill tried to find her. Then they went to the swings, and each one tried to swing higher than the others. When they went home they all felt much warmer in spite of the cold.

This might be presented as follows :

Yesterday John and Mary went to ...(1)... in the park. It was a cold day, so they ...(2)... along briskly. When they reached the park they saw that the green grass had turned ...(3)... with the frost. They met Jane and Bill, and all ...(4)... of them played ball, throwing the ball ...(5)... one to another. After that they played ...(6)... and seek. Jane hid first while John, and Mary, and ...(7)... tried to find her. Then they went on the swings and each one tried to swing ...(8)... than the others. When they went home they all felt much ...(9)... in spite of the cold.

If the children are required to write in the missing words themselves the bracketed numbers in the gaps are omitted. The test is then called a 'completion' test. The gaps should be fairly long and of *equal length*, so as to give no clue to the missing word.

If the gaps are to be filled by selection from alternatives the latter should be set out alongside the passage in rows numbered to correspond with the numbers in the gaps. The right word in each row has to be underlined. Thus, for example:

1. ride play wander swim
2. stopped waited walked came
3. white dark green wet
4. each three children four
5. forward from back bat
6. come find lost hide
7. Bill John Jane Mary
8. up higher down later
9. warmer weary frozen thirsty

Alternatively the passage can be presented without any gaps, with questions to follow which the child has to answer after reading the passage. The answers may be written in or chosen from alternatives by underlining. Thus:

1. When did John and Mary go to the park?
(to-day yesterday to-morrow Friday)
2. What sort of a day was it?
(wet windy cold misty)
3. What colour was the grass?
(green dark brown white)
4. What game did they play first?
(swinging hiding ball racing)
5. Who went to hide first?
(Bill John Mary Jane)
6. How did they feel when they went home?
(colder warmer hungry weary)

Children should become accustomed through practice to reading the whole, and then the parts, of such passages

very carefully before beginning to answer any of the questions or, in completion tests, filling in the gaps. Beyond this there is little to be given in the way of general preparation for such tests.

Sentences and passages for comprehension tests, with suitable gaps or questions, are readily constructed or selected. Indeed, tests of a similar kind have long been a traditional part of the teachers' armoury for testing their pupils' comprehension of what they have been taught. Accordingly no further practice items will be given here beyond the simple examples already given to illustrate the principle.

VIII. Number Series Tests

THE main instruments of reasoning and communication in ordinary life are language and number. It is therefore natural and inevitable that intelligence tests should be very largely couched in terms of these. Hitherto we have been concerned with tests framed almost entirely in terms of words. Now we will go on to consider tests depending upon relations between numbers.

The first thing to say about number tests is that they exhibit a smaller variety of types than do verbal tests. One of the commonest and most important of the number tests is the number series. In general such a test is highly discriminating, though, as we shall see, in some ways it lends itself rather more readily to preparation than do many other tests.

In the test a series of numbers is given, the successive terms of which are linked together by a certain relation or combination of relations. The usual way of discovering whether the child has grasped the relation is to ask him to fill in certain missing terms, generally the two terms which come next after those given. Two terms are asked for, as one only may not provide sufficient evidence that the relationship has been grasped.

Here is a very simple example:

3 5 7 9 11

This is the series of odd numbers, the relationship between terms being that each term is 2 more than its predecessor. The two terms coming next in the above series, which the child has to fill in, are 13 and 15. Sometimes the missing terms are given in a different position—*e.g.*, two at the beginning, or one at the beginning and one at the end; but the principle is exactly the same, and in the examples given the two missing terms will be at the end. It is clear that any such example could, if desired, be readily adapted so that the missing terms come in other positions.

The children should be accustomed to meeting different types of number series. For example, the series may be an increasing one, as in the above illustration, or a decreasing one, as in:

128 64 32 16 8

in which the relationship is such that each term is half its predecessor.

A first step toward finding the required relationship may be by forming another series giving the *differences* between the successive terms of the original series. For instance, take this:

2 3 5 8 12 17

subtracting each term from the one just after it we get the series: 1 2 3 4 5

Hence the differences between successive terms of the original series increase by 1 each time. The next two *differences* are 6 and 7. Hence the two missing terms to be filled in at the end of the original series are 23 and 30.

Here is another example:

200 136 104 88 80

Here the series of differences is: 64 32 16 8, each difference being half the one before. Hence the next two differences are 4 and 2, so that the two numbers to be filled in at the end of the original series are 76 and 74.

There are limits to the effectiveness of this process as the series becomes more complicated, for it may not be easy to spot the relationship between the differences. In the less difficult cases it may be possible, however, to see the relationships involved by going one step further and forming another series of differences. Suppose the original series is:

3 4 6 10 17 28 44

Here the first series of differences is: 1 2 4 7 11 16

If the solution is not now apparent a second series of differences may be formed from this—namely: 1 2 3 4 5

The next two terms are 6 and 7, so that the next two terms in the first series of differences are 22 and 29, and the next two terms in the original series are 66 and 95.

The help afforded by forming series of differences does not detract seriously from the value of the test for the forming of subsidiary series, and the discovery of the

derivative relationships themselves makes considerable demands on intelligence.

Sometimes a test series is formed by the combination of two subsidiary series. Thus:

2 3 4 5 8 7 16 9

which looks rather puzzling at first, but is a combination, by alternate terms of

2 4 8 16

and

3 5 7 9

so that the two missing terms of the original series are 32 and 11.

Again, the series may be a single one but involving a combination of relationships. Thus:

1 2 4 6 7 9 11 12 14

Here there is first an increase of 1, then *two* increases of 2, then another increase of 1, then two more increases of 2, and so on. The two missing numbers at the end are 16, 17.

In constructing a number series test care must be taken to see that there is only one *straightforward* way of continuing the series. "Straightforward" is emphasised for, in theory, there is an unlimited number of ways of continuing a series of which a finite number of terms are given, but nearly all these ways are so complicated or bizarre that they can be ignored. They do not affect the test so far as children are concerned. Sometimes, however, there may be more than one straightforward continuance. Thus, in the series

3 5 7 11 15

the differences are: 2 2 4 4

The next ones might be 6 6, but they might also be 8 8, so that this series will not do as it stands. In this case the remedy is simple. Add a few more terms, thus :

3 5 7 11 15 21 27 35

Here the next two numbers are 43 and 53, without ambiguity. It is important in all cases that a sufficient number of terms should be given to make the principle of the series clear and unambiguous.

Here are some practice items, to be given after some illustrations, with the direction "You have to give the TWO numbers that ought to come next in each of the following sets of numbers."

53. 4 7 10 13 16
 54. 43 36 29 22 15
 55. 5 5 7 7 9 9 11
 56. 243 81 27 9
 57. 5 6 8 11 15 20
 58. 100 81 64 49 36
 59. 2 4 7 9 12 14 17
 60. 5 39 8 33 11 27 14 21 17
 61. 45 43 40 38 36 33 31 29
 62. 2 4 12 14 42 44 132
 63. 3 5 9 17 33
 64. 10 17 26 37 50
 65. 145 101 65 37
 66. 1 4 27 16 125 36
 67. 1 2 6 15 31 56

IX. Number Problem Tests

ANOTHER method of testing intelligence through number is by the working of problems. As these are meant to test the working of intelligence in the grasp and manipulation of number relations, and not the arithmetical ability to handle awkward assemblages of numbers, the numbers employed in the tests are generally simple, though the relationships involved may be more or less complicated.

It is important to construct the problems as far as possible in terms of concepts likely to be quite familiar to the children from their everyday experience. At the same time these concepts must lend themselves to combinations of relationships by means of which effective tests can be readily devised. Accordingly, the concepts most commonly used are those of money, distance, time, and age.

The children can prepare to meet tests of this kind through practice and instruction in the importance of careful reading of the problems. Beyond this no general preparation can be given, for the possible variety of such tests is large, and the children can be keyed up to do their best only by a reasonable amount of suitable practice.

Here are some practice tests:

Bill is 4 years old, Dick is 9, and Mary is 11. Now answer these questions:

68. How old will Mary be when she is twice as old as Bill?
69. How old will Bill be when he is half as old as Dick?
70. What will be the combined ages of the three added together in four years' time?
71. How old will Bill be when Dick's and Mary's ages added together are three times Bill's age?

72. How old will Dick be when his age is 10 years less than Bill's and Mary's ages added together?

A man buys chairs at £5 each, tables at £15 each, and beds at £20 each. Now answer these questions:

73. If the man buys 10 chairs, 2 tables, and 3 beds, how much does it cost him altogether?
74. If he then sells all these at a profit of £1 on each chair, £2 on each table, and £3 on each bed, how much PROFIT does he make altogether?
75. How many chairs could he have bought for the price of 3 tables and 2 beds added together?
76. If he had bought 10 chairs, 3 tables, and some beds, and spent £175 altogether, how many beds would he have bought? ...
77. If he had bought 20 chairs and 6 tables, how many beds could he have bought in addition without spending more than £300 altogether?

Two cyclists, John and Fred, start on a 50-mile journey at the same time—namely, 2 o'clock. John cycles steadily at 10 miles an hour, and Fred cycles steadily at 12 miles an hour. Now answer these questions:

78. How far is Fred ahead after 3 hours? miles.
79. If Fred then stops and waits for John to catch him up, how long has he to wait? ... minutes.
80. How far are they then from the end of the journey? miles.
81. If they now start off again, each travelling at the same rate as he did before, how long after Fred does John reach the end of the journey? ... mins.
82. At what time during the journey is Fred 5 miles ahead of John?

Easier and more difficult examples, on similar principles, can be constructed with the above as models.

X. Order Tests

IN order tests a number of words (or numbers) are given which can be arranged in order in respect of some quality or relation. They are given in the wrong order, and the child indicates grasp of the right order by underlining the word that would then come *in the middle*. An odd number of words is therefore used in each test item. Thus:

yard inch mile foot furlong
would, in order of distance, be arranged as:

inch foot yard furlong mile
so that "yard" is the right word to underline in the first arrangement of the words.

Little preparation can be given for such tests except by working a variety of examples, but where the principle of order is not immediately obvious it is sometimes a help first to consider the words in twos or threes. Here are some practice items. They should be preceded by examples and the direction "Here are some rows of words arranged in the wrong order. In each case see what the right order would be and underline the word which would then come in the MIDDLE."

83. huge tiny small large enormous
84. pound stone ton ounce hundredweight
85. floor ceiling roof chimney foundations
86. eagle sparrow tit owl thrush
87. classroom playground town school street
88. nose toe neck body leg
89. mountain pit mound valley hill
90. youth infant boy man baby
91. page sentence letter book word
92. loving cruel kind indifferent harsh

XI. Code Tests

THE working of code tests depends mainly on the perception of similarities and differences. They are effective tests, for they make peculiarly direct demands on the intelligence and can be simply presented yet constructed to any order of difficulty. Preparation for them can be given by examples in which observation is directed to the discovery of the similarities and differences. Usually a number of ordinary words are given with their code counterparts arranged in a different order. Thus:

B A T S P A

the code counterparts being (say):

+△× ○×□

The order in which these come is not given, but as the only letter occurring in both words is A, and the only symbol occurring in both code expressions is ×, × must stand for A. As A comes in the middle of one word and at the end of the other the code symbols for the other letters can readily be seen—namely:

○—B, □—T, +—S, △—P

Then, for example, the code expression:

△×+□

corresponds to the word P A S T.

Here is another example, with three words given:

N E T P E N T A P

Say the code expressions for these, but in a different order, are:

△+× ○□△ ×□○

(N.B. The code symbols do not stand for the same letters as in the first example.)

Here \square must stand for E, as it is the only symbol occurring in the middle of two code expressions, as does the letter E in two of the words. Also the same letter (N) comes at the beginning of one of these words and at the end of the other. Hence N must be represented by O. From this the code symbols for the other letters are readily seen to be:

$$\triangle - T, \quad + - A, \quad \times - P$$

Then, for example, the code expression :

$$\times + O \triangle$$

corresponds to the word PANT.

Here are some practice items using the same code as in the second example. The children are given the three words and their code counterparts, being told that the latter are not in the same order as the words, and are asked to write the words corresponding to the following:

- 93. $O + \times$
- 94. $\triangle \square O$
- 95. $\times \square \triangle$
- 96. $O \square + \triangle$
- 97. $\times + \triangle \square O \triangle$

XII. Reasoning Tests

ALL intelligence tests require reasoning, but the name 'Reasoning Tests' is specifically applied to tests in which

certain data, simple or complicated, are given from which conclusions have to be drawn.

Reasoning Tests involve the logic of relations, classes, and statements, and it is therefore worth saying a little about the main points to be considered in regard to this.

If A has some relation to B which B also has to A, this relation is said to be 'symmetrical.' Equality, inequality and similarity are examples of symmetrical relations, for if A is equal, unequal, or similar to B, then B is equal, unequal, or similar to A. Cousinship is another symmetrical relation, for if A is cousin to B then B is cousin to A.

'Greater than' is an 'asymmetrical' relation, and so is (say) wifehood, for if A is greater than B then B is *not* greater than A, and if A is wife to B then B is *not* wife to A.

If when A has a certain relation to B, and B has that same relation to C, A also has the same relation to C, that relation is said to be 'transitive.' 'Greater than' is a transitive relation, and so is 'after,' for if A is greater than B and B is greater than C, then A is greater than C; and if A is after B and B is after C, then A is after C.

A 'reflexive' relation is a relation which something has to itself. Equality and similarity are reflexive relations, but 'greater than' and 'after' are not.

Some reasoning tests depend for their solution on the grasp of such relations or combinations of them. To take a simple example:

If Bill is taller than Jack, and Jack is taller than Dick, then Dick is (shorter than, taller than, the same height as) Bill.

'Taller' is a transitive and asymmetrical relation.

Or, again:

If Bill runs faster than Dick but slower than Jack, and Tom runs at the same speed as Bill, what is the result of the race? Underline the right answer. (Bill wins, Dick wins, Jack wins, two of them will tie).

This involves transitive and symmetrical relations.

As for classes, of two groups or classes A and B one may include, exclude, or overlap with the other. A includes B if all the members of A are also members of B, but not necessarily *vice versa*; A excludes B if no members of A are also members of B, and A and B overlap if some, but not all, members of A are also members of B and some, but not all, members of B are also members of A. When all members of A are also members of B and all members of B are also members of A, there is 'coincidence' as a borderline case between inclusion and overlapping.

We then have:

(1) If *all* A's are B's, then (at least) *some* B's are A's. Thus all lions are animals, and therefore some, but not all, animals are lions.

(2) If *some* A's are B's then *some* B's are A's. Thus some flowers are blue, and therefore some blue things are flowers.

(3) If *no* A's are B's then *no* B's are A's. Thus no sparrows are pink, and therefore no pink things are sparrows.

The logic of statements corresponds to the logic of classes. Thus, if p and q are two statements, either of which may be true or false, we have:

(1) If q is *always* true when p is true, then p is *sometimes* (but not necessarily always) true when q is true.

(2) If q is *sometimes* true when p is true, then p is *sometimes* true when q is true.

(3) If q is *never* true when p is true, then p is *never* true when q is true.

All reasoning tests involve one or more of the foregoing principles of the logic of relations, classes, and statements. Most children, of course, cannot grasp these principles in the abstract form in which they have been given above. At the same time it is important that they should become familiar with them in their particular application in reasoning tests, for the latter have a way of appearing complicated and confusing at first reading, and the children may be 'put off' by them. If, therefore, they are to do themselves justice in such tests they should be given some practice in working them and applying the general principles that have been discussed in the foregoing.

The data provided in reasoning tests may be given in tabular or non-tabular form. Here is an illustration of a test with tabulated data.

Look at this table:

	Dark	Fair	Medium
Men	30	15	40
Women	20	25	35
Children	10	20	30

It tells about a group of men, women, and children and says how many of them are dark, how many are fair, and how many medium-coloured. Thus you will see, for example, that 35 of the women are medium.

Now answer these questions:

How many men, women, and children added together were there in the group altogether?

How many of the children were fair?

How many of the adults (men and women added together) were dark?

And so on.

Here is an example with non-tabular data:

Mary, Jane, and Ethel each has a doll, and each lends her doll to one of the others to play with when she has to go out and cannot play with it herself. Mary goes out every afternoon, Jane goes out every morning, and Ethel goes out both morning and afternoon on Tuesdays, Thursdays, and Saturdays.

Now answer these questions:

To whom does Ethel lend her doll on Tuesday mornings?

Ethel is lent one of the dolls on Wednesday afternoon. Whose is it?

How many dolls, counting her own, has Mary to play with on Saturday mornings?

To whom does Ethel lend her doll on Thursday afternoons?

Many reasoning tests are of the "What was the name of the engine-driver?" type and are now a quite common feature in the popular press. In these tests some of the data may, at first sight, appear irrelevant to the question asked, but all turn out in the end to be necessary.

Here is an example:

There are four farms, the North, South, East, and West farms. Dick has been to one of these and has come back with some newlaid eggs. There are some straws on his coat and clay on his boots. Chickens are kept only at the South, East, and West farms. There is no clay anywhere on the farms except where fields have been ploughed up. There

are straw ricks only at the North, East, and West farms. The fields have not been ploughed up at the West farm, though they may have been at the other farms. To which farm has Dick been?

And here are some practice items:

In a certain Junior School there are children of 8, 9, 10, and 11 years of age. Some of them were of course born in spring, others in summer, others in autumn, and the rest in winter. Now look at the table. It tells how many of each age were born in each of the seasons.

Age	Spring	Summer	Autumn	Winter
8	30	25	15	10
9	20	35	30	15
10	15	25	20	30
11	25	30	20	15

The rows across give the numbers of children of each age, and the columns down give the seasons when they were born. Thus you will see, for example, that 30 children of 9 were born in autumn, and 25 children of 11 were born in spring. Now answer these questions:

98. How many children of 10 were born in winter?
99. How many children of 8 were born in autumn?
100. How many children of 11 were born in summer?
101. How many children of 9 were born in spring? ...
102. How many children are there in the school altogether?
103. How many of them altogether were born in summer?
104. How many children younger than 11 were born in winter?

105. How many children altogether of 9 and 10 were NOT born in spring or autumn?
106. In which season were fewest children born altogether?
107. In which age-group are there most children, 8, 9, 10, or 11?
108. Jack is taller than Bill, and Dick is shorter than Bill. Who is the shortest?
109. Three girls are standing in a line: Mary is behind Jane, and Ethel is behind Mary. Who is in the middle?
110. If it rains I shall stay at home or go to the pictures. If it is fine I shall go to the pictures or go for a walk. I cannot get into the pictures for less than ninepence. It is fine and I have sixpence. What shall I do? Underline the right answer below (stay at home, go to pictures, go for walk).
111. B is 1 mile east of A. C is 1 mile north of B. D is 2 miles west of C. E is 2 miles south of D. In which direction is E from A? Underline the right answer below (north, south, east, west, north-east, south-east, south-west, north-west).
112. Pinkweed grows where it is wet and hot. Greenweed grows where it is dry and windy. Redweed grows where it is cold and calm. Blueweed grows where it is hot and calm. Two of these plants are found in Southland, which is hot, wet, and calm. Which two plants are found in Southland. Underline the two right answers below (pinkweed, greenweed, redweed, blueweed).

In such ways reasoning tests of any degree of simplicity or complexity can be constructed.

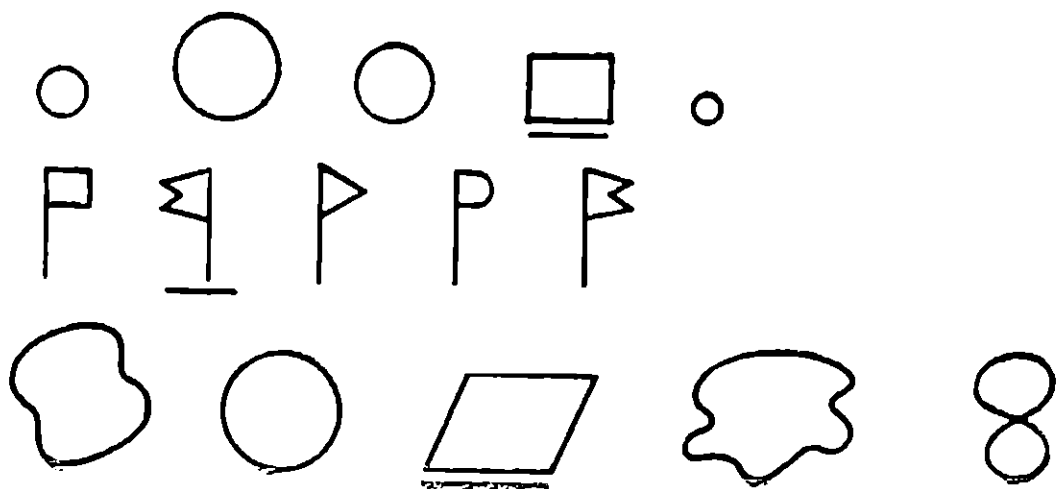
XIII. Non-verbal Tests

By non-verbal tests is meant, not tests presented in pictures for young or backward children of low reading ability, but tests of the various kinds we have been considering in which shapes and figures are used instead of words and numbers. They may be added to 'verbal' tests or used alone.

If we are not tied to words and numbers an endless array of possibilities opens up which lends itself readily to test construction. Accordingly treatment here will be limited to giving some typical illustrations of non-verbal test items corresponding to some of the types of test discussed in the foregoing. With these as models further items can be devised.

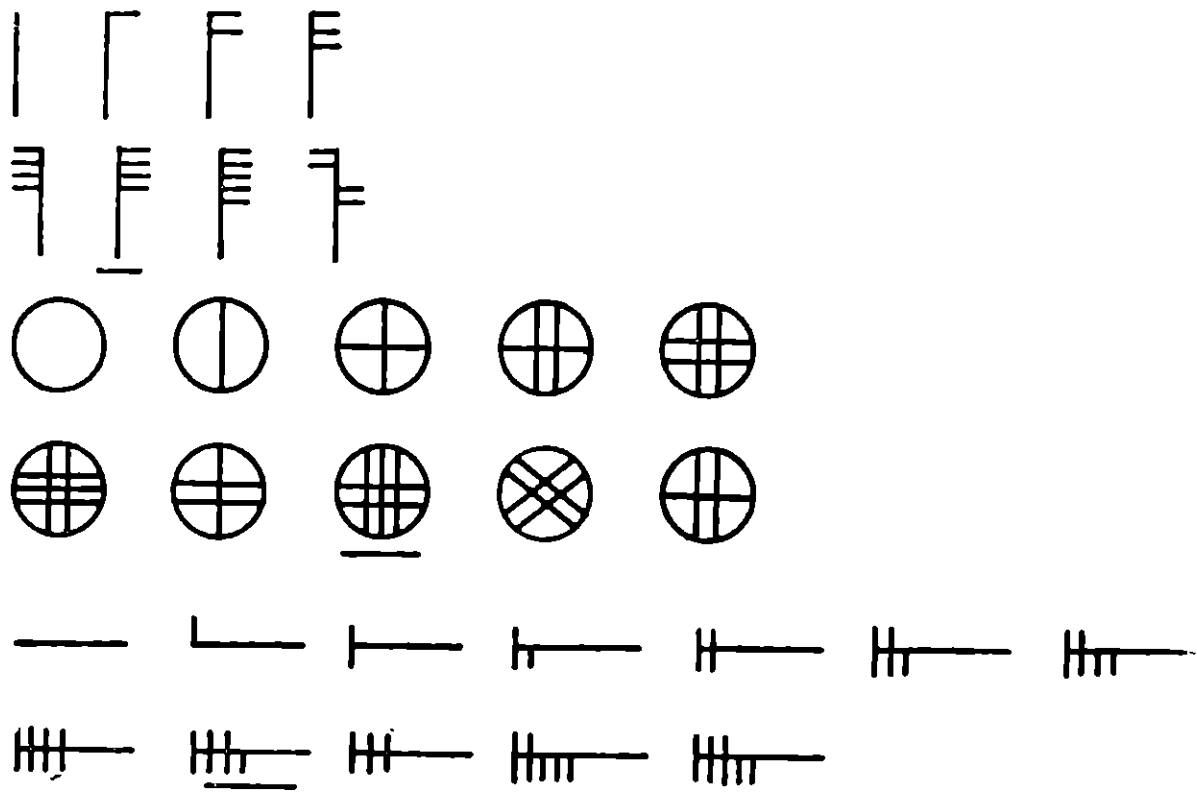
Classification

In each line below the figure that does not go with the others has to be underlined (as shown).



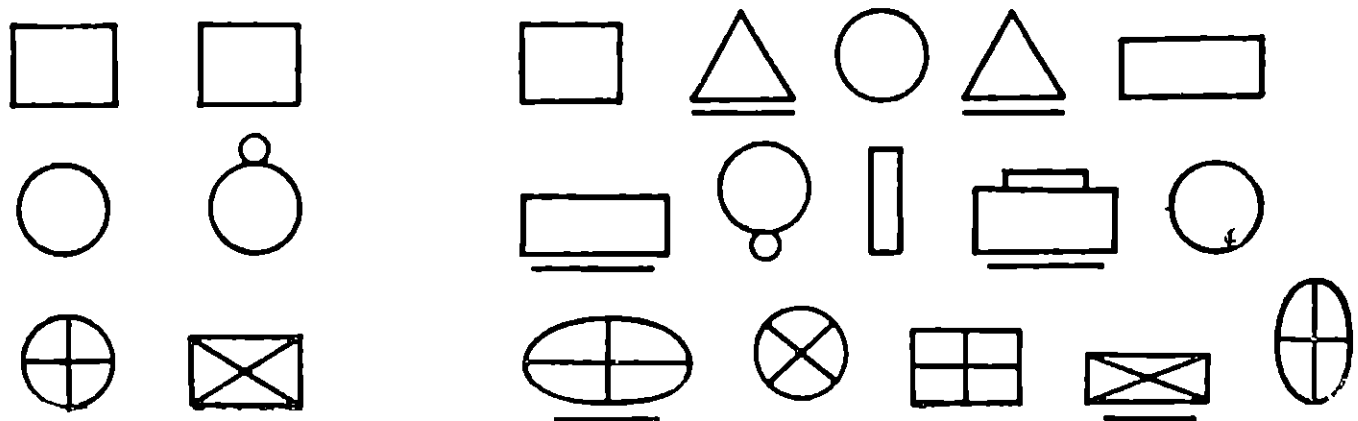
Series

In each pair of rows below, the top row is a series. Pick the figure from the lower row which should come next in the top row series and underline it (as shown).



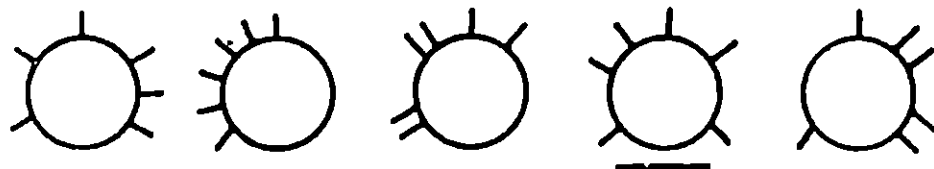
Analogies

In each line below the two figures in the group on the right which are connected in the same way as the two figures on the left have to be underlined (as shown).



Order

In each row of figures below find the figure that would come *in the middle* if the figures were arranged in the right order, and underline it (as shown).



The examples which have been given above are typical of the kind of items which occur in non-verbal tests. It will be seen that there is endless scope for variety and for construction of other items.

XIV. Conclusion

THE possible variety of tests of all kinds is so large that no study of them could be exhaustive. In the foregoing the main types of test have been considered and the different ways in which they may be presented, with illustrations and practice items. This will serve as a basis for the fair and reasonable preparation of children to tackle the tests. All tests employ the general principles which

have been discussed, and types which have not been included will usually be found to be combinations of those which have.

The items which have been given vary in difficulty. In setting and devising tests account must be taken of the age and level of ability of the children concerned, but how far test items and the instructions which go with them are suitable for the group which is to be prepared can only be discovered by actual trial on the group. Once suitability has been determined, however, the test items can be used afterwards on similar groups.

In practising tests the timing should be carefully considered. The time allowed should be such that every child can complete all the items he is able to do. Unless for any reason a test is being used partly as a speed test, it is better to allow rather too much time than too little.

In constructing test items involving the selection of alternatives it is well to include one alternative which is obviously wrong, and others which, though incorrect, may appear plausible. The child who really understands the item will not be led astray by this, while the chance of lucky guesses by those who do not understand the item will be diminished.

Answers to Tests

- | | | |
|-------------------------|---------------|-------------------------|
| 1. daisy | 39. true | 77. 5 |
| 2. sparrow | 40. false | 78. 6 |
| 3. blue | 41. 8 | 79. 36 |
| 4. cowardice | 42. X | 80. 14 |
| 5. when | 43. Z | 81. 14 |
| 6. bird | 44. O | 82. 4.30 |
| 7. flower | 45. D, V, U | 83. large |
| 8. woman | 46. 14, 26, 8 | 84. stone |
| 9. feeling | 47. P | 85. ceiling |
| 10. machine | 48. I | 86. through |
| 11. child, parent | 49. Q | 87. playground |
| 12. arm, hand | 50. A | 88. body |
| 13. woman, queen | 51. L | 89. mound |
| 14. before, after | 52. M | 90. boy |
| 15. lemon, sour | 53. 19, 22 | 91. sentence |
| 16. eat, drink | 54. 7, 1 | 92. indifferent |
| 17. reason, place | 55. 11, 13 | 93. NAP |
| 18. bad, worse | 56. 3, 1 | 94. TEN |
| 19. future, past | 57. 26, 33 | 95. PET |
| 20. false, imaginary | 58. 25, 16 | 96. NEAT |
| 21. fast, quick | 59. 19, 22 | 97. PATENT |
| 22. end, finish | 60. 20, 15 | 98. 30 |
| 23. bad, evil | 61. 26, 24 | 99. 15 |
| 24. tilt, incline | 62. 134, 402 | 100. 30 |
| 25. deep, profound | 63. 65, 129 | 101. 35 |
| 26. hot, cold | 64. 65, 82 | 102. 360 |
| 27. narrow, wide | 65. 17, 5 | 103. 115 |
| 28. clever, stupid | 66. 343, 64 | 104. 55 |
| 29. rejoice, lament | 67. 92, 141 | 105. 105 |
| 30. opaque, transparent | 68. 14 | 106. winter |
| 31. true | 69. 5 | 107. 9 |
| 32. true | 70. 36 | 108. Dick |
| 33. false | 71. 12 | 109. Mary |
| 34. true | 72. 13 | 110. go for walk |
| 35. false | 73. £140 | 111. south-west |
| 36. false | 74. £23 | 112. pinkweed, blueweed |
| 37. true | 75. 17 | |
| 38. true | 76. 4 | |