THE DEVELOPMENT OF FORMAL REASONING
IN PUPILS OF A POST-PRIMARY SCHOOL

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by
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CHAPTER I

INTRODUCTION

Secondary schools try to cater for pupils with a wide range of abilities. This wide range has been acknowledged - both in theory and in practice - but it is often a difficult task for schools to take it into account when organising classes and curricula. Most subjects require some formal reasoning by all pupils in one form or another. The level of difficulty of such formal reasoning varies in different class groups. Class groupings usually reflect the two factors of intelligence and age.

Many writers have been concerned with the influence of intelligence on pupils' problem-solving abilities. The concept of "IQ", and tests of this relatively unknown quantity, are tools that secondary schools use extensively in arranging their classes and timetables.

The influence of age on formal reasoning has not been given as much attention as intelligence. Of the writers who have studied the importance of age on the development of reasoning, Jean Piaget has put forward one of the most comprehensive theories. If his theory has validity, then the age factor must be given careful

consideration in the arrangement of course work in secondary schools.

Piaget's theory emphasises that adult reasoning is not fully mastered by most persons until after their fifteenth year. There exists, therefore, a large group of pupils between twelve years and fifteen years of age who may be expected to understand work beyond their development level. He does not suggest, however, that schools must avoid problem situations until pupils have reached their fifteenth year or until they have indicated in their work that they are capable of adult thinking. In fact, he appears to encourage the creation of opportunities which will allow pupils to handle problems, and points out that a subject's reasoning ability will remain latent unless opportunities are provided for its development and consolidation. Thus the schools must provide a range of experiences which allow pupils, of varying reasoning levels, the opportunities for further development.

In providing such an environment the schools are faced with a complex task. Not only must they provide different levels of experiences but often these must be provided at the same time within each classroom. Failure to take reasoning levels into account in this way would weaken the learning situation: an essential element of learning would be overlooked - i.e. the ability of the subject to gain understanding and insight from a given experience.
STATEMENT OF THE PROBLEM

This study was prompted by the belief that aspects of Piaget's interpretation of the age factor in his theory of intellect and development are worthy of practical demonstration. In particular, this investigation was limited to that part of Piaget's theory that concerns the development of adult reasoning in secondary school pupils over the age of thirteen years. This section of Piaget's work has been the subject of a difference of opinion for many years as many writers support the view that the linguistic factor is more important than Piaget contends. The support given to Piaget's theory by Albert Morf's² case studies (in Switzerland) of the roles of language and formal reasoning led to this wider cross-sectional investigation using a modified form of Morf's tests in a post-primary school in Christchurch in November, 1962 to see if further light could be thrown on the problem.

Specifically, this study involved:

I Three pilot tests through which an attempt was made to adjust Morf's tests to a secondary school atmosphere.

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II A main test. It was the purpose of this main test to be concerned with the following four features.

(a) Whether a quantitative estimate could be achieved of the relative roles of verbal features and reasoning features in children over thirteen years of age in a post-primary school.

(b) Whether or not a group of pupils who are not yet capable of the formal reasoning expected of them exist in a post primary school.

(c) Whether an indication of the age when formal reasoning may be expected to appear in pupils, can be gained, and

(d) Whether there is any difference in the ability of pupils to handle four different operations (and their negatives) used in the formal reasoning tests.

PLAN OF THESIS

In the next chapter a more detailed outline of Jean Piaget's theory of intellectual development will be presented as this will help to clarify the meanings of the reasoning tools that are used. Chapter III deals with the part of Piaget's theory that is concerned with the relation of language to reasoning, and discusses Norf's empirical support of Piaget's views. The progressive modifications of Norf's tests to allow them to be administered to school pupils
in a classroom atmosphere then follows in Chapter IV. The applica-
tion of the group test in its final form and a discussion of the
results of the test are included in Chapter V. The final chapter
summarises the more important findings of this study and suggests
possible avenues for further research.
CHAPTER IX

PIAGET'S THEORY OF INTELLIGENCE

An outline of Piaget's theory will help to clarify the part played by the operational tools of this study in giving an indication of a pupil's ability to reason formally. The formation of these logical instruments is an evolutionary process which begins in the earliest stages of an individual's existence. Through active participation, the person progresses from one stage to another. Progress is achieved through the continued adaptation of the individual to changes in the environment as he assimilates many new experiences and accommodates his actions and thought processes. Other factors (such as the rate of maturation of the nervous system, the amount of formal education each person has received and the richness of his home background) can influence the process of adaptation, for example, by speeding up or slowing down the sequence of developmental changes.

Piaget also outlines the successive stages through which an individual must pass in order to reach the highest stage of intellectual development. These stages consist of: first, sensori-motor actions; second, preconceptual thinking; third, intuitive thinking; fourth, concrete operational thinking and fifth, formal operational
thinking.\textsuperscript{3}

The final stage, that of formal operational thinking, is generally consolidated between the ages of about twelve to sixteen years. Most people reach this level; however, few people master all the aspects of formal reasoning and some people master no aspects at all.

When an individual has reached one of these stages of development he is said to be in a state of intellectual equilibrium.\textsuperscript{4} This equilibrium becomes a disequilibrium, and initiates a move to a higher level of equilibrium when the accommodative skills of existing levels cannot incorporate changes that occur in the environment.\textsuperscript{5} The most stable of these states of equilibrium is that of formal operational thinking, as it alone takes into account possible as well as actual conditions and is thus a more versatile form of logical thinking.

\textsuperscript{3}Formal operational thinking is referred to as "combinatorial analysis," "propositional logic," "hypo-thetical deductive reasoning" or "adult reasoning" in different sections of Piaget's work.

\textsuperscript{4}Equilibrium is described as "a state" in which all virtual transformation compatible with the relationships of the system compensate each other." (Jean Piaget, \textit{Logic and Psychology}, (New York, Basic Books Inc, 1957, p.41).

\textsuperscript{5}Piaget and Inhelder describe these changes as "an extension of the cognitive field". (Barbel Inhelder and Jean Piaget, op.cit., p.243).
The Stages of Intellectual Development

The first stage of intellectual development – that of sensori-motor intelligence – develops in the first eighteen months of a child's life when he masters such acts as pushing, grasping, lifting, biting, listening and looking. These actions are incorporated into behaviour patterns or schemata. These schemata become more complex and interdependent as the processes of assimilation and accommodation continue. This practical intelligence develops as the child comes into contact with the various objects in his limited home environment. Experiences which are distant in time (past or future) and in location do not modify the schemata, because the concepts of Time, Space, Cause, and Effect are not yet understood.

Despite the limitations of the experiences, sensori-motor co-ordinative actions help to give objects some permanence in the child's environment. 6

Understanding the permanence of objects is an essential achievement for progress to the next stage of intellectual development.

The second stage of intellectual development – that of pre-conceptual thinking – begins at approximately two years of age and

6 An object is permanent "when it is recognised as continuing to exist beyond the limits of the perceptual field when it can no longer be felt, seen or heard". Jean Piaget, op. cit., p.9.
continues for the next two years. During this stage the child learns to retain fleeting sense impressions of external objects, for later recall, through the use of symbols. These symbols may be expressed in behaviour (for example symbolic play) or in the first verbal symbols or signs (words). Piaget shows how symbolic play appears as a feature of the behaviour of children at this age: a stick might represent an aeroplane at one moment and a ship the next. Verbal expression of the symbols is usually in terms of words, but these words have much more primitive meanings than those implied in the use of the same words by an adult; for example, the word "cat" may be copied and repeated many times but may mean, in one experience, "a soft furry object," while in another, nothing more than a "warm" object. The use of a word as a true concept, that is representing a class of objects or events, is at first formed in an individual or personal manner—hence Piaget's use of the term "pre-conceptual" to describe these private and often unique concepts. It is only gradually that the child's vague and uncoordinated concepts become the stable concepts of conventional language. Slowly the stocks of symbolic experiences and their linguistic expressions become more extensive and definite in form. However limited are the attempts to symbolise experiences in this

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pre-conceptual stage, they are significant in that they are the beginnings of the mastery of language and symbolic thought.

The equilibriums of this level is reached when all the objects and actions that a child has encountered in his surroundings can be expressed symbolically.

The third stage - that of intuitive thought - appears about the age of four years when the child is capable of combining numerous symbolic expressions of perceptions into groups. Symbols of, for example "furry objects," "objects with four legs" and "warm objects" may be combined and viewed as a group of perceptions. Piaget calls them "sub-groups" as they are quite unstable and incomplete. The sub-groups are isolated from each other as they are not seen as part of a pattern or change from one situation to another, i.e. a transformation, but rather each one has an existence which has no relation to other sub-groups. For example, "ears furry kittens" may be symbolically expressed; and "large warm furry
sens" may also be symbolically expressed, but the two are not linked together as part of the same concept.

The process of sub-grouping is based on immediate and superficial subjective perceptions. These perceptions, expressed symbolically, are linked in "juxtaposition" within the sub-group, usually in the order in which they are perceived. There is no fitting of symbolic experiences into a logical pattern — such as, for example, the relating of cause and effect — as the four to seven year old is as yet unable to appreciate logical analysis. The links are intuitively formed and the only regulations used are those of perception, for example "they all look the same colour" irrespective of other features of the objects. Thus a four to seven year old child will link a ball, a china dog, a live dog and an elephant together because they are all in the same picture book, or all the same colour, without appreciating any distortions and inconsistencies that this link causes through the existence of other, unappreciated features. The child at the intuitive level is quite uncritical in that he is unconcerned about or unaware of these distortions.

As he uncritically views many different sub-groups of symbols the child begins to realise that symbols, which appear in a variety of situations or structures, can be represented by one symbol which can be transferred from one experience to another and eventually, to recognise that symbols have existence independent of the experiences in which they first appeared. Thus he masters the notion of
"conservation" of the symbols and "conservation" of the objects or the properties of objects that they represent. At this stage such properties as height of a table or the size of a ball can be appreciated and later the concepts "height" and "size" are recognised as being separate in themselves. This indicates the achievement of the equilibrium of intuitive thought. The child is now ready to develop concrete operational thinking.

In the fourth stage of intellectual development the seven year old child begins to manipulate the newly conserved symbols of objects, or the physical properties of objects, existing in his environment. These mental manipulations are called operations. More specifically, they are called concrete operations because they are manipulations of symbols in concrete or actual situations as distinct from hypothetical situations. The symbols are now seen as related or linked in patterns although these patterns may be relatively crude and unsophisticated. The structures or sub-groupings of symbols that can be constructed are of two main forms. One involves the classification of symbols into sub-groups, for example, animals such as a fox terrier, labrador, persian kitten, irish setter, spaniel and siamese cat, can be successfully classified into sub-groups such as "dogs" and "cats" at this stage. The reversal operation which recognises the opposite situation is also understood at this stage; that is, the symbols "dogs" and "cats" can be grouped under the heading of "animals".
The second form of logical operation understood at the concrete level demonstrates ordinal relations between symbols or groups of symbols. This operation involves concepts such as those implied in "greater than", "less than", "shorter than" and "longer than". This operation allows the individual to serialise and to form correspondences between symbols; for example to arrange a variety of numbers in descending order. The cancelling or opposite operation, reciprocity, is also understood during this stage of development.

The sub-groups can contain distortions and inconsistencies as they are based on immediate data which may not contain a representative sample of the possible combinations. There is no allowance made for other possibilities as in the "structured whole" of the next stage. Distortions can also result, as only one classification or serialisation can be handled at one time – blue balls may be perceived and later, little balls or bigger balls, but it is difficult for the subject to appreciate little blue balls, large blue balls, and the range of opposites of these, all in one operation. In this way the organisation by the child of the symbols may seem uncritical from the logical point of view, as it lacks the balancing effects of an overview – a feature of the next stage.

Despite these limitations, concrete operations are generally sufficient to cope with most experiences which occur within the limited field of immediate surroundings, as perceived at the time.
Additive or multiplicative sub-groups tend to be of adequate complexity to handle the most complicated arrangement of perceived objects or separate properties of objects.

The equilibrium of concrete operational thinking can be satisfactorily applied to many instances in everyday life where reasoning does not need to go beyond the re-arrangement or re-organisation of the elements perceived in the situation. Because many - perhaps most - situations are likely to be at this "concrete" level of complexity, concrete operations are appropriate even when older subjects can demonstrate, in other situations, that they are capable of more complex and higher level formal operations.

The subject is ready to move from the equilibrium of concrete thought when the complexity of the situation forces him to realise that some conditions cannot be assimilated by his existing accommodative structures or concrete sub-groups. The conditions which bring about this need to change usually appear as inconsistencies that cannot be overcome without making assumptions that go beyond the data given. The individual begins to feel that he must review the problem objectively, from another angle, to see the situation as

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9Additive sub-groups are elementary "groupements" in which it is possible to form further simple groups for examples by adding two sub-groups or subtracting one from another. In multiplicative sub-groups elementary "groupements" can be sub-divided or combined. A detailed explanation can be found in Jean Piaget op.cit., p.30.
a whole. To do this he requires a return to the starting point of the problem so that he may set out again in a new direction. This "return to the starting point" is the essence of reversibility - a crucial operation at the formal level. This operation is a combination or synthesis of the two separate concrete operations - inversion and reciprocity - and is the negative of the new reasoning operations which develop in the fifth stage of intellectual growth. The appreciation of the need to gain an overview and the beginnings of attempts to achieve it in a logical manner, indicate the emergence of formal operational thinking. The individual discovers through his experiences that there is a range of operations (and their negatives) that can be used for exploring and defining the problem as a whole. To the twelve to fifteen year old, they exist simply as a range of operations which are appropriate for particular types of problems (for example, proportions). Piaget enumerates them and their use more systematically through the use of symbolic logic - a calculus of propositions.¹⁰

These more complex operations are called higher-order or second-order operations because they are operations on concrete operations. The relations between symbols formed in concrete opera-

tional thinking become the raw materials for formal operational thought and, as such, are manipulated, organised and compared.

When a problem arises, the relations are structured logically into groups. The groupings are viewed as steps in a transformation - a change from one viewpoint or hypothesis to another - and not as isolated identities. The groupings are more stable than earlier concrete sub-groups as they are formed in such a way that they take into account a wide range of possibilities as well as the one situation under consideration. The reality is seen as but one situation in a wide range of possible situations that could occur, given the set of conditions.

The structuring of the problem is carried out through formal operations. After structuring groups in many situations, through the use of the formal operations, the pupil begins to recognise the formal operations themselves. The structures of the operations are slowly freed from the situations in which they were first employed. The operations are thus conserved in such the same way as the symbols and concrete operations of earlier developmental levels were conserved.

Once they are isolated, the operations are used as instruments of rigorous logical deduction in further situations. In these experiences, the individual implicitly recognises that there is a definite relationship between these operations. The operations are used in such a way that a given set of relations is maintained and
the operations together form a structure. Piaget calls this structure a "groupement". He describes the structure as a "table of propositional operations" and the given set of relations as a "lattice" relation. The full understanding of one operation implies the recognition of the set of relations in the "groupement". To carry out a binary or ternary operation, the individual not only employs one operation such as the incompatible relation (pq) or the disjunctive operation (pq), but the whole "groupement". The thought process "spreads" from the one operation and affects the range of other possible operations through the "groupement", following the lattice framework.

In considering a range of possibilities however, it must be possible to cancel one thought process, to return to the starting point and begin another transformation. This reversal of the thought process requires the cancellation of not only the direct operation but the spread effect in the "groupement". Through a range of experiences the necessary reversible operation is conserved. This operation cancels and compensates, simultaneously, the lattice spread of a thought process.

This reversing operation has a distinctive structure which

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11 A "groupement" has five principles or consists of a relation of five operations: Composition, Inversion, Identity, Tautology, Associativity. Jean Piaget op.cit., p.37.
Pinaget describes. The operation is, itself, formed of a group of negative operations with a definite set of relations existing between them. This synthesised negative operation he calls the INRG group. The relation between the negative operation in the group are summed up in the diagram.\(^{12}\)

\[
\begin{align*}
\text{Disjunction} & \quad \text{Incompatibility} \\
(p \lor q) & \quad (p \land q) \\
\text{Conjunction} & \quad \text{Conjoint Negation} \\
(p \land q) & \quad (p \land \neg q)
\end{align*}
\]

This group represents the synthesised negative operation which counteracts the influence of an operation on the inverse (\(\neg\)), the reciprocal (\(\neg\)), and the correlate (\(c\)) relations formed with other factors by any one factor. The (I) refers to the identity operator or the operation which brings about no change to any factor or proposition.

Thus, with the aid of the "groupement", a series of structures or transformations can be carried out mentally. Using the INRG, these mental operations can be cancelled and other transformations carried out. All possible combinations of situations and of operations can be taken into account with the aid of the structures.
of the "groupement" and reversing process, the INRC. Analysis employing these, he terms: combinatorial analysis.

Once the individual has conserved these mental instruments he is fully equipped for formal thinking and such thinking can be successfully employed in any possible situation likely to arise.

These highly complex tools or schemata can be expressed verbally as in symbolic logic; mathematically as in the notions of proportions or correlation; or behaviourally as in the handling of situations requiring the understanding of mechanical equilibrium. It is the fact that formal reasoning manifests itself in so many fields or subjects that the presence or absence of formal reasoning in a pupil is of importance to the secondary school. The tools of formal reasoning can be used in all subjects even though pupils may rely on less complex forms of thinking in many situations. Where operations are used too infrequently, the "groupement", and the INRC process may remain as latent operations and formal reasoning development hindered.

Thus, for the secondary schools to take into account varying pupil abilities, they must recognise that pupils are capable of different levels of reasoning so that pupils still tied to concrete situations are given the opportunities to experiment with concrete operations; pupils whose operational ability is confined to the early stages of formal operation development are given a sufficiently wide range of experiences to be able to conserve operations; pupils
discovering the "groupement" and other more complex schemata have the opportunity to use these logical tools to construct "hypotheses whose truth status is regarded as hypothetical" and from which conclusions are rigorously deduced.

To ignore the existence of such levels would be to ignore the important fact - that pupils can only gain experience from situations that they are capable of comprehending.

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13 It is from the use of hypotheses that Piaget's term hypothetico-deductive reasoning comes. Barbel Inhelder and Jean Piaget op. cit., p. 251.
CHAPTER III

LANGUAGE AND OPERATIONAL REASONING

Piaget criticises the view held by some writers that levels of reasoning do not exist. They contend that individuals both within the secondary school atmosphere and in after-school situations are faced with problems whose solutions require the use of thinking processes that are essentially the same at each age level. Their argument is then, that problems vary only in the degree of difficulty of such situation, and that reasoning is hindered by verbal difficulties which arise through the influence of such factors as lack of sufficient concrete examples to support verbally expressed ideas. A major problem of curriculum content in schools where this opinion is held would be the task of grading units of work with varying degrees of difficulty.

Piaget on the other hand, supports the view that language development can hinder or help the process of reasoning as language is an essential element in the adaptation of the individual to his environment. Many perceptual experiences are expressed in a verbal medium, especially at the formal level where symbols are purely abstract. Piaget points out however, that at the formal level of

\[14\] Jean Piaget op.cit., pp.2-4.
reasoning there are other means of representing thought processes for example, through algebraic abstract symbols. Most pupils find it is generally difficult to reason through any of these media, including the verbal medium, when formal reasoning is still in the process of being mastered. Piaget stresses that at this level the difficulties that arise from handling media, are the result of operational difficulties. Even though language can influence the growth of operations, Piaget believes that the reverse effects of operational development on language comprehension is of more significance. A more detailed outline of his views on the relation between language and operational development will help to show more clearly why Piaget disagrees with writers on this point. As the levels of language and reasoning abilities are dependent on earlier progress, to fully understand them he treats the relation of language to reasoning in a developmental manner.

PIAGET'S VIEWS ON LANGUAGE IN RELATION TO REASONING

After eighteen months of a child's life two kinds of thinking appear, egocentric thinking and socialized thinking. Two kinds of language appear to be associated with these. Egocentric language is language which represents an expression of the individual's needs, accompanies his actions, or merely takes the form of a running commentary on his behaviour or intentions. It is not used as a means of serious communication but rather as a means of expression.
Gradually the individual realizes that communication implies the use of language in such a way that account is taken of the viewpoint of the "other person", that is, that language is a medium which forms a channel of communication between the speaker and the listener. From 2-11 years, language development is associated with an increasing complexity in symbolic thought. The first loosely conceptualized words and the subsequent undifferentiated phrases develop into concepts which are the instruments of classifying and serializing. As age progresses, language becomes an increasingly flexible tool. At the formal level, words describing abstract concepts such as "honesty" and "loyalty" are added to the vocabulary of the individual. Words which play a part in formal operations, such as "all", "some" and "if" gain a more precise meaning.

However, because the range of individual rates of development is great, the environment may impose a faster rate of progress than the pupil is capable of coping with, and rote learning occurs. The language of the situation may be learned without being accompanied by any understanding of the situation itself. This could happen very easily in purely verbal situations. At the secondary school level simple concrete operations would be expressed in formal operational language.

The opposite situation could also arise when, through a poorly developed verbal environment, the child may not be given the opportunity to expand his vocabulary as rapidly as he needs. Operations
may therefore be expressed in a language suited to a lower level of
development - that is, operations may be expressed in the language
of classes. Pupils may even choose to do this, especially in
spoken language, and use elementary expressions as a short cut
procedure. A great deal of the thought content, in many cases,
remains implied.

Despite such differences in individual development, the
individual's ability is usually surprisingly adequate for communi-
cation. The whole range of language accomplishments is rarely
called on. Even with the use of short cut words and phrases, wrong
interpretations are not as frequent as one would expect.

These impressions in the language tool Piaget recognises.
On the whole, he still believes that language shows characteristics
which indicate the individual's level of reasoning because the con-
tent and use of language is influenced by different stages of logical
development.

To avoid the impression of language, Piaget expresses his
own interpretation of intellectual structures in terms of a more
precise, quasi-mathematical symbolic logic. He considers that, even
though language may not always be formally organised, the intellec-
tual structures behind it have logical consistency and are capable
of logical interpretation through the use of non-verbal symbols.
A child does not merely translate the perceptual data before him.
He uses it in an intellectual structure. If experience and practice
were the only determining factors, then learning words to represent concrete and abstract experiences, and their use in operations, would be present at the earliest levels of children's thinking.

**MORF'S EMPIRICAL VERIFICATION OF PIAGET'S WORK**

Piaget attempted to verify his theory empirically, through longitudinal case studies of his own children in his home in Switzerland. His books contain many detailed accounts of his directive questions and the children's answers as they attempted a variety of problems from finding a watch hidden under a cushion, to testing correlations between hair colour and eye colour. Statisticians have criticised his case study methods, the inadequacy of his experimental controls and his qualitative approach. Some of his colleagues (for example Inhelder) are more concerned with experimental verification of various aspects of his work.

One such investigation of some aspects of the relation of language to reasoning was carried out by Albert Morf.15 As this thesis utilises features of Morf's work, an outline of his investigations is essential to the understanding of later chapters.

**Summary of Morf's Investigation**

Albert Morf carried out a series of one hundred and nineteen

15Albert Morf op. cit.
case studies using a group of seven to fifteen year old children as subjects. He was interested to see if errors in reasoning made by his subjects were the result of faulty operational logic, or a lack of linguistic ability in the changeover period from concrete to formal thinking.

**Table I**

**Age Distribution of the Subjects in Morf's Study**

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>Age in Years</th>
<th>Number of Children</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7-8</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>8-9</td>
<td>20</td>
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<td>9-10</td>
<td>21</td>
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<td>10-11</td>
<td>20</td>
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<td>11-12</td>
<td>20</td>
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<tr>
<td></td>
<td>12-13</td>
<td>12</td>
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<tr>
<td></td>
<td>13-14</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>14-15</td>
<td>10</td>
</tr>
</tbody>
</table>

(Source: Albert Morf op. cit., p.174)

In an interview with each child in turn, he repeated a series of stories as many times as appeared necessary, until he felt that each subject clearly understood the series of events in each story. These stories made use of concrete situations in which the subjects could probably imagine the various relationships between the people in the stories and the events. Four formal operations were tested in the problem. For example, "The Tie" test required the use of the operation of implication (i.e., \( p \rightarrow q \); if \( p \) occurs then \( q \) will occur).

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16 Albert Morf op. cit., pp.173-174. A copy of the complete test is included in the appendix.
A school pupils' fair was held in Lausanne for pupils from all over Switzerland. Those from Geneva decided, just as they were leaving, to wear ties. So each one put on a blue tie. During the fair I was walking with a friend of mine in Lausanne and;

(a) I saw in front of me a pupil from Geneva. But I didn't see his tie since he was walking in front of us. Then my friend asked me, "What colour do you think his tie is?" What answer could I give him?

(b) A little later we saw a pupil who was coming toward us and he was wearing a blue tie. Then my friend asked me, "Do you think he comes from Geneva?" What answer ought I give him?

The formal solution required the understanding of the asymmetrical relation expressed in the statement "if the pupil was from Geneva then he would be wearing a blue tie." If he was wearing a blue tie it did not necessarily infer that he was from Geneva.

The operation of incompatibility (p/q either p occurs or q) was involved in such tests as the "Three Animals" test.

A man travels with three animals: a cat, a dog, and a canary. In the evening, in the hotel, he can't leave them together in the same room, because what would happen? (It is necessary here to make clear that the dog does not attack the canary). So, it is necessary for him to take several rooms. How many? (One can reduce the possibilities if necessary, in order to approach the solution, dog plus canary).

Other alternatives, such as cat plus canary were incompatible with the elements of the problem.

"The melons" test required the use of the incomplete affirmation operation pq (i.e. p and q occur together pq). This operation was called "incomplete" as other possible relations that could be used for comparison with the relations mentioned in the story,
were not stated specifically. For example:

A man came back from Italy and said, "I will never eat olives and melons at the same time. I saw there, someone who had eaten melons and olives at the same time, and the next day he was dead."

Another test, "The Soup" test involved the disjunctive operation \((pq \lor r)\). In this problem either meat, soup or condensed milk caused stomach aches in two people.

My brother and I were climbing in the mountains. Then we arrived at our hut, we found that we had forgotten our food. Then we looked around the hut and found the remains of some provisions, but they were no longer fresh. Here is what we found — condensed milk, soup and an old tin of meat. My brother ate some meat and soup, and I ate soup and condensed milk.

An hour later we both had stomach aches. What could this have come from?

Problems were introduced through the use of standardised questions asked after each story had been assimilated. The solutions were given verbally by the child during the interview. The types of proofs put forward by the pupil to support his answers were taken as an indication of his reasoning processes. A proof was considered adequate if it indicated that the subject had applied the logical operation so that all the elements in the problem could be taken into account (that is the problem was seen in its totality). This characteristic of thinking implied that combinatorial analysis had developed.

The number of correct solutions achieved by pupils in each age group was expressed as either a percentage of the total number of people in each age group, or in qualitative terms. For example,
"it was not until the thirteenth year that fifty percent of the subjects gave correct solutions to the first problem, whereas in the third problem, all the subjects, over eleven years gave a correct solution. In the sixth problem it was not until after the fourteenth year that any correct solutions appeared."\textsuperscript{17}

A complete statistical picture of the results was not presented. Morf, like Piaget, did not appear to be concerned with establishing definite age levels at which certain characteristics of thinking can be expected to appear. Rather, his main concern was to establish that these characteristics in fact, do exist at particular levels of development. Qualitative rather than quantitative criteria were the basis of the estimations in his study.

The solutions to the problems posed by Morf were considered inadequate if they contained distortions resulting from the ignoring of one or more elements in the problems. The number of incorrect solutions was qualitatively stated by Morf. When an incorrect proof was put forward, he attempted to redirect the subject's thinking through the use of various didactic interventions such as, repeating sections of the problem, doubting or rejecting responses, and isolating the main features to see if a correct solution could follow. If a correct solution was eventually achieved (which happened in half the cases) an analogous problem was presented to see if the new successful approach was transferred. When this occurred it was

\textsuperscript{17} Albert Morf op.cit., p.175.
accepted that combinatorial analysis had been successfully employed. Although Morf did not give a percentage figure for the number of correct solutions achieved in this way, he did state that true ability to transfer problem-solution behaviour occurred in only a few cases and then only when the individual was already capable of formal operational thinking. He concluded that combinatorial analysis could not be taught through didactic intervention.

Throughout the testing, incorrect solutions were carefully checked through further questions, to see if they were influenced by purely verbal difficulties. Where such difficulties appeared, attempts were made to remove them to see if the solution varied in any way. Morf did not indicate how widespread such difficulties were. It can only be inferred that they were not originally sufficiently serious or widespread to provoke comment from him. Whatever the extent of such linguistic difficulties he reduced the number to a small group of persistent misinterpretations which he attributed to the influence of the developmental factor - that is, to the level of reasoning that the pupil had reached. The group of persistent difficulties involved words such as "all" and "some". Although the difference between these words was appreciated when they were taken out of context, pupils not yet capable of formal reasoning failed to take account of the differences in the problems.

Thus Morf concluded that the existence of adequate solution methods in problem solving (and some persistent verbal difficulties
which caused certain persistent errors and distortions), could be explained in terms of the availability to the subject of logical operations as they are interpreted in Piaget's developmental theory. Further, he considered 119 case studies to be adequate for empirical verification of Piaget's theory - assuming his own interpretations of the subjects' behaviour were accurate. However, the subjective interview approach did not lend itself to a quantitative interpretation of the results by another person.

Despite the difficulties inherent in evaluating such subjective evidence, the results do seem to indicate that Piaget's theory of intellectual development has considerable value in the study of the thinking of children between seven and fifteen years of age and that many of the linguistic difficulties in handling problems stem from the effects of the level of reasoning ability in the subject.

Significance of Hart's Case Studies for this Study

These results are significant in that they are of considerable importance to schools. Such an interpretation of verbal and problem-solving difficulties in terms of operational developmental levels could have some bearing on the problem of achieving maximal progress in pupils' work. Knowledge of the pupil based on this approach to thinking could help to avoid the occurrence of situations which result in rote learning. The aim of maximal progress of the individuals taking into account the different rates of progress of pupils, is not
a new aim dependent solely on the understanding of the developmental levels. However, the deeper understanding of pupils' reasoning that results from recognition of the operational nature of thinking could help to bring the fulfilment of such an aim closer.

A further study, therefore, held within the school atmosphere seems worthwhile as it may help to indicate if similar reasoning results can be achieved in a more traditional and formal atmosphere. If this is possible then Piaget's theory gains increased practical significance in the educational field.

To test the level of reasoning and verbal ability as it appears in the school situation requires however, that the school atmosphere is maintained during the testing. The individual case study approach lacks an important feature of this atmosphere - the group element of the classroom. In a case study the pupil is separated from the class or group and interviewed in isolation uninfluenced by group pressures.

As a prelude to a school-wide group test three pilot experiments were carried out in a classroom setting in an attempt to adjust Moll's tests to the group atmosphere within a school.
CHAPTER IV

Modification of Morf's Tests for Testing within
A Group Atmosphere

First Pilot Experiment

A preliminary reasoning and linguistic test was carried out on a group of thirty, fifteen to sixteen year old girls of average intelligence. The group was a commercial "A" stream in a Christchurch secondary school. In the preliminary test Morf's problems, unchanged in any way, were introduced on a "class interview" basis to see if this approach was appropriate for indicating a relationship between reasoning difficulties and language.

The problems, treated separately, were read as many times as was considered necessary until all the members of the class appeared to have grasped each problem. Questions were encouraged to help overcome any difficulties in understanding the tests. Pupils were asked to write down their answers after each problem was read to them.

In reviewing the answers, it was found that most answer sheets contained at least one correct reply, indicating that the pupils had

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18 All IQ estimates in these tests are based on the Otis Intermediate Higher E test.

19 See Appendix I for an outline of Morf's tests.
grasped some elements of the problem. But these replies were usually accompanied by a number of answers containing obvious misinterperations of the problem, short cut methods, or merely a "yes" or "no"—despite repeated promptings by the supervisor to give written proofs in support of answers.

Results and comments on a typical answer sheet were as follows:

<table>
<thead>
<tr>
<th>Problem</th>
<th>Reply</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 &quot;The Tie&quot; Problem</td>
<td>(a) Because the people behind could not tell that colour he was wearing.</td>
<td>A concrete operational approach with a search for the reply in a concrete setting.</td>
</tr>
<tr>
<td></td>
<td>(b) Anybody could wear a blue tie and not come from Geneva.</td>
<td>Formal operational reply as the asymmetrical relation was appreciated.</td>
</tr>
<tr>
<td>2 &quot;The Soup&quot; Problem</td>
<td>Soup. They both ate soup.</td>
<td>The formal operation was appreciated, as the common element was noticed.</td>
</tr>
<tr>
<td>3 &quot;The Rules&quot; Test</td>
<td>Ans. I had a picture in mind.</td>
<td>This is a reversion to a concrete situation and a search for the answer in the features of each animal.</td>
</tr>
<tr>
<td>4 &quot;The Pearls&quot; Test</td>
<td>(a) Yes.</td>
<td>No proof.</td>
</tr>
<tr>
<td></td>
<td>(b) Yes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(c) Yes.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(d) Yes.</td>
<td></td>
</tr>
<tr>
<td>5 &quot;The Watch&quot; Test</td>
<td>(a) Yes.</td>
<td>No proof.</td>
</tr>
<tr>
<td></td>
<td>(b) No.</td>
<td></td>
</tr>
</tbody>
</table>
6 "The Melons" Test

Only some replies indicated the presence of formal reasoning.

The group method as used in this pilot test, contained an insufficient number of safeguards against difficulties in structuring the problems (resulting from an inadequate grasp of the problem), and actual wrong structuring of the problem (resulting from misinterpretation of the facts). Both of these difficulties could, perhaps, be partly avoided if the pupils had been able to read and reread written copies of the tests. The class interview approach did not seem an adequate method for gaining an indication of verbal and reasoning difficulties.

However, the first pilot test was useful as it indicated two features; first, that a more standardised written form of testing was required if the tests were to be applied effectively in a school situation; and second, the test did not indicate support for Morf's view that the stage of reasoning of the pupil and not the verbal factor was the main influence in achieving solutions. The difference between these results seemed to stem from the inadequacy of the method of presenting the tests to the school group rather than from any limitations in the tests themselves. A modification of the testing procedure appeared necessary and two further experiments
were carried out. Essentially these were concerned with the form-
alis ing and standardizing of the test method and with gaining a further
general impression of the presence or absence of the characteristics
of language and reasoning emphasized by Norf.

Second Pilot Experiment

The second experiment was presented to thirty-two girls in a
third form, commercial "B" stream. There were thirteen girls
between thirteen and fourteen years of age and nineteen girls four-
teen years of age and over. It was an average group with a mean
intelligence score of 95.

Problems were presented on typed sheets. Sufficient space
was allowed for written replies and written reasons. Changes in
the tests were limited to changes in the arrangement of problem pro-
cedure, the simplification of wording, and the replacement of Swiss
place names and expressions with local names and expressions.

For example, in Norf's "Pathways" test (which became the
"Dangerous Road" test,) "pathway" was replaced by a "road outside
Christchurch" and the "Lantern" that was carried became a "Lamp on
his bicycle". The modified "Pathways" test then read:

THE DANGEROUS ROAD

Not far from Christchurch there is a road which is very

\[20\] The modified tests are included in Appendix I.
dangerous to travel along at night because of the many sharp turns. You are forbidden to ride along the road at night on your bicycle without a light showing on it. You can travel along it in the daytime without a light showing on your bicycle.

a. A bicycle rider arrived at the stretch of road at night and his bicycle had a light showing. 

Has he allowed to ride on the road?

May?

b. A rider arrived at the stretch of road in the daytime and his bicycle had a light showing. 

Has he allowed to ride along the road?

May?

c. A rider arrived at the stretch of road in the daytime. His bicycle did not have a light showing. 

Has he allowed to ride along the road?

May?

Instructions were given verbally and any questions asked by the pupils together with the supervisor's replies were written down by a helper. Three, forty minute lessons were allowed for the test. This appeared to be an adequate time estimation for administering this form of the test.

It was obvious that constant rereading of the problems occurred while the pupils were attempting to solve them. The subjects tended to try to grasp the problems "concretely" as an aid to problem solving - underlining words, whispering to themselves,
pointing at one written element while rereading another. The written form of the test aided the memorisation of the story and the isolation of the elements of the problem more than the form used in the earlier test.

The results of this pilot experiment were much more detailed than those obtained in the first test. Almost all the characteristics of concrete and formal reasoning mentioned by Morf were present in the range of answers. Some replies indicated these features so clearly that they could be easily classified into formal or concrete replies. For example in the "Unknown Animal" test (disjunction), the question "Which of the three animals did I see?" was asked. Replies with reasons such as "The mule, because it was the only animal with both long ears and a thick tail", were accepted as correct as the common features in the relation were appreciated. Replies such as "I don't know as I haven't seen a mule", or "Sometimes a horse can have a thick tail", reflected attempts to try to solve the problem concretely by searching for concrete characteristics of animals, not by seeking an abstract relation between elements in the problem.

In the "Mishap" test (disjunction), formal replies to the

21 It was interesting to note that these features tended to disappear in the problem solving attempts of older pupils with a better grasp of formal reasoning.
question "Which food gave them stomach ache ?" could easily be
distinguished from concrete replies. An example of a formal reply
was "Soup, as they both ate soup", and examples of concrete replies
were "The soup, because soup curdles", and "The meat, because meat
won't keep".

There was also a group of replies which indicated the use
of short cut methods similar to those noted by Norf. Short cut
methods avoid the need to fully structure the problem and do not
give an indication of a pupil's actual structuring ability. In
the "Ties" test (implication), one pupil when asked "What colour
would the tie be ?" gave the answer, "The tie would be the same
colour as her monogram". Another pupil replied, "She would not
need a tie as she had a blue gysfrock on". These replies could
not be automatically interpreted as concrete replies. In the
latter reply the pupil implicitly answered the question in stating
"a blue gysfrock". If she had structured the problem she would
no doubt have discovered the correct answer.

A further significant result of the test indicated that there
was a group of replies which emphasised that some of the girls
showed a lack of skill in expressing their proofs. For example,
in answering a part of the "Travellers" problem (viz, "Another
passenger arrived and said 'I haven't a dog and I have forgotten my
suitcase'. Could he go ?"), one girl replied, "The passenger can
go without my lunch or dog". To the question,"Another passenger
arrived and he said to the driver 'Do you take dogs?' Can he go?" a reply was, "Yes because you can take a dog and yourself."

Such replies were difficult to classify into formal and operational replies. In the second example above it was not clear in the second section whether the dog - or - suitcase alternative had been implied or ignored. Of the replies given by the thirty-two pupils, an average of thirteen in each problem could not be classified as they did not indicate sufficiently clearly the level of reasoning. This group of replies was quite large and pointed to the need to help pupils to set out their answers in such a way that the meanings would be quite clear. While doing so it would also be possible to influence pupils' expressions so that their answers could be classified more easily.

This pilot experiment further indicated that no pupil in the class gained all the correct solutions. Approximately two thirds (21/32) of the pupils achieved one half or less than half the possible correct replies. Most of the mistakes resulted from operational difficulties similar to those MofF discussed. An average of one eighth of the replies (4/32) in each problem reflected linguistic difficulties. In the "Melons" test one reply interpreted the statement "I will never eat olives and melons at the same time" in quite literal terms instead of "at the same meal" as mentioned elsewhere in the test. Most of these words or phrases were capable of substitution. However, it was interesting to note that when such
linguistic difficulties were removed in later interviews with some of the pupils, they still found difficulty in solving the problem (see page 43 for an example of this instance).

In general, a study of the replies in the second pilot experiment seemed to support Piaget's and Morf's work, while the written form of the test, with some further refinements, appeared to have value as a means of gaining a more quantitative indication of their results in a classroom setting. Such a quantitative expression could help to throw further light on the one main point of disagreement - the age at which formal features begin to appear. It is apparent from these preliminary tests either that New Zealand pupils do not develop formal operational features until much later than Morf's 119 Swiss pupils, or that Morf has set the age level of the appearance of these features at too early an age. Whereas Morf's group showed a good grasp of formal reasoning from fourteen years of age, only one third of Christchurch pupils gained over half the correct answers and not one pupil showed a very good grasp of all the features.

**Didactic Interventions**

A number of didactic interventions were made during the test.

These included:

(a) In the preliminary explanation the supervisor described the test procedure to the subjects, using the first part of the "Dangerous Road" test as an example. A sample reply to the question
"A bicycle rider arrived at the stretch of road at night and his bicycle had a light shining. Could he ride along it?" was given as — "Yes, he was allowed to ride along the stretch of road at night because he had a light shining on his bicycle." Almost every pupil used this reply in their own tests but the approach was not generally applied in answering any other part of the test, or any other test.

(b) Many questions were asked by the pupils during the testing time. Replies by the supervisor were designed to encourage the pupils to reread the problem. For example:

" Mishap" Problem Question: Did they cook the things? (soup, meat, milk)
Answer: Does it say so in the problem?

"Animals" Test Question: Were the animals in cages?
Answer: Does it say so?

All but five of the thirty-eight questions asked during the test reflected operational difficulties in solving the problem. Four of the five exceptions concerned the test procedure, e.g. "Do we put our names on the paper?". One question involved a linguistic difficulty with the word "defect" in the "Matches" problem. The pupil seemed to find the supervisor's reply adequate. A later study of the written reply indicated that an appreciation of the word had been achieved.

Another type of didactic intervention was made after the test, when ten case studies were made of selected individuals. The inter-
views were recorded on tape and later transcribed. During the
interviews a positive effort was made to help the pupils reach the
correct solutions to the test problems. Only three cases provided
good examples of pupils who were capable of formal reasoning but
who had previously been working at a lower level of reasoning.
In one case the solution was achieved immediately and quite spon-
taneously even though an incorrect solution had been given in the
actual test. The pupil could give no explanation for her previously
incorrect reply nor for her immediate success at the interview.
In the second case the correct solution was achieved once she
avoided a "short-cut method" that she had used during the test.
The third correct reply was achieved through a flash of in-
sight after some features of the problem were emphasised several times.
For example:

Celia gave a reply to the problem ("The Mishap") in
terms of the characteristics of the three foods meat, soup
and condensed milk, rather than in terms of a disjunctive
relation. Her original answer was "Meat, as it could be
eaten". In the interview she successfully separated out
the elements of the problem:

Celia: She ate meat and soup. I'm eating condensed milk
and soup. We were both eating one thing the same,
eating the soup . . . Yes . . . and I'm
eating the milk and she's eating meat.

At first it appeared she could complete the problem.
However, when asked for the reason why she gave the answer
soup she began to search for the reason in terms of concrete
characteristics of the foods and not in terms of a relation.

Supervisor(s): How look at the question again (pointing
to the written question). Which of these three
things gave us stomach aches?
Celia: .... long pause ....

S. : (Returning to the original reply as she could not say why the soup could have caused it.) You have given the answer "meat" (pointing). Who ate the meat?

Celia: Um .... my girl friend.

S. : Did you eat any meat?

Celia: No.

S. : Therefore could it have given you stomach ache?

Celia: It might have been the soup.

S. : Why?

Celia: .... long pause .... (Celia couldn't give a reason).

S. : Why couldn't we say the condensed milk?

Celia: .... long pause .... condensed milk can stay long in tins but ....

S. : If it had been the condensed milk you could have had stomach ache but could your friend get a stomach ache from the condensed milk?

Celia: No.

S. : Why?

Celia: She ate only meat and soup.

S. : Could the meat have given her a stomach ache?

Celia: .... pause .... could have.

S. : Could the meat have given you a stomach ache?

Celia: No .... (looking at earlier reply written on the test sheet) oh ! .... pause .... I wasn't eating any meat. I was eating condensed milk.
S. : Could the soup have given you the stomach ache?

Celia: I don't know. It's hard to say.

S. : Could the soup have given her a stomach ache?

Celia: Well we don't know what's wrong with the soup.

Having admitted that all three foods could have had something wrong with them appeared to encourage her to attempt a new line of thought, in this case the correct one. The finding of the solution was very rapid and her thinking jumped ahead of the questions.

S. : We know one of the foods had something wrong with it. We don't know what it was and we are not really worried about it. How could it have been the condensed milk . . . . ?

Celia: . . . . no comment . . . .

S. : that gave them the stomach ache?

Celia: Um . . . . Not both of us.

S. : Why?

Celia: Um . . . . 'Cause only one of us ate the condensed milk.

S. : Could the meat have given both of you a stomach ache?

Celia: No, because only one of us — (very quickly) — the other one gave the stomach ache; only one had condensed milk but we both had soup. It could have been the soup! (The reference to the condensed milk appeared to be an explanation of the term "other one" in case she thought the supervisor interpreted the word to mean "condensed milk" instead of the soup.)

S. : Because?

Celia: We both ate it.

S. : Yes. So it was the only thing we both had.

Celia: Yes.
S. : And therefore it was the thing which probably had something wrong with it. Can you see that?

Celia: Oh yes! I see that!

S.: That's good.

In a fourth case, an Asian pupil, who had the lowest overall operational score in the group, appeared to understand the features even in analogous problems, once the problem had been explained. The pupil seemed to lack an interest in experimenting in problems or else lacked the ability to express the answers. This was a particularly interesting case as her IQ appeared to be too low to measure and she was verbally inarticulate although her written expression was adequate. 22 Despite her low scores this pupil successfully topped the class in mathematics and in class averages.

In the six other successful interviews it was not clear if true insight had been achieved or a logical combination had been imposed through the hints and leads of the interviewer without being accompanied by true insight. There was insufficient opportunity to test these pupils with analogous problems to see if their success had been transferred. For example:

In the "Travellers" problem in answer to the question "Another passenger arrived and he said to the driver 'Do you take dogs?' Could he travel on the bus?", Ruth

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22 She obviously suffered from a cultural difficulty in the verbal sense although her ability appeared in other forms such as mathematics.
wrote "Yes, because you were allowed dogs but only if you didn't have a suitcase too". Ruth isolated the incompatible relation — either a dog or a suitcase — but could not apply it in this problem context. Finally, through further questioning she was able to apply the operation to the problem and take into account the statement of "Do you take dogs?" (plural.)

**Supervisor(s):** This part of the answer is correct (pointing to the section of Ruth's answer which read "If you didn't have a suitcase too"). Now look at the word dogs (pointing to the answer).

**Ruth:** (reading the instructions) Only one dog . . . (reading her answer) and it's got dogs.

**S.** : Yes. So there are two things you must remember in order to answer that question. What are they?

**Ruth:** Oh, there's only one dog . . . long pause . . .

**S.** : When you say only one dog what do you mean?

**Ruth:** Oh, only allowed to take one dog on the trip.

**S.** : Yes. And what does question (b) say?

**Ruth:** Do you take dogs?

**S.** : Yes. Well what do you think the word "dogs" means there (pointing).

**Ruth:** One dog . . . Oh ! . . . . long pause . . .

Ruth suddenly discovered the second element in the problem having previously distinguished between the two words "dog" and dogs" out of context. After another unsuccessful attempt she finally managed to incorporate the operation she understood, into the problem situation.

**S.** : If I said to you "Do you take dogs" do you think I mean just one dog?

**Ruth:** No . . . (very slowly)

**S.** : You are not sure?
Ruth: No. If you only take one dog you'd say ... oh I ... I don't know. (Ruth showed difficulty in "holding" both elements).

S.: Well, what would the driver have to ask him when he said "Do you take dogs?"

Ruth: How many dogs?

S.: Yes, that's one thing. Then what would he say?

Ruth: ... pause ... He'd be allowed to take one dog if he didn't have a suitcase too.

S.: Yes. That is good.

The alteration in her answer of "dogs" to "one dog" indicated not only a simple change in the linguistic expression but the inclusion of the second element in Ruth's reasoning structure.

Some linguistic misinterpretations which had appeared in the written replies were queried in the interviews. However the explanations of the words made little difference to the pupils' abilities to handle the problems (with the exception of the Asian pupil). For example:

Celia found difficulty in handling the "Melons" problem. A linguistic misinterpretation was evident. Her answer was, "Yes (she believed what the man said) because he can't fit olives and melons in his mouth at the same time". After accepting the change in phraseology from "at the same time" to "at the same meal" Celia still had a great deal of difficulty in gaining a correct solution.

From this second pilot experiment, it appeared that written replies could be partially successful as a means of indicating the presence of linguistic difficulties and formal operational difficulties. However it seemed apparent that the test required the inclusion of
standardised replies in order to avoid a large number of incomplete or poorly expressed answers. The third pilot experiment was concerned with this feature of the test.

Third Pilot Experiment

Twenty-three, fourteen to fifteen year old girls in a fourth form, homecraft "A" stream, were given a more standardised test. The mean IQ for this group was 103, i.e. it was an average group slightly more intelligent than the group in the earlier tests. The revised problems were typed on separate sheets and each one was followed by a series of questions testing the understanding of the words used in the problems, and a series of questions concerned with operational ability. An example of the tests is the following "Shoes" problem involving the implication operation.

SHOES

At a boarding school a group of girls had caught colds and were forbidden to go outside the building while the wet weather continued. However, some girls slipped outside while it was raining to post some letters. The headmistress suspected but did not know who had disobeyed. She sent a message around the class room which was read to all the girls. "This evening the headmistress will examine all pairs of shoes. The headmistress will know who has been outside because the soles of their shoes will be wet."

Write the number of the sentence or words you have chosen from the following in the brackets at the right of the page.

1. The group of girls was forbidden to . . . ?
2. post letters.
3. catch colds.
4. go outside while the wet weather continued.
C. What is meant by each of the following words?

- **stopped.**
- **did not cease.**
- **blew.**

D. 

**E.**

4. go outside

5. get their shoes wet. Put number here. ( )

The headmistress announced that she would...?

1. examine the shoes the girls were wearing.
2. see only the girls with wet shoes.
3. examine every pair of shoes in the school.

Put number here. ( )

Put number here. ( )

**Continued?**

1. refused to believe.
2. had a suspicion.
3. knew.

Put number here. ( )

Put number here. ( )

**Display?**

1. broken the rule.
2. kept the rule.

Put number here. ( )

Put number here. ( )

**Eve...**

1. nightfall.
2. soon.
3. later.
4. at once.

Put number here. ( )

Put number here. ( )

When the headmistress made the inspection did she find the girls who had slipped out?

1. Yes.
2. No.
3. May be.

( )

Choose a sentence from the ones listed below which best explains the reason for your answer in D.

1. Because some of the girls would hide.
2. Because their shoes would be wet when the headmistress examined all the shoes in the evening.
3. Because the girls who had been outside would change their shoes.
4. Because not all the shoes of the girls who had been outside need still be wet as they would have dried them. Not all the shoes of the girls who had been inside need be dry as some of their shoes could have been wet as a result of something else.
5. Because some of the girls who had not been outside could have wet shoes too as they could have become
damp as the result of some other activity.
Put number here. ( )

F. Write any further explanations here.

Wording which had caused difficulties in the second pilot experiment - as shown in the written answers - was altered. Words and phrases such as "several", and "at the same time" were omitted, and "some", and "at the same meal", were substituted.

Pupils were required to choose one of a range of standardised replies and to write the number of the reply in a bracket at the right of the page. The test took ninety minutes although many pupils required less time.

The use of standardised replies was based on the assumptions that:

1. There were sufficient possible replies from which a pupil could choose.

2. The choice of a particular reply would be influenced by the pupils' ability to view a problem concretely or formally.

Space had been allowed for pupils' comments. Five of the twenty-three pupils took advantage of this space to give different reasons in one of the tests. It was significant that these five replies were merely more complex combinations of the formal operation alternative available in each test and so such did not represent a severe criticism of the range of available answers. In the "Choice" test, reply four was indicated (see page 50 for test replies) and
the comment added, "It could have been five as well".

No questions were asked of the supervisor during the testing time. There was no indication of any operational or linguistic difficulties in this way as in the earlier tests. Pupils constantly reread the problem while attempting to answer the questions. The meanings of the words and phrases appeared to be sufficiently clear after they had been read several times.

Pupils had no difficulty in choosing replies which they felt were adequate (except for the five cases mentioned earlier). The alternatives included several replies indicating concrete operational reasoning and one correct formal reply.

In reviewing the results it appeared that pupils had no difficulty in handling a test with standardised replies. The variety of doubtful answers in earlier tests did not appear and classification of formal or non formal reasoning was easier. Characteristics that Korf described still appeared in the answers of the pupils.

Even with a formal reply before them, some pupils still choose concrete operational replies. Again, not one pupil answered all the problems correctly, but this slightly older group handled the problems better (see Table II). Conversely, there were many operational errors in the replies of these pupils but not as many as there were in the replies of the younger group in the second pilot experiment. Thus, quite apart from the small number of linguistic difficulties, there existed a larger range of difficulties associated with
Operational development. 79.9 per cent of all errors were made in the operational answers and 20.1 per cent of the errors were made in the linguistic answers.

<table>
<thead>
<tr>
<th>Group Number</th>
<th>80-100%</th>
<th>60-79%</th>
<th>40-59%</th>
<th>20-39%</th>
<th>0-19%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Second Pilot Group</td>
<td>- 21.2 44.9 27.2 6.7</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Third Pilot Group</td>
<td>4.3 26.1 47.9 21.7 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Operational difficulties tended to disappear as formal operational thinking appeared. Again, in this test, the New Zealand group did not handle the formal operations as well as Hof's group. Further testing, using a much larger group, was apparently necessary to help to clarify the relative significance of linguistic and operational difficulties and to define the age level at which formal operations could be expected to develop.
CHAPTER V

GROUP APPLICATION AND RESULTS OF THE MODIFIED TESTS

The limited results of the pilot experiments indicated that Piaget's and Vygotsky's work has significance in the understanding of pupils' reasoning. Further evaluation through a test administered to the whole school gave a more satisfactory sample for a quantitative estimate of their work. More specifically, the school-wide test dealt with the following four aspects:

(a) Whether a quantitative estimate could be achieved of the relative roles of verbal features and reasoning features in children over thirteen years of age in a post-primary school.

(b) Whether or not a group of pupils who are not yet capable of the formal reasoning expected of them exist in a post-primary school.

(c) Whether an indication of the age when formal reasoning may be expected to appear in pupils can be gained; and

(d) Whether there is any difference in the ability of pupils to handle four different operations (and their negatives) used in the formal reasoning tests.

School Population

The test was attempted by 526 boys and girls in a Christchurch co-educational post-primary school. The pupils' ages ranged from
thirteen years to over seventeen years of age. The majority of the pupils were between fourteen years and fifteen years six months. The age distribution of the pupils is given in Table III. Several classes did not take part in the test as they were participating in other school activities. As most of these pupils were between fourteen years of age and sixteen years of age, their inclusion in the test would have emphasized the concentration of pupils in the age groups with the largest samples rather than increased the size of the smaller age groups. Their results would probably have accentuated the results of the test rather than altered their emphasis. The average IQ score for each age group was estimated and the figures included in Table III. These figures showed that the school population was of average intelligence in all age groups.

Two forty-five minute lessons were involved in testing the problems although any pupils who had not finished in that time were allowed to continue until all answers were completed. Of the 523 pupils, five took longer than the two lessons to complete the test. The slowest pupil continued for an additional thirty minutes.

Form of the Test

After the papers had been handed out the supervisor gave each pupil a number to put on his paper and said, "These interesting problems are tests to see how well you can handle every day problems".

23 A copy of the test has been included in Appendix I.
TABLE III

AGE DISTRIBUTION OF THE SCHOOL POPULATION

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>No of Pupils</th>
<th>Average IQ Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.7-14.0</td>
<td>6</td>
<td>104.3</td>
</tr>
<tr>
<td>14.1-14.6</td>
<td>94</td>
<td>99.7</td>
</tr>
<tr>
<td>15.1-15.6</td>
<td>116</td>
<td>99.7</td>
</tr>
<tr>
<td>15.7-16.0</td>
<td>95</td>
<td>99.3</td>
</tr>
<tr>
<td>15.1-16.0</td>
<td>61</td>
<td>100.3</td>
</tr>
<tr>
<td>16.1-16.6</td>
<td>36</td>
<td>101.6</td>
</tr>
<tr>
<td>16.7-17.0</td>
<td>22</td>
<td>105.5</td>
</tr>
<tr>
<td>17.1-17.0</td>
<td>39</td>
<td>106.7</td>
</tr>
</tbody>
</table>
All other instructions were written on the test paper. The individual was instructed to choose a reply for each problem from the range of answers listed, and to write the number of the answer in the bracket at the right of the page.

**Problems Included in the Test**

The test contained a series of revised problems. Each problem was followed by a series of questions and a range of standardised replies to each one. The replies included one formal operational reply and several partially correct or incorrect replies. The solving of each problem involved the use of one of four formal operations — incompatibility, implication, disjunction or affirmation.

Some changes were made in the types of problems used in the test. The "Keys", the "Unknown Animal", and the "Shoes" problems used in the pilot experiments were not included as they were considered too easy for pupils over thirteen years of age. Almost all pupils had gained a high score on these problems in previous tests. The problems "Hotel Rooms", "Swimming Costumes", and "Martian Animals" were included in their places. A second group of tests was also added in an attempt to gain further understanding of the pupils' reasoning abilities. The tests consisted of a series of

24 See Appendix I.
simple problems. Each of these problems was a direct statement of one of the four formal operations of incompatibility, implication, disjunction or affirmation. For example, the operation of implication was stated in the "Red Object" test.

**Red Object**

Can I say the following?

If all my books are red then this red object is a book.

1. Yes because it is red.
2. No because it is not mine.
3. Yes because all my books are red.
4. No because it could be something else.
5. No because some of my books are not red.
6. I do not know.

Write the number of your chosen answer here ( )

Only reasoning questions were asked after these simple problems, as this part of the test was concerned with the reasoning features alone and not the relation of language to reasoning.

This schoolwide test was based on the same two assumptions that were held in earlier tests, namely:

1. That there were sufficient possible replies from which a pupil could choose the one he felt was most appropriate.

2. That the choice of a particular reply would be influenced by the pupils' ability to view a problem concretely or formally.

The choice would be based on the appreciation of various words and phrases used in the different possible replies. The pupils would choose replies that were the most straightforward expressions
of their own solutions. Replies appropriate to a higher level of reasoning would appear as nothing more than unnecessary elaborations of simpler replies. It was thus assumed that:

(i) Pupils whose reasoning was still tied to concrete situations, or whose reasoning had reached only the earliest stages of formal reasoning, would choose concretely expressed replies in both the simple tests and the harder problems.

(ii) Pupils whose reasoning had reached an intermediate stage in the development of formal reasoning would be able to handle the operations in the simple tests but not the operations in the main problems. The simple tests contained a direct statement of the operations, that is pupils were not required to isolate the operations from problem contexts. Pupils whose reasoning was still tied to single experiences could successfully answer these simple tests just as well as pupils who had achieved formal reasoning. Thus pupils in the intermediate stage of operational development would choose the formal reply in the simple tests. As these pupils had not conserved the operations, they would find the isolation of the operations and solving of the problems difficult, and would therefore tend to choose a concrete reply or a partially correct reply rather than the formal answer.

(iii) Pupils who had successfully conserved formal operations and implicitly used the "groupement" of formal thinking, would handle successfully the questions in both the simple tests and the main
problems. These pupils would tend to choose the formal reply in both sections of the tests.

Thus, with the aid of the replies to the simple tests and to the problems, it was expected that an indication of the relation between reasoning and language could be achieved together with an indication of the age level at which formal reasoning can be expected to develop in school pupils.

RESULTS OF THE FOUR ASPECTS OF THE PROBLEM

I. The Relative Roles of Verbal and Operational Features in Problem Solving

Three methods were employed to assess the relative importance of these two factors. The first involved using the means for language and reasoning scores; the second involved the use of an index representing the ratio: Reasoning Score; and the third consisted of a comparison of correlation coefficients and "t" scores for language and reasoning.

Comparison of the Mean Scores of Language and Reasoning in Different Age Groups

All the raw scores in the tests were transferred to summary sheets and the answers were marked. A pupil could achieve a maximum of 100 for the language score and 100 for the reasoning score.

25 The correct replies are indicated in the copy of the test in Appendix I. They are written in the brackets at the right of the test pages.
Where there were several language replies then each reply was expressed as a percentage of 100. For example, where there were five language replies required in a problem the maximum value for each reply was twenty per cent. The language percentage scores for every pupil were classified into eight, six month age groups (see page 96 for these groups), and the mean score for each age group was calculated. Reasoning scores were treated in a similar manner. The scores in every problem were processed in this way, and the resultant means are shown in Tables IV and V. (pages 62 and 63).

In six of the eight problems the mean scores for language were above 80 per cent at every age level. Many means were over 90 per cent, particularly in the 17½ age groups. For example, in the "Sports Meeting" problem the age group scores varied from 85.8 per cent to 99.4 per cent. In the "Travellers" problem the figures rose from 81.4 per cent to 95.4 per cent. In six tests the pupils appeared to have an adequate grasp of the words used in the problem setting, and as a result the language scores were generally stable at a high level of achievement. In the remaining two problems, the "Pearls" test and the "Pens" test, the mean scores were lower, varying from 75.0 per cent to 91.5 per cent in the "Pens" test, and from 65.0 per cent to 90.0 per cent in the "Pearls" test. These two tests appeared to be harder linguistically than any of the other problems.

The features of the reasoning scores were essentially different.
**TABLE IV**

LANGUAGE MEANS FOR EACH PROBLEM BY SIX MONTHS AGE GROUPS

<table>
<thead>
<tr>
<th>Problem</th>
<th>Age Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>13·14·0</td>
</tr>
<tr>
<td>Hotel Room</td>
<td>91.7</td>
</tr>
<tr>
<td>Bishap</td>
<td>92.3</td>
</tr>
<tr>
<td>Pons</td>
<td>78.7</td>
</tr>
<tr>
<td>Pets</td>
<td>95.2</td>
</tr>
<tr>
<td>Pearls</td>
<td>71.1</td>
</tr>
<tr>
<td>Sports Meeting</td>
<td>93.1</td>
</tr>
<tr>
<td>Melons</td>
<td>92.2</td>
</tr>
<tr>
<td>Travellers</td>
<td>82.7</td>
</tr>
<tr>
<td>Problem</td>
<td>13-14</td>
</tr>
<tr>
<td>------------------</td>
<td>-------</td>
</tr>
<tr>
<td>Hotel Room</td>
<td>45.0</td>
</tr>
<tr>
<td>Mishap</td>
<td>40.0</td>
</tr>
<tr>
<td>Pera</td>
<td>51.3</td>
</tr>
<tr>
<td>Pets</td>
<td>44.5</td>
</tr>
<tr>
<td>Pearls</td>
<td>45.5</td>
</tr>
<tr>
<td>Sports Meeting</td>
<td>70.0</td>
</tr>
<tr>
<td>Melons</td>
<td>42.7</td>
</tr>
<tr>
<td>Travellers</td>
<td>56.0</td>
</tr>
</tbody>
</table>
In contrast to the high and stable language scores, the reasoning scores showed a marked increase with age and were generally lower. In the "Hotel Room" problem, scores increased from 32.0 per cent in the 141-146 age groups to 54.6 per cent in the 171+ age group. In the "Pearls" test the mean score on reasoning rose from 43.0 per cent at 137-140 to 51.9 at 171+. The "Pearls" test appeared to be the hardest reasoning test as well as the hardest language test.

In all problems, at every age group the mean scores for reasoning questions were lower than the corresponding mean scores for language questions. The differences (language mean - reasoning mean for each age group) between the scores are tabulated in Table VI.

The differences between language and reasoning scores were largest in the youngest age groups. The "Mishap" problem showed the greatest difference between mean scores (52.5 per cent) while the "Sports Meeting" problem had the smallest difference (22.3 per cent). The differences between language and reasoning scores decreased noticeably with increasing age until in the 171+ age groups the differences were as low as 2.3 per cent ("Travellers" test).

As the language mean scores were generally stable at a high level, most of the changes in these difference figures could be attributed to an increase in reasoning scores as age increased. Even in the hardest test, the "Pearls" test, the reasoning mean was noticeably below the relative language mean for each age group. However the difference between language and reasoning scores showed very little
### Table VI

**Difference between Language and Reasoning Mean Scores for Problems by Six Month Age Groups**

<table>
<thead>
<tr>
<th>Problem</th>
<th>13.7–14.0</th>
<th>14.1–14.6</th>
<th>14.7–15.0</th>
<th>15.1–15.6</th>
<th>15.7–16.0</th>
<th>16.1–16.6</th>
<th>16.7–17.0</th>
<th>17.1+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel Room</td>
<td>46.7</td>
<td>32.0</td>
<td>39.3</td>
<td>34.3</td>
<td>31.5</td>
<td>44.9</td>
<td>35.6</td>
<td>12.4</td>
</tr>
<tr>
<td>Mishap</td>
<td>52.5</td>
<td>40.0</td>
<td>38.4</td>
<td>41.4</td>
<td>38.7</td>
<td>15.3</td>
<td>6.6</td>
<td>10.2</td>
</tr>
<tr>
<td>Pans</td>
<td>26.9</td>
<td>22.3</td>
<td>23.8</td>
<td>23.2</td>
<td>16.6</td>
<td>9.6</td>
<td>5.3</td>
<td>5.2</td>
</tr>
<tr>
<td>Pets</td>
<td>51.7</td>
<td>52.5</td>
<td>48.8</td>
<td>45.1</td>
<td>45.2</td>
<td>38.9</td>
<td>10.9</td>
<td>21.0</td>
</tr>
<tr>
<td>Pearle</td>
<td>27.6</td>
<td>29.6</td>
<td>10.1</td>
<td>25.0</td>
<td>23.5</td>
<td>26.5</td>
<td>31.1</td>
<td>32.2</td>
</tr>
<tr>
<td>Sports Meeting</td>
<td>22.3</td>
<td>17.2</td>
<td>20.6</td>
<td>19.0</td>
<td>8.2</td>
<td>7.6</td>
<td>1.2</td>
<td>2.6</td>
</tr>
<tr>
<td>Melons</td>
<td>47.5</td>
<td>49.7</td>
<td>30.9</td>
<td>26.0</td>
<td>31.1</td>
<td>18.0</td>
<td>14.8</td>
<td>11.6</td>
</tr>
<tr>
<td>Travellers</td>
<td>25.0</td>
<td>25.4</td>
<td>24.5</td>
<td>24.5</td>
<td>26.2</td>
<td>24.8</td>
<td>15.1</td>
<td>2.3</td>
</tr>
</tbody>
</table>
change with age. This appeared to result from the lack of ability by the pupils in handling this test - an hypothesis re-inforced by the low reasoning scores, even in the 17½ age group.

However, in general these results appeared to give support to the view that in a series of problems, even when language ability was at a high level, pupils still have difficulty in solving aspects of the problems.

The ability to handle these other aspects could be described as a developing process as the ability tends to improve with age. As characteristics of Piaget's operational thinking have indicated the presence of these other aspects of problem solving, it seems feasible that this developing ability could be adequately interpreted in terms of the formation of formal operational ability.

The Language - Reasoning Index

The performances of different age groups were expressed in terms of age group means. These general scores however, did not give an indication of each individual pupil's relative achievements on language and reasoning questions.

With the ratio $\frac{Reasoning\ Score}{Language\ Score}$ an index was determined for each pupil. Where the pupil answered both sections correctly the index was 1 (i.e. $\frac{Reasoning\ Score}{Language\ Score} = \frac{100}{100} = 1$). Where the pupils' reasoning score was less than the language score, the index was less than 1. For example $\frac{20}{50} = 0.4$. Where the reasoning score
was greater than the language score the index was greater than 1.

For example $\frac{L}{L} = \frac{100}{50} = 2$.

The indices for each pupil were calculated and the scores classified into eight six-month age groups. The scores in each age group were then grouped under four headings: indices less than 1; equal to 1; greater than 1; and no score in either section. The number under each heading was expressed as a percentage of the total number of pupils in the age group.

(a) Where the Language - Reasoning Index ≠ 0

In reviewing the results it appeared that only a small percentage at each age gained the score of 0 in a problem.

Only in the "Fears" test was there a relatively large number scoring zero in both language and reasoning sections. In all other tests, less than 11 per cent of pupils had this index of 0. In the "Total Rooms" problem for example, all percentages were below 8 per cent. In the older age groups the number of pupils scoring zero were very low.

This indicated that the tests were too hard for a small group of pupils in the school and did not give a good indication of pupils' reasoning levels. For most pupils, however, the tests were at a suitable level of difficulty and they helped to distinguish adequately between the pupils' problem solving abilities.
## Table VII

Percentage No. of Pupils with a Score of Zero in Language and Zero in Reasoning

<table>
<thead>
<tr>
<th>Problems</th>
<th>Age Groups</th>
<th>13-14</th>
<th>14-15</th>
<th>15-16</th>
<th>16-17</th>
<th>17+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mishap</td>
<td></td>
<td>3.1</td>
<td>8.5</td>
<td>6.9</td>
<td>4.2</td>
<td>5.9</td>
</tr>
<tr>
<td>Pencils</td>
<td></td>
<td>9.2</td>
<td>9.6</td>
<td>16.4</td>
<td>10.5</td>
<td>9.8</td>
</tr>
<tr>
<td>Pets</td>
<td></td>
<td>4.6</td>
<td>4.3</td>
<td>8.6</td>
<td>6.3</td>
<td>3.3</td>
</tr>
<tr>
<td>Travellers</td>
<td></td>
<td>6.2</td>
<td>8.5</td>
<td>7.8</td>
<td>3.2</td>
<td>3.3</td>
</tr>
<tr>
<td>Hotel Rooms</td>
<td></td>
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<td>5.3</td>
<td>7.8</td>
<td>7.7</td>
<td>4.9</td>
</tr>
<tr>
<td>Sports Meeting</td>
<td></td>
<td>4.8</td>
<td>4.3</td>
<td>10.3</td>
<td>8.4</td>
<td>7.3</td>
</tr>
<tr>
<td>Pans</td>
<td></td>
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<td>6.4</td>
<td>8.6</td>
<td>6.3</td>
<td>6.6</td>
</tr>
<tr>
<td>Helens</td>
<td></td>
<td>1.5</td>
<td>5.3</td>
<td>9.5</td>
<td>10.5</td>
<td>4.9</td>
</tr>
</tbody>
</table>
(b) Pupils who gained an Index Greater than 1

This index stressed the groups of pupils who did better on reasoning questions than on linguistic questions - that is it showed that their main difficulties in solving a problem lay in understanding the language of the problem. The percentage numbers who gained this index are listed in Table VIII. (page 70)

The number of pupils who found language especially difficult in the problems was generally low. In the "Pets" and the "Sports Meeting" problems less than 10 per cent of the pupils were in this group. The "Pens" test was found to have the widest range of linguistic difficulties when compared with reasoning scores.

Approximately one third of the group found language questions harder in this test. As this was a relatively large number of pupils when compared with the number in other tests, a study of the linguistic replies was made. There were six language questions in the "Pens" test. In five of these the percentage number of pupils who found language especially difficult was below 15 per cent - a comparable figure with other test percentages. But in question "3" "What did the inspector tell the manager?" almost 66 per cent of all the pupils gave a reply which was not accepted as the correct reply. That is, 30 per cent of the pupils gave the correct reply four - "Even though I haven't seen all pens made in September, up until now the pens with defects were all made in September," and 66 per cent of the pupils gave the incomplete reply two "All pens in
### TABLE VIII

**Percentage Number of Pupils with an IQ Index Greater Than One**

<table>
<thead>
<tr>
<th>Problem</th>
<th>13-14</th>
<th>14-15</th>
<th>15-16</th>
<th>16-17</th>
<th>17-18</th>
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</thead>
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<td>6.2</td>
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<td>8.6</td>
<td>7.4</td>
<td>11.5</td>
</tr>
<tr>
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<td>1.5</td>
<td>4.3</td>
<td>5.3</td>
<td>6.6</td>
<td>8.3</td>
</tr>
<tr>
<td>Pigs</td>
<td>20.0</td>
<td>19.2</td>
<td>13.0</td>
<td>20.0</td>
<td>21.6</td>
</tr>
<tr>
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<td>4.5</td>
<td>1.7</td>
<td>2.1</td>
<td>4.9</td>
</tr>
<tr>
<td>Pearls</td>
<td>15.4</td>
<td>13.0</td>
<td>11.2</td>
<td>12.6</td>
<td>13.0</td>
</tr>
<tr>
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<td>2.6</td>
<td>4.5</td>
<td>9.7</td>
<td>9.0</td>
<td>4.7</td>
</tr>
<tr>
<td>Nellons</td>
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<td>13.8</td>
<td>6.9</td>
<td>7.4</td>
<td>11.5</td>
</tr>
<tr>
<td>Travellers</td>
<td>6.2</td>
<td>11.7</td>
<td>5.2</td>
<td>11.6</td>
<td>6.6</td>
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<td>Pigs</td>
<td>20.0</td>
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<td>Pets</td>
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<tr>
<td>Pearls</td>
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<td>Sports Meeting</td>
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<td>Nellons</td>
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</tr>
<tr>
<td>Travellers</td>
<td>6.2</td>
</tr>
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</table>
the month of September have defects." The difference between the replies was in the use of the phrase "So far . . ." in the problem. As the linguistic questions came before the reasoning questions, the pupils were not called on to recognize the significance that "so far," plays in the reasoning process. Out of the problem context and questions the term may have had little significance and the difference between the two replies an unnecessary elaboration. If this were so then operational ability would have been involved in the answering of the question. The reply would not be a straightforward linguistic question. This point may help to explain why a higher proportion of pupils in each age group found the linguistic features in the "Pens" test so much harder than the reasoning elements.

In comparing the eight problems (64 age groups) as a whole, it is possible to get an impression of the percentage number of pupils in each age group who found language difficult.

(a) in 42 of the 64 age groups the percentage of pupils who found language more difficult was 10 per cent (or below) of the age group.
(b) in 9 of the 64 age groups the percentage of pupils who found language more difficult was between 11-15 per cent.
(c) in 13 of the 64 age groups the percentage of pupils who found language more difficult was between 16-30 per cent.
(d) That is in 51 of the 64 age groups the number of pupils with noticeable linguistic difficulties was less than 15 per cent.
Thus it would appear, that linguistic difficulties do occur in the solving of these problems but the number of pupils who find that these difficulties are paramount is relatively small.

(c) Pupils who gained an Index of Less than 1 or 1

Most people in each age group were found in two groups—one with an index of 1 and the other with an index of less than 1. The two groups contained over 90 per cent of all pupils in some age groups in the “Fishpond,” “Pears,” “Pots,” “Sports Meeting” and “Melons” tests. At least 60 per cent of each age group in other tests were also in these two groups. The figures in both groups changed in inverse proportion to each other; as the groups who gained an index of less than 1 declined in size with increasing age, the groups who gained an index of 1 increased in size with increasing age. This appeared to indicate that most people had difficulty with reasoning and language questions, and that they moved from this group as their operational ability improved with age, into the group who gained an index of 1 (that is they moved into the group which handled both language and reasoning questions equally as well).

It would seem feasible that an improving ability to reason with increasing age generally stemmed from an improving operational ability rather than improving linguistic ability.

Relation of Language and Reasoning Replies—Correlation Co-efficient

Correlation coefficients (using the Pearson Product Moment
### TABLE IX

PERCENTAGE OF EACH AGE GROUP WHO GAINED INDEXES OF LESS THAN ONE OR ONE

<table>
<thead>
<tr>
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<th>14-15</th>
<th>15-16</th>
<th>16-17</th>
<th>17-18</th>
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<td>72.3</td>
<td>67.2</td>
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<td>4.3</td>
<td>5.2</td>
<td>5.3</td>
</tr>
<tr>
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<td></td>
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<td>56.0</td>
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<td>71.3</td>
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<td>66.3</td>
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<td>8.5</td>
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<td>63.8</td>
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<td>61.7</td>
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<td>61.6</td>
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<td>23.4</td>
<td>17.2</td>
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<tr>
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<td>36.0</td>
<td>40.0</td>
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<td>35.4</td>
<td>46.8</td>
<td>44.0</td>
<td>47.4</td>
</tr>
</tbody>
</table>
Correlation) and \( r^2 \) scores were calculated for the language and reasoning scores of the subjects in each age group.\(^{26}\) The scores are tabulated in Table X. (see page 75)

Most of the \( r^2 \) statistics and correlation coefficients were significant at the five per cent level. The insignificant coefficients were usually accompanied by unacceptable \( r^2 \) statistics. It appeared that the coefficients had been influenced by inadequate samples in these particular age groups.

In the significant coefficients the correlations generally varied from .2 to .5 and pointed to a limited variation of language with reasoning. In six cases there were correlations of over .6. For example in the "Pens" test the correlations \( .669 \) appeared for both the 161-166 and the 167-170 age groups. In examination of the coefficients of determination \( (r^2) \) showed that even for the highest correlation, language explained only forty-five per cent of the total variation of reasoning. In most cases the language explained approximately 20 per cent of the variation in reasoning.

Further the figures did not reflect any distinct change with age from one group to another. Age like reasoning seemed to have little direct influence on the occurrence of language and reasoning.

\(^{26}\) These figures were calculated on an IBM 1620 Data Processing Unit using University of Canterbury Computer Library Programme No. 6.0.067 (Linear Regression with Two Variables).
TABLE X

CORRELATION COEFFICIENTS AND "t" SCORES FOR THE PROBLEMS

<table>
<thead>
<tr>
<th>Problems</th>
<th>13-14</th>
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<th>15-16</th>
<th>16-17</th>
<th>17+</th>
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<td>92</td>
<td>114</td>
<td>93</td>
<td>59</td>
</tr>
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<td>Pearls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correlation Coefficient</td>
<td>r</td>
<td>.491</td>
<td>.498</td>
<td>.584</td>
<td>.591</td>
</tr>
<tr>
<td>Melons</td>
<td>T</td>
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<td>3.549</td>
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</tr>
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<td>r</td>
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<td>.377</td>
<td>.416</td>
<td>.444</td>
<td>.281</td>
</tr>
<tr>
<td>Pots</td>
<td>T</td>
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<td>1.678</td>
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<td>.172</td>
<td>.300</td>
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<td>.569</td>
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<td>.563</td>
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<tr>
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<td>.399</td>
<td>.374</td>
<td>.231</td>
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<tr>
<td>r</td>
<td>.457</td>
<td>.400</td>
<td>.540</td>
<td>.599</td>
<td>.664</td>
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</table>

* Insignificant scores are underlined
Similarly, any variation from one age group to another could not be explained in terms of IQ differences alone (see Table III, page 95).

Thus it appeared that the figures could not be explained through an explanation of language, age or IQ scores. Piaget has explained the variation as a result of a developmental factor - the growth of formal reasoning. These figures help to show that there is another factor that influences pupils' thinking at different ages (age alone does not explain some reasoning characteristics, other factors are involved).

II The Existence of a Group of Pupils in a School not yet Capable of Formal Operational Thinking

The achievement of a low reasoning score of \(33\frac{1}{3}\) per cent or less by individuals was taken as an indication that the pupils found difficulty in handling the problems in that test. The numbers of pupils who gained such low scores were totalled on a class basis to indicate in which classes these pupils were concentrated.

In all classes there were pupils who gained at least one score of \(33\frac{1}{3}\) per cent or less in one of the problems. The largest groups of pupils with these low marks were found in the third and fourth form classes (See Table XI).

The numbers of pupils who gained low scores in a test were high. The numbers ranged from 311 in the "Hotel Room" problem to 36 in the "Swimming Costume" problem. The average number of people who gained \(33\frac{1}{3}\) per cent or less in the problems was 234 (that is
<table>
<thead>
<tr>
<th>Class Rolls</th>
<th>Martian</th>
<th>Animals</th>
<th>Hotel</th>
<th>Room</th>
<th>Message</th>
<th>Pens</th>
<th>Pests</th>
<th>Pearls</th>
<th>Sports</th>
<th>Swimming</th>
<th>Meeting</th>
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</tr>
<tr>
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<td>4</td>
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</tr>
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</tr>
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<th>Pets</th>
<th>Pearls</th>
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<td>19</td>
<td>10</td>
<td>17</td>
<td>16</td>
<td>7</td>
<td>7</td>
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<tr>
<td>H5A (22)</td>
<td>14</td>
<td>18</td>
<td>16</td>
<td>15</td>
<td>19</td>
<td>16</td>
<td>5</td>
<td>5</td>
<td>13</td>
<td>5</td>
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<tr>
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<td>7</td>
<td>11</td>
<td>13</td>
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<td>8</td>
<td>4</td>
<td>2</td>
<td>15</td>
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<tr>
<td>C5B (27)</td>
<td>20</td>
<td>13</td>
<td>24</td>
<td>16</td>
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<td>21</td>
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<td>11</td>
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<tr>
<td>C6B (27)</td>
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<td>30</td>
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<td>19</td>
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<td>3</td>
<td>20</td>
<td>10</td>
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</tr>
<tr>
<td>H5B (29)</td>
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<td>15</td>
<td>15</td>
<td>18</td>
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<td>18</td>
<td>9</td>
<td>6</td>
<td>12</td>
<td>16</td>
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</tr>
<tr>
<td>P5C (25)</td>
<td>14</td>
<td>16</td>
<td>12</td>
<td>11</td>
<td>14</td>
<td>11</td>
<td>8</td>
<td>3</td>
<td>13</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>Special (19)</td>
<td>21(130)</td>
<td>19(149)</td>
<td>23(148)</td>
<td>20(127)</td>
<td>14(120)</td>
<td>22(135)</td>
<td>15(79)</td>
<td>14(51)</td>
<td>23(131)</td>
<td>22(102)</td>
<td></td>
</tr>
</tbody>
</table>

**Total**

**No. of (526)**

**Pupils**

258 314 271 244 267 292 135 96 269 196
over one third of the tested group). This figure represents a substantial number of pupils who have some operational difficulty in problem solving.

Of the tested pupils, 102 gained $33\frac{1}{3}$ per cent or less in every problem (see Table XIII).

**TABLE XIII**

<table>
<thead>
<tr>
<th>Classes</th>
<th>No.</th>
<th>Classes</th>
<th>No.</th>
<th>Classes</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>623</td>
<td>-</td>
<td>P4A</td>
<td>1</td>
<td>P3A</td>
<td>-</td>
</tr>
<tr>
<td>63L</td>
<td>-</td>
<td>G4A</td>
<td>2</td>
<td>G3A</td>
<td>2</td>
</tr>
<tr>
<td>P5A</td>
<td>-</td>
<td>G4A</td>
<td>2</td>
<td>H3A</td>
<td>8</td>
</tr>
<tr>
<td>G5A</td>
<td>1</td>
<td>H4A</td>
<td>3</td>
<td>P3B</td>
<td>2</td>
</tr>
<tr>
<td>F5B</td>
<td>-</td>
<td>P4B</td>
<td>-</td>
<td>C3B</td>
<td>10</td>
</tr>
<tr>
<td>G5B</td>
<td>5</td>
<td>G4B</td>
<td>11</td>
<td>H3B</td>
<td>16</td>
</tr>
<tr>
<td>F5C</td>
<td>-</td>
<td>C4B</td>
<td>5</td>
<td>P3C</td>
<td>3</td>
</tr>
<tr>
<td>H4B</td>
<td>4</td>
<td>3 Special</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>P4C</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4 Proc. \(\frac{16}{37}\) \hspace{1cm} 39 Total 102

102 pupils, representing one sixth of the school, found the handling of problems troublesome. The process of isolating the formal operations from the problem contexts and the solving of them
appeared too difficult for this one sixth and indicated that these pupils were at a stage where formal reasoning was developing but had not yet been fully mastered. The 102 pupils were mainly third and fourth form pupils. Only 6 of them were fifth form pupils and none of them were six formers. Pupils who were still achieving formal reasoning in this school were thus concentrated in the third and fourth forms. Formal reasoning ability had improved by the time pupils had moved to the high forms.

The arbitrary figure of 102 gave some indication of the extent of the group of pupils who had difficulty in employing formal operations in problem solving. The figures however, did not distinguish between the pupils who were still tied to concrete operations and those who had begun to make some progress towards achieving formal reasoning.

To help distinguish between these two groups a series of simple tests were included in the main test along with the problems. The simple tests were less complex and took the form of a direct statement of one of the four formal operations. Pupils who did well on the simple tests but achieved $33\frac{1}{3}$ per cent or less on the problems would indicate that they were capable of handling formal operations in isolated incidents but were unable to handle the same operations in the problem.

Pupils who achieved $33\frac{1}{3}$ per cent or less in both the problems and simple tests would indicate that they were in the earliest stages
of formal operational development and were subject to many lapses
back into concrete operational structures.

Of the one hundred and two pupils who had gained $33\frac{1}{3}$ per cent
or less on the problems, 83 gained scores of over $33\frac{1}{3}$ per cent in
the simple tests. Even though they had not successfully conserved
the operations necessary for handling the problems, their higher
scores in the simple tests demonstrated some success in handling
operations tied to simple experiences.

The remaining 19 of the one hundred and two pupils gained less
than $33\frac{1}{3}$ per cent in both the main problems and the simple tests.
Their lack of success pointed to their being at the concrete opera-
tional level of reasoning. Most of the nineteen — thirteen of the
pupils — were concentrated in two classes, H3R and 3 Special. Both
these classes are third form classes with low IQ levels and with low
educational achievement levels.

In summary, there are four general groups of pupils

(1) A group of 19 pupils whose thinking is still tied to
concrete operations.

(2) A group of 83 pupils who are in the earliest stages of
formal operational development and have not yet learned to conserve
operations.

(3) A large group of over 350 pupils (almost five sixths
of the school), who have learned to conserve operations but not yet
formed the "groupement" necessary to handle successfully the problem
operations.
(4) A group of pupils who presumably have mastered most aspects of formal thinking and are concerned with the structuring of further syllogisms. The relative size of this group is discussed in a later section of this chapter.

The presence of four such groups emphasises that most pupils in a secondary school have not fully attained formal reasoning.

As formal procedures are usually employed in schools' learning programmes, it would seem that most pupils are faced with situations where formal reasoning in the true sense is beyond them. However, five-sixths of the school could gain some benefit from the formally expressed experiences. Where formal reasoning is carried on in a "direct" form (i.e., conservation of operations is not required), pupils should be able to handle the operations. Where each experience is treated separately and pupils are not expected to apply operations to analogous problems, then they can be understood in a limited formal sense.

Despite these limitations, formal procedures could have benefit for most pupils, as they provide the opportunity for the pupils to gain a sufficiently wide range of experiences so that they will be able to employ formal reasoning when it finally develops.

Of equal importance is the existence of a small group of 19 pupils who could benefit little from formal operational experiences as their thinking is essentially concrete even at the end of their third form year.
To cater for such pupils a school would need to provide adequate concrete experiences so that the pupils can successfully master concrete elements and then proceed to a higher form of thinking at a later stage.

The figures quoted in Tables X, XI (and thereafter), suggested that the solving of the main problems in the test required a more complicated logical process than that involved in solving the simple tests. The above figures were organized according to class divisions and pointed to the difficulties facing third and fourth form pupils in problem solving.

Most third and fourth form pupils were between the ages of thirteen and fourteen years six months but as the age variations in forms were considerable a further estimation based on age groupings would give a clearer picture of any operational improvement with increasing age.

In reasoning situations it is not age alone that determines reasoning procedures but operational development which occurs as pupils grow older.

The number of correct answers in each age group were then totalled for each problem and for each simple test. Average figures of correct answers (expressed as a percentage) were estimated for each group of problems which required the use of the same operation. A similar average score was estimated for the simple tests involving the same operation (see Tables XIII and XIV).
<table>
<thead>
<tr>
<th>Operation</th>
<th>Age Groups</th>
<th>13–14</th>
<th>14–15</th>
<th>15–16</th>
<th>16–17</th>
<th>17+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Implication</td>
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<td>68.8</td>
<td>72.5</td>
<td>72.7</td>
<td>73.8</td>
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<td>14–15</td>
<td>62.6</td>
<td>58.2</td>
<td>55.5</td>
<td>63.2</td>
<td>66.1</td>
</tr>
<tr>
<td></td>
<td>15–16</td>
<td>49.6</td>
<td>63.1</td>
<td>62.7</td>
<td>70.5</td>
<td>78.7</td>
</tr>
<tr>
<td></td>
<td>16–17</td>
<td>63.1</td>
<td>84.9</td>
<td>75.0</td>
<td>75.5</td>
<td>82.0</td>
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<td></td>
<td>17+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incompatibility</td>
<td>13–14</td>
<td>68.8</td>
<td>72.5</td>
<td>72.7</td>
<td>73.8</td>
<td>78.9</td>
</tr>
<tr>
<td></td>
<td>14–15</td>
<td>62.6</td>
<td>58.2</td>
<td>55.5</td>
<td>63.2</td>
<td>66.1</td>
</tr>
<tr>
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<td>62.7</td>
<td>70.5</td>
<td>78.7</td>
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<td>16–17</td>
<td>63.1</td>
<td>84.9</td>
<td>75.0</td>
<td>75.5</td>
<td>82.0</td>
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<tr>
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<td>17+</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>72.7</td>
<td>73.8</td>
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<td></td>
<td>14–15</td>
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<td>62.7</td>
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<td>84.9</td>
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<td>82.0</td>
</tr>
<tr>
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<td>17+</td>
<td></td>
<td></td>
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<tr>
<td>Incomplete</td>
<td>13–14</td>
<td>68.8</td>
<td>72.5</td>
<td>72.7</td>
<td>73.8</td>
<td>78.9</td>
</tr>
<tr>
<td>Affirmation</td>
<td>14–15</td>
<td>62.6</td>
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<td>55.5</td>
<td>63.2</td>
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<td>15–16</td>
<td>49.6</td>
<td>63.1</td>
<td>62.7</td>
<td>70.5</td>
<td>78.7</td>
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<td></td>
<td>16–17</td>
<td>63.1</td>
<td>84.9</td>
<td>75.0</td>
<td>75.5</td>
<td>82.0</td>
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<tr>
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<td>17+</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
TABLE XXV

NO. OF CORRECT ANSWERS AT EACH AGE GROUP FOR FOUR FORMAL OPERATIONS (IN PERCENTAGES)

<table>
<thead>
<tr>
<th>Operation</th>
<th>Age Groups</th>
</tr>
</thead>
</table>
|                  | 13<sub>7</sub>-14<sub>0</sub> | 14<sub>1</sub>-14<sub>6</sub> | 15<sub>7</sub>-15<sub>0</sub> | 15<sub>1</sub>-15<sub>6</sub> | 15<sub>7</sub>-16<sub>0</sub> | 16<sub>1</sub>-16<sub>6</sub> | 16<sub>7</sub>-17<sub>0</sub> | 17<sub>1</sub>+
| Implication      | 42.6       | 46.1       | 39.1       | 45.6       | 51.9       | 65.5       | 81.3       | 82.9       |
| Incompatibility  | 26.2       | 18.1       | 26.7       | 31.3       | 32.0       | 33.2       | 50.0       | 60.3       |
| Disjunction      | 33.1       | 35.1       | 48.7       | 71.6       | 47.5       | 60.5       | 75.0       | 76.9       |
| Incomplete       | 26.2       | 18.1       | 26.7       | 31.3       | 32.0       | 35.2       | 50.0       | 60.3       |
| Affirmation      |            |            |            |            |            |            |            |            |
The achievement scores generally increased as pupils became older both in the simple tests and in the problems. In the tests such as those involving implication, the number of correct replies increased in the simple tests from 66.6 per cent to 88.6 per cent with increasing age whereas the number of correct replies in the problems increased from 42.6 per cent to 82.9 per cent. The differences between all the relative scores in simple tests and problems are summarised in Table XV.

In all but one age group the numbers of correct answers, expressed as percentages, were greater than the comparable numbers of correct answers in the problems.

The differences between these scores were much greater in the younger age groups; for example, for the Incomplete Affirmation operation the difference at 13 yrs 6 months was 21.1 per cent but declined to 7.3 per cent in the oldest age group. As the number of correct answers increased by a much larger per cent in the problems tests rather than in simple tests, the decrease in the difference between these scores can be attributed more to an increasing ability to handle the operations in the problems contexts as the pupils get older rather than to an increasing facility to handle the operations in isolated form.
TABLE XV

DIFFERENCES BETWEEN SCORES (OF CORRECT REPLIES) IN SIMPLE TESTS AND PROBLEMS

<table>
<thead>
<tr>
<th>Operation</th>
<th>13.7-14.0</th>
<th>14.1-14.6</th>
<th>14.7-15.0</th>
<th>15.1-15.6</th>
<th>15.7-16.0</th>
<th>16.1-16.6</th>
<th>16.7-17.0</th>
<th>17.1-18</th>
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<tbody>
<tr>
<td>Implication</td>
<td>26.2</td>
<td>26.4</td>
<td>33.7</td>
<td>26.2</td>
<td>27.0</td>
<td>21.8</td>
<td>8.4</td>
<td>5.7</td>
</tr>
<tr>
<td>Incompatibility</td>
<td>36.4</td>
<td>40.1</td>
<td>28.7</td>
<td>32.9</td>
<td>34.2</td>
<td>30.7</td>
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<td>21.8</td>
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<td>Disjunction</td>
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<td>33.0</td>
<td>14.0</td>
<td>1.06</td>
<td>31.2</td>
<td>13.8</td>
<td>4.5</td>
<td>1.3</td>
</tr>
<tr>
<td>Incomplete</td>
<td>23.1</td>
<td>22.3</td>
<td>24.1</td>
<td>21.1</td>
<td>27.9</td>
<td>25.0</td>
<td>22.7</td>
<td>7.3</td>
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<tr>
<td>Affirmation</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
These figures lend support to the view that reasoning improves with age. But it is not a direct relationship with age. Instead the age factor reflects the influence of the development of operational ability over time. The length of time that this takes varies in different pupils.

III Age Levels for the Appearance of Formal Operations and the Relative Difficulty of Different Operations

Figures quoted in the previous section indicated that pupils in a secondary school began to achieve a high degree of success in handling formal reasoning in the fifth and sixth forms. Pupils' successful appreciation of abstract operations represented the final stages of formal reasoning development. Once the operations were fully mastered they became flexible logical instruments acting in a given relation with each other and useful for the organizing of formal schemata such as the correlation schemata. Conversely the satisfactory handling of problems involving such schemata suggests that formal reasoning has been achieved.

A test concerned with the correlation schemata had been included in the main test as well as the simple tests involving the directly expressed operations mentioned previously. The test required pupils to correlate the factors of height, eye colour and hair colour. The scores for each pupil were marked and classified into one of the eight six month age groups. The number of correct answers in each age group were then expressed as a percentage of the total number of
possible correct replies in each age group.

The percentage figures are included in Table XVI.

The figures given show a sudden improvement in the ability of pupils to handle correlations after the age of 16 years seven months (167). The figures increased from 20-30 per cent success in earlier years to over 60 per cent success by 17 years and almost 80 per cent in the oldest age group. If correlation mastery follows the appreciation of formal operations then approximately 60 pupils in this school reached the equilibrium of formal reasoning during their sixteenth year. This feature was given support in the figures of Tables XIII and XIV.

A similar improvement in reasoning ability occurs in the percentages for each separate operation although there was some difference in the ages at which formal reasoning characteristics appeared when the four groups of problems involving the four operations were compared with each other (see Table XIV).

In two of the operations, disjunction and implication, the number of correct answers increased to a figure of over 60 per cent in the 16½-16¾ age group. Similar success did not appear until after the seventeenth year for the incompatible and incomplete affirmation operation. These operations seemed slightly more difficult. The small differences in the achievement of the four operations emphasised that the formation of formal reasoning was a slow process of adjustment involving many experiences rather than an
### Table XVI

**Percentage Number of Correct Answers Involving the Correlation Schemata**

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>13.7-14.0</th>
<th>14.7-15.0</th>
<th>15.1-15.6</th>
<th>15.7-16.0</th>
<th>16.1-16.6</th>
<th>16.7-17.0</th>
<th>17.1+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correlation Test</td>
<td>16.5</td>
<td>21.3</td>
<td>29.3</td>
<td>33.7</td>
<td>16.0</td>
<td>25.0</td>
<td>63.6</td>
</tr>
</tbody>
</table>
"overnight" change.

On the whole the differences between the ages when the operations were understood were generally small (less than a year) and these figures supported Piaget's view that formal reasoning appeared in or after the sixteenth year and success in other schemata followed this development.

Moff, had found that his case studies achieved comparable success after their fourteenth year, a difference of over two years. The discrepancy between the two age levels could be explained however in terms of the interview approach. In a personal interview it would be possible for the supervisor to help pupils reasoning by encouraging the isolation of the operations from the context of the problem. As emphasised in this study, pupils who had not yet conserved operations in their abstract form were capable of handling operations in a direct form. It is possible that Moff has considered such pupils as pupils capable of formal reasoning rather than making a distinction between those pupils whose reasoning was tied to single experiences and those pupils who could comprehend the "groupement".

Moff's results corresponded more closely with the success levels in the simple tests (see Table XIII). By the age of fourteen years one month pupils had achieved at least 60 per cent success in all operations.
CHAPTER VI

GENERAL CONCLUSIONS

The above studies gave support to Piaget's view that there were difficulties in problem solving that existed apart from any weakness in language ability. Language did have some influence in the reasoning situation as few subjects gained 100 per cent in all language questions. A group of pupils, between 10 to 15 per cent of each age groups, found language a serious handicap and relatively more influential in the reasoning situation than other factors.

Apart from the linguistic errors found in the language section of replies there were errors made in the use of particular words and phrases in the operational replies which made up the bulk of the mistakes made by pupils. These errors, although linguistic in nature, were not purely verbal mistakes. The appreciation of these depended on the understanding of the problem situation and the comprehension of operations involved in their solutions. Thus these verbal errors could be classed as operational errors and were dependent on the operational levels of the pupils rather than their vocabulary levels.

The concept of different levels in reasoning has significance for secondary schools as it stresses that pupils within the age levels
catered for by the school can be at different levels of reasoning and require a variety of experiences which actually differ in nature from each other. In this particular school 19 pupils were capable of concrete reasoning only; approximately 30 pupils were in the early stages of formal reasoning and their limited "formal" ability only allowed them to understand operations in a direct and uncomplicated form; most of the school were in the later stages of formal reasoning development. Only approximately 60 pupils were capable of formal reasoning. This theory of operational level has further value as it points out that most pupils in the school were expected to understand formal reasoning (abstract theories, implication, reversal procedures) before they were capable of understanding such intellectual processes.

This study may at first appear to criticize the formal procedures of the schools today. In reality, Piaget stresses, it is only if pupils are given the opportunities to experience problems involving formal reasoning, will they formulate their reasoning tools (or reasoning structure). Without such situations their reasoning ability would remain latent. Thus the more problem situations the schools could create the more they would help their pupils development. Under such circumstances however limited the scope of the reasoning tools, they would remain effective until such time that they evolved into more flexible and more widely adaptive formal reasoning tools. Further investigations could perhaps throw light on
the formation of different levels of experiences so that pupils operational development could be graduated. This would involve a more detailed analysis of the content of schools' curricula.
<table>
<thead>
<tr>
<th>Implication</th>
<th>Non-Exclusive Disjunction</th>
<th>Incompatability</th>
<th>Incomplete Affirmation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Watchmaker</td>
<td>The Soup</td>
<td>Travellers</td>
<td></td>
</tr>
<tr>
<td>The Tie</td>
<td>The Mule</td>
<td>The Pathway</td>
<td>Melons</td>
</tr>
<tr>
<td>The Shoes</td>
<td>The Keys</td>
<td>Pears</td>
<td></td>
</tr>
<tr>
<td>Vehicles A</td>
<td></td>
<td>Three Animals</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The Funicular</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MORF'S TESTS

The Watchmaker

Complaints were received in a watchmaking factory because of watches which were poorly made. The manager sent a foreman or technician or expert into the factory to find out what was the trouble. The foreman inspected the machinery and talked with the workmen, and after a little while telephoned the manager and said,

"So far I've found that all watches we made in the month of September have defects." The manager had several watches in front of him and he looked at them.

a. At first he took a watch which had been made in September and said to himself,

"This one was made in September, therefore it has a defect!" Could he say that?

b. Then he took a second watch and said to himself,

"This one was made in July, so I'm certain it hasn't any defect!" Could he say that?

c. Then he took a third watch which he knew to be defective and said to himself,

"This watch has a defect, so I know that it was made in September." Could he say that?

d. Finally he took a fourth watch and said to himself,

"I know that this one hasn't got a defect, therefore it couldn't have come out in the month of September." Could he say that?

The Tie

A school pupils' fair was held in Lausanne for pupils from all over Switzerland. Those from Geneva decided just as they were leaving to wear ties, so each one put on a blue tie. During the fair I was walking with a friend of mine in Lausanne and,
a. I saw in front of me a pupil from Geneva, but I didn't see his tie as he was walking in front of us. Then my friend asked me,

"What colour do you think his tie is?" What answer could I give him? A little later,

b. We saw a pupil who was coming toward us, and he was wearing a blue tie. Then my friend asked me,

"Do you think he comes from Geneva?" What answer ought I give him?

Shoes

In a holiday camp a group of boys had colds and they were forbidden to go out because it was raining. However, even so, some of them slipped out, and the camp director suspected it but he did not know who had disobeyed. Then he had an idea,

"This evening," he said, "I shall examine all the shoes, then I'll be able to tell who has been outside because they will have wet soles."

The Soup

My brother and I were climbing in the mountains. When we arrived at our hut, we found that we had forgotten our food. Then we looked around the hut and found the remains of some provisions, but they were no longer fresh. Here is what we found... condensned milk, soup and an old tin of meat. My brother ate some meat and soup, and I ate soup and condensed milk. An hour later we both had stomach-ache. What could this have come from?

The Mule

I am thinking of an animal. If this animal has long ears it would be either an ass or a mule. If my animal has a thick tail it is either a mule or a horse. Now I want an animal which has both long ears and a thick tail. What could this be?

The Keys

On the ground floor of a house there are two garages and for each garage two keys have been made. The keys of the first garage belong to M. Dupont (who has one of the keys) and M. Durrant (who has
the other key). Mr. Durant is the caretaker. For the second garage, one of the keys belongs to Mr. Martin, and the other to Mr. Durant. One evening there was a fire in the house. Someone had the two keys and was able to take out the cars. Who was able to do that?

**Vehicles**

A. To get to the station I can take a vehicle which travels on tyres; either a trolley-bus or a motor-car. But I can also take a vehicle which travels by electricity. That is, either a trolley-bus or a tram. Now I want to take a vehicle which has tyres and which travels by electricity. Which one could it be?

B. A similar one is also given involving a motor car, motor-cycle and all-terrain vehicle.

**Funicular**

In a cable car there are very few seats so they ought to be reserved for people who are sick and people who are old. Someone who is ill arrives. Can he sit down? Then someone who is ill and elderly? An elderly lady? Then someone who is not ill but young?

**Travellers**

A travel agency organised car excursions. For Sunday the drivers were given the following instructions,

"You can take passengers who have a suitcase but then they can't bring a dog. You can also take a passenger who has a dog but not a suitcase. One can't take both suitcase and dog."

Here are the passengers arriving so you can tell me if the driver ought to take them or not. The first one says,

a. "Can I bring a suitcase with me?"

Another one said,

b. "Do you take dogs?"

The third one said,

c. "I haven't a dog and I have forgotten my suitcase."
The Pathway

In the mountains there is a path which you are forbidden to travel on when it is night and when you don't have a lantern. You can go on it at night when you have a lantern or without a lantern when it is daytime. A traveller arrives during the night with a lantern. Can he go on the path? What about someone who has a lantern but it is daytime? What about someone who comes in the daytime and who hasn't a lantern.

Three Animals

A man travels with three animals: a cat, a dog and a canary. In the evening, in the hotel, he can't leave them together in the same room, because what would happen? (It is necessary here to make clear that the dog does not attack the canary). So it is necessary for him to take several rooms. How many? (one can reduce the possibilities if necessary in order to approach the solution dog plus canary).

Melons

A man came back from Italy and said,

"I will never eat olives and melons at the same time. I saw there, someone who had eaten melons and olives at the same time, and the next day he was dead."

Pearls

A king possessed a chest full of pearls of all colours, big and little. Inside this chest he placed a golden box which contained the most precious of all his pearls, which were of all colours and shapes. One day he allowed a friend to look at his pearls and in order to show him that he had confidence in him he left him alone. But something unfortunate happened. The friend dropped the golden box and the pearls fell among the others and he wasn't able to distinguish between them any more. Then he called the king's Treasurer because he was frightened and asked his advice. But the Treasurer didn't want to explain to him how the pearls had been arranged, and all he said to him was,

"The red pearls in the box were not little. There were also little ones but they were not red".

Then the friend tried to sort them out with that advice.
a. At first he took a large red pearl and asked himself if it could have fallen from the box. What do you think?
b. After that he took a little pearl also red?
c. Then a little white pearl?
d. Finally he took one which was neither large nor red?
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1. The Dangerous Road (Hero's Title - The Pathway)

Not far from Christchurch there is a road which is very dangerous to travel along at night because of the many sharp turns. You are forbidden to ride along the road at night on your bicycle without a light shining on it. You can travel along it in the daytime without a light shining on your bicycle.

a. A bicycle rider arrived at the stretch of road at night and his bicycle had a light shining.
   Has he allowed to ride on the road?
   Why?

b. A rider arrived at the stretch of road in the daytime and his bicycle had a light shining.
   Has he allowed to ride along the road?
   Why?

c. A rider arrived at the stretch of road in the daytime. His bicycle did not have a light shining.
   Has he allowed to ride along the road?
   Why?

2. A Misfit

My friend and I went tramping in the mountains. We arrived at a hut and, to our dismay, found we had forgotten to bring our food with us. We searched the hut and found a few stores. They looked as if they had been there for a long time. However we were so hungry we decided we could eat them. There were tins of condensed milk, soup and meat. I ate soup and condensed milk and my friend ate meat and soup. An hour later we both had stomach aches.
Which of these three things would have given us stomach aches?

Why do you give this answer?
3. Animals

A man travelled with three animals; a dog, a cat and a canary. He could not leave them alone together in the same room when he wanted to go out, as the dog would attack the cat and the cat would attack the canary. So he rented several rooms. (He could not afford to rent 4 rooms - one for each animal and one for himself.)

How many rooms did he rent?

How were the 4 of them arranged in the rooms?

4. The Unknown Animal (Work's Title - The Mule)

While we were driving along a road near Christchurch I saw an animal in a nearby field but I did not know what it was. So I asked my parents, but they had not noticed it. They asked me to describe it.

"The animal had long ears," I said.
"Oh! Then it could have been either an ass or a mule," said my father. "What else did you notice?"
"The animal also had a thick tail," I continued.
"Then it was either a mule or a horse," said my mother.
I thought for a minute and then from this information I realised what the animal was.
Which of these animals was it?

Why?

5. The Tie

An inter-school sports meeting was held in Christchurch for schools from all over the Canterbury Province. Pupils from Ashburton decided, just as they were leaving, to wear ties. So each one put on a blue tie. I was walking with my friend around the sports-ground in Christchurch at lunchtime and there we met many other pupils.

a. I saw a pupil walking in front of us whom I knew to be from Ashburton as I had been introduced to her before. My friend said, "I cannot see her tie. I wonder what colour it is?"

What did I tell her?

Why should I say this?
5. Later in the afternoon we saw a pupil walking towards us wearing a blue tie. And my friend said to me, "Do you think she is from Ashburton?"

What did I tell her?

Why should I say this?

6. Shoes

At a boarding school a group of girls had all caught colds and were forbidden to go outside the building while the wet weather continued. However, some girls slipped outside while it was raining to post some letters. The Headmistress suspected this but did not know who had disobeyed. Then she had an idea. She called an assembly at four o'clock in the afternoon and said, "This evening I shall examine all the shoes, and then I will be able to tell who has been outside because the shoes will have wet soles."

When the Headmistress made the inspection, did she find the girls who had slipped out?

Why?

7. Vehicles

To get to town I could travel by a vehicle which has a motor — either a car or a power-cycle. I could also travel by a vehicle which has two wheels and this could be either a power-cycle or a bicycle. If I wanted to take a vehicle which has two wheels and a motor — which of the following vehicles could it be?

- car
- power-cycle
- bicycle

Why?

8. The Keys

In the grounds of a large house, which has been turned into a block of flats, there are two garages and for each garage 2 keys have been made. Mr. Brown, the caretaker, lives in a flat in the house. Mr. Smith who lives in a flat in the house keeps his car in the first garage. He has one key to the first garage and Mr. Brown has the other. Mr. Grey, who also lives in a flat in the house, keeps his
8. car in the second garage. He has one of the keys to the second garage and Mr. Brown has the other.

One evening a fire broke out. Someone managed to take both cars out of the garages in time and saved them.
Was the person who was able to take both cars?

What part of the story tells you this?

9. Travellers

A tourist bureau organised a car trip for a group of people who wanted to take a trip into the mountains. As there was a limited amount of space for extras the following instructions were issued to the driver:

"You can take passengers who have a suitcase but then they cannot bring a dog. You can also take passengers who have a dog but not a suitcase. A passenger cannot take both a suitcase and a dog."

a. The first passenger arrived and said to the driver, "Can I bring a suitcase with me?"

What do you think the driver replied?

Why?

b. Another passenger arrived and said to the driver, "Do you take dogs?"

What did the driver tell him?

Why?

c. Another passenger arrived who said, "I haven't a dog and I have forgotten my suitcase. Can I go?"

What did the driver reply?

Why?

10. Melons

A man came back from Italy and said, "I will never eat olives and melons at the same time. I saw someone in Italy who had eaten olives and melons at the same meal and the next day he was dead!"

If the traveller from Italy told you this story would you agree with him?

Why?
11. Travellers (Noyse Title – The Funicular)

At 5 o’clock in the afternoon, during the week, there are many people who want to travel by bus. As there are only a limited number of seats, 4 seats are reserved just for people who are old or for people who are ill.

a. A sick man climbed onto the bus.
   
   Can he sit down in one of the empty reserved seats?
   
   Why?

b. Then a sick old woman climbed onto the bus.
   
   Can she sit down in one of the reserved seats?
   
   Why?

c. Then a young girl who was not ill climbed onto the bus.
   
   Can she sit in one of the reserved seats?
   
   Why?

12. Matches

A watchmaking factory received complaints from customers that some watches were poorly made. The manager sent a foreman to find out what was causing the trouble in the factory. The foreman inspected the machinery and talked to the workers, and, after a little while, telephoned the manager and said,

"So far, I have found that all the watches we made in the month of September have defects."

The manager had several watches in front of him on his desk. After he put down the telephone he began to study them.

a. In the first watch he discovered a defect and said to himself, "Then this watch must have been made in September." He went to check the production list which listed the date each watch was made.

Did he mean correctly?

Write down the reason why you gave this answer.
12. b. The production list also told him that the second watch was made in September and without examining the workings of the watch he said to himself, "This watch was made in September, therefore it has a defect." Was he correct?

Give your reason.

c. The production list told him that the third watch had been made in July, and so he said to himself, "I'm certain it hasn't a defect." Did he find any defect in the watch when he did examine it?

Why do you give this answer?

d. He examined the fourth watch and could find no defect in its workmanship and said to himself, "Therefore it couldn't have been made in September." Was he surprised to see the name of the month in which it was made listed on the production list?

Why do you give this answer?

13. Pearls

A king possessed a chest full of pearls of all colours, big and little. Inside this chest he placed a golden box which contained the most precious of his pearls; which were also of all colours and shapes. One day, he allowed a friend to look at his pearls, and, in order to show that he had confidence in his friend, he left him alone with the chest. But something unfortunate happened. The friend dropped the golden box and the pearls fell among the others in the chest and he wasn't able to distinguish between them anymore. So he called the King's Treasurer because he was frightened and asked his advice. But the Treasurer was too busy to come in and sort the pearls and all he said to the friend was,

"The red pearls in the box were not little. There were also little ones in the box but they were not red." With this advice the friend tried to sort out the pearls.
13. a. First he took a large red pearl and asked himself if it could have fallen from the box. 
   What do you think?
   Why?

b. After that he took a little pearl, also red.
   Did this fall from the box or was it originally in the chest?
   Why?

c. Next he took a little white pearl.
   Where did it come from?
   Why do you think this?

d. Finally he took one which was neither large nor red.
   Could that have fallen from the box?
   Why?
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MODIFIED TESTS USED IN THE THIRD PILOT EXPERIMENT

(The correct solutions are indicated)

**The Pens**

A penmaking factory received complaints from customers that some pens were poorly made. The manager sent a pen inspector to the factory workroom to find out why some pens were poorly made. The inspector looked at the machines and talked to the workmen. He then looked at the production list which told him the date each pen had been made and then telephoned the manager and said,

"So far, I have found that all the pens made in the month of September have defects."

**Answer the following.** Put the number of the sentence or word you have chosen in the brackets at the right of the page.

1. Who complained that their pens were poorly made?
   1. the manager.
   2. the foreman.
   3. all the customers who had received pens from the factory.
   4. some of the customers who had received pens from the factory. (3)

2. What did the inspector tell the manager?
   1. all pens made in the month of September have defects.
   2. all pens have defects.
   3. only pens in September have defects.
   4. up until this moment, the pens with defects were all made in September.
   5. pens with defects were not made in September. (4)

3. What did the inspector do?
   1. visited the customers who complained.
   2. looked at the machines, talked to the workers and looked at the production list. (2)
B. What do these words mean in this story?

Complaints?
1. comments.
2. accusations.
3. praises. (2)

Customer?
1. a person who inspects pens.
2. a person who makes pens.
3. a person who buys pens. (3)

Defect?
1. an error in the making of the pen.
2. a change in the style of the pen.
3. an improvement in the pen. (1)

Discovered?
1. wondered if.
2. found.
3. forgotten. (2)

C. The manager had three (3) pens in front of him on his desk. After his conversation with the inspector on the telephone, he began to study them.

a. In the first pen he discovered a defect and said to himself, "Then this pen must have been made in the month of September." He went to check the production list. Did he guess correctly?
1. Yes.
2. No.
3. Probably.
4. Probably not. (3)

Write in the brackets the number of the sentence you choose from the sentences below which best describes your reason for giving this answer.
1. Because pens made in September have defects.
2. Because only pens made in September have defects.
3. As he checked the production list.
4. But pens made in any month could have had a defect.
5. As pens on the desk are not the same as the pens made in the factory.
6. I don't know. (4)

Write here any comments you would like to add.
b. The production list told him that the second pen had been made in July and he said to himself, "I am certain it has no defect." When he later examined the pen, did he find a defect?

1. Yes.
2. No.
3. Probably.
4. Probably not. (4)

Write the number of the sentence that you choose from the sentences below (which best describes your reason for giving this answer) in the brackets.

1. As didn't know the month in which the pen was produced.
2. As pens made in July could have had defects.
3. As pens made in July could not have had defects.
4. As only pens made in September had defects.
5. I do not know. (2)

Add any further comments here.

c. He examined the workings of the third pen and could find no defect and said to himself, "Therefore it could not have been made in September." Was he correct in saying this with only the information that he had?

1. Yes.
2. No.
3. Probably.
4. Probably not. (3)

Choose a sentence from those below which describes why you said this. Write the number of the sentence in the brackets.

1. As no pens made in September had defects.
2. As all pens made in September had defects.
3. Only the pens made in September that have so far been checked have defects. Other pens made in September that have not been checked may not have defects.
4. As all pens made in July have defects.
5. As all pens made in July do not have defects.
6. Only the pens which do not have defects are made in other months.
7. I do not know. (3)

Add any further comments or explanations here.
The Ties

An inter-school sports meeting was held in Christchurch, on Saturday, for schools from all over the Canterbury Province. Pupils from Ashburton decided just as they were leaving on Saturday morning to travel to Christchurch, to wear blue ties. So each Ashburton pupil put on a blue tie.

Our school, as it is a Christchurch school, also attended.

At the inter-school sports meeting at Christchurch, at lunch-time, I walked around the grounds with a friend of mine from our school and met other pupils from other schools.

A. A pupil, who I knew from Ashburton, waved but did not come over to see us, as she walked away from us we could not see clearly the colour of her tie. My friend said,

"I wonder what colour her tie is?"

1. Yes.
2. No.
3. I don't know.
4. Blue.
5. Not blue. Put number here (4)

Choose a sentence from the following which best describes the reason why you choose this answer and write the number of the sentence in the brackets.

1. Because Ashburton was the only school wearing ties.
2. Because the only school pupils allowed to wear blue ties were Ashburton pupils.
3. Because I knew she was from Ashburton, and Ashburton pupils decided to wear blue ties just as they were leaving.
4. Because you could not see her tie.
5. Because her monogram told us. Put number here (3)

B. Later in the afternoon a pupil was walking towards us wearing a blue tie. My friend said to me,

"She is from Ashburton isn't she?"

What did I reply?
1. Yes.
2. No.
3. Not necessarily. Put number here (3)
Choose a sentence from the following to describe your reason.

1. Because she is wearing a blue tie and so she is from Ashburton.
2. Because Ashburton people were not wearing blue ties.
3. Because the only people wearing blue ties are from Ashburton.
4. Because pupils from other schools in Canterbury may also wear blue ties.
5. I do not know as I did not ask the girl.
   Put number here (4)

C. Word Meanings in this situation.

Interschool Sports Meeting?
1. For one school.
2. Between two schools.
3. For many schools. Put number here (3)

Decided to wear?
1. Ordered.
2. Choose.
3. Forgot.
4. Prevented others. Put number here (3)

Colour?
1. the shade of.
2. the shape of.
3. the pattern of. Put number here (1)

Other schools?
1. Many different.
2. One other.
3. Our. Put number here (1)

D. Schools all over Canterbury Province means?
1. all schools situated in the Canterbury Province.
2. some schools in the Canterbury Province.
3. our school and Ashburton school.
4. schools in Christchurch. Put number here (1)

Add any further explanations here.
Shoes

At a boarding school a group of girls had caught colds and were forbidden to go outside the building while the wet weather continued. However, some girls slipped outside while it was raining to post some letters. The headmistress suspected but did not know who had disobeyed. She sent a message around the class room which was read to all the girls. "This evening the headmistress will examine all pairs of shoes. The headmistress will know who has been outside because the soles of their shoes will be wet."

Write the number of the sentence or word you have chosen from the following in the brackets at the right of the page.

A. The group of girls was forbidden to . . . ?
   1. post letters.
   2. catch colds.
   3. go outside while the wet weather continued.
   4. go outside.
   5. get their shoes wet.  
      Put number here (3)

B. The headmistress announced that she would . . . ?
   1. examine the shoes the girls were wearing.
   2. see only the girls with wet shoes.
   3. examine every pair of shoes in the school.
      Put number here (3)

C. What is meant by each of the following words?

   Continued ?
   1. stopped.
   2. did not cease.
   3. blew.  
      Put number here (2)

   Suspected ?
   1. refused to believe.
   2. had a suspicion.
   3. knew.  
      Put number here (2)

   Disobeyed ?
   1. broken the rule.
   2. kept the rule.  
      Put number here (1)

   Evading ?
   1. nightfall.
   2. soon.
   3. later.
   4. at once.  
      Put number here (1)
D. When the headmistress made the inspection did she find the girls who had slipped out?
1. Yes.
2. No.
3. Maybe. Put number here (3)

E. Choose a sentence from the ones listed below which best explains the reason for your answer in D.
1. Because some of the girls were late.
2. Because their shoes would be wet when the headmistress examined all the shoes in the evening.
3. Because the girls who had been outside would change their shoes.
4. Because not all the shoes of the girls who had been outside need still be wet as they would have dried them. Not all the shoes of the girls who had been inside need to dry as some of their shoes could have been wet as a result of something else.
5. Because some of the girls who had not been outside could have wet shoes too as they could have become damp as the result of some other activity. Put number here (4)

F. Write any further explanations here.

A Mishap (Your Title - The Soup)

My friend and I went tramping in the mountains. We arrived at a hut and, to our dismay, found we had forgotten to bring our food with us. We searched the hut and found a few stores in a cupboard. They looked as if they had been there a long time. However, we were so hungry we decided we would eat them. There were tins of condensed milk, soup and meat. I ate from the tin of condensed milk and from the tin of soup and my friend ate from the tin of meat and from the tin of soup. An hour later we both had stomach aches.

G. Where did we find the stores that we later ate?
1. We brought them from home.
2. We bought them at a shop.
3. We discovered them in the hut in which we decided to stop. Put number here (3)

H. What did I decide to eat?
1. Condensed milk.
2. Soup.
4. All three.
5. Condensed milk and soup.
   Put number here (25)

8. Write down the number of the words you choose from the following which best describes the meaning of the words.

   Eructation?
   1. remembered.
   2. did not remember.
   Put number here (2)

   Stomach?
   1. supplies of food.
   2. shops.
   3. firewood.
   Put number here (1)

9. Which of the three stores do you think gave them stomach ache?
   1. All of them.
   2. None of them.
   5. Soup and milk.
   7. Soup.
   Put number here (7)

D. Why?
   1. As they both ate the three of them.
   2. As they both ate these two.
   3. As they both ate this one.
   4. As milk makes you sick.
   5. As meat does not keep.
   6. In soup curdles.
   Put number here (3)

E. Other explanations here.

The Keys

In the grounds of a large house, which has been turned into flats, there are two garages and for each garage two keys have been made. Mr. Brown, the caretaker, lives in a flat in the house. Mr. Smith who lives in a flat in the house, keeps his car in the first garage. He has one key to the garage and Mr. Brown has the other. Mr. Grey, who also lives in a flat in the house, keeps
his car in the second garage. He has one of the keys to the second garage and Mr. Brown has the other.

After choosing your answers from the words and phrases below, write down the number of the word or sentence in the brackets at the right of the page.

A. Who is the caretaker?
   1. Mr. Smith.
   2. Mr. Brown.
   3. Mr. Gray.
   4. Someone else. (2)

B. Who has a key to the second garage?
   1. Mr. Brown.
   2. Mr. Gray.
   3. Mr. Smith.
   4. Mr. Gray and Mr. Brown.
   5. Mr. Smith and Mr. Gray. (4)

C. What does the word garage mean?
   1. A flat.
   2. A house.
   3. A place in which cars are kept. (3)

D. One evening a fire broke out. Someone managed to take both cars out of the garage in time and saved them. Who was the person who was able to take both cars out of the garages?
   1. Mr. Brown.
   2. Mr. Gray.
   3. Mr. Smith.
   4. Mr. Gray and Mr. Smith (1)

E. Why do you give this answer? Choose one of the following sentences.
   1. Because they were their cars.
   2. Because he had both keys of one garage.
   3. Because he had a key for each garage.
   4. Because he was the caretaker. (3)

F. Add any further explanations here.

The Unknown Animal (Murf's Title - The Mule)

While we were driving along a road near Christchurch I saw an animal in a nearby field, but I did not know what it was. So I asked my parents but they had not noticed it. They asked me to describe it.
"The animal had long ears," I said.
"Oh! Then it could have been either an ass or a mule," said my father. "What else did you notice?"
"The animal also had a thick tail," I continued. "Then it was either a mule or a horse," said my mother.
I thought for a minute and then from this information I realised which of the three animals it was.

Write down in the brackets at the right of the page the number of the phrase or word you choose as your answer.

A. What is the characteristic that both an ass and a mule have?
   1. long ears.
   2. a thick tail.
   3. both. (1)

B. What animals have a thick tail?
   1. a horse.
   2. an ass.
   3. a mule.
   4. a horse, an ass and a mule.
   5. a horse and a mule.
   6. a horse and an ass. (5)

C. Which of the animals had I seen in the nearby field? The horse, the mule or the ass.
   1. the horse.
   2. the mule.
   3. the ass.
   4. the ass and the mule.
   5. the mule or the horse. (2)

D. Why did you give this answer?
   1. Because the horse had a thick tail.
   2. Because the mule had long ears.
   3. Because it is the only animal I have ever seen.
   4. I do not know as I have never seen a mule or an ass.
   5. Because the horses I have seen have both long ears and a thick tail.
   6. Because the mule is the only one of the three animals mentioned which has both long ears and a thick tail.
   7. We need to know more about the animals before we can decide. (6)

E. Add any other comments here.
The Travellers

A tourist bureau organised a car trip for a group of people who wanted to take a trip into the mountains. As there was a limited amount of space for extras, the following instructions were issued to the driver. "You can take passengers who have a suitcase but they cannot bring a dog. You can also take passengers who have a dog but not a suitcase. A passenger cannot take both a suitcase and a dog."

Answer the following questions. Put the number of the word or sentence chosen in the brackets at the right of the page.

A. Who was given the instructions?
1. the passengers.
2. the driver.
3. the tourist bureau. (2)

B. The instructions issued to the driver said:
1. a passenger must have a suitcase.
2. a passenger can take both a suitcase and a dog.
3. a passenger cannot take a suitcase or a dog.
4. a passenger can take two dogs.
5. a person who has decided to go must remember that if he has a suitcase or a dog, he cannot take both of them. (5)

C. A suitcase is . . . ?
1. something to wear.
2. something to carry possessions in.
3. several bags. (2)

A dog is . . . ?
1. a four legged animal.
2. four legged animals.
3. a wild beast. (1)

D. A passenger who was waiting to board the bus asked the driver, "Can I bring a suitcase with me?" What did the driver reply?
1. Yes.
2. No. (1)

Why?
1. Because the passenger had a suitcase.
2. Because you have a dog with you and you cannot take both a suitcase and a dog.
3. Because you haven't a dog with you.
4. If you haven't a dog with you. (4)

A second waiting passenger asked the driver, "Do you take dogs?" The driver replied.
1. Yes.
2. No. (1)

Why?
1. As he did not have a suitcase.
2. As he only had a dog.
3. If you bring one dog and no suitcase.
4. As long as you have no suitcase you can bring your dogs.
5. As the passenger had dogs. (3)

Another passenger arrived and said to the driver, "I haven't a dog and I have forgotten my suitcase. Can I go?"
1. Yes.
2. No. (1)

Why do you give this answer?
1. He can still go as it does not matter that he has neither a suitcase nor a dog.
2. As there is only room left for a man without a suitcase or a dog.
3. He can still go as he has not a suitcase.
4. As he did not have either a suitcase or a dog.
5. He can still go as he has not a dog. (1)

Put any further comments here that you would like to make.

The Animals (Worsh's Title - The Three Animals)

A man travelled with three animals; a dog, a cat and a canary. He could not leave them alone together in the same room when he wanted to go out as the dog would attack the cat and the cat would attack the canary. So he rented a number of rooms. As he could not afford to rent four rooms, one for each animal and one for himself, he rented less than four rooms.

A. How many animals were there?
1. One.
2. Two.
3. Three.
4. Four. (3)
Who would the dog attack?
1. the man.
2. the canary.
3. the cat. (3)

Which animal would attack the canary?
1. the dog.
2. the cat.
3. the man. (2)

B. What is meant by the word rent?
1. hire.
2. buy.
3. arrange. (1)

What is meant by the word attack?
1. fights with.
2. is friendly with.
3. eats with. (1)

C. What was the least number of rooms that he could rent and keep the peace amongst the animals?
1. one.
2. two.
3. three.
4. four. (2)

D. How were the three animals and the man arranged in the rooms?
1. The four of them each had a separate room.
2. Each animal had a separate room and the man shared the room with one of the animals.
3. All in the same room.
4. The dog and the cat were in one room and the man and the canary were in the other.
5. The dog and the canary were in one room and the man and the cat were in the other.
6. It doesn't matter.
7. No rooms were rented as all the animals would attack each other. (5)

E. Write any further comments here.
The Pearls

A King possessed a chest full of pearls of all colours, big and little. Inside this chest he placed a golden box which contained the most precious of his pearls; which were also of all colours, sizes and shapes. One day, he allowed a friend to look at his pearls, and, in order to show that he had confidence in his friend, he left him alone with the chest of pearls. But something unfortunate happened. The friend dropped the golden box and the pearls from the box fell among the others in the chest and he wasn’t able to distinguish between them anymore.

He called the King’s Treasurer because he was frightened and asked his advice. But the Treasurer was too busy to come and sort out the pearls for him and all he said to the King’s friend was,

"The red pearls in the box were not little. There were also little ones in the box but they were not red."

With this advice the friend tried to sort out the pearls which had been in the box from the pearls which had previously been in the chest. After choosing your answer write the number of the sentence or word in the brackets at the right of the page.

A. What type of pearls were originally in the chest?
   1. Red pearls.
   2. Little pearls.
   3. Pearls of all colours.
   4. Pearls of all colours and all sizes. (4)

B. What type of pearls were originally in the golden box?
   1. Red pearls.
   2. Non red pearls.
   3. Little pearls.
   4. Big pearls.
   5. Pearls of all colours.
   6. Pearls of all colours and sizes. (6)

C. What size were the red pearls that the Treasurer advised him were in the box?
   1. Big.
   2. Little.
   3. All sizes. (1)

D. What colour were the little pearls in the golden box?
   1. Red.
   2. White.
3. All colours.
4. All colours except red. (4)

F. What colour were the big pearls in the chest?
1. Red.
2. Not red.
3. All colours.
5. All colours but red. (3)

F. What does miss mean?
1. Its colour.
2. Its shape.
3. How big it is. (3)

G. First he took a large red pearl and asked himself if it could have fallen from the box.
1. Yes.
2. No.
3. Maybe.
4. Maybe not. (1)

Why do you think this?
1. Because all the large red pearls were in the box.
2. Because all the large red pearls were in the chest.
3. Because there were some red pearls in the box.
4. Because there were some large red pearls in the box.
5. Because only small red pearls were in the chest. (3)

H. After that he took a little pearl, also red. Did this fall from the box.
1. Yes.
2. No.
3. Maybe.
4. Maybe not. (2)

Why do you say this? Choose a reason which best describes your reason.
1. Because the red pearls in the box were little.
2. Because the red pearls in the box were big.
3. Because the red pearls in the box were big and all other little ones in the box were not red.
4. As red ones were from the box.
5. As little ones were from the chest.
6. As only the big ones were from the box.
7. I don't know as the pearls are too alike. (3)
I. Finally he took one which was neither large nor red. Could that have fallen from the box?
1. Yes.
2. No.
3. Maybe.
4. Maybe not. (3)

Why do you give this answer? Choose a sentence from the ones below which best describes your reason.
1. Because there were only little ones in the box.
2. Because there were only red ones in the box.
3. Because there were some small pearls that were not red in the box.
4. Because there were some small pearls that were not red in the chest. (3)

II. Finally he took a small pearl which was white. Did this come from the chest?
1. Yes.
2. No.
3. Maybe.
4. Maybe not. (3)

Why do you give this answer? Choose a reason from the ones below which best describes your reason.
1. Because only small red ones fell from the box.
2. Because there were pearls of all sizes and colours in the box.
3. Because there were pearls of all colours and sizes in the chest.
4. Because the ones which were not red were in the chest.
5. Because the ones which were not red were in the box.
6. Because there were all colours in the chest. (3)

III. Add any further comments here.

The Melons

A man came back from Italy and said, "I will never eat olives and melons at the same meal." I saw someone in Italy eat olives and melons at the same meal and the next day he was dead.

Choose a sentence or word from the ones listed below for your answers and write the number of the sentence or word in the brackets at the right of the page.
A. Had the second man seen this man in Italy who later died?
   1. Yes.
   2. No.
   3. He had only heard the story. (1)

   When did the man, she had eaten the olives and melons at the same meal, die?
   1. straight away.
   2. hours later.
   3. next day.
   4. a long time after. (3)

B. What do these words mean?

   meal?
   1. a time of eating.
   2. today. (1)

   at the same time?
   1. together.
   2. separately.
   3. only. (1)

C. Do you think this is a good reason for not eating olives and melons at the same time?
   1. Yes.
   2. No. (2)

D. Why do you give your answer in C. Choose a sentence from the ones below which best describe your reason for this answer.
   1. Because you would not like the same thing to happen to yourself.
   2. Because eating olives and melons at the same time caused the man to die.
   3. Because it did not cause the man to die.
   4. Because the man's death could have been caused by something else.
   5. Because the man's death could be the result of many things although eating olives and melons at the same meal could have had something to do with it. (5)

E. Add any further explanations here.
**OPERATIONS INVOLVED IN THE MAIN TEST**

**TABLE IV**

MAIN PROBLEMS

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<th>Disjunction</th>
<th>Incompatability</th>
<th>Incomplete Affirmation</th>
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<td>Swimming</td>
<td>Martian</td>
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**TABLE V**

SIMPLE TESTS

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<td>Red Objects</td>
<td>Breathe</td>
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<td>Rain</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
WRITE HERE

NAME: SURNAME . . . . . . . . CHRISTIAN NAME . . . . . . . . . .

BIRTHDAY . . . . . . . . . . .

AGE on the 1st December . . . . YEARS . . . . MONTHS

BOY or GIRL . . . . . . . . . .

CLASS . . . . . . . . . . . . . .

YOUR NUMBER in the CLASS for this test . . . . . .

PUT YOUR NUMBER ON THE TOP OF EACH PAGE NOW. Your teacher will
give you this number. You should have five sheets with stories
and sentences on both sides. There is no time limit for the tests
but try to see if you can finish them by lunchtime unless you don't
mind working through lunchtime.

REMEMBER FROM NOW ON ALWAYS PUT THE NUMBER OF THE SENTENCE OR WORD
YOU HAVE CHOSEN IN THE BRACKETS AT THE RIGHT OF THE PAGE.
DO NOT GUESS ANY OF YOUR ANSWERS. IF YOU ARE NOT SURE THEN ALWAYS
CHOOSE AN ANSWER THAT SHOWS YOU DO NOT KNOW.

1. Fruit

A. I can choose either an apple or an orange.
   (1. have not
   I (2. have chosen an apple, therefore I cannot
   (3. don't know
   choose an orange.
   Choose one of the three words and write the number in these
   brackets. (2)
2. Here are some reasons for your choice above. Choose one as your reason and write the number of your reason in the brackets below.
   1. Because I cannot choose both at the same time.
   2. Because I like apples.
   3. Because I don't like oranges.
   4. Because I have not chosen the orange so I cannot choose the apple.
   5. I don't know. Number in these brackets (1)

2. An Egg and Spoon Race

   In an egg and spoon race I must run, holding (or carrying) the egg on the spoon in my right hand.

   Which one of these statements is correct? Write the number of the sentence you choose in the brackets below. Choose the most complete sentence.
   1. I can hold the egg in my left hand.
   2. I can hold the spoon but not the egg in my left hand.
   3. I must hold the egg on the spoon in my right hand as I run the race.
   4. From the story I can tell I can't run in the race.
   5. I must not hold the egg on the spoon in my left hand and I must walk.

   Put number in the brackets (3)

3. Weather

   Three of my friends have been watching the weather. I noticed that when it rained a cold wind came from the West and was very strong. The sky was covered with heavy clouds.
   A. noticed that it was dark and cold on cloudy days when it rained.
   B. noticed that with a West wind it usually rained for part of the day and for the rest of the day the clouds lifted.

   Using this information which of the following statements is most likely to be correct? Write the number of the statement you choose in the brackets.
   1. It usually rains when it is windy.
   2. It usually rains when the wind is from the West.
   3. On cold days it usually rains.
   4. When it rains the sky is usually cloudy.
   5. With a West wind it is usually cold.

   Put the number here (4)
4. **Houses**

Which of these houses would be most suitable for the White family to live in. There are four people: Mr. and Mrs White, a twelve year old boy, and a fifteen year old girl. Mr White cannot afford to build an extra room.

1. A dining room, kitchen, laundry, bathroom, one bedroom.
2. A bathroom, laundry, three bedrooms, dining room.
3. A laundry, kitchen, bathroom, four bedrooms.
4. A kitchen, laundry, dining room, three bedrooms, lounge room.
5. A kitchen, three bedrooms, laundry, bathroom, lounge room, dining room.
6. I don't know.

Write the number of the house you have chosen in the bracket (5).

5. **Books**

1. All
2. Only Books have paper covers.
3. Some
4. Don't know

B. Write in the brackets the number of the word you have chosen which seems to make most sense in the sentence (3).

From the reasons given below choose one which helps to explain why you choose the word in A. Write the number of your reason in the bracket.

1. Because I have never seen a book without a paper cover.
2. Because I have seen some books without paper covers.
3. Because I have never seen anything else with a paper cover.
4. I don't know. Number (2)

6. **Radios**

"So far all the radios made in January, which have since been returned to the factory, have defects."
From this statement can I say any of the following statements, and feel sure that they are correct? Write 1 for yes OR 2 for no. Put the number in the bracket opposite the sentence. (e.g. 1 or 2)

1. Radios made in other months could have defects.
   1 for YES or 2 for NO  (1)

2. All radios made in January have defects.
   1 for YES or 2 for NO  (2)

3. So far, all the radios not made in January, but in other months, do not have defects.
   1 for YES or 2 for NO  (2)

4. I don’t know.

7. Blue Balls

There was a box of balls of several different colours. Some of the balls were large, and some small. The blue balls in the box were not little. The small balls in the box were not blue.

A. What colour were the big balls? Write the number of your answer in the brackets.
   1. Blue only.
   2. At least some were blue.
   3. Every colour but blue.
   4. I don’t know  Number (2)

B. What colour were the little balls? Write the number of your answer in the brackets.
   1. Blue only.
   2. At least some were blue.
   3. Every colour except blue.
   4. I don’t know.  Number (3)

8. Tall Dark People

A. If some people are tall and dark then (1. some  )
   (2. only  ) dark
   (3. all  ) people are tall.

Write the number of the word you choose in the bracket (1)

B. Choose one of the following reasons why you gave this word. Write the number of the reason in the bracket.
   1. Because there are some dark people who are not tall.
2. Because I have never seen a short dark person.
3. Because fair people are not tall.
4. I don’t know. For reason (1)

9. White Socks

If all girls at this school wear white socks then (2) all girls who wear white socks are from this school.

A. Write the number of the word you choose in the bracket (1)

B. Choose one of these reasons why you gave this word.
1. Because all girls from this school wear white socks.
2. Because girls from other schools wear white socks.
3. Because girls from other schools wear other coloured socks.
4. Because girls wearing white socks must be from this school.
5. I don’t know. (2)

10. Red Objects

Can I say the following?

If all my books are red then this red object is a book.
1. Yes because it is red.
2. No because it is not mine.
3. Yes because all my books are red.
4. No because it could be something else.
5. No because some of my books are not red.

Write here the number of your answer chosen (4)

11. Watermelon

Can I say the following?

If a man ate a watermelon and was sick 3 hours later, I will be sick if I eat a watermelon.
1. Yes because there is something wrong with the man’s watermelon.
2. Yes because watermelon makes you sick.
3. No because his sickness was caused by something else.
4. No because his sickness could have been caused
by many things including the watermelon.
5. No because watermelon doesn’t make you sick.
6. I don’t know.

Write here the number of your chosen answer (4)

12. Food

If Pauline ate cheese, butter and bread; Peter ate bread, butter and oranges; and John ate cheese, oranges and bread. What food did they all eat?
1. Cheese.
2. Butter.
3. Bread.
4. Oranges.
5. Oranges and butter.
6. Oranges and bread.
7. Oranges and cheese.
8. Bread and butter
9. Bread and cheese.
10. I don’t know.

Write here the number of the chosen food (3)

13. People

A. only 1.)
   some 2.) people can breathe. Number of answer (3)
   all 3.)
   don’t know 4.)

B. Reason - Choose one and write the number in the brackets below:
   1. Because some people do not breathe.
   2. Because nothing else can breathe.
   3. Because all people must breathe to live.
   4. Because some people must breathe to live
   5. I don’t know.

   Number of reason here (3)

14. Rain

A. because 1.)
   if 2.) it rains tomorrow we will not be able
don’t know 3.) to have our sports.

   Number of answer (2)
15. **Red Balls**

If I have a big red ball and a small blue ball and my sister has a big blue ball and a blue ball which is not large.

A. Which of my balls is similar to one of my sister’s balls.
   1. the big, red ball.
   2. the small blue ball.
   3. the big, blue ball.
   4. neither of them.
   5. both of them.
   6. all of them.
   7. don’t know. 
   Number of answer chosen (2)

B. Reason - choose one and write the number in the bracket.
   1. Because I know it will rain.
   2. Because it will rain tomorrow and our sports will be cancelled.
   3. Because it could be too wet to hold the sports.
   4. I don’t know. 
   Number of answer chosen (3)

16. **Types of People**

These people below can be divided into 2 groups with similar hair colouring, eye colouring and height.

<table>
<thead>
<tr>
<th>People</th>
<th>Features</th>
<th>Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>John</td>
<td>Blue Eyes</td>
<td>5' 11&quot;</td>
</tr>
<tr>
<td>Mary</td>
<td>5' 6&quot;</td>
<td>Dark Hair</td>
</tr>
<tr>
<td>Tom</td>
<td>6' 0&quot;</td>
<td>Blond Hair</td>
</tr>
<tr>
<td>Peter</td>
<td>Dark Eyes</td>
<td>5' 3&quot;</td>
</tr>
<tr>
<td>Joan</td>
<td>5' 10&quot;</td>
<td>Blue Eyes</td>
</tr>
<tr>
<td>Paul</td>
<td>5' 1&quot;</td>
<td>Dark Hair</td>
</tr>
<tr>
<td>Jim</td>
<td>Blue Eyes</td>
<td>Fair Hair</td>
</tr>
<tr>
<td>Anne</td>
<td>5' 1&quot;</td>
<td>Dark Eyes</td>
</tr>
<tr>
<td>Judy</td>
<td>Dark Hair</td>
<td>Dark Eyes</td>
</tr>
</tbody>
</table>

Choose the 2 groups from these listed below. Put the number at the right of the page.

1. Tall, dark, handsome.
2. Blue eyes, dark hair, tall.
3. Short, fair, handsome.
4. Short, dark hair, dark eyes.
5. Short, fair hair, blue eyes.
Roper 6' 3"
Tony 6' 0"
Ruth Fair Hair Not Dark Eyes

6. Fair hair, blue eyes, tall.
7. Dark hair, short, blue eyes.
8. Tall, dark eyes, dark hair.

Two numbers (4, 6)

17. A Mishap

My friend and I went tramping in the mountains. We arrived at a hut and, to our dismay, found we had forgotten to bring our food with us. We searched the hut and found a few stores in a cupboard. They looked as if they had been there a long time. However, we were so hungry we decided we could eat them. There were tins of condensed milk, soup and meat. I ate from the tin of condensed milk and from the tin of soup and my friend ate from the tin of meat and from the tin of soup. An hour later we both had stomach ache.

Choose a sentence from the ones listed for each question and write the number of the sentence in the brackets.

A. Where did we find the stores we later ate?
1. We brought them from home.
2. We bought them at a shop.
3. We discovered them in the hut in which we decided to stop.

B. What did I decide to eat?
1. Condensed milk.
2. Soup.
4. All three.
5. Condensed milk and soup.

C. What does forgotten mean in the story?
1. remembered.
2. did not remember.

D. stores? as in the story
1. supplies of food.
2. shops.
3. firewood.
E. Which of the three stores do you think gave them stomach ache?
   1. All of them.
   2. None of them.
   5. Soup and milk.
   7. Soup.
   8. Meat. (7)

F. Choose one of the following reasons why you gave your answer in E.
   1. As they both ate the three of them.
   2. As they both ate these two.
   3. As they both ate this one.
   4. As milk makes you sick.
   5. As meat does not keep.
   6. As soup curdles. (3)

13. **Swimming Costumes**

   An inter-school picnic was held on the beach at Timaru, on a Wednesday and pupils from all schools went to the picnic. All pupils from Christchurch West High School, (CWHS) decided just as they were leaving on the Wednesday to wear red swimming costumes.

A. I saw 2 pupils in red costumes on the beach at Timaru. Could I be sure they were from CWHS?

   Choose one of these sentences as your answer. Put the NUMBER of the sentence in the bracket.
   1. Yes, as only CWHS pupils were wearing red costumes.
   2. Yes, as no other school pupils were red costumes.
   3. No, as the pupils could have been from any of the other schools there.
   4. No, as all schools, except CWHS wore red costumes. (3)

B. Later I saw 2 CWHS pupils swimming in the water. Could I be sure that their costumes were red?

   Choose one of these sentences as your answer. Put the NUMBER of the sentence in the bracket.
   1. No, as none of the pupils from CWHS wore red costumes.
   2. Yes, as all the pupils from CWHS wore red costumes.
3. Yes, as only the pupils from CMHS wore red costumes.

4. No, as the pupils could have been from any of the schools there. (2)

19. Hotel Rooms

A woman, Mrs Brown, and her three children booked into an hotel to stop over night. There were two girls named Jane and Betty, and one boy named Tom. There was some difficulty in deciding who would stop in each of the three rooms. Mrs Brown had rented. Tom wanted a room to himself; Mrs Brown was afraid of the spider in one room and a mouse in another; Jane was afraid of the mouse and Betty was afraid of the spider.

A. How many rooms did Mrs Brown rent before they discovered the mouse or the spider?
1. One.
2. Two.
3. Three.
4. Four.
5. One each. The number of your answer in the brackets (3)

B. What did Tom ask for?
1. To share a room.
2. A room to himself.
3. He didn’t mind. Number in brackets (2)

C. What was Mrs Brown afraid of?
1. Nothing.
2. A spider in one room.
3. A mouse in one room.
4. A spider in one room and a mouse in another. Put the number of your answer here (4)

D. What was Jane afraid of?
1. Nothing.
2. A spider in one room.
3. A mouse in a room.
4. A spider and a mouse. (3)

E. How many of the three rooms had neither a spider nor a mouse in it?
1. One.
2. Two.
3. Three. Put the number of your answer in the brackets (1)

F. What does the word **afraid** mean in the story?
1. To like.
2. To fear.
3. To be curious about. Put the number of the answer here (2)

G. How were they all arranged in the three rooms?

Choose one of the arrangements written directly below as your answer and write the number of the sentence in the brackets at the right of the page.

<table>
<thead>
<tr>
<th>ROOM WITH SPIDER</th>
<th>ROOM WITH MOUSE</th>
<th>ROOM NEXT TO EITHER</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Jane</td>
<td>Betty</td>
<td>Tom and Mrs Brown</td>
</tr>
<tr>
<td>2. Jane and Betty</td>
<td>Tom</td>
<td>Mrs Brown</td>
</tr>
<tr>
<td>3. Tom</td>
<td>Jane</td>
<td>Betty and Mrs Brown</td>
</tr>
<tr>
<td>4. Tom</td>
<td>Betty</td>
<td>Mrs Brown and Jane</td>
</tr>
<tr>
<td>5. Mrs Brown</td>
<td>Betty and Jane</td>
<td>Tom</td>
</tr>
<tr>
<td>6. It doesn't matter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. All in room three.</td>
<td></td>
<td>Put number of answer here (4)</td>
</tr>
</tbody>
</table>

20. **Melons**

A man came back from Italy and said, "I will never eat olives and melons at the same meal again. I saw someone eat olives and melons at the same meal and the next day he was dead."

For each of the following questions choose your answer for each one from the ones listed below.

Write the numbers of the sentences you choose in the brackets to the right of the page.

A. Had the traveller seen the man in Italy who later died?
1. Yes.
2. No.
3. He only heard the story. Bracket for answer number (1)

B. When did the man, who had eaten the olives and melons at the same meal, die?
1. Straight away.
2. Hours later.
3. The next day. Bracket for answer number (3)
C. What does the word meal mean in the story?
   1. A time of eating.
   2. Today.  Bracket (1)

D. What does "eat olives and melons at the same meal" mean in the story?
   1. Eat them at one meal.
   2. Eat one at one meal and one at another.
   3. Eat nothing else.  (1)

E. Do you think this man's reason for not eating olives and melons at the same meal is good?
   1. Yes as you would not like the same thing to happen to yourself.
   2. Yes because eating olives and melons at the same meal caused the man to die.
   3. No because it did not cause the man to die.
   4. No because the man's death must have been caused by something else.
   5. No as the man's death could be the result of many things although eating olives and melons at the same meal could have had something to do with it.
   6. I don't know.  (5)

21. Pens

A pen-making factory received complaints from customers that some pens were poorly made. The manager sent a pen inspector to the factory workshops to find out why some pens were poorly made. The inspector looked at the machines and talked to the workmen. He then looked at the production list (which told him the date each pen had been made) and then telephoned the manager and said,

"So far, I have found that all the pens made in the month of September have defects."

Answer the following. Put the number of the sentence or word you have chosen in the brackets at the right of the page.

A. Who complained that their pens were poorly made?
   1. The manager.
   2. The foreman.
   3. All the customers who had received pens from the factory.
   4. Some of the customers who had received pens from the factory.  (4)
B. What did the inspector tell the manager?
1. All pens made in the month of September have defects.
2. All pens have defects.
3. Only pens in September have defects.
4. Even though I haven't seen all pens made in September, up until now the pens with defects were all made in September.
5. Pens with defects were not made in September.

C. What did the inspector do?
1. Visited the customers who complained.
2. Looked at the machines, talked to the workers and looked at the production list.

D. What do these words mean in the story:
complaints
1. wishes.
2. criticisms.
3. praises.

E. Customer: A person who
1. inspects pens.
2. makes pens.
3. buys pens

F. Defect
1. An error in the making of the pen.
2. A change in the style of the pen.
3. An improvement in the pen.

G. The manager had three of the pens from the factory in front of him on his desk. After his conversation with the inspector on the telephone, he began to study them.

(a) In the first pen he discovered a defect and said to himself, "Then this pen must have been made in the month of September." Could he be sure his guess was correct?

Choose one of these sentences as your answer. Put the number of the sentence in the bracket.
1. Yes, because all pens made in September have defects.
2. Yes, because only pens made in September have defects.
3. Yes, as he checked the production list.
4. No, because pens made in any month could have had a defect. As not all pens made in September have been checked as yet we cannot say all September pens have defects.
5. No, as pens on the desk are not the same as the pens made in the factory.
6. I don't know.

(b) The production list told him that the second pen had been made in July and he said to himself, "I am certain it has no defect." Can we be certain that this guess is correct?

Put the number of the sentence you choose in the bracket as your answer.
1. No, as he didn't know the month in which the pen was produced.
2. Yes, as pens made in July could not have had defects.
3. No, as pens made in July could have had defects.
4. Yes, as only pens made in September had defects.

(a) He examined the workings of the third pen and could find no defect and said to himself, "Therefore it could not have been made in September." Was he correct in saying this with only the information that he had?

Choose a sentence from those below as your answer. Write the number of the sentence in the brackets.
1. Yes, as no pens made in September had defects.
2. Yes, as all pens made in September had defects.
3. No, only the pens made in September that have so far been checked have defects. Other pens made in September that have not been checked may not have defects.
4. No, as all pens made in July have defects.
5. Yes, as all pens made in July do not have defects.
6. Yes, only the pens which do not have defects are made in other months.
7. I do not know.

22. Travellers

A tourist bureau organised a car trip for a group of people who wanted to take a trip into the mountains. As there was a limited amount of space for extras, the following instructions were issued to the driver.
"You can take passengers who have a suitcase but they cannot bring a dog. You can also take passengers who have a dog but not a suitcase. A passenger cannot take both a suitcase and a dog."

Answer the following questions. Put the number of the word or sentence chosen in the brackets at the right of the page.

A. Who was given the instructions?
   1. the passengers.
   2. the driver.
   3. the tourist bureau. 
   Number (2)

B. The instructions issued to the driver said?
   1. a passenger must have a suitcase.
   2. a passenger can take both a suitcase and a dog.
   3. a passenger cannot take a suitcase or a dog.
   4. a passenger can take two dogs.
   5. a person who has decided to go must remember that if he has a suitcase and a dog, he cannot take both of them.
   Number (5)

C. What is meant by the word suitcase in the story?
   1. something to wear.
   2. something to carry possessions in.
   3. several bags.
   Number (2)

D. What is meant by the word dog in the story?
   1. a four legged animal.
   2. four legged animals.
   3. a wild beast.
   Number (1)

E. A passenger who was waiting to board the bus asked the driver, "Can I bring a suitcase with me?" What did the driver reply?

Choose one of these sentences as your answer. Put the number in the brackets.
   1. Yes, because the passenger had a suitcase.
   2. No, because you have one dog with you and you cannot take both a suitcase and one dog.
   3. Because you haven't one dog with you.
   4. Yes if you haven't a dog with you.
   Number (4)

F. A second waiting passenger asked the driver, "Do you take dogs?" He replied:

Choose one of these sentences as your answer. Put the number in the bracket.
1. Yes because he did not have a suitcase.
2. Yes as he only had one dog.
3. Yes if you bring one dog and no suitcases.
4. Yes as long as you have no suitcases you can bring your dogs.
5. No as the passenger had dogs. Number (1)

G. Another passenger arrived and said to the driver, "I haven't a dog and I have forgotten my suitcase. Can I go?"

Choose one of these sentences as your answer. Put the number in the brackets.
1. Yes he can still go as it does not matter that he has neither a suitcases nor a dog.
2. Yes as there is only room left for a man without a suitcase or a dog.
3. Yes he can still go as he has not a suitcase.
4. No as he did not have either a suitcase or a dog.
5. Yes he can still go as he has not a dog. Number (1)

23. Martian Animals

Charlie Brown was the second man to return from Mars. In order to find the name of a very dangerous animal he had once met, he asked Peter Gray what it was. Peter Gray was the first man to return from Mars, and he was writing a book about his adventures in which he was going to name all the Martian animals.

Charlie began to describe the creature, "Well, it had a long, thin, green neck," he began.

"Then it could have been a Rhondo, a Bunyip, or a Blimp," said Peter.

"But it also had a tiny little green head with many sharp teeth," Charlie continued.

"Then it could have been a Rhondo, a Blimp, or a Thrip," Peter said, "as they all have small green heads with many sharp teeth."

"Oh, it also had six legs and a long pointed tail, which it thrashed around. I had to be very careful to keep away from it, as I fought the animal."

"Well," said Peter, "Bunyips, Blimps, and Thrips have six legs too and when I came to think of it, they have tails which are long and pointed too. I think I know which animal it was I'll draw it for you."

Later, after seeing the drawing, Charlie immediately recognized the beast that had attacked him.
A. Choose one of these as your answer, put the number of your answer in the brackets.
1. a Thrip.
2. a Sunyip.
3. a Rhino.
4. a Klimp.
5. All of them.
6. the Klimp and the Thrip. Why? Number (4)

B. Choose one of these as your reason for your answer in A and put the number in the bracket.
1. Because these two had all the features.
2. Because this animal had all the features.
3. All of the animals had all the features.
4. This animal had some of the features.
5. I don’t know as the passage doesn’t say.
6. A Sunyip, as I have only heard of a Sunyip. Number (2)

24. Pearls

A king possessed a chest full of pearls of all colours, big and little. In the chest he placed a golden box which contained the most precious of all these pearls, which were also of all colours, sizes and shapes. One day he allowed a friend to look at his pearls and in order to show that he had confidence in his friend, he left him alone with the chest of pearls. But something unfortunate happened. The friend dropped the golden box and the pearls from the box fell among the others in the chest and he was not able to distinguish between them any more.

He called the King’s Treasurer because he was frightened and asked his advice. But the Treasurer was too busy to come and sort out the pearls for him and all he said to the King’s friend was, "Amongst all the pearls the red pearls in the box were not little. There were also little ones in the box but they were not red."

With this advice the friend tried to sort out the pearls which had been in the box before, from the ones that were in the chest.

A. What types of pearls were in the chest before the friend dropped the box?
1. Only red pearls.
2. Only little pearls.
3. Pearls of all colours.
4. Pearls of all colours and all sizes.

Put the number of the chosen sentence here (4)
B. What type of pearls were in the golden box before it was dropped?
   1. Only red pearls.
   2. Only non red pearls.
   3. Only little pearls.
   4. Only big pearls.
   5. Pearls of all colours.
   6. Pearls of all colours and sizes. Number here (6)

C. What size were the red pearls that the Treasurer advised him were in the box before?
   1. Big.
   2. Little.
   3. All sizes. Put number of chosen sentence here (1)

D. What colour were the little pearls in the golden box?
   1. Red.
   2. Only white.
   3. All colours.
   4. All colours except red. Number here (4)

E. What does size mean?
   1. Its colour.
   2. Its shape.
   3. How big it is. Number of chosen sentence here (3)

F. The friend picked up a large red pearl first, when he tried to put the pearls back in the box, and asked himself if it could have fallen from the box.

Choose a sentence from the ones below to show what you think. Write the number of the sentence you choose in the brackets at the right of the page.
   1. Yes because all the large red pearls were in the box and no none could be in the chest.
   2. No because all the large red pearls were in the chest.
   3. Yes because there were some red pearls in the box.
   4. Yes because there were some large red pearls in the box.
   5. No because there were only small red pearls in the chest.
   6. I don't know. Brackets (4)
G. After that the friend took a little pearl, also red. Did this fall from the box?

Choose a sentence from the ones directly below as your answer and write its number in the brackets.

1. Yes because the red pearls in the box were little.
2. Yes because the red pearls in the chest were big.
3. No because the red pearls in the box were big and all of the little ones in the box were not red.
4. Yes as the red ones were from the box.
5. No as the little ones were from the chest.
6. Yes as only the big ones were from the box.
7. I don't know as the pearls are too alike. Brackets (3)

H. He took one which was neither large nor red. Could it have fallen from the box.

Choose a sentence from the ones directly below as your answer and write its number in the brackets.

1. Yes because there were little pearls in the box.
2. No as there were only red pearls in the box.
3. Yes as there were some small pearls that were not red in the box.
4. No as there were some small pearls in the chest that were not red.
5. I don't know. Brackets (3)

I. Finally he took a small pearl which was white. Did this come from the chest?

Choose a sentence from the ones directly below as your answer and write the number of the sentence in the brackets at the right of the page.

1. Yes because only small red ones fell from the box.
2. No because the white ones were only in the box.
3. No because all the pearls that were all sizes and colours were only in the box.
4. Yes as the small white pearls could have been in either the chest or the box.
5. Yes as there were pearls of all colours in the chest.
6. I don't know as the story doesn't say. Brackets (4)
25. **Pets**

A man travelled with three pets: a dog, a cat and a canary. He could not leave them alone together in the same room when he wanted to go out as the dog would attack the cat and the cat would attack the canary. So he rented a number of rooms. As he could not afford to rent four rooms, one for each pet and one for himself, he rented fewer than four rooms.

A. How many pets were there?
   1. One.
   2. Two.
   3. Three.
   4. Four. Put the number of your answer in these brackets (3)

B. Which pet would the dog attack?
   1. The canary.
   2. The man.
   3. The cat. Put the number of your answer in these brackets (3)

C. Which pet would attack the canary?
   1. The dog.
   2. The cat.
   3. The man. Put the number of your answer in the brackets (2)

D. What is meant by the word **rent** in the story?
   1. To hire.
   2. To buy.
   3. To arrange. Put the number of your answer in the brackets (1)

E. What is meant by the word **attack** in the story?
   1. To fight with.
   2. Is friendly with.
   3. Fights with. Put the number of your answer here (1)

F. What were the least number of rooms that he could rent and keep the peace among the pets?
   1. One.
   2. Two.
   3. Three.
   4. Four. Put the number of your answer in the brackets (2)
G. How were the pets and the man arranged in the rooms?
1. The four of them each had a separate room.
2. Each animal had a separate room and the man shared a room with one of the pets.
3. They were all in the same room.
4. The dog and the cat were in one room and the man and the canary were in another.
5. The dog and the canary were in one room and the man and the cat were in the other.
6. It doesn't matter.
7. No rooms were rented as all the animals would attack each other. The number of your answer here (5)

26. **At a Sports Meeting**

An inter-school sports meeting was held in Christchurch, on Saturday, for all schools in the Canterbury Province. Pupils from Ashburton decided, just as they were leaving on the Saturday morning to travel to Christchurch, to wear blue ties. So each Ashburton pupil put on a blue tie. Our school attended as it is a school in Christchurch and in the Canterbury Province.

At the inter-school sports meeting in Christchurch, at lunch-time, I walked around the grounds with a friend of mine from our school and met other pupils from all the other schools.

A. A pupil, who I knew was from Ashburton, waved but did not come over to see us. Because he walked away from us we could not see clearly the colour of his tie.

What colour do you think his tie would be?
1. Any colour.
2. Blue.
3. I can't work it out from the passage.

Put the number of your answer here (2)

B. Choose a sentence from the following which gives the reason for the choice of your answer in A. Put the number of the sentence in the bracket at the right of the sentences.
1. Because Ashburton was the only school wearing ties.
2. Because the only school pupils allowed to wear blue ties were Ashburton pupils.
3. Because I knew he was from Ashburton and Ashburton pupils decided to wear blue ties just as they were leaving.
4. Because his monogram told us. (3)
C. Later in the afternoon a pupil wearing a blue tie walked towards us. My friend said to me, ‘He is from Ashburton isn’t he?’ What did I reply?
1. Yes.
2. No.
3. Not necessarily. Number of your answer here (3)

D. Choose a sentence from the following for your answer.
   1. Because he is wearing a blue tie and so he is from Ashburton.
   2. Because Ashburton pupils were not wearing blue ties.
   3. Because the only people wearing blue ties were from Ashburton.
   4. Because pupils from other schools in Canterbury could also be wearing blue ties.
   5. I do not know as I did not ask the boy and I can’t work it out. Number of answer (4)

E. What do these words mean in the story?

   Inter-school sports.
   1. For one school.
   2. Between two schools.
   3. For many schools. Number of answer (3)

   Decided to wear
   1. Ordered.
   2. Choose.
   3. Forgot. Number of answer (3)

   Blue colour of his tie
   1. The blue shade of his tie.
   2. The shade of his tie.
   3. The length of his tie. Number (1)

   Other schools
   1. Many different schools.
   2. One other school.
   3. Our school. Number of answer (1)
BIBLIOGRAPHY


