

*The Growth of Logical Thinking from Childhood to Adolescence.*

BARBEL INHELDER and JEAN PIAGET. Translated by ANNE PARSONS and STANLEY MILGRAM. Routledge and Kegan Paul, 1958. xxvi, 356 pp 32s.

Review by LAWRENCE STENHOUSE in *Journal of the Durham Institute of Education*, November, 1959.

This book is the result of a collaboration between two authors. Inhelder has been responsible for the experimental designs and Piaget for the theoretical interpretation. It is a difficult, but potentially an extremely important book, and its difficulty should not deter a reader from taking what he can from it.

The basic experiments consist of a number of highly ingenious problem situations which are tackled experimentally by the children who are the subjects. The problems presented are problems of understanding and interpretation: that is, the solution lies in an adequate explanation of the facts. In order to arrive at an explanation, the subject must manipulate apparatus, and his manipulation, together with some questioning from the experimenter, makes the pattern of his thinking manifest.

It is not possible here to enumerate all the experiments, but an example may be given. In one experiment the subjects are asked to give an account of the differential flexibility of metal rods which vary in material, length, thickness, form of cross-section and weight applied to the end to bend them. Each of these factors is relevant to the flexibility of the rods and in order to give an adequate explanation of the observable phenomena the subject must separate and test each of the variables by holding the others constant.

In all there are fifteen experiments designed to expose various aspects of logical thinking, and the reports consist of protocols illustrating the responses of children at various ages. These experiments and their protocols are worth examining for themselves even if the reader wishes to avoid embarking upon Piaget's interpretation of them. They constitute a fascinating exposure of the thought-processes of children and adolescents.

They can, however, provide us with no more than intuitive insights into the development of thinking. In order to penetrate beyond this, we need some system of classifying performance in thinking which will allow us to ascertain what are the novel elements at each stage; and this has been a most intractable problem. The reader who attempts to find his own classification of the protocols and base an interpretation on it will immediately appreciate the difficulty. Moreover, this classification is merely the first hurdle in a developmental psychology of thinking, since the classification adopted must be designed in sufficiently definite terms to allow one to examine the development of one approach from another earlier one. It is this problem which Piaget has tackled.

His approach is through a logico-mathematical calculus. Now, neither logician nor psychologist will concede that logic is descriptive of thought. Piaget recognises the justice of this and declares: "Thus it is not as logic (for logic has no more place in psychology than psychology does in logic) but as a calculus or an algebra that we are here using symbolic logic" (269). And this use of symbolic logic he regards as just as important for psychology as the mathematical instrument of factor analysis.

This position raises the problem of the relation of the algebraic symbols to the behavioural situation, a problem which has been serious in factor analysis. Now Piaget claims that at a certain stage of development thinking proceeds according to a system (for example, the system of sixteen possible relationships between two terms) and asks "Is the thinker 'aware' of the system?" He does not regard the system as generally accessible to consciousness. He speaks of the thinker's procedure as action logic. "In the realm of the adolescent's action logic, which has yet nothing to do with the formulated logic of the logician, we can only mean by 'awareness of the system' that a motivated attempt to look for relationships between the possible operations within the set of propositions is made for its own sake". (304). In other words the strategy of the thinker is what it might be if he were consciously aware of the system. The language is in a sense one of 'as if'.

Interest centres upon the later stages of the development of thinking. It is not possible to review extensively Piaget's highly complex theory. Briefly he regards the structure of the sixteen possible relationships between two terms (the sixteen binary propositions set out extensively on pp 103-104 of the book) as fundamental. These propositions are accessible earlier in development than they are fully operational, for it is not simply the ability to handle the propositions as such but their integration into a structured whole which is important, since this makes it "possible to move with accuracy from any one of its sixteen elements to each of the others".

Once faced with specific problems, the adolescent subject develops concepts and special operations in response to a need felt in the face of certain specific problems. The interrelationships between these are not clear at first for, though they are limited, they are not essentially interdependent. These concepts recur in diverse situations and are gradually refined. Their relationships are governed by two logical structures, the "group" and the "lattice", whose further exploration can only be left to the reader, who may best start with the exposition of the group of transformations of a proposition (Identity, Negation, Reciprocation, Correlation) on pages 160-63. Piaget regards these as the fundamental structures of formal thought.

For anyone wishing to penetrate the complex logical structure which Piaget utilises, Piaget's *Logic and Psychology* (Manchester University Press, 1953) is a useful introduction. It is probably best to follow this with a reading of the discussions of the experiments, much of which will no doubt be unintelligible, and then a close reading of chapters 16 and 17, having recourse to the expositions of the sixteen binary propositions and the INRC group cited above. After this it is possible

to reread the discussion of the experiments with a much fuller understanding.

But the foregoing may deter many who are yet interested in the conclusions which Piaget reaches. These in themselves are difficult to formulate clearly and briefly, for their full exposition depends on a grasp of the logical calculus he employs. However, some attempt is demanded.

The earliest stage of development (in Piaget's samples roughly 2 - 7/8 years) is called by Piaget the Sensori-Motor level. This terminology continues over from his previous work. During this period (he claims) symbolic processes appear (words and concepts) which allow the child to organise elementary sense impressions. However, the child sees situations as static rather than leading one into the other and has difficulty in grasping transformation of the situation. Where he does see a transformation, he sees it in terms of his own actions and does not understand that it is reversible. Reversibility (the ability to return to the starting point, eg. subtract to return to the position before addition) is for Piaget an important aspect of operational thought.

At the level of concrete operational thought (roughly 7/8-11/12); as complete reversibility is reached, definite structures such as classifications, serial orders and correspondences (eg. between two linked serial orders "the more.. the more ...") emerge. In a sense these look forward to a possibility; for example, a class potentially includes objects not yet assimilated to it, but it is a very limited possibility based on extension of present reality. Systems built up cannot immediately be generalised from one physical property to another: thus serial systems of length do not necessarily imply the ability to serialize weights. Thought remains essentially attached to empirical reality. Elementary groupings of classes and relations develop but they are not combined into structured wholes so that the several elements are not all inter-related. Reversibility is only possible by inversion (for classes) or reciprocity (for relations). The two types of reversal are not synthesised.

At the formal level from 11+ onwards, the most important development in the equilibrium of thinking is the reversal of direction between reality and possibility. Possibility is now more important to the thinker than the empirical reality and it is a controlled possibility calculated rather than imagined. This is obviously of the greatest importance to the teacher. Thought becomes essentially hypothetico-deductive. That is to say that in a sense the adolescent becomes a theorist where the child is bound by physical reality. Among the notions which are not adequately grasped until this highly developed level are those of proportions, the relativity of motion or acceleration, mechanical equilibrium, probability and correlation.

Two points stand above the details. Piaget asserts that the adolescent essentially looks towards the future and that he "begins to build 'systems' or 'theories' in the largest sense of the term" (339). There is perhaps nothing revolutionary about these assertions, but their source is important. Piaget has provided a theoretical justification for the

emphasis on the present and on the concrete in the education of young children. At the "secondary school level" his emphasis is reversed and the logical derivative would be a demand on behalf of the average pupil for a curriculum which looked towards the future and which provided a system and theory equivalent to that provided for the academic by his subject's synthesis. Some might see in this a mixture of vocational education and "education for life adjustment". Certainly Piaget's conclusions are not without educational significance.

But he goes further than this in assigning to schooling an important role in the development of formal thinking, noting "the convergence between some of our subjects' responses and certain aspects of instruction in school" (338). That is, he regards the development of thinking he has studied, not simply as a result of maturation, but as due in a large measure to experience and schooling. And in so far as his fully operational thought is what we would mean by practical intelligence he presents a challenge to the school which might lead the venturesome to devise an education for thinking.

However, we are flying high and it may be that our engines are not adequate for the trip. In this work, as in his others, Piaget does not prove his point. His evidence is illustrative rather than conclusive. This is not to say that his point is wrong: the very nature of the material he handles makes it difficult to present his evidence in any form compressed enough for inclusion in a book. Even the presentation of statistics for his sample (which he omits) would not carry more conviction, for the crucial point lies in the classification of protocol material which can only be exposed by a complete work-through. It is only fair to say, however, that where others have checked his previous conclusions on independent samples, they have generally confirmed the main lines which Piaget has laid down. How far these confirmatory results are vitiated by the experimentors' acceptance of the task of classifying according to Piaget's categories, rather than attempting to break them by a cross-classification, must be left to individual judgement.

It is a pity that, in a book where many (not least this reviewer) must at times hang on the argument by their eyebrows, there should occur misprints in logical formulae on pages 40, 53, and 170. There may be others, particularly in expansions, which we have missed.

There are also a number of odd phrases which make me a little uneasy about the lack of description of experimental rules: for example the use of "discovers too late" on page 171, line 4.

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