

## 2 : THE EPISTEMOLOGY OF JEAN PIAGET

### 2.1 INTRODUCTION

#### 2.1.1 A Major Epistemological Enterprise

Against this historical background we turn to a more detailed study of the work of the Swiss scientist/philosopher, Jean Piaget (1896-1980). Although his name is known around the world his work has seldom been appreciated adequately, especially outside the French-speaking world.

Richard F. Kitchener has observed that most philosophers - including, it might be added, those with a special interest in epistemology - "have dismissed his views as belonging to child psychology and thus of little significance to philosophy" (Kitchener, 1980:377). Publishers of English translations of Piaget's works have sometimes reinforced this view. A publisher's note to "Behaviour and Evolution" describes Piaget as "the father of the developmental psychology he called genetic epistemology". It would be difficult to imagine a more fundamental misconception of Piaget's work. That such a misconception could be promoted by a respected publisher underlines the desirability of a careful elucidation of Piaget's position and the reasons for its being so widely misunderstood.

It is true that Piaget had a strong interest in questions of developmental psychology and that the Centre international d'Épistémologie génétique that he established in Geneva has carried out over the years, and continues to carry out, extensive experimental work in this field. However this experimental program is not what Piaget called "genetic epistemology".

Majoring in biology in his initial university studies - he submitted a thesis on molluscs for his doctorate at the University of Neuchâtel - Piaget early developed a strong interest in epistemological questions. This led him to a study of philosophy as the traditional disci-

pline for epistemological studies. Later he turned to the study of psychology because he became convinced that it was necessary to have some knowledge of psychology in order to develop a serious epistemology (Piaget, 1972:17).

In further developing his epistemology he established a systematic program of experiments in the area commonly regarded as developmental psychology, not because he had turned away from epistemology, but because he regarded the data derived from such experiments as essential for the epistemology that he was developing. This program of experimental psychology for which Jean Piaget is most widely known was always an adjunct, albeit a crucial one, of his epistemology.

As Piaget (1970b:7) said himself: "Strictly speaking, I am not a psychologist, my work is epistemology and for this work I need psychology" In a similar vein, in an interview in 1968 (1968:49,54) he insisted that he was an epistemologist rather than, or at least more than, a psychologist. More extended discussions of the fundamentally epistemological character of his work appear in a number of his published works (e.g. 1970b:7-58, 118-148; 1972:8-108; 1979:5-10, 77-123).

Neither is this merely Piaget's own assessment of his work. A thorough and comprehensive examination of his work that is not determined to fit that work into preconceived categories can only lead to the conclusion that his genetic epistemology is precisely what the name implies, an epistemology. Anyone who understands the full scope of the continuing work of the Centre he established in Geneva will know that it is concerned with the continuing development of that epistemology.

There are, it is true, practical difficulties for the philosopher in the English-speaking world who wishes to make an adequate assessment of Piaget's work. It is not always possible to take the time to explore carefully at first hand the continuing work of the Centre he established in Geneva. His published works form an extensive corpus

much of which, at first appearance, appears to fit the "developmental psychology" category and some of the most important works expounding the epistemological nature of his work have not been translated from the French original. Further, and perhaps most important, he generally assumed in his writing, without attempting to defend, a conception of epistemology that was commonplace in his own philosophical background but that is alien to the main tradition of English-speaking philosophy.

Nevertheless, there have been those in the English-speaking world, not always philosophers, who have recognised the epistemological importance of his work. It was recognised by the American Psychological Association when it presented him with its Distinguished Scientific Contribution Award in 1969. The citation for this award specified that it was in recognition of his work in epistemology with the contribution to psychology referred to as almost "a by-product" (American Psychological Association, 1970:65).

Similarly the Catholic University of America in 1970 conferred on him its degree, "Doctor of Humane Letters (Honoris Causa)", for his pioneering work in scientific epistemology. The accompanying citation suggested that philosophers, in particular, are indebted to him for his work in epistemology (Piaget, 1970a:i).

To see his work as "developmental psychology" is quite misleading. Even an attempt to extract developmental psychology from his work by isolating the psychological component - as has been done so often - is a risky enterprise. It risks missing or distorting the significance of the psychological experiments by removing them from their proper context of epistemological problems.

In this case, on the one hand, the epistemological significance of the experimental results is either lost or distorted by fitting them into a different epistemological framework. On the other hand, the

developmental psychology that is extracted is in grave danger of distortion. If it is based on the Piagetian experimental data alone it will be based on insufficient data for the purpose of a developmental psychology since the research program that has produced this data has not been designed to answer problems of developmental psychology. It has been designed to find answers to quite specific and limited epistemological problems which, at best, touch only part of the field needed for a complete developmental psychology. And any use of that data supplemented by other data for the purpose of a more comprehensive developmental psychology can avoid the risk of distortion only if it both recognises and respects the epistemological context within which the Piagetian data was developed.

In short, while the experimental research program of Piaget's genetic epistemology has produced data that is significant for developmental psychology this is essentially a by-product of an epistemological enterprise. To be of value to a developmental psychology it is essential that this data be understood within the context of the epistemological enterprise that has generated it.

#### 2.1.2 "Epistemology" and "Épistémologie"

In describing Piaget's work as epistemology it is important to notice a significant difference between the connotation of "épistémologie" in the French speaking philosophical tradition and its etymological parallel "epistemology" in the English-speaking tradition. Whereas "epistemology" has a broad connotation virtually synonymous with theory of knowledge, "épistémologie" has specific reference to scientific knowledge. It is that branch of the theory of knowledge that is concerned specifically with scientific knowledge, bordering on and overlapping with the philosophy of science (Lalande, 1976:293; Bartholy, 1978:12). It is wider than philosophy of science since it is not confined to

problems internal to science per se, yet it is narrower than "epistemology" since it is concerned with broader questions only in so far as they are significant for an understanding of scientific knowledge.

While Piaget was not always precise in his terminology, and certainly never considered himself bound by philosophical usage, it is clear that, in designating his work "épistémologie génétique", he remained within customary philosophical usage. The problems that concerned him during a lifetime of research were quite specifically problems of the growth of scientific knowledge.

In an interview with L'Express in 1968 Piaget was quite explicit about his intention in describing his work as "épistémologie". Asked to define "épistémologie" he replied: "It is the theory of knowledge; essentially of scientific knowledge. It poses the problem of knowing how science is possible, how knowledge is possible" (Piaget, 1968:49).

In this respect, as in other important respects, he followed in the footsteps of his teacher, Leon Brunschvicg. He focussed attention on scientific knowing because he regarded this as the highest level of cognitive development. Scientific knowing is no different in kind to any other. It is simply knowing at its most developed level.

Kitchener (1980:378) therefore misses the point when he suggests that Piaget held a non-standard view of epistemology. Piaget wrote and thought in French and his description of his work with its specific orientation to scientific knowledge as "épistémologie" was in keeping with standard usage in the French-speaking tradition. Although, as a matter of convenience, I shall refer regularly to Piaget's "épistémology", the significant difference in connotation between the customary philosophical use of this term and the French "épistémologie" which Piaget used should be kept in mind.

### 2.1.3 Why "génétique"?

The qualification "génétique" by which he distinguished the epistemo-

logy that he was developing needs some clarification since it often seems to do little more than mystify, if not positively mislead, the uninitiated.

To understand the significance of the qualification "génétique" it is important, first of all, to recognise that, for Piaget, epistemology is concerned with the process by which knowledge grows rather than with the products of knowledge. He did not deny, of course, that the processes result in products, but, as an epistemologist his concern is with the processes of knowing. The plural "processes" is important since Piagetian epistemology does not take as its initial problem the growth of knowledge as a whole but the processes of the growth of knowledge within the specific scientific disciplines. Its basic problem, then, is to identify the processes by which, within the various disciplines, the subject passes from an existing knowledge to another judged to be superior once it is attained; "... comment s'accroissent les (et non pas la) connaissances? Par quels processus une science passe-t-elle d'une connaissance déterminée, jugée après coup insuffisante, à une autre connaissance déterminée, jugée après coup supérieure ..." (Piaget, 1970b:37-38; See also Piaget, 1970b:120-121; 1972:43; 1983:71).

A second factor in understanding the qualification "génétique" is the key role of "historico-critical" method in Piaget's approach to epistemology. In this respect, as in the focus on knowing as activity rather than on knowledge as product, Piaget followed closely in the footsteps of Brunshvicg.

As a young man Piaget, in his search for answers to epistemological questions, turned to the study of philosophy and for a time seriously considered philosophical study as a life career. To this end he studied philosophy under Arnold Reymond at Neuchâtel and later under

André Lalande and Léon Brunschvicg in Paris. For a time, early in his career, he held the chair of philosophy at Neuchâtel. From Reymond he gained a lasting respect for the historico-critical approach to epistemology, a respect which was reinforced by his later studies with Brunschvicg. In later years Piaget wrote to Reymond, on the occasion of Reymond's 70th anniversary, that he had continued in the historico-critical direction of epistemological research that he had encountered first in Reymond's work ("... je suis resté ... dans votre ligne <historico-critique>") (Piaget, 1969:112; see also 1972:14,15,18,34).

In following the historico-critical path, therefore, Piaget took a well-established and respected path in the French speaking philosophical tradition. Yet he did not merely remain within the traditional limits of that path but attempted to push it forward across new frontiers.

The historico-critical method attempted to answer epistemological questions by a critical analysis of the historical unfolding of knowledge. The history of science is taken, not merely as a factual reconstruction of the development of science, but as the "epistemological laboratory of science" (Piaget, 1983:70; cf. Deschoux (1964:214) on Brunschvicg). History is subjected to a "critical" analysis in a sense analogous to that of the Kantian critique with the aim of isolating the deductive and experiential factors that have led to the development of knowledge.

Attention is focussed on the knowing activity of the human subjects in order to reconstruct, by a critical analysis, the nature of the experiences (taking experience in a broad sense) and the deductions, but, especially the deductive or interpretive systems according to which these experiences were conceptualised, as these subjects formulated key principles, ideas or theories in the development of science from the ancient Greeks to the present time. This historical analysis

is not seen as a mere historical reconstruction but as a key tool for the elucidation of all the fundamental epistemological questions in relation to contemporary science. In a critical reconstruction of the historical unfolding of science we encounter all the basic epistemological questions (Piaget, 1967:16,107).

Piaget never lost his respect for the historico-critical method. One of his last published works (Piaget & Garcia, 1983) was a collaboration with the physicist Rolando Garcia that brings together an historico-critical analysis with the findings of the psychogenetic research that formed such a large part of his life's work.

However he early developed the view that the historico-critical method needs to be supplemented by psychogenetic research in order to establish a satisfactory scientific epistemology. This research parallels historico-critical studies in that, as historico-critical studies analyse the historical unfolding of knowledge in order to dissociate the experiential and deductive factors constitutive of the successive stages of that unfolding, so psychogenetic studies analyse the psychogenetic unfolding of knowledge in order to dissociate the experiential and deductive factors constitutive of the successive stages of this unfolding.

They complement historico-critical studies by tracing the processes of the growth of knowledge back to the more primitive stages of development that are inaccessible to historico-critical study but that are essential to a full understanding of the universal cognitive processes (Piaget, 1936b:21-23). These psychogenetic studies do not constitute simply a genetic psychology since the problems to which they are addressed relate not to the functioning of the individual intelligence but to epistemological questions concerning the growth of knowledge as a process common to all subjects. The questions involved are, in this sense, trans-subjective (Piaget, 1967:118-127; 1972:34,43).

Psychogenetic studies and historico-critical analysis, for Piaget, are simply two complementary varieties of the one genetic approach to epistemology. Psychogenetic studies are an extension of the historico-critical method, the two together constituting a complete "genetic" approach to epistemological questions (Piaget, 1967:65; 1970b:93, 126-128; 1972:106-107; 1979:8-9).

In adopting the term "génétique" as the distinguishing qualification of his epistemology Piaget emphasised his conviction that cognition is to be understood in terms of its genesis. The tools for this he saw as historico-critical analysis extended and reinforced by psychogenetic studies (Piaget, 1979:7). This did not mean any belief that knowledge is to be understood in terms of an absolute genesis. Knowledge is a continuing process of genesis elucidated by historical analysis but in no sense historically determined.

Although, owing to its previous neglect (see Piaget, 1979:7-8), Piaget devoted a great deal of attention to psychogenetic studies in developing his epistemology, he never regarded these as constituting an epistemology, not even when added to the more traditional historico-critical analysis. These studies he regarded as the source of crucial data and experimental checks for an epistemology that can be achieved only by means of interdisciplinary collaboration involving specialists from a range of scientific disciplines, including logicians and mathematicians.

In this interdisciplinary work psychogenetic studies and historico-critical analysis go hand in hand with "direct" and "formalising" ("formalisantes") methods of analysis. By "direct" analysis Piaget meant the identification of the conditions of knowledge by a simple reflection on advances in scientific knowledge of which we have direct experience. By "formalising" analysis he meant an analysis of the conditions of the formalisation of knowledge and the links between

this formalisation and experiences. The development of a satisfactory epistemology requires an interdisciplinary co-ordination in which all four of these methods - historico-critical studies, psychogenetic studies, direct analysis and formal analysis - are interdependent components (Piaget, 1967:64-65, 128-131; 1970b:166-167; 1972:44-45; 1973b:10; 1979:8). Always the focus of attention is on the genesis of knowledge in the subject.

Knowledge for Piaget is neither the possession of facts or truths that can be established or discovered once for all nor the ordering of experience according to fixed categories or structures. Knowledge is not a state to be attained but a never-ending process or activity of the human subject that is open at both ends. It has no absolute beginning and attains no absolute end.

As "genetic" epistemology Piagetian epistemology is concerned with knowledge as an ongoing genesis rather than with the genesis of knowledge. The emphasis is on knowing as a process rather than knowledge as a product. The genetic analysis that is so characteristic of this epistemology is not designed to trace knowledge back to some original beginning, to a definitive genesis as the ultimate root and foundation of all knowledge, but to trace the processes by which knowledge is continuously generated. If this includes tracing these processes back from the most sophisticated forms in which they occur in scientific thought to their most primitive beginnings where cognitive processes merge with the biological this is not because these primitive phases of cognitive activity have any privileged place in epistemology. It is because an adequate understanding of the nature of knowledge requires the most comprehensive possible understanding of all the processes that constitute knowledge (Piaget, 1970b:166-167; 1968:246-247; 1979:6-7; 1967:131).

#### 2.1.4 Knowledge as Open-ended Activity

For Piaget all knowledge is a continual becoming and consists in passing from a state of lesser knowledge to a more complete and efficacious state. Given such a conception of knowledge it follows that epistemology must consist in the most complete and accurate possible understanding of the processes of this becoming. The product - what is known - is wholly secondary. What is crucial is the activity of the subject, an open-ended activity without either an ultimate end or an absolute beginning. (Piaget, 1967:127; 1968:267; 1977:306; 1979:8).

Yet it is not the subject as individual with which we are concerned. Knowing is characterised by a universal value that transcends all individual variations. It is not an ordered activity that is the same in all subjects. The development may be more advanced in one individual by comparison with another but the processes that constitute knowledge are the same in all. Piagetian research, therefore, quite deliberately sets aside all that is individual in order to identify the cognitive processes common to all subjects that alone constitute knowledge. These common processes viewed as a whole Piaget called "the epistemic subject" (*le sujet épistémique*) (Piaget & Beth, 1966:329; Piaget, 1972:149; 1981:188).

A clear understanding of this Piagetian conception of knowledge as an open ended activity of the subject is essential in dealing with what is probably the most vexed - and vexing - question of Piagetian theory for philosophers, particularly those trained in the modern English-speaking tradition where formal logic has played such a large part. As Apostel has pointed out in a sympathetic, but critical, article, such a philosopher venturing to explore the logic that is involved in Piagetian epistemology will find himself in strange territory where "one astonishment will come after another" (Apostel, 1982: 567-568).

While logic has a normative role in Piaget's epistemology, it is the logical activity of the subject that has the primacy, not formal logical systems. The logic that interests Piaget "proceeds from the general coordinations of the actions of the subject" (Piaget,1972:79). Further, this logic in its most primitive forms is wholly independent of language and symbolisation (Piaget,1983a:78-81). Formal logical systems have epistemological interest only as formalisations of that activity. To begin with formal logical systems is, in terms of Piagetian theory, to begin at the wrong end. As Apostel puts it, Piaget "was looking for 'the natural logic'" (Apostel,1982:661). Given his conception of knowledge it is only such a logic that can be epistemologically significant.

#### 2.1.5 Knowledge as a Progressive Spiral

It has been observed already that Piagetian epistemology is concerned specifically with the growth of scientific knowledge. The way in which Piaget wrote at times could lead to the conclusion that he not only restricted his epistemology to questions of scientific knowledge but that he also regarded knowledge itself as restricted to scientific knowledge.

He argues, for example, that anything of value that philosophers have ever contributed to the understanding of knowledge has been the result of their reflections on science and scientific developments (Piaget,1972:67-75,159,160). Again, in a debate with philosophers in 1966, he argued that knowledge, properly speaking, is dependent on a verification such as results from the scientific attitude (Piaget, 1966:62). The way in which he spoke about cognitive meaning and scientific meaning (Piaget,1972:58-61), science and knowledge (Piaget,1968: 49) as though they are interchangeable lends further weight to the conclusion that he equated knowledge with science.

Yet a more careful examination of his position shows that such a

conclusion, though not without substance, is too simple. In this respect my own earlier discussion (1982:7-12,42,43) needs sharpening. A more precise formulation of the Piagetian position is that science represents the leading edge of a progressive spiral; it is knowledge in its highest and most elaborated form that is continuous in its basic character with a sub-stratum of pre-scientific knowledge.

This spiralling process leads to ever richer and more fully elaborated knowledge as the content elaborated by the existent forms of the subject's thought generates new and richer forms leading to a still better elaboration of content, and so on indefinitely. It is a spiral with neither end nor absolute beginning (Piaget,1977:306).

There is only one kind of knowledge existing in more or less developed forms. The cognitive processes of pre-scientific thought and practical intelligence are identical in kind with those of scientific thought but less developed and hence less authoritative. Science is an extension of more primitive forms of knowledge but incorporating two new requirements not found in these more primitive forms: "internal coherence (of the total system) and experimental verification (for the non-deductive sciences)" (Piaget & Garcia,1983:38-39).

"There is a continuity between pre-scientific and scientific thought, so far as the mechanisms at play in the cognitive process are the same; and, on the other hand ... there is a certain kind of 'rupture' each time the transition is made from one state of knowledge to another, within science as much as in psychogenesis" (Piaget, & Garcia,1983:282). In the spiralling development of knowledge science both surpasses the pre-scientific and continually surpasses itself.

While Piagetian theory, therefore, does not restrict knowledge to science it does quite decisively regard all non-scientific forms of knowledge as a primitive sub-stratum on which rests scientific knowledge as knowledge in its most highly developed form.

Kitchener has noted, correctly, the convergence with Popper in Piaget's interest in the growth of science as the focus of his epistemology (Kitchener, 1980:378). However, we should not lose sight of the sharp divergence between them that emerges as soon as we explore further the relation between science and the knowing subject.

In Popper's scheme the objectivity of scientific knowledge is achieved by distinguishing objective (scientific) knowledge, that exists as autonomous knowledge independent of the subject, from the knowing activity of the subject (Popper, 1979:77,148-150; 1983:94-97). Though it is a product of human subjects objective (scientific) knowledge is not that which is known by any subject (Popper, 1983:95).

In contrast, Piaget maintains that knowledge is always and only the activity of subjects. There is no place in Piaget's scheme for Popper's World 3 of objective knowledge existing independently of all actions of subjects.

Scientific knowledge is the most highly refined and fully elaborated form of cognitive activity of the subject the objectivity and authority of which are secured by the incorporation within this activity of the dual requirements of internal logical coherence and experimental verification (Piaget, 1970b:116-117; 1972:153-154; Piaget & Garcia, 1983:39). There is and can be no knowledge detached from the subject.

In his view of scientific knowledge as a higher level development of more primitive forms of cognitive activity Piaget appears to be closer to Polanyi than to Popper. The connections, and disjunctions, between Piaget, Popper and Polanyi will be examined in detail later. For the moment it is important to note that for Piaget any non-scientific knowledge can only be a more primitive and less developed activity of the same kind as scientific knowledge.

This has important implications for his historico-critical analysis and psychogenetic studies. Scientific knowledge in its current state

of development functions as the epistemological paradigm so that the historical and psychogenetic research is directed to understanding the development of patterns of activity of the same kind as those taken to be characteristic of science. In other words, the research proceeds in the opposite direction to the presumed course of cognitive development. The formulation of problems for research proceeds by reflection on what is taken to be the most highly developed form of knowledge, the knowledge of the sciences, especially the physical and deductive sciences.

Very suggestive of the way in which this research, in the formulation of its problems, moves from scientific knowledge back to more primitive forms, is the title of an article by the Piagetian - or neo-Piagetian - researcher, Bruno Vitale: "From Dynamics in Physics to the representation of Motion in children" - the title given by the author in his English abstract of the article (Vitale, 1984). Taking his starting point in concepts of physical science Vitale sets out to analyse the genesis of these concepts in the child quoting Marx (Vitale, 1984:165) with approval to the effect that we can only understand earlier stages of historical development in the light of later development ("L'anatomie de l'homme est la clef de l'anatomie du singe").

#### 2.1.6 Scientific Epistemology and the Piagetian Vision

Piaget describes his frustration with the philosopher I. Benrubi when the latter persisted in classifying Piaget as a positivist (Piaget, 1972:27-28). The frustration is understandable since such a classification suggests either a too superficial acquaintance with Piaget's work or a loose use of the term "positivist". Yet in one respect Piaget's position provides some mitigation for such a mistake.

His conception of the nature of science and of the relation between scientific knowledge and empirical reality decisively distanced him

from positivism. Yet he shared with the positivist tradition a faith in scientific activity as the key to universally compelling, intersubjective truth (Piaget, 1974:296). One of his repeated criticisms of positivism, in this respect, was that it unduly restricts the field of problems to which scientific methods can be applied successfully.

With this vision before him he set out to establish genetic epistemology as a scientific epistemology separated from philosophy. As other sciences had once been dealt with within philosophy but, in the course of historical development had one by one become established as autonomous sciences, so he argued that the time had come for epistemology to be established as an autonomous scientific discipline. By this means he expected to develop an epistemology that would compel the universal assent of all rational minds.

Philosophy, in his view, can pose problems and, in doing so, provides a valuable service to the growth of knowledge but it can never resolve the problems. (The comparison with Popper in this respect will be discussed shortly.) Only science, with its instruments of verification, can resolve problems (Piaget, 1972:305-307). Hence the resolution of epistemological problems can be achieved only by dealing with them in a rigorously scientific manner. Piaget, confident that epistemological questions, like any other question, could be resolved in this way, saw his genetic epistemology as a pioneering endeavour in just such a scientific epistemology.

As an attempt at developing a scientific epistemology Piaget's genetic epistemology can be understood only in the context of the Piagetian conception of science. In the Piagetian conception the rigorous delimitation of problems is fundamental to science. Scientific activity begins by setting aside all those larger and more general questions on which the human mind naturally reflects in order to delimit a problem such that an agreement of minds can be achieved with

regard to this one problem. Scientists who work together on this one, limited problem may well disagree about a host of other questions but they agree at least in the identification of this problem (Piaget, 1970:39-41; 1970b:16).

Employing agreed methods of verification, deductive and experimental, scientists develop answers to these delimited problems, answers that have the status of assured truth. However, as yet all we have are answers to isolated problems. The co-ordination of these answers as coherent knowledge is a matter for interdisciplinary scientific activity.

While it is possible, even essential, to assign the resolution of the delimited problems to specialists in the various disciplines, and even sub-disciplines, on the larger field of knowledge these are interrelated and interdependent. The establishment of these interrelations and the coordination of knowledge that is dependent on them is not a matter for some science of the whole. Involving questions internal to the sciences in their differentiated specialisations the desired coordination can be achieved only by the interaction of scientific specialists.

A scientific epistemology, then, must proceed in the same way as any other scientific activity. It must begin by setting aside, for the time being, those large scale questions about the nature of knowledge and of cognitive activity as a whole that have preoccupied philosophical epistemology through the centuries. Instead it selects carefully delimited problems for resolution by careful scientific research. Since the chief tools for the resolution of these problems are psychogenetic experimental research and logical/mathematical deduction, it is psychologists, logicians and mathematicians who must play the key role at this level of the development of a scientific epistemology.

But this is only, as it stands, the gathering of data. As a theory

of the cognitive processes that are internal to scientific knowledge in all its branches, a scientific epistemology can result only from an interdisciplinary co-ordination that embraces a wide range of disciplines. The notion of interdisciplinary activity as the means of cognitive co-ordination is basic to Piaget's view of science and hence to his scientific epistemology (Piaget, 1966:75; 1972:44; 1970:101-103; 1970b:15).

In establishing the Centre international d'Épistémologie génétique in Geneva, therefore, Piaget was not setting up a centre for psychogenetic research, though such research has been and remains an important component of the activities of the Centre. He was establishing an interdisciplinary centre for the development of a scientific epistemology. Significantly the current Director of that Centre (1985), Gil Henriques, is not a psychologist but a mathematician. Interdisciplinary co-ordination involving the participation of scientists from a range of disciplines remains central to the Centre's activity as a centre for the development of a scientific epistemology in the Piagetian tradition.

There is, of course, a strong flavor of Comtean positivism in this notion of science as the solution of delimited problems that are subsequently co-ordinated in a comprehensive scientific understanding that, in principal, can provide answers to all the issues of human life (Piaget, 1972:59). Nevertheless it is a flavour in an epistemology that, in its basic character, is far from positivist.

Piaget certainly saw himself, correctly in my judgment, as closer to Kant than to Comte (Piaget, 1972:28). The Kantian influence is apparent, among other ways, in the relation between science and philosophy. Like Kant, while Piaget wished to make science the supreme arbiter of cognitive values, he had no wish to reduce all human values to scientific values. There is far more to life than can be yielded by

scientific knowing. In relation to this large realm of human values beyond knowledge philosophy has its place, a place essential for every thinking man (Piaget, 1972:57-63; 1966:62; 1970:26).

It is tempting to see a convergence between Piaget and Popper in a shared view that there is no sharp line separating science and philosophy (Kitchener, 1980:379). A closer examination shows rather that there is, in fact, a fundamental divergence at this point.

For Popper there is no sharp dividing line between philosophy and science because it is impossible to assign a problem definitively to a specific discipline. Problems are liable to cut across all distinctions of disciplines including the distinction between science and philosophy and their solution may as well be a matter for philosophy as for science. Furthermore, there is no specific philosophical method or set of methods for solving problems; "... any method is legitimate if it leads to results capable of being rationally discussed" (Popper, 1972:66-74).

All this Piaget denies. The methods used to solve problems are crucial and only the methods characteristic of science and will do. Precisely because it does not use these methods philosophy is incapable of contributing to the solution of problems. Whereas Popper insists that science generates problems to which philosophy can provide answers, Piaget insists that philosophy's chief value is that it generates problems that only science can answer. Philosophy does not solve problems (Piaget, 1970c:16-17). If philosophers have contributed to the growth of knowledge by furnishing answers to problems this has not been due to their philosophical activity but only to their practice of science side by side with philosophy (Piaget, 1972: 63-67).

In short, Piaget, in direct contrast to Popper insists on a sharp line separating science and philosophy characterised by the distinctive methods of science. Piaget is in agreement with Popper in

regarding the distinction of disciplines within sciences as artificial, a mere matter of convention (Piaget, 1969a:79,80; Popper, 1972:66-68). But he maintains a fundamental distinction between science and philosophy. As regards problems, it is true, there is no sharp separation since any problem of philosophy may become a problem of science once the appropriate methods adapted to it are developed. But this is not a matter of the lack of a clear boundary. The border between science and philosophy is fluid, not blurred or overlapping. The borders of science constantly expand and as they expand science takes over problems that were previously problems of philosophy (Piaget, 1972:43,44; 1970:89-91).

#### 2.1.7 The Need for a Systematic Review

The evaluative analysis of Piagetian epistemology, particularly in relating it to philosophical discourse in the English-speaking tradition, requires great care to avoid the distortion that can result from hasty conclusions based on a too superficial acquaintance. For that reason, before proceeding further with an evaluative analysis it is important to review more carefully and systematically the fundamental contours of the Piagetian epistemology as expounded by Piaget, with special attention to works published - either as a first publication or in a new edition - from 1966 onwards.

This period is chosen for special attention, on the one hand, because the works published during this period, including new editions of important earlier works, deal with all the main features of Piagetian epistemology. On the other hand, while the main contours of his thought were fixed at an early date Piaget was continually developing, refining and modifying his ideas so that a concentration on the more recent publications enables us to view his epistemology in its most mature development, while still gaining a clear view of the basic contours it had from the beginning. In short, the works published in

this period give a substantially complete view of Piagetian epistemology in the most developed form achieved in Piaget's lifetime. At the same time the number of works requiring detailed study remains within manageable proportions.

The qualification "as expounded by Piaget" is of some importance since interaction with personnel at the Centre international d'Epistemologie genetique in Geneva in 1984-5 suggests that it may be appropriate to speak of the development of a neo-Piagetian theory that modifies Piaget's position in important respects in the continuing development of genetic epistemology.

#### 2.1.8 Questions of Terminology

There is a certain looseness, or to put it more charitably a certain fluidity, about Piaget's use of terminology. Garcia (1983:10) tells us that during the final stages of writing the book that he co-authored with Piaget (Piaget & Garcia, 1983), which was one of the last on which Piaget worked, some attempt was made to standardise terminology. Even then Garcia leaves the impression that it was he who took the initiative and secured Piaget's agreement to the standardisation. Piaget himself never seems to have shown any great interest in a precise systematising of his terminology.

In the following discussion of his epistemology I have made no attempt at any greater degree of standardisation of terminology than emerges from the Piagetian corpus itself. I believe that preserving the fluidity of terminology characteristic of Piaget's own writings will preserve a distinctively Piagetian "flavour" to the analysis without serious loss of clarity.

Another issue of terminology arises from the diversity in English translations with regard to a number of key terms of Piagetian epistemology. Where translators have generally concurred in using a single

term in English I have followed this convention. In those cases where translators have used differing terms I have chosen what seems to me to be the most felicitous term in each case. For those interested in a comparison of the English terms used by different translators, Vuyk (1981) provides a useful appendix listing the main terms.

## 2.2 CONSTRUCTIVISM AND STRUCTURALISM

The notion of structure is clearly important to Piagetian epistemology. This raises the question of the relation between genetic epistemology and structuralism. Is it a structuralist epistemology?

Gardner (1981:xiii,498) regards Piaget as one of the "architects of structuralism" suggesting that Piaget encouraged him in this view. Piaget (1969a:77) said of himself and his colleagues at Geneva that "we have been employing structuralism for thirty years". In the development of an epistemology of the human sciences he says (1970:9) that he was "constantly inspired by a certain structuralism" common to the human sciences and the "exact and natural" sciences.

Yet it would be simplistic and misleading to classify Piaget's genetic epistemology as "structuralist" without further qualification. There is affinity but not identity. Structuralism, of course, is a broad movement within which there is room for considerable diversity rather than a "school" showing systematic coherence. Nevertheless the role that structures and structuralist method play in Piaget's epistemology places that epistemology outside, though in affinity with the movement. Although there are features of genetic epistemology that parallel structuralism the role of these "structuralist" features is subordinate, not definitive.

To put in perspective Piaget's own assertion that he employed structuralism we need to remember that he was speaking of structuralism as a method that, like all other methods, has limited application. It is useful only as it takes its place as one method among others. Neither

the method of structuralism nor any other method has priority. Science proceeds neither by the use of one privileged method nor by the use of a specified set of methods but only as the scientist develops methods suited to the problem at hand (Piaget, 1970:42). The method of structuralism is not a universally valid method but one, like others, that is useful in particular instances where it is suited to the specific nature of the problem to be addressed. As soon as it becomes a doctrine or a philosophy or the one preferred method that supplants or subordinates to itself other methods it loses its value (Piaget, 1969a: 78,85; 1983a:118,123).

A structuralist, of course, may be equally insistent that structuralism is not a philosophy or a doctrine but a method (Benoist, 1975: 207). However it makes no sense to classify an epistemology as structuralist unless the structuralist method has a privileged place in it. It decidedly does not occupy such a place in the Piagetian epistemology. It is simply one method among others.

Indeed, there is no method or group of methods that can occupy a privileged place in Piagetian epistemology. It is fundamental to Piaget's position that epistemology is not reducible to a methodology. His most fundamental criticism of the work of Popper and Lakatos is that, by reducing epistemology to methodology, they have failed to address the real epistemological problem (Piaget, 1983:293).

It is true that Piaget regarded the advance of scientific knowledge as dependent on the development of scientific methods for dealing with problems (Piaget, 1966:53; 1970:18-19,89-91; 1972:21-22,307). The key, however, is the development of methods that are appropriate to the problems concerned. There are basic characteristics of a scientific method but no such thing as "the scientific method". No one method is the universal key to knowledge. The growth of science requires the development of methods suited (adaptes) to each problem or group of

problems (Piaget,1970:42).

In this respect Piaget's position closely parallels that enunciated by Spykman (1985:77): "It belongs to each discipline to develop methods appropriate to its own unique field of investigation. For there is no single scientific method. Methods are as differentiated as the various disciplines ...". A difference is that Piaget connects the differentiation of methods to a differentiation of problems rather than to disciplines per se.

Following Brunshvicg, Piaget rejects both the Kantian identification of the governing principle of knowledge with a universal a priori conceptual structure of thought and the Comtean identification of the governing principle with a universal a priori method of processing empirical data. Both conceptual - and logical - structures in which knowledge is organised and the methods that are employed in gaining knowledge are the products of the knowing activity of the subject governed by an innate dynamic structuring principle.

It is the knowing subject and not the method of structuralism, or any other method, that is definitive in the Piagetian epistemology. The structuralist method is no more than one of the several methodological tools that epistemology employs. The Piagetian employment of "structuralism" must be understood in this context of the primacy of the knowing subject.

Cognitive structures in the subject are essential to cognition. "A well developed structure within the subject is needed in order to take in the data which is outside." At no level is knowing a matter of "passively registering what is going on around us" (Piaget,1971:4). Always it is a matter of reading data within the framework of a structure, "the system of connections that the subject can and must use" in order to know anything (Piaget,1971b:13; see also 1970:55).

Piaget criticised structuralists for their evasiveness with regard to the ontology of structures (Piaget,1969:79). His own treatment of this problem, on the other hand, is not the most lucid. In the final count, however, it seems clear that he identified cognitive structures with the structured and structuring activity of the knowing subject. The cognitive activity of the subject is a structured activity that structures the subject's experience (Piaget,1969a:79-81; 1970:266-268; 1974:74).

Cognitive structures are not independent entities but characteristic products of the subject's cognitive activity. They have neither the eternal existence outside the subject of the Platonic Ideas nor the innate conceptual status of the Kantian categories. They are the structured ways in which the knowing subject acts in interaction with the environment structuring its own thought at the same time as it structures its view of reality.

Piaget specifies three characteristics distinctive of a cognitive structure. (1) A structure is a whole (totalité) that is more than the sum of its elements; the laws of the whole being distinct from the laws of its elements. (2) A structure is a system of transformations governed by laws of transformation; it is never static but always transformational. (3) A structure is self-regulating. It remains within its own frontiers in its transformational constructions; these constructions neither lead beyond the system nor make appeal to anything outside the system (Piaget,1969a:73-75; 1970:10; 1970c:22-23; 1983a:5-16).

On the one hand, as a closed self-regulating, lawful system the structure has an intrinsic necessity. On the other hand, as a system of transformations the structure is an instrument of construction that continually opens up new realities; "the structure is simultaneously structuring and structured" (la structure est structurante en même

temps que structurée, Piaget, 1969a:74; 1973:9).

The cognitive structure is neither an image of a structured reality external to the subject nor a mere mental construct. It does more than provide the subject with a structured view of reality. Every structure is generative of further structures. It is a structured instrument for structuring reality that generates new and more effective structures in its interaction with reality.

The subject is not programmed with predetermined structures in this structuring activity. The structures are in no sense innate but are constructed in and through the subject's activity in interaction with reality. The subject is a centre of structuring activity governed by an innate dynamic structuring principle, not one containing ready-made structures (Piaget, 1970:267-268; discussed at length in Piaget, 1975).

While structures are important to Piagetian epistemology, therefore, it is not the structures but the structuring subject with its dynamic governing principle that is definitive. Structures are the products of the subject's structuring activity. To know what the structures are is of little epistemological importance. The central question is: How does the subject construct the structures?; "... the only truly omnipresent factors in cognitive development ... are of a functional, not a structural, nature" (Piaget & Garcia, 1983:292). The key question is how the subject functions in constructing the structures of knowledge and not what are the structures.

In spite of the affinity with structuralism it is clear that Piagetian epistemology is more accurately described as "constructivist" than as "structuralist".

### 2.3 COGNITIVE ABSTRACTION

The Piagetian structures neither replicate in thought a universal, eternal order of reality nor organise in thought data registered in sensory experience. Nor are they Kantian-type conceptual structures

for organising phenomena.

The structures, without which knowledge is impossible, go beyond the phenomena. Not to be confused either with the observable or with the "event" experienced by the subject, they underly the phenomena. They are, "... in a sense analogous to what the classical philosophies called the essence in contrast to the phenomena." (Piaget, 1969a:74-75). To know is always to know more than phenomena; it is to know the structures that underly the phenomena.

In speaking of an analogy with the essences of classical philosophies Piaget was certainly not suggesting any identity between Piagetian structures and Aristotelian essences. He has not reverted to Aristotelian essentialism or, for that matter, to any other kind of essentialism. His structures are analogous to the Aristotelian essences in the sense, and only in the sense, that they are neither given in nor derived from the phenomena and phenomenal relations but have an existence underlying the phenomena by means of which the phenomenal world is understood.

It is evident that Piagetian epistemology is not empiricist; knowledge, in Piaget's view, can never be reduced to the registering and processing of sensory data. And the rejection of innate categories together with the insistence that knowledge goes beyond the phenomena clearly distinguishes it from Kantian epistemology. On the other hand, he appears to have inherited from Brunshvicg a type of intellectualism in which knowledge is experience structured by an actively structuring intellect.

On such a view of Piaget, Lesquins (1981:20) concludes that, in the final count, knowledge in the Piagetian epistemology is determined unilaterally by the internal development of the subject's intellect. The polarisation of modern rationalist epistemologies around a mentalist intellectualism and empiricism makes this an easy misconception

to fall into given the unmistakable indications that, whatever it is, Piagetian epistemology is not an empiricist epistemology. However, the more closely we examine Piagetian epistemology the more difficult it becomes to sustain a view that categorises it in terms of an empiricism/mentalistic intellectualism polarity.

First there is the question: How are the cognitive structures acquired? They are given neither in the subject nor in the objects. The subject does not approach the objects possessing innate structures within which to read the objects but neither are the structures read out of the objects and their relations. Yet neither are they inventions of the subject. Piaget's answer to the question of their acquisition is that they are constructed by the subject in a process of abstraction in an interaction of subject and object.

"All new knowledge supposes an abstraction, since, in spite of the component of reorganisation that it calls for, it never constitutes an absolute beginning but draws its elements from some previous reality" (Piaget, 1974:81).

While sensory perception is essential for knowledge it can never in itself constitute even the most elementary form of knowledge or supply basic cognitive data. Sensory perception only provides us with signals of reality as undifferentiated composites. "When I perceive a house, I do not see first the colour of a tile, the size of a chimney, etc., and finally the house! I perceive from the beginning the house as a 'gestalt' and go on subsequently to analyse it in detail". This perception yields knowledge only as it is transformed by the subject's acting on it. "One ... only knows an object in acting on it and transforming it" (Piaget, 1970b:83-85).

As passive recipients of sensory perception we would know nothing at all; we would not even have the most elementary cognitive data. All we would have would be uninterpreted signals. We would be like someone

receiving coded radio signals without the key to the code. It is only as the subject acts on the signals of sensory perception that they can be read as knowledge. By the subject's activity the signals are transformed into cognitive data.

Fundamental to this transformational activity is a double process of abstraction. Two kinds of abstraction are distinguished according to the source from which the abstraction is made. In "empirical abstraction" - which Piaget earlier called "simple abstraction" (Piaget, 1970c:17; 1974:81) - the source is exogenous; the subject abstracts properties from the observed objects and from the observed material aspects of the subject's own action. In either case the source from which the subject abstracts is external to the subject's thought. The subject abstracts from observables (Piaget, 1970c:16-19; 1970b:85; 1977:5-7, 305-323; 1974:81).

As an example of this kind of abstraction Piaget cites the case of a person who, through the action of hefting a solid object, abstracts the property "weight" while ignoring, for the present purpose, the other properties of the object. "Weight", in other words, is a property of solid objects that exists only in solidarity with the object of which it is a property. It is known only through the action of the subject that enables the subject to abstract it from the total complex of the object's properties.

While this empirical abstraction abstracts from the observables of sensory perception the subject can perform this abstraction only as the observables are assimilated to schemes or structures of the subject's actions. There is no passive registration of cognitive data by the subject through sensory perception even at the most elementary level; "only reality (le réel) in itself, that is to say composed of objects and events known and unknown, exists independently of the subject, though becoming knowable exclusively on the condition of

being assimilated, hence interpreted by him" (Piaget, 1981:182). The properties of objects, which exist independently of the subject's cognition of them, can be abstracted from the objects only as the subject reads the sensory signals in terms of an interpretive framework of the subject's thought.

This structured cognitive activity of the subject's thought provides the endogenous source for the second kind of abstraction, which Piaget called "reflective abstraction" (abstraction réfléchissante) that abstracts elements from the subject's own cognitive activity. It is called reflective for two complementary reasons. Firstly, it is reflective in the sense that what is abstracted from a scheme or structure of cognitive activity is transposed to or reflected in a higher level cognitive structure. This transfer or projection of abstracted elements of cognitive activity from one level to another Piaget designated "réfléchissement". Secondly, the abstracted elements of one level projected onto a higher level are reconstructed to form a new, higher level cognitive structure. The process of cognitive reorganisation of the abstracted elements he designated "réflexion" (Piaget, 1970a:17-18; 1977:6-7; 1974:82).

It is important to note carefully that this reconstruction of cognitive structures by reflexion is not necessarily a conscious process. It can be and commonly is an unconscious mental activity. Even when, at higher levels of cognition, reflection is the work of thought it is to be distinguished carefully from the conscious thought in which we reflect on this cognitive activity in a retroactive "thématisation" (i.e. making the cognitive structures objects of conscious thought) (Piaget, 1977:6; 1971b:12-13). This distinction is vital when we come to consider the relation between cognitive structures and formalised systems.

Reflective abstraction is the process by which cognitive structures

develop. At the most elementary level the human subject has only a few, very general sensory-motor schemes - sucking, looking, listening, touching. These do not constitute an elementary innate knowledge, not even as incipient knowledge. They are nothing but co-ordinated patterns of sensory-motor activity that provide the subject with primitive tools for reading sensory data. It is the co-ordinated character of the activity that is important for cognition; the ability to co-ordinate actions is the indispensable innate basis of cognition (Piaget, 1970c:18).

In the co-ordination of his own activities the subject possesses a framework for organising sensory experience. Only by this organising of experience do we know. As the existing organising framework proves inadequate for the assimilation of all the experiences the subject constructs a new framework or structure by reflective abstraction abstracting elements from the existing framework and reconstructing them in a new higher level structure - "higher level" because it is more adequate for the assimilation of experiences.

So, for example, notions of empirical order are founded in the simple co-ordination of sensory-motor actions in the subject's observations, e.g. the eye or body movements (*déplacements*) needed to observe order in a group of objects such as a series of trees on a river bank. Increased co-ordination of actions leads to an increased experience of order in observations (Piaget, 1970c:28-30; 1970d:704-706; 1971a:3-5; 1977:309).

At this level the human subject is continuous with other animal subjects. The human subject is distinguished from other animals by the semiotic function that enables the human to interiorise actions in thoughts, first as representations and then as concepts. Basic to Piagetian epistemology is the contention that concepts are founded in actions of the subject interiorised by means of the semiotic function

that is peculiar to the human - the "language" of bees is nothing more than a system of sensory-motor signs (Piaget, 1975:106-137; 1968:50; 1970:47-48).

This is by no means to say that concepts are merely interiorised actions. Conceptualisation is initiated as the semiotic function enables the subject's actions to be interiorised in thought, first as representations and then as primitive conceptual structures. Even this initial interiorisation is not a simple copy of the motor activity as mental image however but involves a conceptual reconstruction (Piaget, 1975: 60). Once initiated in thought the conceptual structures are able to generate further more complex and more refined conceptual structures by means of reflective abstraction acting on existing conceptual structures. Once the conceptual structures of thought are established the cognitive locus shifts from sensory-motor activity to the mental activity of thought.

So reflective abstraction, which has its foundations in the sensory-motor activity that the human subject shares with other animals, in its developed form is a process internal to thought by which more and more powerful conceptual structures are constructed from conceptual elements abstracted from the subject's existing conceptual structures.

While this reflective abstraction is internal to thought it is dependent for its development on the interaction of thought with objects external to thought. The difficulties in assimilating sensory experiences to the existing conceptual structures provide an essential stimulus to the development of more adequate conceptual structures by the process of reflective abstraction. To be sure, once possessed of sufficient conceptual structures the subject can construct more complex and powerful structures by reflecting directly on the conceptual structures of thought themselves as in "pure" mathematics and logic. Nevertheless, the interaction of thought and sensory experience re-

mains an essential stimulus to conceptual development by means of reflective abstraction (Piaget, 1969b:125-127; 1976:28; 1975:58-68; 1970b:38-44, 87-100; 1977:303-324; 1974:74, 98-99; Piaget & Garcia, 1983:7-8).

Interaction of subject and object is fundamental to Piagetian constructivism. Objects are known only by means of the structures that the subject supplies but these structures are developed in the subject only in acting on objects external to the subject. Cognition is a transformational acting on the environment by the subject while the structures of this transformational action are themselves the result of the subject's accommodation to the environment (see Piaget, 1973: 17). Lesquins' description of Piagetian epistemology (Lesquins, 1981: 30) as the unilateral determination of empirical knowledge by operatory structures misses entirely this factor of interaction that is basic to Piagetian epistemology.

An important effect of reflective abstraction is the attribution of properties to objects. In empirical abstraction the subject isolates in thought properties of the object that are possessed by the object before being observed by the subject. The structures developed by reflective abstraction, on the other hand, lead to the enrichment of the objects by attributing to them co-ordinative properties that they did not possess before. These are then read from the objects by the subject as though by empirical abstraction. Piaget calls this "pseudo-empirical" abstraction because although the properties are read from the objects as though by empirical abstraction they can be read in this way only because they are first attributed to the objects by the subject. The real source of these properties is the co-ordination of the subject's action.

The term "pseudo-empirical" abstraction is not to be taken as implying any pejorative connotation. It is not a primitive weakness to be

discarded in more mature thought. On the contrary, it is an important component of empirical knowledge at every level. Its role is proportionally greater at the more primitive levels and proportionally less at the more advanced levels but it has a legitimate role at all levels of empirical knowledge. It is the source, for example, of explanation in physics, a concern of all creative physics. What is important is not that we discard pseudo-empirical abstraction but that we recognise it for what it is, the reading from objects of properties derived from the co-ordination of our own actions on the objects and attributed to the objects (Piaget, 1973:11-18; 1977:6-7, 306-323).

Since in both cases the subject abstracts the properties from objects how are we to distinguish the properties of empirical abstraction which exist in the object before being observed by the subject and the properties of pseudo-empirical abstraction that are first attributed to the objects by the subject? Although Piaget does not appear to have given a precise delineation of the necessary criteria it seems clear that the properties of empirical abstraction are those properties that are abstracted in the simple subject-object relation in which the subject focusses on an object without regard to its relation with other objects - e.g. weight, colour, texture. The properties of pseudo-empirical abstraction, on the other hand, are those that are abstracted when the subject focusses on objects as a co-ordinated group - e.g. number, class, sequence.

Once we have a clear view of the importance of abstraction in Piagetian epistemology it begins to emerge clearly that it embodies an abstractive intellectualism that, in spite of its thoroughly modern character, exhibits striking parallels with that of Aristotle.

Like Aristotle Piaget takes sensory perception as the starting point of knowledge; without the sensory experience of objects external to the subject there can be no knowledge (Piaget, 1970b:81-109). Again

like Aristotle but unlike empiricism Piaget denies that cognitive data are given in sensory experience. They are obtained only as the subject acts abstractively on the objects of sensory experience.

For Piaget, as for Aristotle, cognition leads from sensory experience to the intelligible by which the sensible is ordered; in Aristotle's *De Anima* (1928:429-432) it leads to the intelligible forms and for Piaget (1969a:75) to the structures that, in both cases, underly sensible phenomena - "La structure ... est située sous les phénomènes".

The founding of knowledge in the sensory experience of objects external to the subject distinguishes Aristotle and Piaget from the intellectualism of Plato and of Kant. The necessary intervention of abstractive thought distinguishes them from empiricism.

There is, however, a significant difference between Piaget and Aristotle. It is to be found at the point of decisive ontological cleavage between the mainstreams of modern and Greek philosophies. With an ontology of intelligible as well as material reality external to human thought, Aristotle (1928:Metaphysica,103,1059; *De Anima*,432) was able to regard the order of human thought as replicating the order of an intelligible reality existing in the material world external to thought. The order attained by abstractive thought, therefore, is not, as it is with Piaget, a construction of thought attributed to objects but is the order of intelligible reality embedded within the sensible objects and dissociated by abstractive thought.

As a thoroughly modern thinker such a notion of an intelligible reality within the material world external to thought is itself unintelligible to Piaget. In the ontology of the material world with which he operates there is room only for material reality and thought about that reality. Wishing, therefore, to retain the empirical basis of knowledge without falling into empiricism he turns to thought as the

source of cognitive order constructed in interaction with material reality. This notion he develops in his theory of reflective abstraction.

It is important to note that, for Piaget, neither empirical nor reflective abstraction is reducible to lingual or conceptual abstraction. With the development of the semiotic function the abstractions can be conceptually interiorised in the subject but the abstraction is prior to its symbolisation and conceptualisation. In the case of reflective abstraction, it is true, once a conceptual structure is developed further abstraction can occur by reflection on this conceptual structure yet its development is impossible without a basis of abstraction that is independent of all symbolisation or conceptualisation.

#### 2.4 COGNITIVE STRUCTURES AND FORMAL SYSTEMS

Piaget regularly speaks of empirical abstraction as the source of the content of empirical knowledge and of reflective abstraction as the source of its forms. For this reason both kinds of abstraction are essential at all levels of empirical knowledge. Empirical abstraction cannot take place without the forms supplied by reflective abstraction. Though purely formal knowledge in logic and pure mathematics is possible without empirical abstraction it cannot yield empirical knowledge except as it is joined with empirical abstraction to give content to the forms (Piaget, 1977:5-7, 303-23). And even as purely formal knowledge it cannot exist without a base of empirical knowledge.

The empirical content of knowledge, then, consists in the properties of material objects abstracted by means of the subject's structured thought. The form of knowledge is supplied by the structure of this thought developed in interaction with the objects. Order arises from the subject's ordered thought, but developed only in interaction with the material content to be ordered. The content of empirical knowledge

arises from the observations of material objects, but only on condition that these observations are ordered by the subject's thought or, at a primitive level, sensory-motor activity.

But this form supplied by the subject's thought is not to be confused with a formal symbolic system. The structures that are so essential to Piagetian epistemology are not reducible to the structures of a language whether a "natural" or a formalised language. It is true that at the more advanced levels of knowledge the cognitive structures receive a systematic formalisation in logic and mathematics but this is the formalisation of structures that have an existence prior to and independent of their formalisation in a symbolic system.

The Piagetian structures are not merely formal abstractions but "realities deeply rooted in natural thought". Formal structures constitute an axiomatisation of natural structures; they formalise the structured functioning of the subject. Formal structures as formal logical and mathematical systems axiomatise natural structures that constitute a reality independent of and prior to all formalisation (Piaget, 1969a:82; 1970:100-101; 1971a:1-4; 1973:10; 1977:320).

For example, arithmetical systems are founded on the concrete, pre-scientific experience of numbering concrete objects, an experience that gives rise to "natural numbers". Similarly, formal systems of classification and seriation are founded in the subject's pre-scientific and informal activity of classifying objects and arranging these in series. In this respect what is important in the pre-scientific experience is not the subject's consciousness but the structuring activity intrinsic to his activity and reasoning of which he is only partially conscious (Piaget, 1970:100).

With respect to formal logic Piaget suggests that "pure logic" is "a formalisation of the formalising activity of the subject" (Piaget & Garcia, 1983:22-23). A formal system of any kind is the formalisation

of the already co-ordinated activities of the subject; its systematic character is dependent on the prior systematisation of the subject's actions (Piaget,1973a:7). In the case of logic, the activity underlying all formal logical systems is the formalising activity itself.

Formal systems only emerge at the highest cognitive levels where the subject is able to reflect on the processes of thought without reference to external objects. They are the product of reflexion on reflexion, the most advanced level of reflective abstraction which Piaget designated "abstraction réflexive" (Piaget,1977:6). But they only formalise the cognitive structures that already exist as structures of the subject's cognitive activity. This is a feature of Piagetian epistemology that I did not recognise adequately in my earlier study (1982:99).

Once we recognise that Piaget's cognitive structures are not formal structures but the structures of the subject's cognitive activity in interaction with objects it becomes clear why there is a gulf between Piagetian epistemology and epistemology in the analytical philosophical tradition.

Epistemology can have a legitimate place within the latter tradition only on condition that it is assumed that there exist unproblematic cognitive data of some kind and that the cognitive activity of the subject is confined to the processing of this data by means of a language system, whether a natural language or a formal language. Then, and only then, can it be legitimate to restrict epistemology to the analysis of the appropriate language.

On the other hand, it is basic to Piagetian epistemology to insist that there are no unproblematic cognitive data but only data constructed by the subject as the solution of problems posed in interaction with the objects. And a language system of any kind is never merely a tool for processing cognitive data but is a product of the construc-

tive processes that constitute cognition. In other words, knowledge is not constituted by the processing of data within a language system; on the contrary, a language system emerges from the complex of the subject's activities that constitute knowledge. On this view the restriction of normative epistemological questions to questions of language and formal logic while ignoring the underlying (psychological) questions concerning the subject's cognitive processes can only lead to sterile debates that miss the real epistemological issues.

Given the assumptions of analytical philosophy Hamlyn (1971:19,23) was right in finding in Piagetian epistemology "a degree of incoherence" and even "a muddle". And given his own assumptions Piaget (Piaget & Garcia,1983:293) was right in charging Anglo-Saxon epistemologists with failing to address the basic epistemological problems.

However, such charge and counter-charge gets us nowhere. What is needed is a careful evaluation of the underlying assumptions that give rise to the charge and counter-charge. Is knowledge the processing of unproblematic data within some kind of language system or is it a constructive, interactive process out of which emerges language systems (including formal, symbolic systems) which enable the subject to articulate knowledge?

It is simply begging this fundamental question to dismiss the extensive experimental research of genetic epistemology as epistemologically irrelevant because of its psychological nature. It can be dealt with satisfactorily only by a careful evaluation of the research in question to determine to what extent, if at all, it supports the Piagetian answer to this fundamental question and, if not, what alternative, more satisfactory account can be given of the experimental evidence. Piagetian epistemology undoubtedly makes use of research that is psychological in character and therefore beyond the scope of philosophy. However, as psychological research which, it is claimed,

gives support to a certain answer to fundamental epistemological questions and simultaneously casts doubt on other answers to the same questions, it is directly relevant for philosophical epistemology.

## 2.5 COGNITION AS DIALECTICAL PROCESS

Piaget elaborated on the process of the construction of cognitive structures in the subject with his theory of equilibration; a theory that Hans Furth once described as "both very philosophical and very difficult" (Piaget, 1971:26). The development of this theory introduces a dialectical process at the very heart of Piagetian epistemology. Piaget (1975) provides a thorough and detailed exposition of this theory on which the following discussion is based except where another reference is given.

As we have noted already, all experience, according to Piaget, requires a "well developed structure within the subject ... in order to take in the data which is outside" (Piaget, 1971:4; see also Piaget, 1975:50-51). In other words, the subject can make observations only so far as he possesses the necessary structure, or form, for ordering the sensory stimuli which provide the content of those observations. This process in which elements external to the subject are known by incorporation in a cognitive structure within the subject is designated "assimilation".

There is an obvious, and intended, biological parallel in the use of this term that reflects the Piagetian view that cognition is an extension of biological interaction between the organism and the environment. Just as the organism feeds itself by assimilating into its organic structure material taken in from outside so the subject acquires knowledge by assimilating into his cognitive schemes or structures observations of the external world compatible with these schemes (Piaget, 1970d:706-710; 1975:10-13).

Piaget illustrates this point by reference to a child who, even when faced with clear visual evidence, is unable to see that the line formed by the level of water in a tilted bottle is horizontal and not parallel with the bottom of the bottle as the child had anticipated. This, he argues, is because the child does not possess the necessary system of co-ordination to provide the cognitive framework for assimilating the sensory stimuli in the way adults do (Piaget, 1971:4).

Inseparable from this process of assimilation is a second cognitive process that Piaget designated "accommodation". As the subject encounters in his observations material that is not assimilable to the existing cognitive structures this material, by its resistance to assimilation, introduces a disturbance, a disequilibrium, into the structures of the subject's thought. This calls for an accommodation of the cognitive structure to the observational material so that it can be assimilated by the structure.

There is potential conflict in the competing requirement of assimilation and accommodation. "Assimilation" requires the conservation of the structure by the assimilation of all observational data to it. "Accommodation" demands the changing of the structure in order to accommodate the observational data. Sometimes this conflict is avoided by making minor adjustments to the assimilative structure that do not change its character - all structures have some capacity for accommodation without changing the structure - or by setting aside or ignoring the disturbing observational data in order to preserve intact the assimilative structure. But on other occasions the conflict cannot be avoided and there is a head-on clash between the conflicting requirements of assimilation and accommodation.

This conflict is resolved by the construction of a new and more powerful assimilative structure constructed in reflective abstraction from elements abstracted from the existing structures that have proved

inadequate. In this way the disequilibrium is overcome in a new equilibrium; or, to put the matter another way, the contradiction is resolved in the new synthesis of a higher level structure.

Since the new structure does not displace the old but incorporates it within the new the integrity of the assimilative structure is preserved while the observational data that created the disturbance gains its place in the epistemic system as a variation internal to the new structure.

It is important to keep in mind that the Piagetian structures are always more than the sum of their constituent elements. A structure has its own properties and its own laws distinct from those of its constituents (Piaget, 1969a:73-4; 1970:10; 1983a:8-9). It is only on this condition that a new structure constructed by the reconstruction of elements abstracted from existing structures can be a more powerful and comprehensive structure than those from which its constituent elements are drawn.

The dialectical character of this process that Piaget designated "equilibration" is unmistakable. The development of knowledge is a spiral without end. In this spiral knowledge grows as the subject's cognitive equilibrium is disturbed by the polarisation of the essential and indissociable factors of assimilation and accommodation and this disequilibrium is resolved in a new equilibrium as the polarised factors are re-united in a new, higher level structure before repeating the cycle again in a new polarisation. This unending cycle of disequilibrium and renewed equilibrium is in no sense a deficiency. On the contrary, it is the process essential to the growth of knowledge (see Piaget, 1977: 303-324).

Thus far we have discussed this dialectical process only in relation to the assimilation of empirical data. It plays an equally important role in Piagetian epistemology, however, in the internal co-ordination

of cognitive structures. The cognitive structures that are generated by the subject in interaction with empirical objects are multiple and diverse. The coherence required by knowledge demands their co-ordination and integration within the subject by a dialectical interaction between the structures.

This occurs at two levels. At one level it is simply the co-ordination of structures by reciprocal assimilation and accommodation between the structures. A typical case of this occurs when more than one structure is used to apprehend the same object - e.g. at the sensory-motor level the schemes of "grasping" and "looking at" an object. Conflicts occur between these structures which are resolved by co-ordinating the structures through reciprocal assimilation and accommodation.

At the other level all the cognitive structures are co-ordinated in a totality structure that encompasses them all as sub-systems of a single cognitive system. The dialectic of assimilation and accommodation is then a dialectic of integration and differentiation of cognitive structures. Integration demands the assimilation of all cognitive structures within one all-embracing system. The expansion of knowledge, on the other hand, generates a differentiation of structures that demands the accommodation of the system to this differentiation. The conflicting demands of the conservation of the system and the differentiation of structures that do not fit the system produces cognitive disequilibrium characterised by the polarisation of integration and differentiation. The conflict is resolved not by negating either pole but by uniting them in a new and more comprehensive system of the whole that enlarges the cognitive powers of the subject.

This leads us to an important feature of the Piagetian dialectic. Throughout the dialectical process there is complete conservation of the structures. The generation of a new structure does not supersede

an earlier structure but adds to it. It is not the case that the constituents of one structure are reconstituted in a new structure while the earlier structure is discarded. The earlier structure itself is conserved with undiminished validity. It is shown to have limits but its validity remains unquestioned, and it retains an unchallenged place within the cognitive system; "le depasse est toujours integre dans le depassant" (Piaget & Garcia, 1983:303).

As an example of this Piaget cites the case of euclidean geometry once thought to embody universal geometric truth. In the dialectic of cognitive development this sweeping claim for euclidean geometry has been shown to be false; it is now seen to be only "a particular case of general metrics". It remains, however, a completely valid system within certain limits (Piaget, 1977:323-4).

This principle of the conservation of structures applies at every level including that of the totality structure of the total cognitive system. When the dialectical process generates a new, more comprehensive totality structure the old totality structure is not discarded but is incorporated as a sub-system within the new totality structure.

It would be easy at this point to conclude that knowledge is viewed simply as a dialectical process in Piagetian epistemology. Yet such a conclusion would be a serious mistake. Although Piaget assigns a fundamental role to a dialectical process he decisively rejects the notion that thought is reducible to a dialectical process (Piaget, 1980:9,10). The dialectical process concerns only the construction of the cognitive structures, as cognitive instruments, within the subject. It extends the cognitive powers of the subject, but the use of those powers for the acquisition of knowledge by the subject is not at all dialectical. It is a non-dialectical deductive process using the structures developed in the dialectical process.

Piaget distinguished these two processes, each equally important, as

the dialectical and discursive phases of cognitive development, where "discursive" is used in the Kantian sense. He is quite explicit (1980:9,10,213-27) that knowledge is not reducible to its dialectical phase. Cognition involves an alternation of the discursive and dialectical phases. The discursive phase is not at all dialectical; only in the dialectical phase does the cognitive process have any dialectical character.

In developing this distinction Piaget uses a somewhat confusing terminology. He describes the discursive phase as purely deductive and the dialectical as inferential, which, in itself, scarcely makes the distinction crystal clear. It becomes more confusing when we read that the discursive process is an inferential process (Piaget,1980:217).

In spite of this terminological confusion, a careful examination of the context enables us to obtain a clear enough picture of Piaget's intention. In the discursive phase the subject proceeds deductively on the basis of the existent cognitive structures in a state of equilibrium. Empirical observations are co-ordinated and logical and mathematical operations carried out in terms of the developed structures of the subject. It is a phase of equilibrium in the cognitive structures and in the subject-object relation; the inferences are inferences within a closed system.

The dialectical phase is activated by disequilibrium within the system arising either from the inadequacy of the system in dealing with empirical data or from an inadequacy internal to the system that is experienced as a disturbance or obstacle by the subject. This disequilibrium activates the dialectical process by which equilibrium is restored through the construction of new, enriched structures in the subject. Once these new structures are established knowledge returns to its non-dialectical, discursive phase.

In brief, the dialectical phase is the equilibrating cognitive

process that is formative of new cognitive structures while the discursive phase is the cognitive process in the state of equilibrium that utilises the already formed structures. Knowledge, so far as it is making any progress, is a constant alternation of these two phases.

To put the matter in another, but still typically Piagetian way, the dialectical phase is productive of the forms of knowledge. The discursive, non-dialectical, phase is the ordering of the content of knowledge in accordance with already constructed forms.

García has suggested that this distinction is important in understanding why scientists, and physicists in particular, have difficulty in recognising any dialectical role in scientific theories. Most of what goes on in science is knowing in the discursive, and hence strictly non-dialectical, phase, proceeding as it does in a state of cognitive equilibrium based on an established theory. It is only at the point of theory change that the dialectical phase is activated in science, with the non-dialectical, discursive phase resumed as soon as a new theory is established (García, 1980:238-9).

While, then, there is a dialectical process at the heart of Piagetian epistemology it is not to be characterised as a dialectical epistemology since the dialectical process, though crucial, is only one component of the total cognitive process that can never be reduced to the dialectical.

While Piagetian epistemology is thus clearly not to be characterised as a dialectical epistemology, this still leaves open the question of a more appropriate categorisation. Before attempting to answer this question, however, there remain some further important issues to be elucidated.

## 2.6 PIAGET, HEGEL AND MARX

The dialectical factor in his epistemology together with the emphasis on history and the activity of the subject have given rise to discus-

sions about the relation between Piaget, Hegel and Marx.

Among those that have discussed the Hegelian connection are Garcia (1980), Kitchener (1980), Fetz (1982) and Wartofsky (1982). Their assessments range from Kitchener's assertion that "as an epistemologist Piaget is Hegelian" (Kitchener, 1980:388-389) to Fetz' contention that, though there are fundamental convergences between Piaget and Hegel there are equally fundamental divergences (Fetz, 1982:426-428).

Anyone at all familiar with both Piaget and Hegel cannot fail to recognise points of convergence. It seems equally clear that Fetz (1982:426) is right in pointing out that whatever Hegelian influence there is in Piaget's thought came only indirectly through Brunshvieg (see also Wartofsky, 1982:474). It is also clear that the differences to which Fetz points, in part at least, are of such a fundamental nature that Kitchener must be regarded as mistaken in describing Piagetian epistemology as Hegelian.

The basis for this mistake seems to be Kitchener's assessment that "Piaget is essentially dialectical in his epistemology" (1980:389). As has just been discussed, the dialectical component, though crucial, is only one component of Piaget's epistemology. It is giving an unwarranted place to the dialectical component, therefore, to regard Piaget's epistemology as "essentially dialectical". One can legitimately say no more than that there is an essential dialectical component to Piaget's epistemology.

Even if we were to pass over this important point, the differences between Piagetian and Hegelian dialectic are too fundamental for it to make sense to characterise Piagetian epistemology as Hegelian. Not only does the dialectic of Piagetian epistemology lack the connection with a metaphysical dialectic that is so fundamental to Hegel but there is, in Piaget, a total absence of any kind of dialectical ontology.

For Hegel (1975:116,118,174), on the one hand, knowledge is necessarily dialectical through and through because: "Everything that surrounds us may be viewed as an instance of dialectic". "Wherever there is movement, wherever there is life, wherever anything is carried into effect in the actual world, there Dialectic is at work." And again; "Contradiction is the very moving principle of the world ...". Epistemological dialectic is necessitated by an ontological dialectic. Dialectic is deeply embedded in the nature of things.

For Piaget, on the other hand, the dialectical process in cognition is in no sense consequent on any kind of ontological dialectic. The disequilibrium, or contradiction, that activates the dialectical process in cognition is neither inherent in the constitution of the objects nor inherent in the actions, or structures of thought, of the subject. It is nothing but a temporary polarisation occurring in the course of cognitive development - "contingent historical situations" - that polarises temporarily elements that belong together in mutual coherence (*solidaire*). These temporary polarisations arise from the temporary insufficiency of the cognitive structures either with regard to the objects to be known or with regard to their internal coordination. The development of new, more adequate structures in the resultant dialectical construction resolves the polarisation so that the polarised elements resume their place as interdependent elements in the coherence of the cognitive structures (Piaget,1975:17-21).

This notion of a cognitive dialectic based on temporary polarisations within contingent historical situations is far removed from the all-embracing Hegelian dialectic. But there is also a fundamental difference internal to the epistemologies in question that sets the Piagetian epistemology decidedly apart from the Hegelian. In the dialectic of the Hegelian epistemology knowledge, beginning in sensory experience, transcends that experience to apprehend in pure thought

stripped of all sensory connections the absolute supersensible notion that is "the single essence of life, the soul of the world". Knowledge leads us beyond the sensible world to the ultimate reality of the supersensible in which all the sensible and conceptual contradictions are finally resolved in the infinite absolute of self-consciousness (Hegel, 1977:58-103).

Piagetian epistemology diverges from this scheme in two fundamental respects - the supersession of the sensible by the supersensible and the ultimate cognitive apprehension of the Absolute.

Although Piaget writes of a knowledge that goes beyond the sensible in a way that can lead the reader not thoroughly familiar with his epistemology to conclude that he holds to a cognitive transcendence of the sensible of an Hegelian kind, a more thorough understanding of the Piagetian epistemology shows this to be a misconception.

It is logico-mathematical knowledge, and this alone, that is able to function in detachment from sensory experience. By this, as he makes clear, Piaget means simply that the subject is able to operate within formal systems of logic and mathematics without requiring empirical content or reference ("pure" logic and "pure" mathematics). That, in itself, appears to be uncontroversial (Piaget, 1970b:88-92).

But logico-mathematical knowledge is only one component of the totality of knowledge; it is the source of the forms of knowledge. In order for there to be empirical, or physical, knowledge these forms must receive empirical content through sensory experience. It is true that sensory experience is never a simple registering of sensory impressions in the manner of empiricism but is always a reading of the sensible in terms of the forms (structures) of the subject's action. Nevertheless it is always a reading of data from a sensible world; the content of all empirical knowledge is always drawn from the sensible world, not from the action or thought of the subject which supplies

only the forms with which to organise the empirical content.

For Hegel cognition leads us to transcend the sensible world to apprehend the ultimate reality of the supersensible. For Piaget cognition is the development of ever more effective forms (structures) that enable us to penetrate more effectively the reality of the sensible world (see Piaget, 1977:321-2; 1981:183). The difference is fundamental.

It is important to recall that in the Piagetian dialectic higher level structures never supersede the earlier, more primitive structures. The new, higher level structures enrich and extend the subject's cognitive structures in an increasingly complex cognitive system without superseding the earlier structures. Even the most primitive structures of elementary sensory perception permanently retain their validity as essential components of the cognitive system though their role becomes more limited with the progressive enrichment of the system's structures. In short, Piagetian epistemology embodies a clear rejection of the Hegelian notion of the supersession of the sensible by the supersensible.

Equally decisive is the Piagetian rejection of the Hegelian notion of the apprehension of the Absolute as the end of cognition. The highest level of knowledge in Piagetian epistemology is scientific knowledge which remains always open. Its goal is not an absolute Notion or Idea but the object which, for the empirical sciences - as distinct from the deductive sciences of logic and mathematics - is the object of sensory experience. The object is the cognitive limit existing independently of the knowing subject and known by the subject in successive approximations yet never wholly attained by the subject (Piaget, 1970:89-91; 1979:10,119; 1983:173). There is an obvious parallel in this respect with Popper's notion of absolute truth as a regulative idea at which we aim in our knowledge but only ever succeed