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, jugee après coup insuffisante, a une autre connaissance determinee, 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 Brunschvicg.

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 experiental 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, inter-subjective 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 structualist 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 Brunschvicg, 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 clealy distinguishes it from Kantian epistemology. On the other hand, he appears to have inherited from Brunschvicg 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 unmistakeable 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/mentalist 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 tranformed 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 phenomènes".

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 réflective" (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 cogitive 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 unmistakeable. 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 differentiaion. 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.

Garcia 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 (Garcia,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 Brunschvicg (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 unwarrented 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 a 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 occuring 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

in approximating in ever better approximations (Popper,1983: 25,26,57-58).

However we may characterise Piagetian epistemology, then, it is clearly wholly inappropriate and misleading to characterise it as Hegelian.

With regard to the relationship between Piagetian and Marxist theory, as early as 1928 the French psychologist Henri Wallon entered into a critical engagement with Piaget initiating an ongoing debate that continued till Wallon's death in 1962. The issues in this debate are discussed in some detail by Jalley (1980). On the other hand, as time went on others began to make a more positive evaluation of Piaget's work from a Marxist perspective. One of the foremost of these was the philosopher and sociologist Lucien Goldman who published an appreciative review of Piaget's "La Psychologie de l'Intelligence" in 1947; his evaluation of Piaget's work at that time he had found no reason to alter substantially in his review of Piaget's "Sagesse et Illusions de la Philosophie" in 1966.

The debate remains unresolved. Opinion remains divided between those who see a close affinity between Marx and Piaget and those who see the two positions as incompatible (Garcia,1980:230). No one seriously wants to claim that Piaget was a Marxist or that he developed his epistemology under the influence of Marx. It is generally recognised that Marx and Marxist sources had no direct influence in the development of Piaget's thought and, indeed, that for a good deal of his career he took no notice of either Marx or Marxism. The debate concerns the extent to which, in his independent development, Piaget has reached a position that has an affinity with that of Marx and Marxism.

Claude Fronty (1983) provides a good survey of the current state of the debate. It is beyond the scope of the present study to explore this debate in detail. That would provide ample material for a com-

plete study of its own. There is one important aspect, however, which requires some attention because of its importance for the present study. This is the question of the role of socio-historical praxis in cognition. In an appreciative, but critical, review of Piaget's work written in 1932 the Soviet psychologist Vygostsky brought this question into sharp focus when he wrote: "The developmental uniformities established by Piaget ... are not laws of nature but are historically and socially determined" (Vygotsky,1962:23). Vygotsky's treatment of Piaget generally is now dated and full of misconceptions but in this particular respect he has put his finger unerringly on a fundamental divergence between Piaget and Marx.

More recently Wartofsky has discussed this divergence in some detail leading to the conclusion that it is a matter of complementary inadequacies in Piagetian and Marxist epistemologies rather than a fundamental incompatibility between the theories. He argues therefore for "an integration of the insights of the one with the insights of the other" in which each is "mediated and reconstructed in terms of the insight of the other". He envisages that there may emerge from this integration "a genetic epistemology which is at the same time an historical epistemology" (Wartofsky,1982:506-507).

Yet, when we examine Wartofsky's proposal more closely it seems clear that his proposed integration can only mean the assimilation of Piagetian epistemology to Marxist epistemology with consequent loss of its Piagetian distinctives. And, indeed, the divergence highlighted by Vygotsky so sharply is so fundamental that it is impossible to see how there could be any integration without the assimilation of one to the other or the loss of both within a new synthesis fundamentally different from both.

Wartofsky proposes that Piagetian epistemology be modified by the recognition of the cognitive primacy of socio-historical praxis; the

acceptance by Piagetian theory of the thesis that both the subject and the object in the constructive interaction of Piagetian epistemology are constituted by a history of socio-cultural praxis. There is, he argues, an "essential sociality of human praxis" that applies also to the most "elementary forces of action" such as Piaget finds at the very beginnings of cognition. He seems to think that any remaining questions about this can be reduced to purely empirical questions that can be answered decisively by experimental research.

To accept this proposal could only mean the demolition of Piagetian epistemology leaving only an experimental methodology to be absorbed within a Marxist epistemology.

Wartofsky's proposal makes socio-historical praxis epistemologically definitive mediated by the psychogenetic processes studied experimentally by Piaget. For Piaget, in contrast, it is the interactive structure of the organism as revealed in the psychogenetic processes that is definitive with social and historical factors having only a modifying role in the individual subject. These two views simply cannot be merged without the surrender of one to the other or the loss of both in a third view.

Piaget did not deny the role of social and historical factors in cognition but he assigned them a modifying and not a definitive role. The primary and definitive role he assigned to the assimilative structures of the organism, rooted in biological organisation common to all subjects regardless of socio-historical factors. It is only these common structures that make social interaction itself possible (Piaget,1970b:61-67; 1971:12-13).

In this respect the questions raised by Wartofsky about the nature of objects as largely "a world of artifacts" are peripheral. The crucial question is the nature of the subject as epistemic subject. Piaget recognised an epistemically significant dimension, or "domain

of activity", in the subject that is historically dependent - what he called in the later development of his theory "the psychological subject" (Piaget,1981:8,187-188). However, although epistemically significant, this domain is not epistemically definitive. That role belongs to another domain, or dimension, of the subject; "the structuring and organising activities" of the subject that constitute an atemporal centre of structuring activity common to all subjects - what he called "the epistemic subject". As the atemporal source of cognitive structure rooted in the biological organisation of the organism this definitive epistemic subject is shaped in its ongoing development not by historical and/or social factors but by laws internal to itself in interaction with objects. It has a history but it is not historically defined. Rather it defines its own history by its own laws.

This view of an epistemic subject as a dynamic, atemporal structure governing the structuring and organising activities of the subject in accordance with laws internal to itself is fundamental to Piagetian epistemology. Wartofsky's proposal, by demanding a recognition that the subject at every level, including the core of epistemic structuring, is defined by socio-historical praxis, would abolish Piaget's atemporal epistemic subject and with it the whole edifice of Piagetian epistmology as a distinctive theory.

This is a convenient point at which to look a little more closely at the role of praxis and history in Piagetian epistemology. The emphasis on the activity of the subject and historical/psychogenetic studies makes it easy to conclude with Kitchener that Piaget has a praxis view of knowledge of an historicist kind (Kitchener,1980:389-391,400). It is, nevertheless, like Kitchener's use of the Hegelian label, a mistaken conclusion.

It is true that Piaget regards the action of the subject as fundamental to cognition but action as such is not constitutive of knowl-

edge. Knowledge is constituted only in interaction of subject and object in which the object acts reciprocally on the subject as the subject acts on the object (Piaget,1970b:34-35; 1973:17; 1974:74,92; 1975:49). The subject is formative of a knowledge the content of which is supplied from the objects.

Further, from the side of the subject it is not the actions as such but the co-ordination of the actions that is cognitively formative. The subject as subjective individual will centre attention on the actions as such; the epistemic subject is characterised by a turning from the actions as such to their co-ordination, a co-ordination that constitutes a "natural logic" rooted in the organic nature of the subject. The actions of the subject, then, are fundamental to cognition, not for their own sake but because they embody this "natural logic" (Piaget,1970c:18-19; 1972:147-149; 1973:10; 1979:118-123).

Finally, the action that is of concern to Piagetian epistemology is not "praxis" in general but specifically cognitive activity. All activity is not cognitive activity but only cognitive activity is epistemologically significant. Piaget quite explicitly distinguished knowledge, which he associated with science, from praxis, which he placed outside the realm of cognition, denying that he was concerned with praxis in his epistemology. "J'etudie la connaissance, je n'etudie pas la praxis..." (Piaget,1966:63-64).

So far as it may be characterised by the role played by the subject's actions then, Piagetian epistemology is an interactive theory based on a "natural logic" of the organism rather than a praxis theory of knowledge.

This "natural logic" also throws important light on the place of history in Piagetian epistemology. In this respect Wartofsky misses the point when he says that Piaget "has made the history of science the norm against which the development of child-thought is measured

(Wartofsky,1982:506). Cognitive normativity for Piaget has an organic, not an historical, source in the logic inherent in biological organisation itself (1983:8). The epistemological significance of the history of science will be missed unless this history is re-read within the problematic of genetic epistemology with its emphasis on the roots of knowledge in the structure of the organism (Piaget & Garcia,1983: 45).

Historical and psychogenetic studies are epistemologically crucial, not because knowledge is defined by its history or development, but because it is only in its historical and developmental unfolding that the underlying structure guiding that unfolding is revealed. To study knowledge as it is at any one moment of history, therefore, is to study only a fragment of the process with consequent epistemological distortion. But, and this is crucial, it is not the historical unfolding or a law inherent in the historical process that governs the cognitive process. That process in its historical unfolding is guided by laws inherent in the structure of the organism. These laws operate throughout history in a way that is in no sense defined by history.

The aim of genetic epistemology, both in psychogenetic and in historical studies, therefore, is not to identify an historical process. It is to identify those universal, extra-historical factors that reveal throughout history and psychogenetic development the characteristics of the atemporal epistemic subject common to all knowing subjects irrespective of historical and social relationships. History, for Piaget, is an epistemological laboratory but not an epistemological factory.

Whatever other points of convergence a more detailed comparison might show it is clear that there is as decisive a divergence between Piaget and Marx as between Piaget and Hegel. The connection is probably best described by Garcia when he places Piaget "in the continuation

of a line of epistemological thought that passes through Hegel and Marx (but which begins well before them)" while at the same time recognising that Piaget has developed a distinctive position within that line that is neither Hegelian nor Marxist (Garcia,1980:230-231).

The most fundamental point of convergence that places Piaget firmly within this line of epistemological thought is the actively formative role given to the knowing subject; a position that is, of course, neither exclusively nor pre-eminently represented by Hegelian and Marxist epistemologies. As regards the nature of that formative role Piaget developed his own distinctive position that has created a distinctively Piagetian epistemology that is not to be confounded with either Marxist, Hegelian, or Kantian epistemology.

2.7 OBJECTIVITY, NECESSITY AND THEORIES

I am indebted to Gil Henriques for pointing out, in a private discussion, that Piaget was more interested in the question of necessity than that of objectivity. Nevertheless the two remain closely linked in Piagetian epistemology since underlying Piaget's interest in necessity was the same basic concern that has led others to focus their attention on the question of objectivity.

"Objectivity" can be a slippery term with a wide range of meaning. However, running through all the variations of its use in epistemological discussion is a common concern to exclude, or at least limit, epistemic distortions arising from the human subject. How these distortions are to be excluded or limited has been and remains a matter for debate leading to widely variant versions of objectivity.

For Kant objectivity is secured by the conformity of our knowing to the rules of a universal structure of thought. Comte, on the other hand, argued that objectivity is secured by restricting knowledge claims to the mathematically analysed results of observations obtained by the experimental method; a view that retains a widespread currency

in a popular view of the grounds of scientific objectivity.

Logical Positivism shifted attention to the logic of the language of knowledge claims within an empiricist context; objectivity is secured by the strict conformity of the language of observation reports to specified logical rules; observation reports taken to be reports of unambiguous observations common to all subjects.

Scheffler summarises reasonably well the tradition up to this point when he describes the ideal of objectivity as "an ideal that subjects all scientific statements to the test of independent and impartial criteria, recognising no authority of persons in the realm of cognition" (Scheffler,1967:1). Scheffler wrote in defence of this traditional view of objectivity, and against the views of Thomas Kuhn in particular, at a time when the authority of this traditional view was crumbling.

This erosion of the traditional view did not mean the abandonment of the search for objectivity, though those, like Scheffler, committed to the traditional view tended to see it as such. It has meant, rather, a significant shift in the conception of objectivity. Previously it had been assumed generally that objectivity is a quality attaching to knowledge claims on condition that those claims result from a knowing process conforming to specified criteria. Or, to put it the other way around, there exist knowledge claims that, having been established on objective grounds, will pass all specified tests of objectivity.

Popper is one of the most influential figures in the new wave of epistemologists that have departed significantly from this traditional view of objectivity, though without establishing any new consensus about what constitutes objectivity. For Popper all knowledge claims are conjectures or guesses. Their objectivity consists in their criticizability (Popper,1979:136-7; 1980:44; 1983:48).

No longer is there an expectation that subjective distortions can be

eliminated so as to give us strictly objective knowledge statements. All we can do is limit the distortion through rational criticism which requires that we formulate our knowledge claims explicitly in such a way as to facilitate their criticism. In this way we may expect that our knowledge claims will better approximate absolute truth without ever attaining it. The distinction now becomes simply that between dogmatic statements formulated in such a way as to insulate them against intersubjective criticism and statements formulated in such a way as to invite such criticism.

Polanyi, approaching the question from a different perspective, challenged the assumption that objectivity requires impersonal detachment. For him the objectivity of knowledge not only allows but demands the full involvement of the personality of the subject. Objectivity is secured as the involved subject strives "passionately to fulfil his personal obligations to universal standards" so ensuring that our knowing establishes "contact with a hidden reality" (Polanyi,1962: vii,viii,17). Significantly, the warrant advanced for such a view is no longer a universal rationality but the author's personal allegiance to a specified set of beliefs (Polanyi,1962:viii).

In a more recent work Deutscher (1983) denies that objectivity is in any sense a quality of knowledge claims, arguing instead that it is a (possible) quality of the knowing subject. Polanyi, while denying the disjunction of "personal" and "objective" sustained the "subjective/objective" disjunction by asserting that objectivity is a transcending of subjectivity. Deutscher (1983:41,129) goes further to challenge the disjunction of "subjective" and "objective" by claiming that objectivity is "a form, a style, an employment of our subjectivity" It is perhaps not surprising that Deutscher denies any special relation between science and objectivity.

Then, of course, there is Feyerabend's inversion of the traditional

view of objectivity. That view, in all its variants, sought to remove subjective distortion by bringing the individual subject under intersubjective controls of one kind or another. Feyerabend's argument is that it is precisely these intersubjective controls imposed on the individual that cause distortion. Objectivity, therefore, can only be secured by removing all such controls so that "anything goes"; the individual subject is free to think and speak as he/she wishes with a consequent infinite scope for variety. Variety of opinion, as a necessary feature of objective knowledge, has higher value than unanimity which takes on negative value (Feyerabend,1965:178; 1975:35-46).

Throughout all its variations, then, the search for objectivity is a search for a way to eliminate epistemic distortions due to the knowing subject. The differences concern how this is to be achieved. Two other epistemological goals are closely associated with the goal of objectivity; the goal of intersubjective universality and the goal of maximum certitudinal value.

There was a time, when rationalism reigned supreme, that it was possible to pursue these goals in absolute terms. Objectivity could be pursued as a total exclusion of subjective distortion resulting in intersubjective unanimity of all rational persons concerning knowledge statements having absolute truth value.

As rationalism has lost its dominant position - due in no small measure to its failure to secure the desired intersubjective unanimity - there has been a retreat from such absolute goals not only by those who have abandoned rationalism but also by those who continue to defend it. Deutscher (1983:17) goes rather too far when he says that "No one wants to have any truck with absolutes these days", but certainly talk of absolutes is out of favour. It remains on the fringes of contemporary philosophical discourse confined generally to those who subordinate their philosophising to some kind of theological

dogmatics that requires cognitive absolutes.

With this retreat from absolutes the goal of objectivity and the other two goals associated with it have undergone modification. Objectivity becomes a matter of limiting or controlling subjective distortion, whether by Popper's rational criticism or Polanyi's commitment to universal standards or Feyerabend's abolition of supra-individual authority. Intersubjective universality becomes a provisional consensus whether based on Popper's criteria for preferred theories or Polanyi's shared commitment or Feyerabend's democratic decision procedures. Maximum certitudinal value ceases to be absolute certitude to become the highest available degree of certitude whether based on Popper's verisimilitude or Polanyi's fiduciary confidence or Feyerabend's pragmatic personal decision.

These three goals, closely associated with the question of objectivity in Anglo-saxon philosophical discussion, are fundamental goals also in Piagetian epistemology. That Piaget looked for the answers in the direction of an understanding of necessity was due to the different philosophical context of his work.

The concern with objectivity in Anglo-saxon philosophy has its roots in the positivist tradition with its emphasis on knowledge statements the status of which can be, or are thought to be able to be, established on subject-independent grounds. Consequently attention has been focussed on the objectivity of knowledge statements.

Deutscher, it is true, has shifted attention away from the status of knowledge statements to treat objectivity as a cluster of qualities attaching to the action of the subject. Yet even he remains influenced by the positivist tradition in that his position is adopted in reaction to the deficiencies he finds in that tradition, as appears from the pervasive polemic against the notion of objectivity developed in that tradition that characterises his work.

Piaget, however, approaching the basic problems from within a quite different philosophical tradition, has only limited interest in the question of the objectivity of knowledge statements. Beginning from the position that the knowing subject is the constructor of knowledge his concern is to identify mechanisms within the subject's cognitive activity that will limit distortion and secure intersubjective universality with high certitudinal value. He looks for, and believes he has found, this mechanism of control in the conceptualisation of necessity.

It is important to note carefully that it is the process of the conceptualisation of necessity and not "necessity" as a function of an articulated logical system that Piaget has in view. It is the conceptualising activity of the subject and not the operation of a formal system of logic that is his prime interest. Although formal systems have an indispensable role at the more advanced levels of knowledge, the necessity of which Piaget speaks acts as an objectifying control in the subject's thought prior to all formalisation. It is a control that is "natural" to thought.

So, Piaget (1983:5) specifies in the opening sentence of his introduction: "In approaching the problem of necessity, we have no intention of engaging in a study of modal logic, but of bringing the necessary ... into connection with the evolution of the notion of the <real>" ("En abordant le problème du nécessaire, nous n'avons pas l'intention de faire une étude des logiques modales, mais de mettre le nécessaire ... en relation avec l'évolution de la notion du <réel>").

In this connection there is a link with Kant in the notion that objectivity is dependent on a necessity originating in the thought of the subject (Kant,1933:126-140,218-233,247-252). Piagetian necessity, however, lacks the a priori character of Kantian necessity. It certainly does not mean that Piaget returned to what Popper calls the

"new way of ideas" of Locke, Berkeley and Hume - a method that Popper claims Kant also employed (Popper,1980:17,22). The point is an important one since the application of the term "genetic" to this "new way of ideas" (Popper,1980:17) can readily lead to the conclusion that Piaget's "genetic epistemology" is a return to that way of approaching epistemological questions.

The "new way of ideas" set out to understand knowledge by the analysis of an existent body of ideas or notions and trace their origins in the conscious thought of the subject. The Piagetian approach has no more use for such an analysis of ideas than it does for the analysis of language as a way of resolving epistemological problems. The processes of conceptualisation that interested Piaget are the inner mechanisms, or functioning, of the subject's thought of which the subject is not conscious (Piaget,1970a:3-4; 1971b:12-13; 1977:6). These cannot be identified by a logical analysis of either ideas or language, which are results of human intelligence, but only by experimental studies designed to uncover the inner structure and functions of that intelligence. One of the last works published in Piaget's name (Piaget,1983) details a series of such experiments directed to the question of the conceptualisation of necessity.

Piaget argued that one of the principal results of this research is that necessity is not "an observable given in the objects" or a concept emanating from "objective facts". All that can be derived from observations is an inductive generalisation or "extensional generality" but never a necessity. We can conclude on the basis of observations, for example, that a ball "always" rolls down an inclined surface and never "up", but this is no more than an extensional generalisation from "n" observations. It does not constitute a necessity that the ball roll down (Piaget,1983:163-164).

The confusion of empirical generality with the necessary leads to

"pseudo-necessities" that hinder the growth of science. These pseudo-necessities may arise from assuming that what exists is necessarily so, or from a confusion of the factual and the normative or from a conception of the world, or world view, tied to religious conceptions of a certain kind (Piaget,1983:5-6; Piaget & Garcia,1983:73).

While these pseudo-necessities are characteristic of the early thought of the child they may also be present in adult thought, and by imposing their constraints on scientific thought create insurmountable barriers to its advance. A prime example of this, according to Piaget, is Aristotelian physics which imposed false limitations on science that persisted for centuries. The fault with Aristotelian physics was not that Aristotle failed to make observations of nature but was due to the "pseudo-necessities", with associated "pseudo-impossibilities", that functioned as epistemological presuppositions in the "reading" of the experience of nature and the use made of observations (Piaget & Garcia,1983:73-74).

Aristotle did base his physics on empirical observation of physical bodies. The errors occured because, proceeding from these initial observations by reasoning with rigorous internal logic, he constructed a system in which the generality of these observations becomes a universal necessity - making any contrary occurence an impossibility - and the factuality of the observations is taken as normative (Piaget & Garcia,1983:57-74).

In short, it was not the failure to observe that was the basic cause of the deficiency of Aristotelian physics but the faulty though internally consistent logic of the conceptual structure which directed the way the observations were made and subsequently dealt with. In particular, it was the construction of pseudo-necessity and pseudo-impossibility on the basis of the factual generality of observations.

It is not denied that the observations on which Aristotelian physics

was based were limited and that, from a 20th century perspective, it is clear that other simple observations would have been sufficient to invalidate the physics based on those initial limited observations. What is argued is that it was neither an inability nor an unwillingness to give a proper place to empirical observation in science that led Aristotle, and others who followed him, to maintain a physical theory in the face of clear empirical evidence that refuted it. Rather the pseudo-necessities generated by a rigorous internal logic from empirical observations tied to a certain conception of the world - a metaphysics - led to the dismissal of any counter-evidence from other observations as an impossibility.

The importance of this for contemporary debate about the role of theories in science will be evident. Piaget certainly maintains that physical science has advanced since Aristotle and that this advance has been achieved by a progressive elimination of pseudo-necessities (Piaget & Garcia,1983:75). However, he was no scientific utopian. What has happened once may well happen again. Just as the embodiment of pseudo-necessities in the scientific theory of Aristotelian physics prevented physicists for centuries from recognising the force of empirical evidence as refutation of the theory so it may do for a contemporary scientific theory.

There is an important difference in this respect between Piaget and Popper to which Garcia draws attention when he says: "Experiments do not refute theoretical systems. A system is refuted by another system" (Garcia,1983:39). Garcia represents the difference too simplistically when he says: "The history of science shows that theories are not killed by negative experiments as maintained by Popper ..." (Garcia, 1983:13). While Popper certainly claims a role for empirical refutation in theory change he acknowledges that a theory may persist in the face of empirical refutation and that the emergence of an alternative

theory is necessary for theory change (Popper,1980:42; 1983:xxi-xxv). Nevertheless, there are significant differences between Piaget and Popper at the point indicated by Garcia, though considerably more complex than is suggested by Garcia's comment. These differences will be discussed in detail later.

If human thought, including the most sophisticated scientific thought, can be clouded by pseudo-necessities how are these distortions to be removed? It is clear that this cannot be achieved by any amount of observations, even if these are conducted with the greatest systematic rigour, since necessity is not an empirical given. Multiplying observations, in itself, can lead at best only to inductive or extensional generalisations and, at worst, to the multiplication of pseudo-necessities through the confusion of generality with necessity, fact with norm. However we categorise Piagetian epistemology it is not inductivist.

The removal of the distortions of pseudo-necessities and their concomitant pseudo-impossibilities is dependent on the development of more adequate structures of the subject's thought which enable the subject to read the observations more objectively, that is to say, in better agreement with the objects. An essential feature of this development is the differentiation of the real, the possible and the necessary.

In the initial human experience, both in the individual and in the history of science, there is no differentiation of these three, just as there is no differentiation of the factual and the normative. Possibility and necessity are taken to be qualities of external reality as observed by the subject. Possibilities are simply extensions of existing states of affairs in the experienced reality and necessities consist in taking what is as what must be (Piaget,1983b:5-7,170-171).

This situation changes as the assimilative schemes of the subject's

thought are extended, engendering possibilities as givens of the logical structure of the subject's thought integrated in inferential necessities. A possibility is no longer merely a possibility of extending reality as given in observation but a possibility of transforming reality so that it becomes other than that given in observation. A necessity no longer attaches to what is as given in observation but to the constraints imposed on the transformation of that given by the integrative inferential logic of the subject's thought (Piaget,1983: 163-173).

A full discussion of this aspect of Piagetian theory would require a separate study. For the present purpose the important point is that the source of necessity according to Piaget is not external reality as observed by the subject. Any attempt to locate it there will produce pseudo-necessity with consequent cognitive distortion. Genuine necessity arises from the logical integration of the subject's thought entailing logical necessitations in the reading of observations. Necessity is a product of the logic of thought.

Yet the interactionist nature of the logic of thought in Piagetian epistemology separates the Piagetian view of necessity from idealist versions of necessity. Necessity is not an a priori law of thought that is subsequently imposed on experience of external reality. The accommodation of thought to a reality external to and independent of thought is an indispensable factor in the logic of thought from which necessity is generated (see the entire discussion in section 2.5 above).

It is also important to remember, in this connection, that this logical integration of the subject's thought is not to be identified with a formal system of logic. It relates to the internal logical structure of thought which is formalised in logical systems but is never to be confounded with such formalisation. It is not a formal

logical system but the logic internal to the subject's thought that is normative for knowledge.

Further, necessity is never an absolute necessity. All necessity is a conditional necessity which, in the never-ending spiral of the growth of knowledge requires its own surpassing (dépassement). Each necessity opens the door on a new world of possibilities which, in their integration create new necessities. Epistemic necessity is always a provisional necessity resulting from a dynamic process of necessitation in a knowing subject in interaction with the objects to be known. Therefore "there exist no apodictic judgments considered as intrinsically necessary" ("il n'existe pas de jugements apodictiques en tant qu'intrinsèquement nécessaires" Piaget,1983:173). Yet, again it must be remembered that the construction of a new necessity does not mean abandoning the old but incorporating it in a richer necessity (Piaget, 1983b:167-173).

The evolution of the necessary in the logical structure of the subject's thought plays a crucial role in the construction of scientific theories. Piaget rejects the positivist notion that science is merely descriptive of facts and the laws that connect them. Science, as the most highly developed form of knowledge, must furnish explanations. Scientific theories are explanatory in character; they go beyond description and a simple collation of observations to give "reasons" that explain why the facts are as we observe them.

In doing so, theories go beyond the observed facts and inductive generalisation from the facts. They place the facts within a deductive framework with its necessary relations; "to identify the reason of any reality, formal or real, is to show that it is necessary, and consequently to rely on a deductive model" (Piaget,1973:7). To go beyond mere description and move toward explanation we must introduce an element of necessity (Piaget,1970:112). The inner structure of a

theory, then, is a structure of deductive necessity, supplied by the subject yet developed by the subject only in interaction with objects external to the subject, that co-ordinates the facts in a systematic explanation (Piaget,1975:179-180; 1970:112; 1983:7).

Theories not only provide a systematic explanation of observations that goes beyond a mere description of laws. They provide also the framework for the formulation of the questions to be investigated (Piaget,1977:321). The indispensable role of theories in science, then, is well recognised in Piagetian epistemology. A distinctive contribution of Piagetian epistemology in this respect is the claim, supported by experimental psychology, that these theories have an inner structure of deductive necessity founded in the logical structure of the subject's thought.

The development of necessity as a deductive necessity of thought, advances the objectivity of knowledge in two respects. It removes the distortion of the elementary perception of reality as a necessary reality embodying all possibility. At the same time the subject's observation of reality is enhanced because it is a better understood reality; the object is no longer a mere observable but is an observable within an intelligible framework, an "interpreted reality". This ever improving understanding of reality that characterises the advance of scientific knowledge results not only in a better analysis of the objects but in an enriched empirical abstraction of properties of the objects; the subject is able to identify by observation hitherto negelcted properties of objects. The objects are better known in their objectivity (Piaget,1975:103-104; 1977:320-322; 1981:183-184; 1983: 173).

The scientist immersed in theoretical models can readily forget the role that theoretical interpretations founded in the deductive necessity of thought play not only in the construction of hypotheses but in

the experimental observations themselves. Yet their role is indispensable in securing the impressive increase in both the number and the precision of observations of contemporary science (Piaget,1977:321-322).

While it seems clear enough in what sense the growing deductive necessity of the subject's thought is held to enhance the objectivity of knowledge does it not simply lead us back, with a different terminology, to Kant's noumenal/phenomenal distinction? Since the objectivity that is secured is an objectivity of an interpreted reality and not of reality as it is, is it not clearly a purely phenomenal objectivity drawn from the structure of the subject's thought that tells us nothing about the reality of material objects in themselves?

Piaget recognised the possibility of this objection and replied to it with a decided negative on the ground that in his theory, in contrast to Kant, the object is not an "unknowable and immutable noumenon" but is a reality directly experienced by the subject that is increasingly better known by the subject through the subject's cognitive activity. While the subject never gains absolute knowledge of the object - since the better it becomes known the more complex it becomes - the subject does have genuine knowledge of the object in successively better approximations (Piaget,1983:173; 1966-67:163; Piaget & Garcia,1983:34-35).

Undoubtedly this distinguishes Piaget's position sharply from that of Kant. A reality that is known by successively better approximations without reaching an absolute is very different to Kant's unknowable noumenon. However the question still remains how this view of knowledge as successively better approximations to the reality of the object is to be reconciled with Piaget's description of the process of knowing as a constructive activity in which objectivity is secured by conforming knowledge to the deductive necessity of the logical struc-

ture of the subject's thought. In spite of Piaget's assertions to the contrary does not such a cognitive process necessarily lead the subject away from the object to a logical construct of the subject's own thought imposed on the world of observed objects?

That Piaget did not appear to regard this as a question needing serious discussion is no doubt due to the fact that he was so immersed in the interactionism that is basic to his epistemology that the answer seemed to him self-evident. Yet for many who view the matter from outside Piaget's genetic epistemology the significance of this interactionism that is at the very heart of that epistemology is the easiest thing in the world to miss.

In Piaget's writings terms like "cause" and "causality" recur frequently in connection with the physical sciences. Piaget recognised the dangers in the use of this terminology but chose to use it, without metaphysical connotations, as a synonym for "physical explanation". Whether he was wise in adopting this terminology he did so for the important reason that he wished to distinguish clearly between explanation in the deductive sciences - logic and mathematics - which he saw as a matter of furnishing purely deductive "reasons" and explanation in the physical sciences which he saw as requiring interaction between logico-mathematical deduction and observations of physical reality (Piaget,1973:7-12).

The nature of this interaction is well illustrated in the construction of physical models. On the one hand such a model cannot be simply a deductive construction of thought imposed on the objects; it must be adapted, fitted to the facts, as the observations of physical objects. On the other hand, it is not an "iconic" model of the kind described by Suppe (1977:97); it is not simply a structure isomorphic to the objects as observed but provides logico-mathematical schema constructed by the subject into which the objects can be fitted.

Piaget summarises this situation by saying that an explanatory physical model must do more than exhibit a logico-mathematical structure that is applied to physical objects; it must be of such a kind that a "structure" isomorphic to the model can be attributed to the physical objects. It adds to the objects but in such a way that what is added is adapted to the already structured nature of the objects. In other words, it is not any and every logico-mathematical structure that can serve as a physical model but only one that fits the physical objects in question. Such a model is neither the product of deductive thought imposed on observations of physical objects nor a reproduction or likeness of the structures of those objects as they are in themselves. It is the product of a fully reciprocal interaction between logico-mathematically structured thought and propertied objects that, to be an adequate model, must conform to the deductive necessity of the structure of thought in such a way as to fit the propertied physical objects (Piaget,1970:113; 1973:12-18; 1975:60).

To use a characteristically Piagetian terminology the logico-mathematical structures of thought provide the form of the model and the observations of physical objects the content. But then it is vital to remember that the content is not an indeterminate content that can be moulded to any form whatsoever but is a content of propertied particulars whose propertied existence is wholly independent of thought with its logico-mathematical structures. In short, the objects are not formless content but already formed particulars.

The form supplied by the logico-mathematical structures of thought is a co-ordinative form that co-ordinates these propertied particulars. On the one hand, placing the objects within these co-ordinative forms enriches them by the attribution to them of co-ordinative properties that enables them to be better known. On the other hand, since the properties of their particularity are always conserved, neither

destroyed nor modified in the transformations that result from their incorporation in these co-ordinative structures, the form supplied by thought must be adapted to the propertied character of the objects to be co-ordinated.

The situation is somewhat analogous to the builder of a house who on the one hand co-ordinates the materials according to an architechtural plan and on the other hand must employ a plan that fits the materials to be used.

The constructive cognitive processes of Piagetan epistemology, then, do not lead us away from the objects of our observation since the constructions must be adapted to these objects. Hence Piaget can write: "The theory of knowledge is ... essentially a theory of the adaptation of thought to reality, even if this adaptation reveals in the final count ... an inextricable interaction between the subject and the objects" (Piaget,1970b:35). The development of logico-mathematical structures of thought as co-ordinative structures attributed to physical objects advances our knowledge of those objects by enhancing our powers of observation not only through increasing the range and quality of our observations but also through ensuring that they achieve an increasingly closer fit with reality ("... progrès considérables en nombre absolu ainsi qu'en qualité, autrement dit en adéquation au réel." - Piaget,1977:320-321).

While Piaget did not regard the deductive necessity of thought as in itself sufficient to secure objectivity - he speaks of the need also of intersubjective experimental controls (Piaget,1970:45-47) - it does play a central and crucial role in securing the three goals associated with objectivity.

It eliminates the distortion that arises from the subjective confusion of the real, the possible and the necessary, enabling the objects to be observed within a co-ordinative framework that enhances and

sharpens our powers of observation; it secures intersubjective universality by the tying of knowledge to a deductive necessity that is common to all subjects at the same level of development; and the quality of rational, if provisional, necessity that attaches to the resultant knowledge gives it the highest attainable certitudinal value.

2.8 REALISM WITHOUT EMPIRICISM

The one issue that provoked vigorous debate in my discussions with personnel of the Centre international d'Épistémologie génétique in early 1985 was the significance of the "realist" element in Piaget's epistemology. While no one would deny that there was such an element in Piaget's writings some contended that it was an incidental feature of his thought that could be abandoned without altering the fundamental character of his epistemology. One even went so far as to suggest that it was an alien vestige in Piaget's thought that needs to be eliminated if the true value of his epistemology is to be realized.

This point of view, it seems to me, is fundamentally mistaken, especially in its more extreme form. If pursued I believe it will lead not merely to a refinement of Piagetian epistemology but to an epistemology that differs in quite fundamental respects from the epistemology expounded by Piaget.

Clara Dan (1971:43-44), in a positive evaluation of Piaget's work, maintains that one of his great achievements was the definitive separation of realism from empiricism with the result that "the final realist value" of human knowledge is firmly established. It is this decisive separation of realism from empiricism that makes it so difficult for the philosopher who is conditioned to see realism as inseparable from some form of empiricism to take the Piagetian realism seriously.

The difficulty arises because it is usual for an empiricist realism,

in Dan's words, "to define realism by the minimalisation of the role of the knowing subject". The question then arises how a constructivist epistemology that gives a key formative role to the knowing subject can be realist? It appears on the most usual 20th century conception of realism, at least in the English-speaking world, to be contradictory.

The term "realism" has been applied with differing connotations to a number of different philosophical positions but for the present purpose I use the term to describe an epistemological position that maintains the view that there exists a subject-independent reality that is known by the subject, functioning as a subject-independent control in the subject's knowing. This is a definition that, it seems to me, fits satisfactorily most of the epistemological positions to which the term has generally been applied. It should be noted that the subject-independent reality need not be a sensible reality; it may equally well be an intelligible reality. Hence Platonic intellectualism, for example, is a realism that takes transcendent Ideas as a subject-independent reality that is known by the subject, functioning as a subject-independent cognitive control.

In modern times Kantian idealism involved a decisive rejection of all forms of realism; the cognitive objects and controls are entirely internal to the knowing subject. The post-Kantian reassertion of realism, at least in the English-speaking world, has been predominantly empiricist in nature with the result that it has been widely assumed that empiricism and realism go together as the alternative to idealism.

Modern empiricist realism rests on the claim that a class of observations can be identified in which there is an immediate and reliable sensory registration in the subject of cognitive data about propertied

objects existing independently of the subject.

Piaget rejects this claim, appealing to experimental evidence in his support. He maintains, on the contrary, that all observation is subject-interpreted observation. Even the most elementary observations require a co-ordinative scheme supplied by the subject in order to read information from objective reality (Piaget,1970b:80-109).

Two possible misconceptions need to be guarded against at this point. Firstly, the co-ordinative scheme supplied by the subject is not to be identified with a conceptual scheme. Piaget is not arguing that the subject brings a conceptual structure as the interpretive framework of observation. His position in this respect is quite different, for example, from that taken by the psychologist Rudolph Arnheim who argues that every percept is a primitive concept (Arnheim, 1969:13-36). While the co-ordinative scheme supplied by the subject ultimately develops a conceptual character, in its most primitive form it is simply the co-ordination of the subject's sensory-motor activity (Piaget,1977:5-6).

Secondly, Piaget's position is not to be confused with any of the various theories - including Popper's dispositional knowledge version - of the theory-ladenness of observations. "Theory-ladenness" is an argument for the recognition of a component of theories <u>accompanying</u> observations; these accompanying theories provide the conceptual framework for interpreting the observations. Observations however, retain their character as registers of information about the object world and, as such, are able to force a revision of the theories at critical points, whether that critical point is Popper's decisive falsification or Kuhn's paradigm failure.

Piaget's argument, however, concerns the structure of observations themselves. It is not that observations are "laden" with theories but that observation itself has a structure supplied by the observing

subject that enables the subject to read information from the object world. Without such a structure we would not have observations but only a succession of disconnected sensations from which we would obtain no information about the object world.

Because of the inadequacy of the co-ordinative structure of observation the subject's most primitive observations are distorted observations yielding information about the object world that is incomplete and, in significant respects, misleading. As the subject's co-ordinative framework for observation is further developed in interaction with the object world the distortions are progressively removed from observation allowing a reading of the object world with greater penetration and accuracy. The logico-mathematical framework employed in scientific thought, being the most highly developed framework yet available enables us to read the object world - including the human as object - with unparallelled accuracy and penetrating power (Piaget, 1970:55; 1975:103; 1977:321-322).

If Piaget is right in this understanding of observation then the empiricist criterion of an unproblematic base of observations registering information about the object world cannot secure the relation between knowledge and objective reality that is required for a realist account of knowledge. No such unproblematic observational base exists. Empiricism's simplistic view of the nature of observation frustrates a clear understanding of the necessary conditions for the effective observational reading of the object world that is essential if knowledge is to be knowledge of a subject-independent reality. In other words, a realist account of knowledge is possible only on condition that we reject the basic assumption of empiricism.

In short, Piaget has offered a clear and logically coherent account of the relation between knowledge and objective reality that not only dispenses with empiricism but makes empiricism incompatible with a

realist account of knowledge. Whether or not we are prepared to accept Piaget's account is another matter to be discussed further later but it is clear that what he offers is, in every important sense, a genuinely realist account of knowledge and not some strange infertile hybrid.

There is, of course, an important ontological shift involved in the Piagetian detachment of realism from empiricism. On any empiricist view the stability of knowledge depends on invariance in the object world. On the Piagetian view the stability of knowledge depends on the stability, but not invariance, of the subject's structures for reading the object world. Reality becomes a transformational reality that is always open to transformation through the action of the subject.

In this respect Piaget undoubtedly followed closely Brunschvicg's position that "... knowledge constitutes a world that is for us the world. Beyond this there is nothing; a thing that would be beyond knowledge would be by definition the inaccessible, the indeterminable, which is to say that it would be equivalent to nothing" (Brunschvicg,1964:2). Reality is the known. The Kantian noumenal world is abolished.

Objective reality is of such a kind that it is not merely read by the knowing subject but undergoes an enriching transformation in the subject's knowing of it. It is a reality susceptible to change through the subject's action on it, including cognitive action. Yet it is important to note that whatever transformation it undergoes as a result of the subject's action it always retains without modification the properties intrinsic to it as a reality independent of the subject (Piaget,1983:171). The transformation it undergoes enriches it while conserving in its entirety all that it was prior to the transformation. This stable core of properties intrinsic to the object constitutes the object as a reality remaining always external to and

independent of the subject however extensively it may be enriched by the subject's cognitive activity.

For those nurtured in an empiricist view of reality Piagetian reality will appear a strange reality indeed. Such may well wish to give reasons for rejecting the Piagetian view of reality; to be satisfactory, however, any rejection of this view will need to give a satisfactory alternative account of the experimental data on which Piaget relies to support his view. However, any such arguments are arguments for rejecting Piaget's account of realism and not for denying that his position is realist.

Piaget himself was not accustommed to describing his position as "realist". Indeed he speaks of the influence of realism as a distorting factor in the development of mathematical knowledge (Piaget, 1973b:261-346). However, in his parallel discussion of physical knowledge, he charges Brunschvicg with failing to give sufficient weight to the compelling realism with which we are confronted in a study of biological knowledge. (Piaget, 1974a:314). The Piagetian distinction between logico-mathematical and physical knowledge is important in this connection. With regard to logico-mathematical knowledge Piaget wants to banish realism; but with regard to physical, or empirical, knowledge, knowledge has a realist character (See Piaget,1974a:336). Hence, science "is neither purely realist nor purely idealist" (Piaget,1973b: 48).

The realism of Piagetian epistemology is certainly neither a simple realism nor the kind of empiricist realism associated with the positivist tradition. Nevertheless, Piaget's position certainly satisfies the criteria of realism which I stipulated above and which, I suggest, clearly links his realism with other philosophical positions that have been regarded as realist. It seems, therefore, appropriate to speak of the realism of his epistemology.

However, I have no desire to argue over terminology for its own sake. If others want to dispute the appropriateness of the description "realist" I would have little inclination to debate the point, provided that what I prefer to call the "realist" element in Piagetian epistemology is clearly recognised. Any attempt to remove that "realism", by whatever name we may call it, will require the most fundamental change at the very heart of Piagetian epistemology leading not merely to modification but to the complete reconstruction of that epistemology.

An indispensable component of empirical knowledge in Piagetian epistemology is that gained by empirical abstraction in which knowledge is knowledge of properties of physical objects that exist as propertied particulars independently of the subject's knowing. Not only do they possess these properties prior to our knowing but these properties remain unchanged as properties of these objects at the most sophisticated possible level of our knowing (Piaget,1977:6-7). The development of more sophisticated structures of thought enhances and sharpens our powers of empirical abstraction but it does not supersede them as a source of empirical knowledge.

With regard to observations of the physical world Piaget argues that the subject reads two distinct classes of objective properties. One class consists of inalienable properties of propertied particulars wholly independent of the subject; the second consists of co-ordinative properties initiated in the co-ordination of the subject's cognitive actions and attributed to objects.

Not only is the first of these dependent on a realist account of some sort but so also is the second. Discard all forms of realism and it is obvious that there can no longer be a cognitive reading of properties of particulars independent of the subject; Piaget's empirical abstraction must reduce to no more than an abstraction from

phenomena experienced by the subject. In that case all distinction between inalienable properties of the object and properties attributed to the object must disappear, or at least be seriously blurred.

But the basis for the attributability of co-ordinative properties to objects also disappears if we discard the realism of Piaget. It is not any and every co-ordinative property that is attributable indiscriminately to any and every object but only those that fit, those that are adapted to, the objects in question (Piaget,1970:113; 1973:12-18). But in order to determine whether the properties fit the objects - i.e. are attributable to them - we must have some knowledge of the objects independently of properties to be attributed to them. Remove the realist element from Piagetian epistemology and the door is firmly shut to any such knowledge so that there is no way to determine the attributability of co-ordinative properties.

Even this does not end the reconstruction that Piagetian epistemology must undergo if Piaget's realism is discarded. The theory of the development of the cognitive structures of the subject - the logico-mathematical structures of thought - themselves will have to be reworked in a way that will leave little but an empty shell of Piaget's theory. The development of the cognitive structures of the subject in Piagetian epistemology depends on interaction between the subject and a physical reality independent of the subject. The requirement that the structures of the subject accommodate to the physical reality that exists independently of the subject is an indispensable factor in the development of these structures , even though the construction itself is wholly internal to the subject's thought. (Piaget,1966-7:17-18; 1968:51-53; 1970b:109; 1975:12-49).

If we discard the realist element from Piagetian epistemology then we will have to replace the Piagetian interaction of subject and object with an interplay between different elements within the cogni-

tive structure of the subject without known relation to any subject-independent reality. This is an epistemological change of a most fundamental kind.

The realism, of Piagetian epistemology, by whatever name we call it, is in no sense peripheral but central. Piaget himself declared that the problem of the relations between subject and object is the central issue of epistemology (Piaget,1968:51). "Object" for Piaget is not reducible to a phenomenal object within the consciousness of the subject but is a structured reality existing independently of the subject (Piaget,1979:10,109). It is possible, of course, to retain the Piagetian terminology while discarding the realism but in that case the very heart of the epistemology will have to be restructured.

The difficulty that many have in taking Piaget's realism seriously is that it requires a significant shift in fundamental conceptions with which we have become accustomed in this connection. This situation is well illustrated by criticism offered by Wartofsky in relation to the correspondence between knowledge and reality in Piagetian epistemology.

Wartofsky (1982:487-493) refers to Piaget's argument that the structures of knowledge are not copies of reality but transformational structures "more or less isomorphic to transformations of reality" (Piaget,1970c:15). He suggests that this is no more than a "rhetorical realism" since it begs the question of correspondence.

How, he asks, can we know that cognitive transformations correspond to reality if we know reality only by means of these transformations? He goes on to argue that any isomorphism can only be among the cognitive structures of the subject and not between these and "reality", "since this is precisely what we cannot know".

This entirely misses the point of the interactive nature of Piagetian epistemology. Wartofsky's argument remains bound to the empiri-

cist conception that reality external to the subject can be known by the subject only by a simple registration in the subject of objects and/or properties of objects that remain unchanged in our knowing of them. It remains locked within the empiricism/mentalist intellectualism polarity in which cognition either corresponds to an objective reality external to the subject because it registers that reality as it is independently of the subject or it constructs cognitive structures independently of objective reality which it then projects on that reality. Hence, since Piaget insists that we cannot know reality except by employing instruments of cognition constructed by the subject Wartofsky assigns him to the mentalist intellectualism pole, concluding as a result that his realism can be no more than a "rhetorical realism".

Yet it is precisely this polarity that Piaget rejects with his interactionist conception of cognition. Only by recognising this so that we are able to view Piagetian epistemology outside the empiricism/mentalist intellectualism polarity can we do justice to his realism as more than a mere "rhetorical realism".

In this Piagetian interactionist conception objects external to the subject that exist as propertied objects independently of the subject's knowing are primary objects of cognitive activity. Empirical knowledge must match this objective reality. However this match is not obtained by means of sense data, information received in a detached observation of objects, that give the subject the properties of the objects as basic cognitive data. The subject knows the properties of objects only by acting on the objects, action that transforms the objects without destroying their intrinsic properties. In this cognitive activity the subject transforms the objects by enriching them with new properties while the objects in turn constrain the subject by the requirement that the subject's cognitive transformations match, or

fit, the nature of the objects. We know that our structures of knowledge are isomorphic to reality only by their fit with reality in our acting on the objects of reality.

Piagetian reality is neither an empirical given nor a mere intellectual construct. It is the product of an interaction between the constructive activity of the subject that transforms and enriches reality and the reality of propertied objects external to the subject which provide the subject-independent base to which the subject's constructive activity is responsive.

Piaget in no way asserts, as Wartofsky claims, that we cannot know objects as a subject-independent reality. On the contrary, it is just such objects that function as the "limit" for all our empirical knowledge; as "limit" we never know objective reality exhaustively but we do know it truly in successive approximations (Piaget,1979:10,109; 1983:173). What he does maintain is that we can know these objects only as our actions in relation to them are co-ordinated by mathematical co-ordinations constructed internally to the subject and not drawn from the objects. It seems clear that Piaget uses the term "limit" in a mathematical sense as a fixed value that can be approached in ever closer approximations without ever being attained. The objects are not simply registered in a passive subject but are read by the subject within a co-ordinative framework constructed by the subject.

While this co-ordinative framework - the transformational systems constructed by the subject - transforms it does not destroy but wholly conserves the object with its intrinsic properties as an external reality independent of the subject. In reading the object with the aid of this co-ordinative framework the subject is able, more and more clearly and exhaustively as the framework is better developed, to read the intrinsic properties of the object. In other words the transforma-

tions do not leave us with only the transformations of our own structure of thought as cognitive object but are instruments by which we better read the subject-independent object with its inalienable properties.

Further, and this is crucial, if, on the one hand, we do not know objective reality apart from the co-ordinative structures of our own actions in relation to them, on the other hand, the cognitive objects, as a structured reality always independent of our knowing and with which we have immediate contact in our knowing, act as a decisive control on our constructive activity.

A useful analogy, which may be more than an analogy, since there is reason to suppose that Piaget saw knowledge as a special kind of artefact, is that of an artisan constructing an artefact out of given raw materials of which he has no prior knowledge. On the one hand, the artefact is not given in the materials but is dependent on the constructive activity of the artisan. On the other hand, the properties intrinsic to the given materials both become known to the artisan by his working with them and act as a "limit" to his constructive activity which can be only such as is adapted to the properties of the materials.

After he has transformed the materials into the artefact the materials that have been transformed by his constructive activity retain all the intrinsic properties they had prior to the transformation and the artisan by means of his transformational activity has come to know those properties better than he did in the simple observation of them as given. He knows the materials better not merely in their new form but in the intrinsic properties they possessed prior to the transformation. In addition new relational properties attach to the materials as a result of the artisan's transformational activity.

Two features are essential to the Piagetian account of the relation

between knowledge and objective reality; or the isomorphism of cognitive transformation with transformations in reality. One is the total conservation of the primitive object with its intrinsic properties independent of the subject throughout all the cognitive transformations. The other is the subject's immediate empirical contact with these subject-independent propertied objects in which contact the subject's transformational constructions function as instruments to facilitate the reading of the properties of the object and the experience of those properties in turn acts as a control on the transformational construction.

Hence Piaget's suggestion, that mystifies Wartofsky, that the transformational structures provide only "possible isomorphic models among which experience can enable us to choose" (Piaget,1970c:15). Since experience always brings us into contact with a structured reality of objects, independent of ourselves and our knowing of them and conserved in all our cognitive transformations, this empirical contact with objective reality can enable us to select transformational structures best adapted to that reality.

It must be granted that Piaget's own exposition of his position leaves a great deal to be desired for anyone wishing to come to terms with it as a coherent, systematic epistemology. Nevertheless if we take the trouble to disentangle the systematic thread that runs with remarkable consistency through his work it exhibits an internal coherence that refutes most of the charges of incoherence levelled against him. His realism is no exception.

2.9 COMMITMENT, WELTANSCHAUUNGEN AND EPISTEMIC FRAMEWORKS

From the discussion to this point it might well appear that Piaget saw scientific knowledge as simply the ordering of experience guided inexorably by a universal logic of thought toward ever increasing richness and precision. And, indeed, the main body of his works could

readily lend themselves to such a conclusion.

There appear to be two related reasons for this. The first is that in endeavouring to develop what he regarded as a scientific epistemology he quite deliberately set to one side broader questions of knowledge that have usually occupied the attention of epistemologists to focus attention on specific questions of detail for which he saw the possibility of obtaining scientific answers. He did this not because he regarded the broader questions as unimportant but because of what he took to be the requirements of a scientific approach.

Secondly, the specific questions on which he chose to focus were those related to the cognitive mechanisms of the knowing subject so far as these could be regarded as universal processes - questions such as the development in the subject's thought of operations associated with the inversion of arithmetical operations (addition and subtraction, multiplication and division), the construction of additive and exponential series, the relations between parts and a whole (the examples are taken from research projects reported in detail in Piaget,1977 and Piaget,1981). Hence the main body of his published works comprise reports and discussions of his research in relation to these specific questions (Piaget,1970b:116-118; 1973b:17,18; Piaget & Garcia,1983:292). The continuing research of the Centre international d'Epistemologie genetique proceeds along the same lines (see e.g. Dionnet,1983 and Wells,1984).

However, Piaget always recognised that these cognitive mechanisms function in a wider context, not only in the subject-object relation but also within the subject. His research was directed to the identification of what he called "the epistemic subject". This "epistemic subject" is the universal element in the subject; it is a core common to all subjects at the same level of development (Piaget & Beth,1966:329; Piaget,1983a:120) that ensures the functional invariant

guaranteeing intersubjective universality in cognition. Its base is the co-ordination of actions and in its cognitive development it is the internal logic of thought that leads to deductive necessity.

But, although the functioning of this "epistemic subject" was the focus for his research, Piaget did not suppose that cognition was a simple matter of the functioning of the "epistemic subject" detached from the other properties of human subjectivity. In this respect his use of the terminology "epistemic subject", with the complementary terms "individual subject" and "psychological subject" tends to be misleading. It suggests distinct and separable concrete modes of subjective functioning such that "epistemic subject" is identical to "knowing subject". On closer examination it is clear that this is not at all what Piaget intended. The knowing subject includes the "individual" and "psychological" as well as the "epistemic" subject (Piaget & Beth,1966:329; Piaget,1970:45-48; 1981:184-188).

By "individual", "psychological" and "epistemic" subjects, then, it seems we are to understand different modes of the subject's functioning that are distinguishable but never separable from one another so that the concrete activity of the subject involves an interaction between them in which each plays a greater or lesser part according to the nature of the activity. The term "epistemic subject" does not indicate that this mode of functioning alone is involved in epistemic activity but only that it plays an increasingly dominant, and always decisive, role. As the role of the epistemic subject becomes more dominant with a corresponding decrease in the role of the individual subject knowledge becomes more objective. Yet this is a reducing of the role of the individual subject to a minimum rather than abolishing it (Piaget,1970:46). The concrete knowing subject, then, is never reducible to the "epistemic subject", though the increasing dominance of the "epistemic subject" with its universal deductive necessity is

the key to the objectivity and intersubjective universality of scientific knowledge.

Concentrating his attention on limited questions related to the functioning of this "epistemic subject" Piaget for the most part made only occasional references to the other modes of the subject's functioning without a detailed elaboration of their connection with the distinctively epistemic mode.

However, in his later years he began to give more extended attention to this question. This led him, on his own account of the distinction, beyond the bounds of what counts as scientific epistemology into the realm of philosophy. Perhaps the recognition of this deterred him from doing so earlier but, on the other hand, the need to relate his epistemology to the mainstream of epistemological discussion appears to be a compelling reason for his doing so in the end.

Although his treatment of the question still remains scanty, enough is said to enable us to form a clear picture of the broad contours of his position on the relation between his "epistemic subject" - the subject's logico-mathematical structuring function with its logical necessity - and the role played by other factors in cognition.

For Piaget the human subject is more than a knowing subject. The human subject, as a complete individual, is a committed, or involved, subject who in this commitment (engagement) constructs his own norms in relation to the concrete problems of human life (Piaget,1966:53, 64; 1972:299). The search for scientific truth is of interest only to a minority of humans and, even for that minority, it can never exhaust the nature of man. The human is never locked within the boundaries of scientific knowledge. The complete human subject lives, takes sides, believes and arranges in a hierarchy a multitude of values, in so doing giving a meaning to his existence by choices that go beyond the frontiers of his avaiable knowledge (Piaget,1972:281).

As a rational subject he develops a rational co-ordination of all the values of human life, including the cognitive values, in which the subject takes up a rational position with regard to reality as a whole. This rational co-ordination of values in relation to the whole of reality is the concern of philosophy and is outside the realm of knowledge as such though it includes the subject's existent knowledge within the rational co-ordinarion. (Piaget,1972:57,281; 1973b:13-14).

While it is the object of philosophy this rational co-ordination is not the exclusive province of philosophy as an academic discipline. It is a wisdom that is developed individually by every rational subject. And, although rational, this wisdom is not intellectualist but engages the whole person in a unified conception of life. (Piaget,1972:63,281-282).

Knowledge, represented in its most developed form by science, does not have overriding normative value for human life. Cognitive activity is not the pinnacle of human achievement but one of several higher level human activities that include moral, aesthetic and faith ("religious or humanist") activities which the committed individual human subject co-ordinates with cognitive values in a unified conception (Piaget,1972:57).

Science for Piaget represents the highest achievement of human knowledge but it is not, as it is for Monod (1970:203-225) the kingdom of human freedom that transcends the darkness out of which we have come. Human life is guided by a conception of the world, a Weltanschauung, that incorporates the cognitive values of science but is not determined by them.

The other side of this is that science itself is guided by this Weltanschauung in so far as it influences the nature of the problems to be investigated by science. It is at this level that philosophy, having the character of a systematic Weltanschauung, can be of ser-

vice to science by identifying problems to be resolved by scientific investigation. Philosophy, being restricted to the reflective method, can never resolve any problem but by its reflection on reality as a whole it provides valuable impetus to science by identifying problems that might otherwise be neglected. (Piaget,1972:307). Piaget even went so far as to say that "philosophy is indispensable in training reflective thinking and in posing relevant problems" (Piaget,1970a:16-17).

But a Weltanschauung may hinder as well as stimulate the growth of knowledge. In developing this theme Piaget introduced, in one of his last published works (Piaget & Garcia,1983), the term "epistemic framework" (cadre épistémique). This work was unusual in that it was co-authored with Rolando Garcia. In earlier works what Piaget had written was published in the same volume together with what others had written, with occasionally a chapter jointly authored, but in this case no attempt is made to distinguish the contribution each made but the whole work is presented as a joint effort.

Garcia tells us that the development of the notion of "epistemic framework" was the result of interaction between himself and Piaget. He also tells us that an epistemic framework has directed the course of scientific development by determining "the type of questions one asked nature at a certain moment of time" (Garcia,1983:17). Piaget & Garcia (1983) develop this notion of epistemic framework and bring it into connection with the notion of Weltanschauung.

Piaget recognises two sources of constraint on the growth of scientific knowledge that have nothing to do with the adequacy of the cognitive mechanisms available to the knowing subject but constrain the subject in the employment of those mechanisms. One of these is the complex of stimuli and restraints imposed on science by the requirements of society external to science. This creates external pressures that concentrate scientific endeavour in certain directions to the

neglect of others. At the same time he recognises that there is a reciprocal influence from science in the shaping of the social values which in turn constrain the further development of science. This complex of social values he called the "social paradigm" (Piaget & Garcia,1983:276,278).

The other source of constraint, which is internal to science as an intersubjective human endeavour, is the conceptual complex that, at any given time, is regarded by the scientific community as constituting the valid body of scientific concepts. This acts as a restraining filter excluding any concept that does not meet the currently endorsed conceptual requirements of "scientific". This conceptual complex internal to the scientific community he called the "epistemic paradigm". This epistemic paradigm is not imposed by any logical necessity but solely by the authority of the scientific community that passes it on from one generation of scientists to the next as an inherent component of the accepted knowledge as naturally as language is transmitted from one generation to the next (Piaget & Garcia,1983:278-280).

As as example of the constraining influence of an epistemic paradigm on science Piaget cites the case of Newtonian mechanics which for some thirty years the French scientific community refused to accept, not because of any fault found with Newton's mathematics or because of experimental refutations but simply because it was not "physics" - hence not science - since it did not conform to the currently accepted concept of physical explanation.

The eventual acceptance of Newtonian mechanics, however, led to a new epistemic paradigm in which the Newtonian concept of mechanism was regarded as indispensable to scientific explanation. This new paradigm decreed that no theory could be countenanced as scientific unless it embodied this concept of mechanism. This new paradigm, according to Piaget, by its reductionist influence had a widespread distorting

effect on science.

The social paradigm and the epistemic paradigm belong to an epistemic framework rooted in a Weltanschauung or ideology. This epistemic framework specifies the limits of the questions that can be asked, the kind of problems that can be accepted as appropriate. The Greek static conception of the world is cited as an outstanding example of the retardation of science not primarily because of an inadequate methodology but because of the constraint of an epistemic framework imposing this static conception on the formulation of scientific problems.

The breakthrough, or revolution in science of the 16th and 17th centuries, therefore, was not due to the development of a better methodology. The necessary methodology had existed since the 13th century. The scientific advance of the 16th and 17th centuries was due to an ideological revolution, a major shift of Weltanschauung, that led to the introduction of a new epistemic framework opening up a whole new range of questions that had hitherto been unthinkable. "It is not the methodological considerations (or at least never these alone) that cause the advance of science at critical moments of its development but rather the modifications undergone by the epistemic framework that uses or directs this methodology in an autonomous manner" (Piaget & Garcia,1983:71).

This is all reinforced by contrasting the development of Chinese science with ancient Greek science at the zenith of Greek science. A sharply contrasting Weltanschauung in China gave rise to an epistemic framework significantly different to that of ancient Greek science and consequently to a contrasting set of scientific problems that in certain respects are more akin to modern science than those of the ancient Greeks (Piaget & Garcia,1983:280-285).

While the distinction of "social paradigm", "epistemic paradigm" and "epistemic framework" appears to be conceptually clear enough it is a

distinction not always easy to make so sharply in practice, as Piaget himself acknowledges (Piaget & Garcia,1983:284-285).

The parallels with Thomas Kuhn, both in the use of the terminology of "paradigm" and in the talk of "scientific revolutions" will be obvious (see Kuhn,1962; 1970). Piaget himself explicitly recognises this connection, saying that, up to a point, the "views of Kuhn converge in their major directions, with our own" (Piaget & Gacia,1983: 275-276,187). However, there is also fundamental divergence such that it would be misleading to equate Piaget's position with Kuhn's.

In the first place, the Piagetian paradigms do not appear to have exact parallels in Kuhn's notoriously ambivalent use of the term "paradigm". [A usage that Kuhn (1977) did try to clarify in response to criticisms.] Piaget suggests that the concept of paradigm as understood by Kuhn relates to sociology of science rather than epistemology as such. While he does not see his and Kuhn's positions as opposed he stresses that they are distinctly different approaches and finds major deficiencies in Kuhn's approach (Piaget & Garcia, 1983:275-279).

The fundamental divergence that Piaget identifies is that, while he agrees with Kuhn - and to a lesser extent with Feyerabend - that there are discontinuities, or "leaps", in the growth of science he does not regard these as "leaps in the void" but as responding to a logic internal to the knowing subject which is responsible also for the stability of "normal" science (Piaget & Garcia,1983:292-293). This brings us back to the heart of Piagetian epistemology: the role of the subject as a structuring subject guided by an internal logic that is common to all subjects. Scientific revolutions, therefore, are not due, as Kuhn argues, to the persistent empirical failure of theories but are due to a restructuring of the subject's epistemic framework in order to remove disequilibrium in the internal logic of the subject's action.

For all the readiness to recognise common ground Piagetian epistemology retains a rationalist base that marks it off sharply from the "Weltanshauungen analyses" of recent Anglo-saxon philosophy of science. (For the term "Weltanschauungen analysis" and a discussion of some of the main representatives of this approach see Suppe,1977:125-192.) In the final analysis knowledge is the ordering of experiences in accordance with the logic internal to a universal, self-authenticating rationality of the subject that assures the intersubjective universality and objectivity of science as knowledge at the highest level of development. This ensures that the mechanisms for acquiring knowledge are universal, unaffected by social context, personal commitments, ideologies or Weltanschauungen. The identification of these mechanisms and how they operate has been the major concern of genetic epistemology.

Knowledge, in its inner mechanism of which the subject is usually unconscious, is a thoroughly rational activity governed by a universal inner logic. But knowledge is not definitive of human life and its mechanisms do not operate in isolation from the totality of that life. The definitive role belongs to the human subject as a complete subject (with commitments and beliefs as well as knowledge) who co-ordinates life's experiences in a Weltanschauung that forms the context within which the universal cognitive mechanisms function at any given time. This Weltanschauung imposes an epistemic framework, an approved conceptual grid that specifies what is to pass as valid knowledge of the world.

This epistemic framework does not alter the universal cognitive mechanisms by which knowledge is acquired. These constitute an epistemic functionional invariant. The framework constrains the development of knowledge by specifiying the kinds of problems that are to count as scientific problems and the kinds of concepts that are to be acknowl-

edged as valid scientific concepts. An epistemic framework, and its associated Weltanschauung, then, will advance or retard the growth of scientific knowledge as it widens or narrows the possible interrogative and conceptual fields within which the universal cognitive mechanisms are allowed to operate. On the other hand, arbitrary restrictions imposed on these mechanisms by an epistemic framework tend to produce disturbances, disequilibriums, in the cognitive mechanism that, sooner or later, force a change in the epistemic framework. When such a change is sufficiently fundamental we have what we may call a revolution in science.

While Piaget is able to agree with Kuhn, then, that "revolutions" are significant in the development of science, his analysis of the nature of these revolutions and their relation to what Kuhn calls "normal" science is quite different. On Kuhn's analysis, the revolution occurs because of the failure of the existing paradigm for solving the defined problems (Kuhn,1962:76). On Piaget's analysis the revolution occurs because of inadequacy in the definition of the problems that the existing epistemic framework allows. For Kuhn the revolution is a revolution in the problem-solving tools; for Piaget it is a revolution in the definition of the problems to be solved, not, at least first of all, in the tools for solving them.

In brief, the fundamental difference between Piagetian epistemology and recent Anglo-Saxon discussion in the philosophy of science is that while the latter analyses the formal conceptual structure of knowledge (theories, etc.), the former analyses the mechanisms of the knowing subject by which these conceptual structures are produced. A failure to recognise this will frustrate any effective interaction between the two.

A clear example of the result of such a failure is the use Feyerabend makes of Piagetian research to support his theory of incom-

mensurability. Citing a fragment of the total body of Piagetian research he uses the results of this research to support the thesis that "the development of perception and thought in the individual passes through stages which are mutually incommensurable" and that there are families of perception-related concepts between which "neither logical nor perceptual connections can be established" (Feyerabend,1975:227-229,274). Yet viewed in terms of the problems to which the Piagetian research was directed the research cited warrants no such conclusion.

Feyerabend analyses the research solely in terms of the formal structure of the concepts involved. As a result of that analysis he finds an incommensurability in the results with, he concludes, no possibility of establishing a connection between them. With the first part of this finding a Piagetian might have no special difficulty but would dissent quite emphatically from the second. He would point out that the existence of a connection between these diverse results is precisely what the research has established. This connection is not found where Feyerabend looks for it, in a comparison of the formal logical structure of concepts, but in the inner logic of the cognitive mechanisms operative in the subject. On the Piagetian analysis Feyerabend's incommensurability based on comparison of formal cconceptual structures dissolves into a fundamental commensurability based on the inner logic of the subject's actions.

This appears to be an instance of the effect of what Piaget calls the "epistemic framework", since the difference between the Feyerabendian and Piagetian analyses lies in the nature of the problems addressed. Feyerabend misses the point of the research because he fails to recognise the central problem to which that research is addressed. He does not criticise or evaluate the Piagetian problem or offer an alternative theory in relation to it. He disregards it.

The problem to which the Piagetian research is addressed is not the

analysis of conceptual structures employed by the subject, which is Feyerabend's concern, but the nature of the cognitive mechanisms of the subject that produce conceptual structures and by which knowledge advances. This is what Garcia (1983:8) calls "The `A` of the A,B,C" of Piagetian epistemology. Viewing the research in terms of the Piagetian problem, the research, so far from showing incommensurability, shows a continuity in the cognitive mechanisms.

Even with regard to the conceptual structures the incommensurability that Feyerabend finds by his formal analysis of the conceptual structures abstracted from the constructive activity of the subject disappears when the research is analysed in terms of the Piagetian problem. In the constructive activity of the subject the conceptual structure of one level is not discarded at the next level as incommensurable with the new conceptual structure of that level but is transformationally incorporated as a component of the new, more complex structure.

A clear recognition of the fundamental difference in problem orientation, then, is essential for any fruitful interaction between Piagetian epistemology and philosophical/scientific discussion and research in the mainstream of contemporary Anglo-Saxon thought. Without this each party is bound to view the contributions of the other in one of two ways, either of which will frustrate effective dialogue. Either party A will regard the contribution of party B as irrelevant, or at best peripheral, because it does not address the problem that party A takes to be central, or does so only in a peripheral way; or party A will distort the contribution of party B by reading it within his own quite different problem framework, as Feyerabend does with Piaget in the example just cited. Only as the difference in problem orientation is recognised clearly and common ground is found in common underlying problems can fruitful dialogue develop between the parties.

2.10 AN AFFINITY WITH PRAGMATISM?

Certain features of Piagetian epistemology suggest, at first sight, an affinity with the pragmatism of William James. In particular, this affinity is suggested by the interactive character of cognition and the transformational character of reality (James,1914:60-69,201-217).

There is no doubt that significant and striking parallels exist. Further these parallels indicate a common tendency, characteristic of the main trends in modern epistemology, away from cognitive absolutes towards an open-ended view of knowledge. Beyond this, however, as we look more closely it is clear that there is a sharp and fundamental divergence between the approaches taken by James and Piaget.

The pragmatism of James leads away "from abstraction towards concreteness" (James,1914:51). In sharp contrast to this in Piagetian epistemology while knowledge begins in the concrete it develops only by abstraction; it is abstraction that is characteristic of cognition. "All new knowledge supposes an abstraction" (Piaget,1974:81).

Secondly, James makes the usefulness, or worthwhileness, of the ends the governing principle in cognition. Certainly he insists that there must be agreement with existent reality but this existent reality is itself reality as experience directed towards worthwile ends; the agreement of an idea with reality itself embodies the principle of successful leading to a worthwhile end as its most fundamental criterion (James,1914:55-64,204-216). In fundamental contrast to this, the governing principle in Piagetian epistemology is the logic internal to the subject's cognitive activity; it is the dynamic rationality of the subject's activity which governs that activity even when the subject is not conscious of it. It is not the usefulness of the ends but the rationality of the cognitive process that is definitive for Piaget.

Finally there is a decisive divergence between James and Piaget in that whereas James' position is clearly irrationalist Piaget maintains

a rationalist position. There is, for James, no universal rationality guiding cognition according to any a priori universal governing principle. There is only the subjective judgment - which in the end is always an individual judgment - of the usefulness of the products in the concrete, factual situation (James,1914:51-64).

Decision and choice in the pragmatist sense occurs for Piaget only on the level of the subjective co-ordination of values (see Piaget, 1972:281). It has no place in cognition.

In my earlier study of Piaget (1982:89,90) I concluded that Piaget had adopted an irrationalist position. I now regard that conclusion as mistaken. My earlier conclusion that Piaget's position is irrationalist was based on a mistaken conception of the role of history in Piagetian epistemology; a mistake that was made easier because of the limited categorisation of rationalism I was then using.

I mistakenly took Piaget to be giving an historicist account of cognition in which his epistemic subject is submerged in an evolutionistically conceived flux of history. Given the definitive role that Piaget gives to the epistemic subject such an historicist interpretation would certainly put Piagetian epistemology in the irrationalist category. My further intensive study of Piaget's work, however, has satisfied me that this historicist interpretation is a mistake. For Piaget cognition has a history and the study of that history is indispensable for an understanding of the universal mechanisms of the epistemic subject but this epistemic subject is in no sense historically defined (See the discussion above at the end of section 2.6).

I was led into this mistake, I believe, because of the difficulty in fitting Piagetian epistemology within either of the two categories of rationalism with which I was then working; a categorisation that required either an a priori conceptual structure or an a priori rational method as the universal governing principle of cognition in a

rationalist epistemology. It is clear that Piagetian epistemology fits neither of these categories.

My further study of Piaget, together with the Brunschvicgian background to his thought, has led me to the conclusion that an adequate categorisation of modern rationalism requires the addition of a third category: a type of rationalism that is characterised by a universal a priori structuring principle as a dynamic principle inherent in the rationality of the subject. Identifiable neither with a conceptual structure nor with a rational method but known only in its operations in the cognitive activity of the subject this dynamic principle nevertheless has all the characteristics of a rational a priori principle universally governing the cognition of all rational subjects.

Piaget's atemporal epistemic subject is clearly just such a universal a priori governing principle giving his epistemology a rationalist character that distinguishes it decisively not only from the pragmatism of James but from every other kind of irrationalism.

2.11 PIAGETIAN EPISTEMOLOGY - AN OVERVIEW

A rationalist epistemology requires one of two types of ontology. Either there is a reality of an inherent rationality to which the rational order of knowledge in the subject corresponds or the objects of knowledge are such that they are susceptible to the rational ordering of the subject. An ontology of an intransigent irrationality is incompatible with any form of rationalism.

Piagetian epistemology rests on an ontology that is a synthesis of the two types. There is a rationality inherent in reality in that objects possess permanent intrinsic properties to which significant elements in the subject's knowledge correspond. However, this rationality does not exhaust the rational potential of reality. This rational potential is such that the rationality of reality can be enhanced indefinitely by the rational ordering of the knowing subject.

Since this means a growing subordination of reality to the rational ordering of the subject's thought does it not involve Piaget, for all his protests to the contrary, in a form of idealism? Piaget recognised the force of this objection and answered it by saying that his position is not idealist since the subject that subordinates reality to its rational ordering activity is itself an object that forms part of reality (Piaget,1970:45; 1975:28; 1981:181,183; Piaget & Garcia,1983: 473).

In short, Piaget rejects all dualism of body and mind. The activity of thought that subordinates reality to its rational order is itself part of that reality since it is nothing but the higher level functioning of the material organism. The enhanced rationality that results from the subordination of reality to thought, then, is the result of an activity that is generated by that reality and not the imposition on it of an ideal order.

Piaget rejected what Ryle (1949:13-17) called "the official doctrine" of mind. He denied that the subject has any privileged access to the working of his own mind. The subject alone may know what he is thinking at a given time but is customarily, even at the highest levels of thought, unaware of how he has come to think what he is thinking (Piaget,1970a:3,4; 1971b:13). No amount of reflection on his own thought or the combined reflection of a group of subjects on their collective thought can give more than speculative answers to this question.

Thought is not the activity of an entity called "mind" but is simply a higher level development of the activity of the living organism the functioning of which we come to know in the same way as we come to know anything else about material organisms - pre-eminently by systematic scientific investigation of the organism as object.

It is this that makes scientific psychological investigations so

crucial for epistemology. Without them epistemology must remain wholly speculative. With them we are able to submit theories of knowledge to systematic empirical testing in the same way as other scientific theories.

While Piaget was a materialist he was not a physicalist. He strongly resisted all tendency to reduce material reality to the object of physical science or to regard this as some kind of essence of material reality. Although, therefore, he regarded the physical sciences as an important model for the human sciences he insisted that the model could be effective only if the specificity of the problems of these sciences as distinct from those of the physical sciences is clearly recognised (Piaget,1970:36-38). Reductionist tendencies that blur this distinction are cognitively distorting.

The distinction on which he insists in this respect, however, is not that between material reality as object of the physical sciences and a different mental or psychological reality as object of the human sciences. It is a distinction between different aspects of the one material reality that is far too rich - its riches are inexhaustible (Piaget,1970:113,114) - to be reduced to its physical aspects such as are investigated in the physical sciences.

The inner logic by which the knowing subject increases the rationality of reality in a subordination of reality to itself, then, is itself an aspect or dimension of this material reality. Central to the Piagetian ontology is the living organism in interaction with its environment. Epistemologically this translates into the interaction of subject and object. The living organism, as "living" is distinguishable from the non-living environment yet is inseparable from it, not merely because dependent on it but because the living organism in its very existence is "deeply rooted in physical reality itself" (Piaget, 1973b:344-346).

In a significant passage for understanding his underlying ontology Piaget (1972:11,12) tells how early in his life through reading Henri Bergson's `L'Evolution créatrice`, "... in a moment of enthusiasm bordering on ecstatic joy, I was seized with the certitude that God is Life under the form of that `élan vital` of which my biological interests at the same time afforded me a small sector of study". He never seems to have lost that certitude though he soon abandoned the Bergsonian dualism in which Life transcends physical reality.

Although in other respects Bergson appears to have little lasting formative influence in his thought, life continued for Piaget to be the major ordering principle of reality, guided by its own inner logic, but as a wholly immanent principle that is deeply rooted in the physical reality of which it is the ordering principle. Life is not a principle of freedom transcending logico-mathematical order but, in its interaction with the environment of which it is itself a part, is the source of that order.

In spite of the qualifiction of his epistemology as "genetic" Piaget showed no interest in ultimate ontological questions of genesis. Indeed, even in his epistemology he had no interest in any ultimate genesis. He held that epistemologically there is no absolute beginning (Piaget,1977:306). His interest was in understanding the existent relations of organism and environment, subject and object and not in tracing these to their origins. Historical studies were significant for him not for any hope that they will lead us back to an ultimate origin but as a way of elucidating the existent relations of subject and object.

The qualification "genetic" that Piaget applied to his epistemology, therefore, implies that knowledge is seen as a continuing genesis, a constructive activity of the knowing subject in interaction with objects. We can understand knowledge only as we understand the nature

of this continuing genesis. It decidedly does not mean that cognition is to be understood in terms of its historical genesis. Historical studies are valued not because they take us back to an historical origin but because they contribute to the understanding of the continuing genesis as a never-ending interactive spiral.

Knowledge, in Piagetian epistemology, is the conquest of the environment by the organism, the subordination of the environment to the internal logic of the organism, but only on condition that the organism in turn submit to the exigencies of the environment in its subordination of that environment to its own ordering logic. If it fails to accommodate its logic to these exigencies it will be frustrated in its attempt to subordinate the environment to itself.

This ordering logic is characteristic of all living organisms and is not, in itself, peculiar to the human subject. It is a fundamental property of life itself ensuring that the action of the organism is always purposive, or rather teleonomic, action.

This view of organic action as always teleonomic action led Piaget to take issue with neodarwinian evolutionary theory for its excessive reliance on chance factors (Piaget,1976). He proposed in its place a complex theory of his own which endeavours to rescue something from the wreckage of Lamarckianism without attempting to rehabilitate Lamarckianism as such. In this Piagetian theory of evolution the action of the organism as teleonomic action - directed toward an end not by conscious purpose but by the inner law of the organism - plays a decisive role in its own evolution.

The human organism is distinguished from other organic forms, and its powers over the environment immeasurably enlarged by the semiotic function that, by the internal conceptualisation of actions, enables the knowing subject to develop its native logic into symbolic systems. These symbolic systems, rooted in the inner logic of the subject and

developed in interaction with the environment provide the subject with powerful instruments for transforming reality (the environment) far beyond what could be achieved in their absence.

Knowledge is thus an important extension in the human subject of the power that belongs to every living organism to organise and modify the environment to its own advantage, though always with regard to the exigencies imposed by the environment.

Cognition is, therefore, neither a mere registering and processing of information about experiential reality nor the organising of experience in accordance with an a priori structure of the subject's thought but is an enriching transformation of empirical reality by the subject, such that the objects of reality never lose their own intrinsic properties that are and remain independent of all the subject's cognitive transformations. Cognition makes reality more than it was but without destroying anything of what it was before; it is a constructive enrichment of empirical reality not its revolutionary overthrow.

This leads to the never ending spiral of cognition. In empirical cognition the subject aims at and attains knowledge of the objects of material reality by placing those objects within a framework generated from the co-ordination of the subject's own actions. But this cognitive activity results not only in knowledge of the objects; it results also in the objects becoming more complex requiring a fresh cognitive conquest if they are to be known by the subject in their newly acquired complexity.

Hence empirical knowledge leads to ever better knowledge of empirical reality but also to an ever increasing complexity of that reality. While it is increasingly better known it can never be fully known by the subject since the better it is known the more there is to know. Parallel with this increasing complexity of reality is an increasing

complexity and refinement of the logico-mathematical cognitive instruments developed by the subject for the conquest of reality. Hence knowledge exhibits an ever increasing complexity both in its subjective instruments and in its empirical conquest.

There are two sides to this cognitive transformation of reality - discussed in detail by Piaget in two of his last works (1981; 1983). One is the generation of possibilities. In primitive perception the perceived reality is the only possibility. As the subject interacts with the objects of this reality the inner logic of the subject generates multiple possibilities some of which, by the further action of the subject, enrich reality as actualised possibilities.

The other side to this cognitive transformation is the co-ordination of the diverse particulars of empirical reality by deductive necessities - not inductive generalisations. In the most primitive perception what is is what necessarily is, but as the subject's cognitive activity multiplies possibilities from the logic of the subject's action this pseudo-necessity gives way to the deductive necessity of the logic of the subject's actions.

Although this leads to the organisation of reality in closed logical systems it does not close off the growth of knowledge since the integration of reality within a closed system of deductive necessity generates new possibilities that in turn require co-ordination by an expansion of the system of deductive necessity. The relations between possibility and necessity are complex but the net effect of the interaction between them and between them and reality is the continuous growth of knowledge with a corresponding increase in the complexity of empirical reality.

While knowledge is thus a conquest of reality by the subject, characterised by the growing autonomy of the subject, it is a conquest that can be achieved only as there is interaction with, and not merely

an acting on, reality as a propertied existent independent of the subject. For this reason experimental verification has a crucial role in Piagetian epistemology.

Piagetian "verification" is not to be confused with the "verificationism" that is so decisively rejected by Popper. Working against the background of an empiricist tradition, "verification" in Popperian terminology refers to procedures that establish, or at least confirm decisively, the truth or probability of theories on the basis of inductive logic. What Piaget intends by "verification" is an entirely different procedure more akin to, though also quite different from, Popper's "corroboration" or deductive testing of theories (see Popper, 1980:32-34,387-419; 1983:217-277). It is "more akin to" in that it rests on deductive logic, without dependence on inductive logic, but it is different in the nature of the deductive testing employed.

"Verification" in Piagetian epistemology is the employment of systematic controls such as to secure intersubjective agreement (Piaget, 1966:62). These controls are of two kinds, logical or normative and experimental or factual. Logical controls test for logical coherence consistent with the deductive logic of the subject's actions that is ultimately formalised in logical systems. They are deductive controls that do not in any sense rely on inductive logic (Piaget,1970:41-43, 89-91; 1972:v,21-22).

Experimental or factual controls test for the existence of facts - intersubjective experiences of reality - that fit the logico-mathematical structure supplied by the subject's thought. They do not establish or confirm the truth or probability of a theory. They establish the factual content of a theory; they establish that the facts as observed fit the theory. This experimental verification is crucial since without the factual content it supplies we would not have empirical knowledge but only an empty form.

An understanding of experimental verification in Piagetian epistemology provides the final answer to Wartofsky's difficulty with Piaget's notion of the testing for isomorphism between the transformational structures constructed by the subject and transformational structures of reality discussed above (section 2.8). The testing consists in experimental verification to determine whether there exists factual content adapted to a transformational structure constructed by the subject.

Experimental verification thus no more puts Piaget in Popper's verificationist category than does his logical verification since experimental verification no more depends on inductive logic than does logical verification. The facts of experimental verification are co-ordinated by the deductive logic internal to the subject, a logic that co-ordinates the subject's reading of the facts from reality; they are not in any sense the basis for an inductive logic that unites initially discrete data registered in the subject in sensory perception.

While experimental observations do not establish the truth or probability of a theory, but furnish factual content, neither do they refute theories. The history of science shows the persistent resistance of theories to experimental refutation (Garcia,1983:11-14). This is not unexpected since, according to Piagetian epistemology, observations are made and theories are constructed within the same logico-mathematical framework that originates in the co-ordination of the subject's actions. Theories are overthrown, then, not because they have been empirically refuted but because of a change in the subject's epistemic framework within which they are constructed.

This is not to say that observations play no part in theory change. By confronting the subject with aspects of reality that are not assimilable to the subject's existing structure of thought they may set up a disturbance, a disequilibrium, within that structure that if it per-

sists requires the internal reconstruction of the subject's structure of thought in order to restore equilibrium. Experimental observations can thus force changes in the structure of empirical knowledge but by provoking changes in the logical structures of the subject's thought, the epistemic framework, and not by the empirical refutation of theories.

While Piagetian epistemology makes scientific knowledge the instrumentality par excellence for the human conquest of the environment (reality) it does not attempt, after the fashion of Monod (1970), to subordinate all of life to scientific knowledge. The human subject is always more than a knowing subject and life is always more than knowledge. Knowledge, including scientific knowledge at the highest level, requires co-ordination with other higher level activities distinctive of the human organism - moral, aesthetic, faith activities, etc. - in a rational position adopted by the subject in relation to reality as a whole.

"Rational" in this connection does not imply subordination to the deductive logic that characterises knowledge nor does it imply that there is a general agreement of rational subjects such as knowledge requires. It implies no more than that it is a reasoned position, one on which the subject reflects rationally, and not a practical or affective position adopted without reflection (Piaget,1972:57).

While this co-ordination is not determined by the current state of knowledge but by the human subject as committed, deciding subject, the need to incorporate within it the current cognitive values does influence the shape of the resultant view of reality as a whole. Reciprocally, the Weltanschauung that emerges from this co-ordination influences the ongoing development of knowledge by the kind of questions it authorises the knowing subject to formulate. Yet the twin pressure of reality external to the subject and the logic internal to the subject

that is rooted ultimately in that same reality, ensures that knowledge is never indefinitely confined within arbitrary boundaries imposed by a Weltanschauung.

Although knowledge is an ever-expanding activity which, in principle, can encompass the whole of reality, this expansion of knowledge does not diminish the role of the rational co-ordination of values effected by the committed human subject. It reduces the speculative element in that co-ordination and yet even this can never be wholly eliminated since the increasing complexity of reality that results from increase in knowledge means that the knowing subject never reaches the outer limits of reality; the more knowledge expands the more the limits of reality expand. But even to the extent that speculation is overtaken by cognitive certitude the need for the rational co-ordination of values transcending knowledge is not diminished since the fulness of human life requires the co-ordination of the cognitive with the other higher level human activities without the subordination of one to the other.

With regard to the basic problems with which this study is concerned, Piagetian epistemology assigns the key formative role in cognition to the knowing subject directed by a universal structuring logic internal to the subject in interaction with an external, structured reality that is both independent of the subject and constitutes the sub-stratum in which the subject itself is rooted.

The intersubjective universality of knowledge is founded in the intersubjective universality of the structuring logic of the subject in its interaction with a common structured reality. The fit between knowledge claims and the experiential universe is tested by a co-ordinated double testing procedure using intersubjective logical and experimental controls to test respectively for logico-mathematical form and matching factual content.

Although Piaget clearly takes his beginning in Brunschvicgian intellectualism, his introduction of empirical controls at the foundations of knowledge decisively modifies that intellectualism yet without abandoning it for empiricism. His strong interest in biological science, that first stimulated his epistemological interest, appears to have been a major factor in Piaget's concern for a strong empirical base. It is difficult for a scientist with Piaget's high regard for the physical sciences to adopt an epistemological position that lacks such a base (see the important discussion in Piaget,1973b:311-316).

This modification of the Brunschvicgian intellectualism sets Piagetian epistemology apart from both mentalist intellectualism and empiricism. If we attempt to interpret it within the mentalist intellectualism/empiricism polarity that has characterised the main body of modern epistemological development we will inevitably distort it in one way or another.

The kind of intellectualism that Piaget developed in his modification of the Brunschvicgian base is, I suggest, best described as an abstractive intellectualism that has important affinities with the abstractive intellectualism earlier identified in Aristotle. Some of these affinities have been discussed in detail already in section 2.3 above.

This does not mean, of course, that Piagetian epistemology is simply a revived Aristotelianism. Piagetian epistemology is a decisively modern epistemology framed within a 20th century framework of thought. It is, however, a type of epistemology that, allowing for the significant differences that different historical contexts have made in the shaping of the epistemologies, shows strong affinities with the abstractive intellectualism of Aristotle.

The search for an epistemology with a firm empirical base that nevertheless is not empiricist led Piaget to postulate that the kno-

wing subject acquires empirical data by a process of abstraction - what he called "empirical abstraction". On this view the acquisition of empirical data is not a matter of the direct sensory registration of data but requires the active intervention of the intellect to abstract the data from the total field of sensory experience. Cognitive data is not sense data but data intellectively abstracted from sensory experience. The cognitive objects by which the subject-independent material reality is known are not sense-data but abstracted intelligibles. There are significant differences between Aristotle and Piaget, of course, in the way this abstractive process operates, but they are agreed in claiming the intervention of such a process in the acquisition of empirical data by the subject.

Dan (1971:40) has recognised the parallel with Aristotle in Piaget's empirical abstraction as did Piaget himself (Piaget,1973b:9). Both appear to have missed the no less clear parallel between the logico-mathematical structuring activity of the subject - Piaget's epistemic subject - and Aristotle's active intellect, particularly as expounded in Aristotle's De Anima (1928:430).

For Aristotle, intellect (vous), which in its essential nature is activity (ἐνεργεια), immortal and eternal, is the co-ordinating principle that gives form to an amorphous matter and assures the intersubjective universality of knowing subjects. Parallel to this Aristotelian eternal, active intellect Piaget proposes the atemporal epistemic subject, the activity of the subject directed by universal logic inherent in the subject, that, by its logico-mathematical co-ordinative structures gives form to undifferentiated empirical reality (Piaget,1970:45,46; 1981:187,188).

Once again, there are, of course, differences between Piaget and Aristotle, not least of which is their contrasting conceptions of "activity", but the parallels in the role assigned to a universal

atemporal intellectual activity are none the less striking. An important difference between Piaget and Aristotle is the mathematical character of the governing principle of the intellect in Piaget. This modifies the Aristotelian affinities in a platonizing way that has historical parallels in Xenocrates and Speusippus. See the discussion by Merlan (1975:34-58).

One further comparison that should be noted concerns the determined effort of Piaget to avoid ontological dualism. The basic structure of his epistemology built as it is around interaction of subject and object, form and content, logico-mathematical structures and empirical reality is loaded with dualities that, in the absence of a transcending unifying principle, implies an ontological dualism. The threat of dualism is increased when we recognise that these dualities arise from two distinct sources. One side of the dualities arises from the subject as living organism while the other side arises from physical reality.

Piaget attempts to escape the resultant dualism by postulating a unity of life and physical reality in the living organism; while the organism embodies life it has its roots in the physical-chemical world. Physical reality is not only the world external to the subject; the living subject is part of this physical reality and as such is an object of its own knowing. The roots of the subject's thought in the subject's physical-chemical structure, which is identical to the physical-chemical structure of physical reality external to the subject, ensures agreement between the mathematical structures constructed by the subject and physical reality. (Piaget, 1973b:327-346; 1983:173).

This is well and good. That the living organism, including the human subject, itself has a physical-chemical structure that shows a continuity with the material world to be known external to itself is an important insight.

However, this still leaves unanswered the question: What is the original unifying principle that secures the unity of the organism? Since Piaget regarded Life as God it would be natural to conclude that Life is the original unifying principle, but Life itself originates from physical reality. How can it be the original unifying principle of that which engenders it?

Is it then physical reality that is the original unifying principle engendering Life as the instrument of its own self-conquest? That might suffice except that it would require a physicalist reductionism such as Piaget vigorously opposed. Life would be reduced to a property of physical reality.

Perhaps then we can find in logic the necessary unifying principle, a choice that is tempting because of the unifying role logic plays in cognition. But if we were to take this as the original unifying principle we appear to be faced with a logical reductionism and Piaget abjured all forms of reductionism. Besides, we must then lose the autonomy of those other higher level human activities - moral, aesthetic, fiduciary - subordinating them to the logic of cognition whereas Piaget clearly maintained the parity of these various higher level activities in a rational co-ordination that is achieved by the human subject that, in its complete subjectivity, transcends them all.

With this we seem to have exhausted the candidates for a single ontological unifying principle. It appears, then, that Piaget deceived himself if he thought he had escaped ontological dualism by postulating the solidarity of Life and physical reality.

No doubt this was made easier by his lifetime preoccupation with epistemological problems so that ontological questions were only considered peripherally to the epistemological problems. Epistemologically the logic of Life provided a powerful and comprehensive unifying principle such that, while the attention is focussed on the epistem-

ological questions, with ontological questions peripheral to these, it is easy to sustain the illusion that the epistemological unity is paralleled by an ontological unity.

As we shift our attention to a more concentrated critical scrutiny of the ontological questions, however, it becomes apparent that the dualities that play such a decisive role in Piagetian epistemology create an unresolved tension in the underlying ontology, a tension for which there is no apparent solution other than an ontological dualism.

As noted in my earlier study of Piaget (1982:80) his anthropology also exhibits a dualism consisting of a temporal individual subject, bound to the here and now, and an atemporal epistemic subject that transcends the here and now.

The later recognition (Piaget,1981:188) of a "psychological" subject distinct from both "individual" and "epistemic" subjects does not appear to affect this dualism. The "psychological" subject, as object of psychological studies, like the individual subject is "temporal and causal" representing those properties of the temporal subject common to all individuals; "... psychology is not merely the science of the individual, but of man in general and more especially of the <subject> to the extent that it is universal." (Piaget,1966-7:15).

"Individual" and "psychological" subjects, then, represent the individual and universal properties of human temporality; the "epistemic subject" is atemporal. The anthropological dualism of temporal and atemporal remains.

2.12 CONCLUSION

Whatever our final evaluation of the contribution of Jean Piaget one thing is certain: He has presented us with a full-fledged epistemological alternative that deserves to be taken seriously by all who are seriously interested in contemporary epistemological discussion.

This epistemology inherits from Brunschvicg a form of rationalism in

which the a priori governing principle consists neither in the content of an a priori conceptual structure nor in an a priori method but in a dynamic ordering principle internal to the subject's activity; a dynamic ordering principle that, in Piaget as well as Brunschvicg, has a mathematical - or as Piaget would say "logico-mathematical" - character.

Piaget's dissatisfaction with the idealism of Brunschvicg - a dissatisfaction that appears to be, in part at least, due to Piaget's biological interests and training - led him to develop his rationalism in terms of an abstractive intellectualism with a constructivist interaction between knowing subject and empirical objects external to the subject.

It is common among contemporary Piagetians to regard constructivism as the most fundamental feature of Piaget's epistemology. This is a view for which support can be found from Piaget himself (e.g. Piaget, 1981:5) and undoubtedly a form of constructivism is a key feature of Piagetian epistemology.

Nevertheless an analysis of his epistemology leads me to the conclusion that, as an epistemological type, it is more accurately described as an abstractive intellectualism with the undoubted constructivism qualifying this abstractive intellectualism. As an abstractive intellectualism Piagetian epistemology has close affinities with Aristotle; its development of this in terms of constructivist interaction, as well as in the mathematical character of its governing principle, modifies these basic Aristotelian affinities.

Finally, Piagetian epistemology is developed within a dualist ontological and anthropological framework in which an attempt is made to isolate the knowing activity of the subject from other features of subjectivity.

It is clear that Piaget has done a lot more than present a develop-

mental psychology masquerading as epistemology. He presents us with a systematic epistemology as creatively rich and suggestive as any that has been developed in this century. Contemporary philosophical epistemology will remain seriously impoverished while ever Piagetian epistemology remains relegated to the fringes of epistemological discussion noticed only in the fragmentary, ad hoc references that characterise the treatment Piaget receives, if at all, by philosophers in the Anglo-Saxon world.