

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 Vygotsky 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 epistemology 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 organization 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 (García, 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 occurred 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 occurrence 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 neglected 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 architectural plan and on the other hand must employ a plan that fits the materials to be used.

The constructive cognitive processes of Piagetian 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 accompanying 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 unparalleled 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 Brunshvicg'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" (Brunshvicg, 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 accustomed 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 Brunshvicg 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 available 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-ordination. (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 an 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 & Garcia, 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 "Weltanschauungen 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 functional invariant. The framework constrains the development of knowledge by specifying 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-

measurability. 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 conceptual 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 worthwhile 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 Brunshvicgian 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 qualification 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 coordinated 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 Brunshvicgian 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 Brunshvicgian 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 Brunshvicgian 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 intellectually 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 coordinative 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 Brunshvicg 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 Brunshvieg, has a mathematical - or as Piaget would say "logico-mathematical" - character.

Piaget's dissatisfaction with the idealism of Brunshvieg - 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.