From here he proceeds to show that this knowledge can apply either to the universal whole (which contains its parts potentially) or to the integral whole (be it sensible or intelligible), since both kinds of "wholes" can be known, but only confusedly as long as the parts are not known distinctly.

> Sic autem potest cognosci tam totum universale, in quo partes continentur in potentia, quam etiam totum integrale; utrumque enim totum potest cognosci in quadam confusione, sine hoc quod partes distincte cognoscantur.[27]

In order to know the universal whole distinctly would demand that one know the less common, that is to say, "animal" as "rational" and as "brute": "cognoscere autem animal distincte est cognoscere animal inquantum est animal rationale vel irrationale; quod est cognoscere hominem, vel leonem."[28]

Saint Thomas continues the article by showing that this same principle applies on the sense level as well as on the intellectual level. To do this he uses one of the same signs Aristotle presented in the Physics — the one concerning common sensible knowledge. He says that we judge the more common before the less common in both the instances of place and time. With respect to place, when an object is seen at a distance one judges it as a body before it is recognized as animal, and as an animal before it is judged a man, and man before it is judged a Socrates or Plato.

> Secundum locum quidem, sicut cum aliquid videtur a remotis, prius deprehenditur esse corpus quam deprehendatur esse

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[27] Ibid.

[28] Ibid.

> animal; et prius deprehenditur esse animal quam deprehendatur esse homo, et prius homo quam Socrates vel Plato.[29]

Similarly, according to time, a child can distinguish man from non-man before he distinguishes this man from that. To support his claim he quotes Aristotle's example that all children call all men "father" and only later is able to distinguish his "father" from among many.

> Secundum tempus autem, quia puer a principio prius distinguit hominem a non homine, quam distinguat hunc hominem ab alio homine.[30]

He concludes these ideas by saying that he who knows a thing indistinctly is in a state of potentiality with respect to the principle of distinction just as one who knows a genus is in a state of potentiality with respect to the difference.

At this point he concludes the argumentation by saying that since intellectual knowledge follows from sense knowledge, and that knowledge of the individual singular is prior to the knowledge of the universal, nevertheless what is first known about the object (be it on the sense level or the intellectual level) is the more common element and then the less common element. Or, in other words, we may say that our first knowledge is of the more common (i.e., a certain whole) but it is known only in a vague and confused way

With these remarks we conclude the first part of our chapter which was concerned with three things: preliminary remarks concerning the principle as found in the Physics, an explanation of the principle as such and lastly Saint Thomas' mode of

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[29] Ibid.

[30] Ibid.

presentation in I, q. 85, a. 3. We are now ready to present three examples of Aristotle's theory.

THREE EXAMPLES ILLUSTRATING ARISTOTLE'S THEORY

"Nature"

The first example is that of "nature". Although we shall only summarize the main ideas Aristotle used in defining "nature", they shall be adequate to indicate that he recognized the vagueness and confusion in our knowledge, whether "nature" be considered as an integral whole or as a universal whole.

We shall begin with a very important observation, which Aristotle makes in the course of the discussion, but which we feel ought to be recognized by all from the very outset, namely, that it is absurd to attempt to prove that nature is. He argues in this fashion: there are so many things of this nature that anyone who attempts to prove that nature is shows himself to be one who cannot distinguish between what is self-evident and what is not.

> Quod autem est natura tentare demonstrare, ridiculum est. Manifestum enim est quod huiusmodi rerum sunt multa: demonstrare autem manifesta per immanifesta, non potentis iudicare est propter ipsum et non propter ipsum cognitum.[31]

Saint Thomas, commenting on this passage, brings Aristotle's thought into relief. First, he repeats the same idea:

> Velle autem demonstrare manifestum per non manifestum, est hominis qui non potest iudicare quid est notum propter

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[31]Saint Thomas, In II Phys, l. 1, caput n. 96 (Aristotle Physics, II, ch. 1, 193a 1-5).

> se, et quid non est notum propter se.[32]

Then he makes the following distinction:

> Naturam autem esse, est per se notum, inquantum naturalia sunt manifesta sensui. Sed quid sit uniuscuiusque rei natura, vel quod principium motus, hoc non est manifestum.[33]

Thus we are to conclude that all men recognize that nature is but the knowledge of what nature is is difficult since it is not per se nota. To come to a definition of nature Aristotle begins with the common knowledge of what all men mean by the term "nature". He realizes that all men recognize the difference between natural things and artifacts: "eorum quae sunt, alia quidem sunt natura, alia vero propter alias causas."[34] That is to say, man sees natural things as realities which "come to be" not by some extrinsic principle but rather by an intrinsic principle. Three actions: change of place, growth and alteration are commonly held as the manifestations of this intrinsic principle.

> Quae quidem enim natura sunt, omnia videntur habere in seipsis principium motus et status; haec quidem secundum locum, ... secundum augmentum et decrementum, ... secundum alterationem.[35]

Thus Aristotle defines nature (as an integral whole) as an intrinsic principle of movement and rest belonging to the reality in itself and not through some

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[32]Saint Thomas, In II Phys., l. 1, n. 148.

[33]Ibid.

[34]Ibid., caput n. 92.

[35]Ibid.

accidental cause. He says,

> Est igitur natura principium alicuius et causa movendi et quiescendi in quo est primum per se et non secundum accidens.[36]

To this point one knows that nature is and one has a definition of ~~motion~~ considered as an integral whole. However this same integral whole can be regarded as a universal whole (containing potential parts) and thus one can continue further determining the very nature of the principle. Such an investigation would determine whether nature should be identified with either one or all of the basic principles in created reality. Aristotle considers the composite itself, matter, and form each in their turn, and, after a careful discussion of each, concludes that nature most properly is said of form. Saint Thomas presents the reasoning thus:

> Posset autem aliquis credere quod quia materia dicitur natura et etiam forma, quod compositum possit dici natura; quia substantia dicitur de forma et materia et de compositio.
>
> Sed hoc excludit dicens quod compositum ex materia et forma, ut homo, non est ipsa natura, sed est aliquid a natura; quia natura habet rationem principii, compositum autem habet rationem principati.
>
> Ulterius autem ex ratione praemissa procedit ad ostendendum quod forma sit magis natura quam materia; quia unumquodque magis dicitur secundum quod est in actu, quam secundum quod est in potentia. Unde forma, secundum quam aliquid est naturale in actu, est magis natura quam materia, secundum quam est aliquid naturale in potentia.[37]

From the above discussion one sees that Aristotle began with the

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[36]Ibid., n. 93.

[37]Saint Thomas, In II Phys., l. 2, n. 152-3 (underscoring mine).

realization that nature is, formulated a definition of nature as an integral whole based on the common knowledge possessed by all men and then proceeded to a definition of nature as a universal whole.

Thus, to say that nature is most properly identified with form is far from the original knowledge with which one began, i.e., a coming forth from nature or by nature. However, if one follows Aristotle's argumentation (which has only been outlined here) one will see that the final conclusion is but the development of the knowledge possessed in a common conception. It is true to say that this statement: "form claims the greatest title to nature" would be meaningless if presented to someone first and in preference to that which he knew by way of common conceptions. But this statement is not presented as the first meaning; it is rather the term of a long and careful analysis wherein one moves from nature as man first knows of it to nature as it is in itself.

Having arrived at this point in the investigation the remaining task would be to make precise the various kinds of "forms" which are responsible for nature being found in all its variations. Such an investigation would be equivalent to studying the subjective parts or species of the universal whole. The product of such an endeavor would be to possess a clear and precise knowledge of every species falling under the definition already established of "natural things".

Three observations are in order at this time with respect to the universal as an integral whole which is capable of being defined. First, notice where one finds the real or essential definition in Aristotle's theory. He began with a common conception which all men hold (i.e., that there is something within which causes life and

motion) and then progressed gradually to the point where he would identify nature most properly with form. This procedure is far from Descartes' idea that once the knowledge of a nominal definition was possessed one had sufficient clarity as well as certitude to guarantee a demonstration a priori. Secondly, one begins to observe that there is a certain distance between common conceptions and proper conceptions which makes the formation of a proper conception (a definition) a most difficult task. Thirdly, having reached some degree of clarity and certitude about the "nature" as an integral whole the task then to be accomplished would be to determine the proper definition of nature as it applies to each species or subjective part of the integral whole.

"Motion"

The second example is that of "motion"[38]. To do Aristotle justice one needs to study the first three books of the Physics since it deals with the principles of motion. Again, a sketch of his position must suffice, in order to situate the place of a proper definition.

Consequent upon the definition of "nature" as "the principle of motion and change" is an investigation into the nature of motion. Book III is devoted to motion and realities immediately consequent upon it, i.e., the infinite, time, place and the void.

Again Aristotle begins from common conceptions since in grasping "nature" one already has some idea of "motion". To prepare for the real or essential

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[38]It behooves us to examine Aristotle's treatment of motion very carefully since it was this definition that Descartes criticized so severely in Règle XII. See Part 1, chapter 1, footnote 36.

definition he treats of certain ideas which are requisites for the study. He employs a process of division to show that everything is either in potency or in act. These are the most fundamental divisions of being. Thus motion will be defined in terms of these since they are prior to all other divisions. He reasons in this fashion: motion is not in potency as potency since potency is only the capacity to be moved, nor is motion in act as act since the change would have already taken place. Thus motion must be between potency and act (i.e., the act of transition), or as Aristotle says: "the act of a thing in potency". Saint Thomas states it thus:

> Considerandum est igitur quod aliquid est in actu tantum, aliquid vero in potentia tantum, aliquid vero medio modo se habens inter potentiam et actum. Quod igitur est in potentia tantum, nondum movetur: quod autem iam est in actu perfecto, non movetur, sed iam motum est: illus igitur movetur, quod medio modo se habet inter puram potentiam et actum, quod quidem partim est in potentia et partim in actu; ut patet in alteratione.[39]

Hence Aristotle claims motion to be the act of a thing existing in potency insofar as it is in potency: "sed potentia existentis cum actu ens agat aut ipsum aut alius, inquantum mobile, motus est."[40] Now it is precisely because motion is characterized by this imperfect state that it is extremely difficult to define. Saint Thomas makes this comment in Book III, 1, 3 of the Physics.

> Et quod sit actus imperfectus ex hoc patet, quod illud cuius est actus, est ens in potentia, ... Et ideo difficile est accipere quid sit motus.[41]

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[39]Saint Thomas, In III Phys., l. 2, n. 285.

[40]Ibid., caput n. 197. (Aristotle, Physics, III, ch. 1, 201a 10-12).

[41]Saint Thomas, In III Phys., l. 3, n. 296.

To substantiate such a claim, that the fact of movement is most certain but that it is most difficult to know what it is in itself, one need only examine the concept of motion held by the early philosophers. The two classic examples: Parmenides and Heraclitus. Parmenides, finding motion such a difficult reality to understand, denied its existence claiming the undeniable evidence provided by the senses to be only opinion. Heraclitus, to the contrary, seized by the undeniable reality of motion, claimed that all was motion — that it was the very heart of reality. As for ourselves, we would scarcely be inclined to accept Aristotle's definition since it seems so remote from that which we first grasp as motion if it were presented as the first and initial definition of motion. However, Aristotle never intended that this proper definition be given as a substitute for that which one first knows of motion. His definition is to be accepted as the fruit and completion of that which one grasps only imperfectly in common knowledge. Again there is proof of Aristotle's position that one begins with what all men commonly hold and can verify in experience. Wiggle your finger. There is motion. But what motion is in itself comes only after a long and arduous investigation.

It must also be remembered that this is the definition of motion considered as an integral whole. Should one view motion as a universal whole (containing many kinds of motion as potential parts), then there would be a certain degree of vagueness and confusion still present with respect to the various species of motion until their nature was known distinctly.

"Soul"

The third and last example is drawn from the De Anima. In the opening paragraph Aristotle announces his aim — to discover the nature of the soul and all the

accidents belonging to it. "Inquirimus autem considerare et cognoscere naturam ipsius, et substantiam, postea quaecumque accidunt circa ipsa."[42] Then he immediately adds that it is very difficult to arrive at any knowledge that is trustworthy concerning the soul. He says: "omnino autem et penitus difficillimorum est, accipere aliquam fidem de ipsa."[43] Keep in mind the distinction he has made between the fact that the thing is and what the thing is. Saint Thomas comments on this distinction with respect to the soul in this wise:

> secundum hoc scientia de anima est certissima, quod unusquisque in seipso experitur se animam habere; et actus animae sibi inesse, sed cognoscere quid sit anima difficillimum est.[44]

The actual experience, common to all, of acts flowing from this principle affords the greatest possible assurance that it is. No one is ever mistaken in this. But it is another matter to decide what the nature of the principle is in itself.[45] Aristotle begins the investigation with what all men commonly understand by the word "soul" – "that by which one moves and senses". Movement and sensation are the characteristics that distinguish the animate from the inanimate.

> Principium autem quaestionis praeponere quae maxime videntur ipsi inesse secundum naturam. Animatum igitur ad inanimato in duobus maxime differre videtur, motu et sensu.[46]

Aristotle begins his investigation of the soul by carefully examining the

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[42]Saint Thomas, In I De Anima, l. 1, caput 402a 6.

[43]Ibid., 402a 10.

[44]Saint Thomas, De Veritate, q. 10, a. 8, ad. 8.

[45]Saint Thomas, De Veritate, q. 10, a. 8, ad. 2.

[46]Saint Thomas, In I De Anima, l. 3, caput 403b 25-30.

opinions of his predecessors in order to adopt what is right in their conclusion and guard against their mistakes. He says,

> Intendentes autem de anima, necesse est, simul dubitantes de quibus bene dubitare oportet pertranseuntes, priorum opiniones comprehendere, quicumque aliquid de ipsa enuntiaverunt; ut bene quidem dicta accipiamus; si vero aliquid non bene, hoc vereamur.[47]

Book I is devoted to the opinions of these men. What is Aristotle's conclusion after studying each of these? That those who identified the soul with either one of these activities or both failed, since the definition does not apply to all souls in general nor to all parts of any one soul.

> Omnes autem et qui ex eo quod cognoscit et sentit anima ea quae sunt, ex elementis dicunt ipsam, et quam maxime motivum, non de omni dicunt anima. Neque enim sensitiva omnia motiva. Videntur enim esse quaedam animalium, manentia in loco, et tamen videtur hoc solo motu movere anima animal. Similiter autem et quicumque intellectivum et sensitivum elementis faciunt. Videntur enim plantae vivere, non participantes loci mutatione, neque sensu, et animalium multa intelligentiam non habere. Si autem aliquis et haec segregaverit, posueritque intellectum partem aliquam animae, similiter autem et sensitivum, neque utique sic dicent de omni anima, neque de tota, neque utique de una.[48]

Thus the paradox: the soul insofar as it exists affords the greatest certitude possible, yet what it is by nature is a most difficult reality to grasp. All men accept the nominal definition: that according to which one moves and senses. However, a precise knowledge of this principle or source of these movements still remains very vague.

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[47] Ibid., l. 2, caput 403b 16-24.

[48] Saint Thomas, In I De Anima, l. 12, caput 410b 16-25.

Clarification comes only after a long and careful study. Here is a striking example no only of certitude and confusion co-existing simultaneously but the difficulty involved in the formation of a proper concept or definition of "soul" as an integral whole.

With Book II Aristotle sets out to formulate his own definition of the soul. He begins by stating that he will reject all that his predecessors have said concerning the soul and will make a fresh start endeavoring to give a precise answer to the question.

> Quae igitur a prioribus tradita de anima sint, prius diximus. Iterum autem nunc tamquam ex principio redeamus, conantes determinare quid sit anima, et quae sit communissima ratio ipsius.[49]

One might ask, at this juncture, if there is a certain parallel between Descartes and Aristotle in this respect. Recall that Descartes likewise wished to reject all previous knowledge in order that it might be re-grounded on a firm and evident basis. Upon reflection, however, one realizes that while Aristotle rejected all the theories proposed by his predecessors concerning the soul he did not reject their starting point. That is to say, he began from the same vantage point, namely, a common conception, held by all men, concerning the soul as that by which a thing moves and senses. Descartes, on the contrary, not only rejected previous theories but even the starting point in an attempt to re-ground knowledge on a certain and evident bases.

To return now to the development of Aristotle's thought. He establishes his definition by means of division. The division of substance into matter, form and the composite demands a knowledge of the Physics wherein he reasons to this threefold division. Likewise, to say that matter is attached to potentiality, while form is

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[49]Saint Thomas, In II De Anima, l. 1, caput 412a 1-6.

attached to actuality, is using a principle drawn from the philosophy of nature. Since there are bodies that are not animate, he concludes that the soul is not a body, hence not to be identified with matter. Thus the soul must be related to form and be identified with actuality. From this he draws his definition that the soul is the first actuality of a natural body having in it the capacity for life:

> Si autem aliquid commune de omni anima oportet dicere, erit utique primus actus corporis physici organici.[50]

Such a definition adequately describes the "soul" considered as an integral whole. In the remainder of the De Anima Aristotle treats the potential parts (i.e., the nutritive and sensitive souls). In other words he is seeking to clarify the notion of soul insofar as it is a universal whole possessing parts that are only known indistinctly and confusedly.

All previous observations regarding Aristotle's procedure obtain in this example, to which another must be added. In this instance we have the most striking proof of the validity of Aristotle's position. He does not demand that one renounce or forsake the first knowledge one possesses. His definition of the soul as "the first act of the body" retains all that man grasped originally, but grasped only vaguely and confusedly, since the first experience of the soul is something intimately connected with the body. In recognizing one's soul one necessarily recognizes one's body wherein the soul operates. Thus his definition is the fruition and completion of what was first known. How different from Descartes! Recall that Descartes demanded that man hold a definition of the soul completely at odds with what he first experienced of his soul.

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[50] Ibid., 412 b 8.

In Aristotle's position the proper definition clarifies what man originally grasped in common knowledge; whereas in Descartes' position man is asked to reject that which he had grasped with certitude, thus leading him to accept a definition no longer verified in common experience.

CONCLUSION

In order to recapitulate and at the same time link these considerations concerning the second portion of Aristotle's principle to the first portion treated in the previous chapter, let the following remarks be made.

This chapter treated the nature or quality of man's knowledge as he moves from the more known to the less known. Aristotle stated the matter very succinctly by saying that man proceeds from vagueness and confusion toward clarity and distinctness. Such is the case, since that which is first known is a whole but it is known only vaguely and confusedly. He substantiated his claim by employing three examples: one of a sensible integral whole, a second of an intelligible integral whole, and a third of a common sensible. In all three cases that which was first known was a certain confused whole, after which a clearer and more distinct knowledge of the reality in question was forthcoming.

The reduction of vagueness and confusion to clarity and distinction is based on the double aspect under which a reality may be considered a "whole". Aristotle recognized that the universal concept abstracted from sensible material reality to be a "whole". In one respect it possesses the qualities of an integral whole; in another respect it possesses the qualities of a universal whole. In each instance Aristotle claimed a certain movement from vagueness and confusion toward clarity and distinctness.

With respect to the integral whole one finds a progression from the vagueness and confusion characteristic of common conceptions to the clarity and distinction of a definition of the given genus (i.e., the integral whole). Hence there is a certain clarity and precision about the whole with respect to its causes, principles and elements. Recall the definition Aristotle formulated of "nature", "motion" and the "soul". In each case he has provided an accurate and precise definition for the nature involved taken as a "whole". However, as has been shown in our analysis, this same universal concept may be seen under another aspect of its universality, namely, as a universal whole. Under this aspect of a universal whole we recognize that it contains subjective parts (i.e., species) which, when not alluded to, investigated and studied, are known only confusedly and indistinctly. Precise and distinct knowledge in this area is attained when each species is known perfectly and completely.

In the last section of this chapter we selected three examples drawn from Aristotle's own works which would illustrate the theory he propounds. In each instance, be in "nature", "motion" or "soul", Aristotle began the investigation with a common conception and proceeded to clarify the integral whole (i.e., the genus) as an integral whole. However, such a definition left something to be desired concerning the different species within the respective genus. That is to say, vagueness and confusion still surrounded the notion if it was viewed as a universal whole, hence possessing subjective parts which were only potentially known. The task that then lay before Aristotle was to study and investigate and reach a precise and accurate knowledge concerning each species.

With these remarks we conclude our treatment of Aristotle's general principle

governing the common mode of procedure followed by man in his quest for knowledge. We have attempted to show how Aristotle understood the two aspects of his principle: first, that man proceeds from the more known to the less known and secondly, this procedure is one in which man moves from vagueness and confusion toward clarity and distinction. Hence we are now in a position to turn to an investigation of the genetic psychology of Jean Piaget in order that we might determine if and in what measure a rapport might be established between his thought and that of Aristotle.

PART TWO

JEAN PIAGET'S THEORY ON THE DEVELOPMENT OF CONCEPTS

Chapter 1

PRELIMINARY CONSIDERATIONS

I. GENETIC PSYCHOLOGY, LOGIC AND EPISTEMOLOGY

II. THE CLINICAL METHOD

III. VOCABULARY

PART TWO

Chapter 1

PRELIMINARY CONSIDERATIONS

The psychological research of Jean Piaget attempts to reveal the nature of intellectual activity by determining the conditions under which it develops in children. Piaget maintains that it is by understanding how concepts are formed in children that one can explain the nature of intellectual activity in the adult. From the very beginning of his studies in zoology he dreamed of establishing an epistemology based exclusively on the notion of development. He says,

> au temps de nos études en zoologie, un double intérêt pour les problèmes de variation et d'adaptation et pour les questions logiques et épistémologiques nous a fait rêver de construire une épistémologie biologique fondée exclusivement sur la notion de développment.[1]

However, he makes it very clear that he does not pose the problem on a philosophic level by demanding how does knowledge in general begin; rather he confines himself to the domain of observation and experimentation by asking how particular concepts come to be.[2] Forty years of research, which Piaget claims marks only a beginning,

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[1]Piaget, Jean. Introduction à l'épistémologie génétique, (Paris: P.U.F. 1950), preface.

[2]Piaget, J. "Genetic Psychology and Epistemology", Diogenes, 1953, Vol. 1, p. 51; cf. Introduction à l'épistémologie génétique, p. 12.

furnish abundant studies and experiments dealing with the formation of specific concepts together with an explanation of the mechanism which produce them. Recognizing that certain concepts and certain operations characterize intellectual activity at various stages of development, Piaget sets forth an interpretation of the nature of knowledge, of intellectual activity and of the intellect itself based on the sum total of these findings.

The task of this portion of our thesis is to present the principle upon which his theory rests. In this chapter we will present certain general considerations which are relevant to a proper understanding of Piaget's thought. The two subsequent chapters will deal specifically with the principle which he has formulated as a result of his empirical studies. Chapter 2 will present his interpretation of the principle which may be stated as follows: "toute genèse part d'une structure et aboutit à une structure" and "toute structure a une genèse." This passage from one structure to another always implies a transition from the global and confused to the clear, the distinct and the coordinated. Piaget describes this movement as one "d'indifférenciation chaotique à ... différenciation avec coordination correlative." Chapter 3 will be concerned with presenting this aspect of the principle.

To draw maximum benefit from the investigation of Piaget's thought certain preliminary remarks must be made. We have chosen to make three remarks which seem indispensable if the reader is to appreciate the work of the Genevan psychologist. The first remark concerns genetic psychology as such and its relation to logic and epistemology; the second concerns the clinical method; the third concerns Piaget's vocabulary.

GENETIC PSYCHOLOGY, LOGIC AND EPISTEMOLOGY

In a recent volume Piaget defined genetic psychology as a study which seeks "à expliquer les fonctions mentales par leur mode de formation".[3] Or again, from an earlier work "la méthode génétique revient à étudier les connaissances en fontion de leur construction réelle psychologique, et à considerer toute connaissance comme relative à un certain niveau du mécanisme de cette construction".[4] The genetic method differs from a historical-critical method which is concerned with a study of notions already constructed and in use, since it (i.e., the genetic method) is concerned with the actual steps in the formation of a given concept.[5] It is primarily "La méthode génétique" because it "...se borne à étudier ces données de faits, en tant que processus d'accroissement des connaissances."[6] Thus the study of cognitive development from such an optic, according to Piaget, not only provides the unique and valid scientific approach in determining the nature of intellectual operations but it ultimately provides the only scientific knowledge of the nature of the intellect itself.[7]

Because the entire emphasis is on the genesis of concepts such synonyms as "qualitative", "functional", "operational", and "developmental" are often used to replace the term "genetic" since each conveys the idea that this type of psychology

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[3]Piaget, J. (avec B. Inhelder). La psychologie de l'enfant, p. 6; cf. Piaget, J. (avec P. Fraisse), Traité de psychologie expérimentale, tome VII: L'intelligence (Paris: P.U.F., 1963), p. 110.

[4]Introduction à l'épistémologie génétique, p. 13.

[5]Ibid., pp. 15-16.

[6]Ibid., p. 27.

[7]Ibid., p. 27 ff.

is concerned with the formation of concepts.[8]

Now Piaget makes a sharp distinction between logic and psychology. He claims that "logic is the axiomatics of reason"[9] since it facilitates the analysis of operations that have already been formed but it is of no value in discovering how these structures come to be.[10] The task of psychology is to seek the mechanisms by which the intellect arrives at these coherent structures which are then susceptible to logical formulation. Thus he declares that "la logique est une axiomatique de la raison dont la psychologie de l'intelligence est la science expérimentale correspondante".[11] Since an axiomatic system is purely hypothetical-deductive (i.e., it does not rely on recall to experience) it can never replace the corresponding experimental science.[12] As he says: "que la logique soit le miroir de la pensée et non pas l'inverse."[13] He is attempting to find out how one arrives at logic,[14] thus he is working toward a psychology of thinking wherein he shows the fundamental way the

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[8]The term "developmental" has been used extensively by John Flavell in The Developmental Psychology of Jean Piaget, (New York: D. VanNostrand Co., Inc., 1963).

[9]Piaget, J. La psychologie de l'intelligence, p. 37.

[10]Piaget, J. Logic and Psychology, (New York: Basic Books Co., 1957) p. xviii.

[11]La psychologie de l'intelligence, p. 37.

[12]Ibid., pp. 37-38; cf. Logic and Psychology, p. xvii.

[13]Ibid., p. 37.

[14]Ibid.

intellect proceeds prior to formulating any laws of reasoning.[15] To do this, he claims, one must turn to children in order to discover where, when and how the intelligence begins to appear. It is in children that one can observe the progressive development of mental activity from its most elementary forms to the logical reasoning of an adult acquired during the period of adolescence.

The line of demarcation between genetic psychology and genetic epistemology is not as clearly drawn as the previous distinction between logic and psychology. Piaget insists that he is not asking the question: how is scientific knowledge (taken as a whole) possible?, (which is a question of philosophy or classical epistemology), but rather a purely positive question: how do different concepts come to be; nevertheless it is true to say that it is an epistemological problem discussed on the level of genetic psychology. Miss Barbel Inhelder pointed this out saying:

> Piaget has, from the very beginning of his career, constantly posed questions of genetic epistemology. It is true that in their most general terms such questions as: "What is knowledge?" can give rise only to speculative controversy; but, if formulated in more restricted terms and in terms of genesis, questions such as "Under what laws does knowledge develop and change?" can be dealt with scientifically.[16]

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[15] Piaget's criticism of Aristotle rests in part on this point. He claims that Aristotle confounded logic and psychology (or as Piaget would say with the natural history of thought). See La psychologie de l'intelligence, p. 39 ff. One might ask: is Piaget familiar with Aristotle's treatment of the natural mode of human knowing as found in Physics I?

[16] Inhelder, B. "Some Aspects of Piaget's Genetic Approach to Cognition", cited in Thought in the Young Child, MONOGRAPH OF THE SOCIETY FOR RESEARCH IN CHILD DEVELOPMENT, edited by W. Kessen and C. Kuhlman, (Yellow Springs, Ohio: The Antioch Press), Vol. 27, n. 2, 1962, p. 19.

Thus despite the fact that Piaget attempts to develop an explanation of cognitive development by means of the scientific techniques of genetic psychology, this psychology tends to elaborate itself into an epistemology. This is manifest if we examine the description of genetic epistemology provided by Miss Inhelder.

> Research work in genetic epistemology seeks to analyze the mechanisms of the growth of knowledge insofar as it pertains to scientific thought and to discover the passage from states of least knowledge to those of the most advanced knowledge.[17]

Again with respect to the intimate link between genetic psychology and genetic epistemology, two remarks, drawn from the Dedham Conference,[18] are worth mentioning. The first remark touches the goal of Piaget as expressed in his more theoretical writings.

> If we accept the evidence of his theoretical writings – notably in the first chapter of the Origins of Intelligence, the last chapter of Construction of Reality, and all of Logic and Psychology, Piaget's conceptual goal is the statement of a theory of development (one may even say of organic change) that will be relevant to biological as well as psychological phenomena, that will have implications for the construction of logic and of science, and ultimately that will be the framework for a rapprochement between psychology and philosophy.[19]

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[17] Ibid.

[18] The Dedham Conference was held the weekend of April 29, 1960 under the auspices of the Committee on Intellective Processes Research founded by the Social Science Research Council. It brought together several American psychologists who have worked with or are interested in the work of Piaget. Such men as Flavell, Braine, Berlyne were participants. Barbel Inhelder represented Piaget at the meeting. The committee report was published under the title: Thought in the Young Child, MONOGRAPH OF SOCIETY FOR RESEARCH IN CHILD DEVELOPMENT (Ed. W. Kessen and C. Kuhlman), Vol. 27, n. 2, 1962.

[19] Ibid., p. 168.

This remark is adequately borne out if one reads Piaget's address to the XVIII Congrès International de Psychologie wherein he showed that genetic psychology with its epistemological dimension (or superstructure) is sufficient as the unique and coordinating discipline for all the other sciences.[20]

The second remark is a prophecy but it is not without significance.

> One prophecy the editors are willing to make about Piaget's speculations: they will have in time a shattering impact on the development of philosophy. Unless all signs are amiss, Piaget is the chief bandit in the theft of epistemology from normative philosophical treatment and its transition into a psychological specialty.[21]

CLINICAL METHOD

The "clinical method" consists in a free dialogue between the child and the experimenter which enables the experimenter not only to discover the answer a child will give in a certain situation but, by asking "why", to discover how the child justifies his answer. It is the justification which indicates the mechanism available to a child during a given period of development.[22] Such a procedure permits the experimenter "de dépasser la méthode de pure observation et, sans retomber dans les inconvenients du test, d'atteindre les principaux avantages de l'expérimentation".[23]

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[20]See Introduction, footnote 15.

[21]Thought in the Young Child, p. 170.

[22]For a comprehensive treatment of the "clinical method" as such see Vinh-Bang: "La méthode clinique" cited in Psychologie et épistémologie génétique, ed. by F. Bresson et M. Montmollin, (Paris: Dunod, 1966), p. 67 ff.

[23]Piaget, J. La représentation du monde chez l'enfant, (Paris: P.U.F., 1947), p. xiii. This introduction furnishes the first summary of Piaget's clinical method.

As Miss Inhelder explains:

> The method aims at an analysis of the different qualitative forms of intellectual elaboration. ... It is somewhat analogous to the experimental method used in studies of "problem-solving" in that it uses apparatus, and to the interview-method in that it involves discussion with the subject. This aspect of discussion plays an important role in that it enables the experimenter to grasp the type of reasoning that underlies the child's conduct.[24]

It is precisely this "free discussion" that marks the point of controversy. For Piaget it has a decided advantage since it

> consiste toujours à converser librement avec le sujet, au lieu de se borner à des questions fixes et standardisées, et elle conserve ainsi tous les avantages d'un entretien adapté à chaque enfant et destiné à lui permettre le maximum possible de prise de conscience et de formulation de ses propres attitudes mentales.[25]

For those trained in the behavioral and statistical tradition (as are the majority of psychologists in the United States) such "free discussion" has a twofold drawback. First, the flexible nature of the questioning prohibits the amassing of stable data. Secondly, there is a lack of statistical analysis with regard to the results.[26] Recognizing the criticism, Miss Inhelder still maintains, in agreement with Piaget, "that

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[24]Inhelder, B. (with B. Matalon) cited in Handbook of Research Methods in Child Development edited by Paul Mussen, (New York: John Wiley Co., 1960, p. 448. Cf. also Traité de Psychologie, p. 117.

[25]Piaget, J. Le jugement et le raisonnement chez l'enfant, (Genève: Delachaux et Niestlé, 3è édition, 1947), p. 7.

[26]Inhelder, B. Handbook of Research ..., p. 448; Cf. Bruner, J. "Inhelder and Piaget's Growth in Logical Thinking: a psychologist's point of view", British Journal of Psychology, 1959, 50, p. 363; Kessen, W. and Kuhlman, C. (eds.), Thought in the Young Child, p. 163.

by the means of the exploratory method, ... we believe we obtain a truer picture of the child's thought than we would have by the use of standardized tests which often involve the risk of missing unexpected and often essential aspects of the child's thought."[27]

Moreover, since the method aims at a qualitative rather than quantitative analysis, many psychologists have placed the findings of Piaget in a philosophical tradition rather than a psychological one.[28] However, many psychologists will admit that one cannot readily dispense with the vast body of empirical literature which Piaget has contributed to the study of child development. "He has added to our knowledge more facts about cognitive development than any other investigator."[29] "The Geneva School has told us more about the child's knowledge of the physical universe than any other researcher or school."[30]

VOCABULARY

Of great importance is Piaget's vocabulary. Neither time nor space permits an exhaustive treatment of terms but a few key words will be cited to facilitate the reader's grasp of Piaget's theory.

The term "stade" or stage of development often confuses a reader since

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[27]"Some aspects" ..., p. 21; cf. Tuddenham, R. "Jean Piaget and the World of the Child", American Psychologist, Vol. 21, no. 3 (March, 1966). p. 208-209.

[28]Cf. Isaacs, N. "Some Aspects of Piaget's Work", London, National Froebel Foundation, 1955, pp. 30-31.

[29]Thought in the Young Child, p. 168.

[30]Ibid., p. 170.

Piaget has used the term interchangeably for the major periods of intellectual development as well as for any sub-division thereof. In general "period" means a major level of attainment (in an order of successive stages) which possesses a certain degree of equilibrium and is "caracterisé par une structure d'ensemble qui englobe toutes les opérations du stade".[31] The term "stade" will refer to any sub-division of a major period. For example, children pass through four major periods of cognitive development: the sensorimotor period (birth to 1-1/2 - 2 years); the preoperational period (2 - 7 years); the concrete operational period (7 - 11 years) and the formal operational period (11 - 16 years). The sensorimotor period has six stages (or sub-divisions).

A "scheme" is defined as "les organisations sensori-motrices susceptibles d'application à un ensemble de situations analogues et temoignant ainsi d'assimilations reproductrices, ... récognitives, ... et généralisatrices".[32] Or, to simplify, a scheme is "une action particulière, accomplié par un sujet dans une circonstance donnée, et qui peut se généraliser dans des circonstances sembables".[33]

To grasp the meaning of "operation" one needs to contrast it with a "simple action" which is rigid, unilateral, and directed toward material objects.[34] Piaget

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[31]Notes distributed by Gerald Noelting, PhD. in a course entitled "Le développement de l'intelligence" taught at Université Laval 1965-66. Hereafter referred to as NOTES. Dr. Noelting, professor Genetic Psychology at Université Laval, completed his doctoral studies under Piaget and is a member of the Geneva School.

[32]Piaget, J. (avec L. Apostel et Mandelbrot). Logique et équilibre. ETUDES D'EPISTEMOLOGIE GENETIQUE, Vol. 2, (Paris: P.U.F., 1957), p. 46.

[33]Vocabulary distributed by G. Noelting, PhD. Department de Psychologie, Université Laval, 1966-67.

[34]Psychologie de l'intelligence, p. 16; Cf. Piaget, J. The Growth of Logical Thinking from Childhood to Adolescence, (New York: Basic Books, Inc., 1958), preface p. xiii.

defines an operation in this fashion: "nous nommerons opérations des actions interiorisées ou interiorisables, reversibles et coordonnées en structures totales".[35] Or again one finds at greater length an excellent comparison in Logic and Psychology.

> Psychologically, operations are actions which are internalized, reversible, and coordinated into systems characterized by laws which apply to the system as a whole. They are actions since they are carried out on objects before being performed on symbols. They are internalized, since they can be carried out in thought without losing their original character as actions. They are reversible as against simple actions which are irreversible. In this way, the operation of combining can be inverted immediately into the operation of disassociating, whereas the act of writing from left to right cannot be inverted. ... Finally, since operations do not exist in isolation they are connected in forms of structured wholes.[36]

The term "reversibility" is crucial to the understanding of Piaget. "Nous appellerons reversibilité la capacité d'exécuter une même action dans les deux sens de parcours, mais en ayant conscience qu'il s'agit de la même action."[37] Or again, "reversibility" is defined as "the permanent possibility of returning to the starting point of the operation-in-question".[38] Eventually Piaget will distinguish between two types of reversibility: first, that concerned with the object which he calls direct action and its inversion or negation; secondly, that concerned with the transformations which he

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[35] Logique et équilibre, p. 45.

[36] Logic and Psychology, p. 8. (underscorsing mine); Cf. Piaget, J. Growth in Logical Thinking from Childhood to Adolescence, (New York: Basic Books, Inc. 1958), preface p. xiii.

[37] Logique et équilibre, p. 44.

[38] The Growth of Logical Thinking..., p. 272.

calls reciprocity and its negation (or as he says its correlative).[39]

Lastly, consider two terms that are closely related, "structure" and "structure d'ensemble". Piaget conceives of a structure as interposed between function (i.e., characteristics of intelligent activity which hold true for all periods) and content which may vary or change with each stage. "Structures" are the organizational properties of intelligence, organizations created through functioning and inferable from the behavioral content whose nature they determine.[40] They are links between the invariant functions on the one hand and the variegated behavioral content on the other. Now structures at given periods have certain definite properties and Piaget refers to this kind of totality as a "structure d'ensemble". A "structure d'ensemble" is an "ensemble de relations se refermant sur lui-même"[41] and they correspond "à toutes les operations de l'intelligence à un niveau considéré"[42]. "Ces structures sont les formes d'équilibre ... et la structure d'ensemble présente des lois en tant que totalité par opposition aux lois des éléments particulièrs de ces structures."[43] As the theory of Piaget unfolds one finds "structure d'ensemble" governing the concepts that are formed as well as the mechanisms which regulate the passage from one period to another.

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[39]Ibid., p. 272; cf. Inhelder, "Some Aspects of Piaget's Genetic Approach to Cognition", p. 23.

[40]Flavell, J. The Developmental Psychology of Jean Piaget, p. 17.

[41]Vocabulary distributed by G. Noelting, Ph.D. during his course given at Université Laval, 1966-67.

[42]NOTES, p. 17.

[43]Ibid.

These remarks terminate our preliminary considerations concerning: the nature of genetic psychology; the procedure known as the "clinical method"; and Piaget's vocabulary. We are now ready to investigate the principle upon which Piaget's theory rests.

Chapter 2

TOUTE GENESE PART D'UNE STRUCTURE ET ABOUTIT A UNE STRUCTURE ET TOUTEX STRUCTURE A UNE GENESE

I. EXPLANATION OF THE PRINCIPLE

A. "Genesis", "structure", "equilibrium"

B. Assimilation, accommodation, adaptation

II. FOUR MAJOR PERIODS OF INTELLECTUAL DEVELOPMENT

A. Sensorimotor

B. Preoperational

C. Concrete operational

D. Abstract operational

Chapter 2

TOUTE GENESE PART D'UNE STRUCTURE ET ABOUTIT A UNE STRUCTURE ET TOUTE STRUCTURE A UNE GENESE

As has been pointed out in the previous chapter, Piaget's aim is to determine empirically how concepts are developed in order to discover the nature of intellectual activity and ultimately the nature of the intellect itself. To this end he has observed, experimented and interpreted data concerning intellectual activity in children. As a result many of the studies undertaken by Piaget and his colleagues deal with the formation of particular concepts while relatively few are specifically concerned with the theoretical presentation of the principles involved. Among his prolific writings the following are considered to be the best sources for the presentation of principles: La psychologie de l'intelligence, La naissance de l'intelligence (Chapter 1 and the conclusion), La construction du réel (conclusion), La formation du symbole (conclusion), Logic and Psychology, and Six études de psychologie. Hence it is from these works primarily that we have drawn material to present in this chapter.

The chapter will be divided into two major parts: the first part will provide the explanation of the basic principle of Piaget's theory; the second part will provide a sketch of the major periods of intellectual development according to Piaget.

In order to adequately present the principle we will make a twofold division. The first part will describe the principle in its widest dimensions, i.e., in terms of

"genesis", "structure" and "equilibrium". The second part will present the model upon which Piaget patterns his theory of cognitive development. He claims that the biological model of assimilation-accommodation-adaptation adequately describes the process of development in its genetic aspects. In sketching the four major periods of intellectual development we will indicate the structures that are formed at each of the successive periods, which Piaget interprets in terms of a mathematical model.

EXPLANATION OF THE PRINCIPLE

Genesis, structure, equilibrium

During a lecture given at Cerisy, France, in 1959, Piaget definitely stated the basic principle upon which his theory rests in this fashion: "toute genèse part d'une structure et aboutit à une structure" and conversely "toute structure a une genèse".[1] However, one must not conclude that the principle itself is of but recent origin. On the contrary, it has been the subject of thought and careful deliberation for many years.[2]

He maintains that the concepts as well as the capacity for logical operations found in the adult are neither innate in the child nor do they arise spontaneously by observing reality or reflecting upon self. Rather, they develop slowly over a long period of time. Or as he would say: they are gradually constructed by the child

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[1]Piaget, J. "Genèse et structure en psychologie de l'intelligence" cited in Congrès et Colloques, Vol. 9 sous le titre: Entretiens sur les notions de 'genèse' et de 'structure', Mouton et Cie., (Le Haye-Paris, 1965), p. 40, p. 42.

[2]Logique et équilibre, p. 27, footnote 1; cf. also pp. 94 ff; Introduction à l'épistémologie génétique, Vol. 1, introduction.

during the period of development from childhood to adolescence.[3] The formal logical reasoning pattern of an adolescent "ne tombe pas du ciel, elle a une genèse"[4].

> Le résultat le plus clair de nos recherches en psychologie de l'intelligence, c'est que les structures mêmes les plus nécessaires dans l'esprit de l'adulte, telles que les structures logico-mathématiques, ne sont pas innées chez l'enfant; elles se construisent peu à peu.[5]

These two aspects, the structure that is formed and the successive steps in its formation, cannot be disassociated. One may consider them separately in the logical order but they co-exist in the temporal order. To understand how concepts develop is as necessary to the understanding of intellectual knowledge as is the understanding of the content of the concepts (or structures) that are formed.

> Bref, genèse et structure sont indissociables. Elles sont indissociables temporellement, c'est-à-dire que si l'on est en présence d'une structure au point de départ, et d'une autre structure, plus complexe, au point d'arrivée, entre les deux se situe nécessairement un processus de construction, qui est la genèse.[6]

In the same conference given at Cerisy in 1964 Piaget declared that the relationship he now sees existing between "structure et genèse" has been drawn from

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[3]The word "construction" has a special meaning for Piaget. It is his way of expressing the child's ability to come to grips with reality, to reconcile his thinking with a new situation, to produce or develop a new concept or structure that will establish a state of equilibrium once again between the mind and external reality. This new structure incorporates the best of the previous concept and yet is enlarged to include a new situation.

[4]Six études de psychologie, p. 169.

[5]Ibid., p. 171.

[6]Ibid., p. 172.

years of experimentation and was not a pre-established hypothesis that he sought to verify.

> Elle (i.e., the conclusion regarding the relation between structure and genesis) m'a été imposée par l'ensemble des faits que j'ai récoltés depuis environ quarante ans en étudiant la psychologie de l'enfant. Je tiens à souligner que cette longue enquête a été menée sans aucune hypothèse préalable sur les relations entre la genèse et la structure.[7]

To claim that intellectual knowledge develops little by little over the years between infancy and adolescence avoids two extremes that have been held concerning the origins of knowledge: first, that it arises "ex nihilo"; secondly, it is innate.[8]

Piaget's experiments throw new light on the process by which knowledge is acquired. They reveal very clearly that knowledge does not arise "ex nihilo". There is always something which forms a kind of basis from which a certain degree of knowledge is forthcoming. He recognizes the role played by the external world, the need for bodily maturity and physical activity, and the importance of language or social communication.[9] These indispensable factors are at work constantly as the child tries to harmonize the way in which he conceives reality and how it is in itself.

As a psychologist Piaget could not accept the notion that ideas were innate nor that the intellect was a nascent power, fully developed and ready to operate. The concept of the intellect as a faculty capable of activity without any prior period

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[7]Ibid., pp. 167-168. (content of parenthesis mine).

[8]La psychologie de l'intelligence, p. 20 ff.

[9]Cf. Traité, pp. 149-150.

of development or growth was repugnant to him. As a psychologist he saw children who in the beginning years were in no way capable of intellectual activity and yet at the term of their development had acquired the power of logical reasoning.[10]

Now the question arises: what is the relation existing between genesis and structure since both are necessary, both play an indispensable role, yet both are dependent one on the other. To answer this question Piaget advances his equilibrium hypothesis because "la notion d'équilibre paraît avoir une valeur particulière pour permettre la synthèse entre genèse et structure"[11]. The specific characteristics of this notion of equilibrium will be seen in the subsequent section of this chapter.

Genesis, structure, and equilibrium are the terms in which he formulates his general theory. To acquire some insight into the meaning of these terms turn now to a consideration of the observations which led Piaget to formulate this principle.

Assimilation, accommodation, adaptation

Looking at the child with the eyes of an experimental scientist (trained in biology but tending toward psychology) he saw a living organism situated in a certain environment. It is from a beginning such as this that he proceeded to record observations.[12] This situation of a child reacting to and being acted upon his environment

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[10]Since we are limiting ourselves to a consideration of the principle involved in cognitive development we shall simply state Piaget's view on the nature of the intellect and shall not attempt a discussion, analysis nor an evaluation of his position.

[11]Six études de psychologie, pp. 173-174; cf. Logique et équilibre, pp. 95-96.

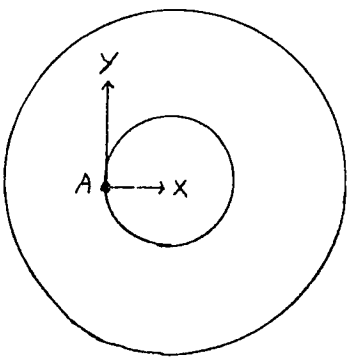
[12]Piaget's children, Laurent, Jacqueline, and Lucienne, served as his first subjects for experimentation. See La naissance de l'intelligence, (Neuchâtel: Delachaux et Niestlé, 1936).

is accepted as common knowledge by all men. Moreover it has philosophical implications: first, that there is an objective world, prior to and independent of the individual; secondly, that a living organism differs from the non-living organism; thirdly, that man's first knowledge is of the material world.

The infant, giving no sign of intellectual activity as such, either acts upon or reacts to his immediate environment. This led Piaget to say,

> L'intelligence ne débute ainsi ni par la connaissance du moi ni par celle des choses comme telles, mais par celle de leur interaction, et c'est en s'orientant simultanément vers les deux pôles de cette interaction qu'elle organise le monde en s'organisant elle-même.[13]

To explain this fundamental idea as clearly as possible Piaget says "une image fera comprendre la chose"[14].



> Soit l'organisme représenté sous la forme d'un petit cercle inscrit dans un grand cercle, lequel correspond lui-même à l'univers ambiant. La rencontre entre l'organisme et le milieu s'opère au point A et en tous les points analogues, à la fois les plus extérieurs à l'organisme et les plus extérieurs au milieu lui-même. Autrement dit les premières

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[13] La construction du réel chez l'enfant, p. 311.

[14] Ibid., p. 311.

> connaissances que le sujet puisse acquérir de l'univers ou de soi-même sont des connaissances relatives à l'apparence la plus immédiate des choses ou à l'aspect le plus externe et matériel de son être.[15]

The relation between the subject and his environment consists in a radical interaction so that awareness begins neither by awareness of objects nor awareness of the activity of self but from an undifferentiated state of knowledge of self and knowledge of reality. From such a beginning proceed two complementary movements: incorporation of all things to the subject and the accommodation of the subject to the things themselves.[16]

Piaget's formation as a biologist led him to interpret the interaction of subject-milieu in terms of a biological model of assimilation-accommodation. Biology acknowledges that a living organism has distinctive characteristics which separate it from non-living organism. These are: its composition as an organized structure of interdependent relationships, its attempt to conserve its structure by assimilating chemical and energetic elements from its environment, its reaction to the environment to preserve its equilibrium.[17]

> En effet, contrairement aux êtres inorganisés, qui sont également en équilibre avec l'univers, mais qui n'assimilent pas à eux le milieu, on peut dire que l'être vivant assimile à lui l'univers entier, en même temps qu'il s'y accommode, puisque l'ensemble des mouvements de tout ordre qui caractérisent ses actions et réactions à l'égard des choses s'ordonnent en un cycle dessiné par sa propre organisation autant que par la nature des objets externes.[18]

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[15] Ibid., pp. 311-312.

[16] La naissance de l'intelligence, pp. 363-364.

[17] Ibid., pp. 356-357.

[18] Ibid., p. 357.

The interplay of subject-milieu, of assimilation-accommodation found in the biological order is a model (or we might say a sign) of intellectual activity. If Piaget begins with any hypothesis it would be this one which he states himself: "Or, et c'est là toute notre hypothèse, il semble que le développement de l'intelligence prolonge un tel mécanisme au lieu d'y contredire"[19]. However he is very precise in pointing out both the similarity and the difference existing between biological and psychological assimilation. In La psychologie de l'intelligence he draws the distinction very sharply.

> Or, dans le cas de l'adaptation organique, ces échanges, étant de nature matérielle, supposent une inter-pénétration entre telle partie du corps vivant et tel secteur du milieu extérieur. La vie psychologique débute au contraire, nous l'avons vu, avec les échanges fonctionnels, c'est-à-dire au point où l'assimilation n'altère plus de façon physico-chimique les objets assimilés, mais les incorpore simplement dans les formes de l'activité propre (et où l'accommodation modifie seulement cette activite). On comprend alors que, à l'interpénétration directe de l'organisme et du milieu, se superposent, avec la vie mentale, des échanges médiats entre le sujet et les objets, s'effectuant à des distances spatio-temporelles toujours plus grandes et selon des trajets toujours plus complexes.[20]

Piaget conceives the whole of mental development, which ranges from perceptions and motor habits through memory and symbolic function to the operational activities on the concrete and abstract level, as a functional interaction between the

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[19]Ibid., p. 357. "The use of such models in no way implies that the psychologist has succumbed to logicism, that is, he has decided in advance that the real thought of the child should conform to the laws which govern logical and mathematical structures. ... More than twenty years of research have shown that cognitive development approximated these models without attaining them completely." Inhelder, B. "Some Aspects of Piaget's Genetic Approach to Cognition", p. 22.

[20]La psychologie de l'intelligence, p. 14.

subject and some aspect of his milieu taking place at greater and greater distances. The subject is gradually liberated from the perception here and now, from acting on things or aspects of things, to act upon his own activity and on all hypothetical situations.[21]

In the early stages which Piaget calls the "sensorimotor intelligence" there is only a foreshadowing on the biological level what will eventually be accomplished on an intellectual level. Now just as sensorimotor assimilation of things to the subject's schemata extends biological assimilation of the environment to the organism, so also it presages the intellectual assimilation of the object to the mind.[22]

On the rational or intellectual level "l'intelligence est, en effet, assimilation dans la measure ou elle incorpore à ses cadres tout le donné de l'expérience. ... c'est-à-dire de structuration par incorporation de la realité extérieure à des formes dués à l'activité du sujet"[23]. The primacy of assimilation is expressed in the primacy of judgment. However for Piaget "Juger, ce n'est pas nécessairement identifier, comme l'on dit parfois, mais c'est assimiler, c'est-à-dire incorporer une donnée nouvelle dans un scheme antérieur, dans un système déjà élaboré d'implications"[24].

With regard to intelligence and accommodation, Piaget says "Que la vie mentale soit aussi accommodation au milieu ambiant, cela ne peut faire davantage de doute"[25].

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[21] Ibid., p. 15.

[22] La naissance de l'intelligence, p. 358.

[23] La naissance de l'intelligence, p. 12.

[24] Ibid., p. 359.

[25] Ibid., p. 13.

However, "accommodation n'est jamais pure mais se manifeste nécessairement à l'intérieur d'un schème d'assimilation"[26].

Piaget summarizes this twofold relation of accommodation-assimilation in this fashion:

> Or l'adaptation de la raison à l'expérience suppose aussi bien une incorporation des objets à l'organisation du sujet qu'une accommodation de celle-ci aux circonstances extérieures. Traduits en termes rationnels, on peut donc dire que l'organisation est la cohérence formelle, que l'accommodation est l'"expérience" et l'assimilation l'acte du jugement en tant qu'unissant les contenus expérimentaux à la forme logique.[27]

This functional continuity which Piaget sees extending from the most elementary activities to the most systematic and abstract thought in no way prohibits the formation of increasingly complex structures.[28]

The third and last factor connected with the accommodation-assimilation model is that of "adaptation". In general adaptation can be considered as the state of equilibrium existing between subject and milieu (or any assimilation-accommodation situation). Three terms constantly appear in discussing this notion: "adaptation", "organization" and "equilibrium". To clarify one might say that adaptation has both

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[26]Piaget, J. La formation du symbole chez l'enfant, (Neuchâtel: Delachaux et Niestlé, 1946), p. 290; La naissance de l'intelligence, p. 359.

[27]La naissance de l'intelligence, p. 359.

[28]Piaget was gravely aware of the problem he faced in declaring that the same functioning was at work on physiological and on the rational level. Since physiological assimilation is wholly subjective how does the child become objective enough to situate himself as a being among others in a world of material reality? Piaget claims it is the sensorimotor period which adequately bridges the gap. For a discussion of this problem see La naissance de l'intelligence, pp. 359-360 ff.

an internal and external aspect. The internal aspect is that of organization; the external aspect is that of equilibrium. By organization is meant the restructuring of the given situation to include new aspects so as to incorporate them into the former pattern and at the same time enlarging and expanding the patterns to meet the needs of new situations Equilibrium can be considered as the exterior relation or balance between the subject and exterior reality. Adaptation in this perspective "est une mise en équilibre progressive entre un mécanisme assimilateur et une accommodation complémentaire"[29].

It is primarily in reference to intellectual operation that the term equilibrium is used: "l'équilibre de l'intelligence n'est pas un état de repos mais un "équilibre mobile" tel qu'en présence des perturbations extérieures le sujet tend à les compenser par des transformations orientées en sens opposé."[30] In his Six études de psychologie Piaget lists three essential characteristics of equilibrium: first, a certain kind of stability; secondly, a certain ability to compensate; thirdly, a certain type of activity.

The first of these characteristics "stability" must not be confused with immobility. "La notion de mobilité n'est donc pas contradictoire avec la notion de stabilité: l'équilibre peut être mobile et stable."[31]

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[29] La naissance de l'intelligence, p. 13.

[30] Traité, p. 153; Logique et équilibre, pp. 36-37.

[31] Six études de psychologie, p. 173. Jerome Bruner has taken issue with this notion of equilibrium. See J. Bruner, "Inhelder's and Piaget's Growth of Logical Thinking: a psychologist's point of view", British Journal of Psychology, 1959, 50, pp. 363-370.

> Un système opératoire sera, par example, un système d'actions, une série d'opérations essentiellement mobiles, mais qui peuvent être stables en ce sens que la structure qui les détermine ne se modifiera plus une fois constituée.[32]

Or again, a given structure may have a relative stability during a certain period; however it has the possibility of being incorporated into a structure that is more inclusive which shall appear during a subsequent period.

> Chaque structure est à concevoir comme une forme particulière d'équilibre, plus ou moins stable en son champ restreint et devenant instable aux limites de celui-ci.[33]

With regard to the second characteristic, that of compensation, Piaget says:

> tout système peut subir des perturbations extérieures qui tendent à le modifier. Nous dirons qu'il y a équilibre quand ces perturbations extérieures sont compensées par des actions du sujet, orientées dans le sens de la compensation.[34]

The third characteristic, that of activity, is described thus:

> Equilibre est synomyme d'activité. ... Une structure sera en équilibre dans la mesure où un individu est suffisamment actif pour pouvoir opposer à toutes les perturbations des compensations extérieures. Ces dernières finiront d'ailleurs par être anticipées par la pensée.[35]

To this point the investigation of Piaget's basic principle has centered around

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[32]Ibid.; cf. Inhelder, B. "Some Aspects of Piaget's Genetic Approach to Cognition", p. 28.

[33]La psychologie de l'intelligence, p. 12.

[34]Six études de psychologie, p. 173.

[35]Ibid.

the factors involved in the development or genesis of intellectual concepts. It is his claim that the assimilation-accommodation model adequately describes this process of cognitive development. However the intimate link between development and structure must now be considered because it is the structure that affords a certain degree of equilibrium on the one hand, and opens up the possibility of the formation of a superior structure on the other hand. It is this area of structure that must be investigated in the description of the major periods of intellectual development. Thus in the subsequent treatment of these periods our attention will be focused on these structures and their characteristics. It will be shown that just as Piaget uses a biological model for the process of development, he uses a mathematical model to interpret the structures that are formed.

FOUR MAJOR PERIODS OF INTELLECTUAL DEVELOPMENT

Piaget establishes four major periods of intellectual development: the sensorimotor period, the preoperational period, the concrete operational period and the abstract (or formal) operational period. In the course of describing each successive period the reader shall see how each period is built upon its predecessor but at the same time advancing beyond it. This sketch shall serve as the concrete example of how Piaget's fundamental principle is to be interpreted, i e., that every structure has a certain genesis and every genetic activity results in a certain structure.

Sensorimotor period

It is during the sensorimotor period (birth - 1 -1/2 - 2 years) that Piaget observes the progressive differentiation between assimilation and accommodation. Such an

activity permits the child to situate himself as a body among other bodies in an objective world of space and time.[36] This period begins with pure reflexes (that of sucking and moving arms and legs) and terminates in the first foreshadowing of intellectual life.[37]

Because of the difficulty during this period, of differentiating structures that are formed from the activity which produce them, Piaget is content to call these structures "schema of activity".[38] Since a schema is a mode of action elaborated by the subject and capable of conservation, of transformation by generalization and coordination with other schema, it enables the child's command of and response to reality to become progressively more meaningful.[39] At one and the same time a schema coordinates two previously distinct activities while opening up the possibility of further and more refined coordinations. One might see here a prefiguring of Piaget's notion of equilibrium which is both stable and mobile.[40]

The period is subdivided into six "stades" (or stages). The first and second stages are concerned with pure reflexes. The third stage shows the first coordination among schema taking place between that of sight and grasping. The fourth stage

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[36] La construction du réel chez l'enfant, p. 308, 312.

[37] La naissance de l'intelligence, p. 358; cf Lunzer, E.A. Recent Studies in Britain Based on the Work of Jean Piaget, London: National Foundation for Educational Research in England and Wales, 1960, p. 5.

[38] La construction du réel chez l'enfant, p. 310.

[39] La formation du symbole, p. 87; cf. La psychologie de l'enfant, p. 11, footnote 1.

[40] La construction du réel chez l'enfant, pp. 312-313. Also Six études de psychologie, p. 19.

marks the first foreshadowing of intellectual life since the child subordinates one schema to another. However, only familiar schema are used. For example, in trying to reach an object at a distance he will employ all his old schema of striking, rubbing, shaking whatever object might be at hand to attain his goal.[41] The fifth stage marks the discovery of new means to obtain a goal. The child now experiments. He will drop an object repeatedly as if testing to see the outcome. However the goal is still a posteriori since he wishes to have an interesting result persist. The last stage announces the transition to the next major period of development for it marks the beginning of representation, of interiorization of an action or an event. The classic experiment records Lucienne's experience with a watch-chain which she has seen her father put into a matchbox.[42] In attempting to open the matchbox the child repeatedly opened and closed her mouth. This imitation with delay is the herald of representation in a proper sense.

As these various schema develop Piaget sees four concepts (or structures) taking shape: object, cause, space and time.

There is a gradual passage from a "world-to-be-sucked" to a "thing" that is to be sought when placed at a distance, subject to visible displacements (i.e., covered by an handkerchief or hidden in a box) or subject to invisible displacements (i.e., rolled behind a chair or through a tunnel). Despite the fact that the object is no longer a perceptual tableau it still remains a sensible totality, a here-and-now phenomena or

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[41] La naissance de l'intelligence, observation 120.

[42] Ibid., observation 180.

appearance.

Causality during this period remains magical and egocentric: magical in the sense that the child by moving a string of toys strung across his bassinet intends that this mother reappear or that an interesting sound continue; [43] egocentric in the sense that he does not distinguish between his own proper causality and external physical causality.

In seeking a visibly displaced object, the child has some awareness of "before", "after", "near", "upon", "far". So likewise with objects invisibly displaced the child eventually waits for the ball to roll out at the other end of the tunnel or the other side of the chair. These observations indicate some rudimentary awareness of space and time.

Despite the apparent advance from a purely subjective to a more objective world it must be remembered that the child's world still remains basically egocentric since everything is related to his own activity. Everything is accomplished on a purely individual and practical basis. However, this period shows the gradual construction of schema which are independent, then coordinated, then put into a means-end relationship. Such procedure illustrates Piaget's basic principle that knowledge proceeds from some existing kind of knowledge or structure.

Preoperational period

The preoperational period (2-7 years) marks the second major step in intellectual development. It is characterized by the advent of representational thought.

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[43] La naissance de l'intelligence, observations 113, 121; cf. La construction du réel, p. 330.

The first part is called the symbolic period (2-4 years) wherein representation begins in the form of play and imitation. The second part is called the intuitive period (5-7 years) wherein the image and the preconcept predominate. Piaget often identifies this period with the period of practical intelligence.[44] The entire study, La formation du symbole, is concerned with showing the continuity of the assimilation-accommodation process from the sensorimotor period and at the same time how this process opens into an enlarged and expanded domain during the preoperational period. The continuity is rooted in the notion that an excess of accommodation produces imitation and an excess of assimilation produces play. These two, play and imitation, when placed in a state of equilibrium will eventually produce an image.[45] It is precisely this activity which indicates that the assimilation-accommodation of the sensorimotor period has been surpassed since the child can establish a state of equilibrium between what has been signified and the means used to signify.

> La représentation nait donc de l'union de "signifiants" permettant d'évoquer les objets absents avec jeu de signification les reliant aux éléments présents. Cette connexion spécifique entre des "signifiants" et des "signifiés" constitue le propre d'une fonction nouvelle, dépassant l'activité sensori-motrice, et que l'on peut appeler de façon très générale la "fonction symbolique".[46]

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[44]Piaget maintains that between the purely mechanical functioning of an organism and the level of abstract thought there is a practical intelligence wherein "penser, c'est opérer, transformer", i.e., a logic of action precedes a logic of thought. La naissance de l'intelligence, p. 8; p. 307; Piaget, J. "Development and Learning" in Piaget Rediscovered. Report of the Conference on Cognitive Studies and Curriculum Development, Cornell University, (R. Ripple and V. Rockcastle etd.), 1964, p. 8.

[45]La formation du symbole, p. 8; p. 92.

[46]Ibid., p. 292.

During the symbolic period imitation advances beyond sensorimotor imitation since the field of immediate perception is transcended by the use of an absent model. Piaget says, "... le propre de la représentation est ... de dépasser l'immédiat en accroissant des dimensions dans l'espace et dans le temps, du champ de l'adaptation, donc d'évoquer ce qui déborde le domaine perceptif et moteur".[47] Imitation presents things to be represented (i.e., the "signifiés"); play supplies the means by which things are to be represented (i.e., the "signifiants").[48] In the measure in which play and imitation cease to be personal they become communicable symbols. However, the representation spoken of here is still far from a concept in the proper sense of the term. It is a "préconcept" and plays an intermediary role between the sensorimotor schema and conceptual thought.

> Le préconcept, c'est-à-dire la première forme de pensée conceptuelle se superposant grâce au langage aux schèmes sensorimoteurs, est, en effet, un cadre notionnel n'atteignant ni la généralité (inclusion hiérachiques) ni l'individualité vraie (permanence de l'objet identique en dehors du champs de l'action proche).[49]

The presence of the image attests to an activity that is superior to that of simple perception, however less perfect than that of conceptual thought. Piaget says, "... le produit d'une accommodation imitative, ... atteste elle-même l'existence d'une activité au-dessus des perceptions et des mouvements, mais au-dessous de la pensée

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[47]Ibid., p. 286.

[48]La psychologie de l'enfant, pp. 41 ff; La formation du symbole, pp. 78 ff. and pp. 292-293.

[49]La formation du symbole, p. 298.

reflechié."[50] Again, he says,

> . . . le concept est un schème abstrait et l'image un symbole concret, mais, bien que l'on ne réduise plus la pensée à un système d'images, il se peut que toute pensée s'accompagne d'images, car, si penser consiste à relier des significations, l'image serait un "signifiant" et le concept un "signifié."[51]

At one and the same time this form of representation bears a definite advance over the sensorimotor period as well as a marked limitation in comparison with abstract thought. It remains the transitional stage between the two.

Pass on now to the second part of the preoperational period, the intuitive period (5 - 7 years). This period is preparatory to the concrete operational period wherein a certain degree of equilibrium is again established in the assimilation-accommodation process. During this period the child is confronted with new situations which he fails to meet successfully because he lacks the necessary logical tools. For example: the child when presented with two balls of plasticine (A and B) of equal quantity, which are changed into various shapes before his eyes, cannot distinguish the quantity which is conserved and the various forms the quantity assumes. When asked if ball B (transformed into a pancake) has the same amount as ball A (in the original form) the child will reply in the negative. His justification is either "There is less (ball B) because it is thinner" or "there is more here (ball B) because it is longer", depending on the dimension that strikes him most forcibly. However, reasoning about ball B transformed into a sausage the child often contradicts himself

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[50] Ibid., p. 78.

[51] Ibid., p. 68.

without being aware of it. The sausage has been seen as being greater because it is longer, or smaller because it is thinner.

What does such an experiment reveal? That the child attempts to resolve the problem with the only structure he has — a mental image. As a result he reasons on sensible appearances, i.e., the successive states assumed by the object in question rather than on the concept involved. It is true that a transformation produces a different sensible appearance and since the child fixes on successive states then for him a change in the configuration is a change in the substance itself. He is incapable of dealing with the transformations involved. It is precisely because "le jeune enfant raisonne seulement sur les états ou configurations statiques et néglige les transformations comme telles"[52] that leaves him vulnerable to contradiction. He has the tendency to "center" on one aspect (i.e., to seize one striking characteristic, situation or phenomenon and neglect all others) at one moment, and then, in a subsequent situation to "center" on an opposite aspect. To recognize simultaneously two aspects of the same reality (e.g., length, width) or successive states of the same object, or successive states together with their transformations demands that a child "decentralize" (i.e., to recognize all factors in a given situation and harmonize them accordingly).[53] However, during the intuitive period the child does not have a structure at his disposal capable of accomplishing this task. The structures that must be forthcoming are two: first, that of an "operation" (as opposed to a "simple action") which

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[52] Six études de psychologie, p. 93.

[53] See Logique et équilibre, pp. 49 ff. for a discussion of these "strategies" as Piaget calls the activity of "centralizing" and "decentralizing". Cf. also La formation du symbole, p. 301.

possesses the characteristic of reversibility; secondly, the notion of conservation. It is this fixation on the state of an object that differentiates intuitive thought from operational thought.

> L'accommodation propre à la pensée intuitive reste encore dépendante de certaines configurations, tandis que l'accommodation opératoire se libère de toute influence figurale en s'attachant aux transformations comme telles et non plus à l'image des états isolés et statiques.[54]

Before terminating the description of the preoperational period let the following remarks be made. This period, limited though it be, indicates a stage of operation superior to yet developing out of the sensorimotor period. No longer is the child trying to harmonize his own body and objective reality. He is now concerned with the relationship existing between objects or between various aspects of the same object. Limitations are seen both on the side of the object and on the side of the subject. With regard to the object the child is still working on surface qualities and with regard to his action it is rigid and unilateral.[55] What is needed is the notion of conservation (i.e., an invariant that remains stable despite the variations) and that a "simple action" become an "operation". Both these structures are forthcoming in the following period.

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[54] La formation du symbole, p. 306.

[55] It is interesting to note the reason why Piaget says this preoperational period takes almost six years. "La réponse est simple: c'est que l'adaptation à des realités nouvelles, avant d'atteindre les rapports essentiels entre le sujet et l'objet, commence toujours par demeurer à la surface, et du moi ... et des choses." La formation du symbole, p. 299.

Concrete operational period

Intellectual activity, properly speaking, begins in the concrete operational period (7 - 11 years). During this period the child becomes capable of effecting in thought that which has transpired in reality. Or, as Piaget will claim, a "simple action" has become an "operation" (i.e., reversible, interiorized and capable of being coordinated with other operations.[56]) This capacity permits the child to see an action executed in two senses (direct and inverse) and it liberates him from the static fixation on the configurations of a given state. His thought, according to Piaget, has become "mobile".

Correlative to "operation" is the recognition of the notion of conservation, i.e., a concept or an invariant that persists beneath a given set of transformations.[57] (The classical experiments attesting to the presence of conservation shall be reserved for the following chapter.) Suffice it to say that with the construction of the notion of conservation and the development of operations the child has the basic equipment for intellectual reasoning.

He can apply the notion of conservation in a variety of ways: he can classify, put into order or a series, and grasp the notion of number. It is from the ability to

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[56]Logique et équilibre, p. 45. Cf. also, Six études de psychologie, p. 91.

[57]"Note that in the history of thought, we have the same thing. The first Greek physicists, the presocratic philosophers, discovered conservation of substance independently of any experience. I do not believe this is contradictory with the theory of operations. The conservation of substance is simply the affirmation that something must be conserved. The children do not know specifically what is conserved. They know that since the sausage can become a ball again there must be something which is conserved, and saying "substance" is simply a way of translating this logical necessity for conservation". Piaget, J. "Development and Learning" in Piaget Rediscovered, p. 19.

classify and to put in a series that the notion of number actually develops.

> ... The child who counts ten pebbles and discovers that there are always ten even when the order is changed is making an experiment of quite a different kind: he is not really experimenting with pebbles but with his own activity of arranging and enumerating. ... These activities confer properties on the object which it did not possess for the collection of pebbles comprised neither order nor number independently of the agent: it is he, then, who abstracts the information from his own activities and not from the object as such.[58]

Piaget claims that these four: class, series, relation and number form a "structure d'ensemble" which he calls a "groupement" since they possess certain characteristics in common with a mathematical group. That is to say, additivity and its negation, identity, tautology but only partial associativity.[59] These characteristics derive either from inversion (classes) or reciprocity (relations) but entail no general synthesis of the two forms of reversibility.[60] Such a synthesis is accomplished in the subsequent stage of formal operations.

Just as reversibility and conservation mark the perfection of this period over the preceding one, there still remains certain limitations both on the side of form and on the side of content. From the standpoint of form, concrete operations consist in nothing more than a direct organization of immediately given data. Piaget says, "les opérations concrètes ne consistent, en effet, qu'une structuration directe des données actuelles: classer, sérier, égaliser, mettre en correspondence."[61]

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[58]Piaget, J. "Genetic Psychology and Epistemology", Diogenes, p. 54. Cf. Six études de psychologie, p. 94 and Logique et équilibre, p. 113 ff.

[59]La psychologie de l'enfant, p. 79; Traité, p. 131.

[60]De la logique de l'enfant à la logique de l'adolescent, p. 249.

[61]Ibid., p. 218.

That is to say,

> l'enfant du niveau concret ne fait pas, à proprement parler, d'hypothèses: il agit dès le départ et cherche simplement, au cours de son action, à coordonner les lectures successives des résultats qu'il obtient, ce qui revient à structurer la realité sur laquelle il agit.[62]

On the formal level the child will formulate a hypothesis and then proceed to its verification.

With regard to content, the limitations arise from the fact that concrete thought cannot be immediately generalized to include all physical properties. Instead it proceeds from one area to another with a time lag. For instance, the child recognizes quantity, then length, then weight, and then volume.[63] But this gradual unfolding of quantity through volume is but another instance of the fundamental principle which Piaget proposes: that knowledge begins in a certain degree of vagueness and confusion and gradually becomes distinct when all the factors are coordinated.

Granted that the structures constructed at this period attain a certain degree of equilibrium, there are still aspects of reality that have not been recognized nor coordinated into an intelligible structure. Thus the equilibrium acquired in concrete thought covers only a relatively narrow field, the boundaries of which remain unstable. These two conditions make the elaboration of formal thought necessary.[64]

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[62] Ibid., p. 220.

[63] La psychologie de l'intelligence, pp. 175-176. Six études de psychologie, p. 140; La psychologie de l'enfant, p. 75.

[64] La psychologie de l'enfant, p. 104.

Abstract operational thought

During the formal operational period the subject attains abstract logical thinking in its complete form. Piaget provides the following conclusions, after much experimentation, as indications that this period has been attained. First, the structural invariant of the operational period (i.e., the principle of conservation) is now extended to volume, proportion, direction, inertia, equivalence, etc. Secondly, the "structure d'ensemble" of the operational period (i.e., "groupement") which dealt with classes, series, relation, number and simple propositions is now applied to the "combinatoire" and possessing all the characteristics of a mathematical "group". That is to say, that the subject moves from classification of object to all possible combinations; from series to permutations; from number to proportion; and from the logic of simple propositions to the logic of propositions (or propositional calculus.)[65] Thirdly, just as the child on the concrete level could perform a direct act (I) or its inverse or negation (N) on the one hand, and see the relation (R) and its inverse or correlative (C) on the other without integrating these two systems, the subject on the formal level can integrate these two series of transformation into the famous INRC theory.[66]

The perfection of this period is found in the child's capacity to work in the

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[65] La psychologie de l'enfant, pp. 104 ff.

[66] Cf. Traité, pp. 144-149; Six études de psychologie, pp. 144 ff; La psychologie de l'enfant, p. 108-114; La logique de l'enfant à la logique de l'adolescent, pp. 245 ff. This theory has been subject to much criticism and speculation among modern mathematicians and logicians. Cf. Parsons, Chas. "Inhelder and Piaget's Growth of Logical Thinking", Brit. J. Psychology, 1960, 51, pp. 75-84.

hypothetical order. No longer is he restricted to concrete objects and situations. On the contrary "avec la pensée formelle, enfin, une inversion de sens s'opère entre le réel et le possible. Au lieu que le possible se manifeste simplement sous forme d'un prolongement du réel ou des actions exécutées sur la réalité, c'est au contraire, le reél qui se subordonne au possible."[67]

> La pensée formelle est, en effet, hypothético-déductive: la déduction ne porte plus directement sur la réalités perçues, mais sur des énoncés hypothétiques, c'est-à-dire sur des propositions formulant les hypothèses ou posant les données à titre de simples données, indépendamment de leur caractère actuel.[68]

Or to express the matter again in order to show the level of thought the child has attained Piaget says:

> C'est cette inversion de sens entre le possible et le réel qui, plus que toute autre propriété subséquente, caractérise la pensée formelle: au lieu d'introduire sans plus un début de nécessité dans le réel, comme c'est le cas des inférences concrètes, elle effectue dès le départ la synthèse du possible et du nécessaire, en déduisant avec riguer les conclusions de prémisses dont la verité n'est admise d'abord que par hypothèse et relève ainsi du possible avant de rejoindre le réel.[69]

This period marks the maximum development of intellectual activity according to Piaget. The assimilation-accommodation process has now passed from a consideration of concrete objects and any transformations thereof to the relations

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[67] De la logique de l'enfant à la logique de l'adolescent, p. 220.

[68] Ibid.

[69] Ibid.

existing between the real and the possible. The operations and structures of this period, which have the characteristic of a mathematical group, can thus be formulated in terms of mathematical logic.[70] They likewise form the instrument par excellence of logical thinking.

CONCLUSION

Piaget's basic principle implies that there is an intimate and necessary connection between any given intellectual structure and the steps leading to its formation. This indissociable relationship existing between structure and genesis is kept in balance by a form of equilibrium which becomes progressively ever more flexible and mobile. Hence "structure", "genesis" and "equilibrium" express this basic principle in its widest dimensions.

An inspection of the factors which led to the formulation of such a principle reveals that Piaget used a biological model to interpret the process of development and a mathematical model to describe the resulting "structure d'ensemble".

The assimilation-accommodation model provides the prototype of all operations since, according to Piaget, it adequately describes the process whether it be on a biological level, the sensorimotor level, the practical or concrete level or the rational level.[71] On the intellectual level the interplay of these two factors, kept in balance by a mobile equilibrium, contains both a dynamic and a static element. Its

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[70]It is at this point that the genetic approach of Piaget joins forces with modern symbolic logic. Cf. De la logique de l'enfant..., p. 276. Piaget Rediscovered, p. 33.

[71]La construction de réel, p. 309.

dynamic aspect is characterized by the invariant process of assimilation-accommodation; its stable aspect is characterized by the invariant state of equilibrium which becomes progressively more stable and flexible.

Such an operational theory implies that at every period there be certain factors which provide a limited degree of equilibrium but at the same time this form of equilibrium remains incapable of resolving new problems. To stabilize a new situation demands a superior form of equilibrium. Hence it is in terms of "structure", "genesis" and "equilibrium" that Piaget builds up an operational theory without having structures present from the beginning or riding "ex nihilo".

Both functional invariants and structural invariants are developed and enriched at each successive period. Functional invariants progress from pure reflexes to schema of activity during the sensorimotor period permitting the child to become the master of activity. Then during the preoperational period the child masters representation: either by play and imitation of the earlier period or by mental image and preconcept of the later period. On the concrete operational level the child passed from performing "simple actions" to "operations" thus permitting him to master states and transformations simultaneously. The formal period brought the functional invariants to perfection since the child was no longer limited to concrete operations but could operate on operations (i.e., he could reason on a hypothetical situation).

The same growth and development likewise appears in the structural invariants. During the sensorimotor period the child had some awareness of object, cause, time and space. The representation of the preoperational period supplied for certain areas of activity yet needed further development (notably by developing an invariant)

to adequately meet new situations faced by the child. The concrete operational period develops the notion of an invariant (or the notion of conservation) and the reversible operation. Together these provide the child with the "structure d'ensemble": to classify, to put into series and to recognize number. The "structure d'ensemble" attained during the formal period provides the child with the ability to integrate states and transformations into a harmonious whole whose structure bears the characteristics of a mathematical group.

Having set forth an explanation of the basic principle of Piaget's operational theory of cognitive development together with a sketch of the major periods of intellectual development we are ready to take a closer look at the transition from one period to another. Such is the endeavor of the following chapter. In so doing we shall see Piaget's principle from another vantage point: that all knowledge proceeds from vagueness and confusion toward clarity and distinctness by means of differentiation and coordination.

Chapter 3

D'INDIFFERENCIATION CHAOTIQUE A ... DIFFERENCIATION AVEC COORDINATION CORRELATIVE

I. AREAS OF GLOBALISM AND CONFUSION

A. Between self and the world

B. On the side of self: action, representation, thought

C. As the self sees the world: things and other things; different aspects of the same thing

II. STEPS IN TRANSITION

A. Failure: incomprehension and confusion

B. Transition: ambiguity

C. Success: differentiation and coordination

III. MECHANISMS INVOLVED

A. Analysis of justifications: identity, compensation, reversibility

B. Differentiation and coordination

C. Differentiation and coordination in light of the accommodation-assimilation-equilibrium model

Chapter 3

D'INDIFFERENCIATION CHAOTIQUE A ... DIFFERENCIATION AVEC COORDINATION CORRELATIVE

A discussion of the principle, in the preceding chapter, revealed the factors which Piaget employs to interpret his operational theory. The child passes through four periods of intellectual development each of which is characterized by a certain capacity for action and a limited recognition of certain aspects of reality. The basic relationship existing between the subject and the object in every instance is one of assimilation-accommodation which tends toward a state of equilibrium. The state of equilibrium has a twofold nature: a certain harmony within, and, at the boundaries, a certain potentiality for further development. This assimilation-accommodation-equilibrium model provides the continuity between the most elementary activities of the sensorimotor period and the most advanced and abstract activities of the formal operational period. However, such continuity (i.e., of structures proceeding from previous structures which continue to persist as sub-structures) in no way hinders the successive structures from being qualitatively different from one another.[1]

Having set forth the general theory and having sketched the major periods of intellectual development the reader is now ready to examine more closely the nature of the assimilation-accommodation model. The first part of this chapter will indicate

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[1] La psychologie de l'intelligence, p. 181.

the areas of globalism and confusion, as seen by Piaget, during the various stages of intellectual development. The second part will describe the general steps in transition from globalism to clarity and distinctness. The third part of the chapter will deal with the mechanisms involved during this process of reduction from globalism to distinctness.

AREAS OF GLOBALISM AND CONFUSION

In La construction du réel Piaget sets forth the principle which governs the relationship existing between all phases of the assimilation-accommodation-equilibrium process. He sees this principle as "une sorte de loi d'évolution que l'on peut énoncer comme suit:

> l'assimilation et l'accommodation procèdent d'un état d'indifféren-ciation chaotique à un état de différenciation avec coordination corrélative.[2]

Globalism and confusion are inescapable factors at the origin of knowledge (be it considered in the absolute sense as the child's first contact with reality, or relatively as when the child encounters a particular aspect of a problem for the first time). The following remarks will indicate the areas which remain global and confused in the child's thinking and areas which obtain some measure of differentiation and coordination as the child passes from one period to another.

Self and the world

In the earliest stages of the sensorimotor period the child's activity and the object which is assimilated constitute a single undivided experience. The child has no way of distinguishing his acts from the reality-events which these acts produce nor

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[2]La construction du réel, p. 309.

from the reality (or object) upon which they bear. In short, the agent and the object, the ego and the external world are inextricably bound together in every action.

> Au point de départ de l'évolution mentale il n'existe à coup sûr aucune différenciation entre le moi et le monde extérieur, c'est-à-dire que les impressions vécues et perçues ne sont rattachées ni à une conscience personelle sentie comme un "moi", ni à des objets conçus comme extérieurs: elles sont simplement données en un bloc indissocié, ou comme étalées sur un même plan, qui n'est ni interne, ni externe, mais à mi-chemin entre ces deux pôles.[3]

Because of this primitive indisassociation all things are perceived as centered on the activity of the subject (i.e., the self is the center of reality).[4] Reflex activities, predominating in the early stages, gradually coordinate with acquired activities so that the world becomes "a-thing-to-be-sucked" or a "thing-to-be-shaken". Then during the fourth stage of this sensorimotor period the child extends these schema of activity to new experiences. However, success remains fortuitous since he only employs known schema to accomplish his goal. During the fifth stage a decided advance in the assimilation-accommodation process takes place: "la recherche de moyens nouveaux par différenciation des schèmes connus".[5] That is to say, the child begins to distinguish, in a purely practical way, among those schema which can serve as means and those which can serve as ends.

These schema of activity or practical groupings (i.e., direct action and its reversal such as grasping and letting go; walking and sitting down, etc.) are what Piaget calls the "sensorimotor concepts": "...une action apte à être répetée et

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[3]Six études de psychologie, pp. 19-20, (underscoring mine).

[4]Ibid., p. 20.

[5]La psychologie de l'enfant, p. 13.

généralisée à des situations nouvelles est comparable à une sorte de concept sensori-moteur".[6] They are responsible for the constitution of the four fundamental categories with which the subject meets reality: object, causality, space and time. These categories serve as the invariants during the sensorimotor period.[7]

To indicate that the object (i.e., reality) has obtained some degree of permanence Piaget cites the following observations. First, the child continues to seek an object which has been subject to visible and invisible displacements.[8] Secondly, the child will accommodate his body to a given situation by stretching out to reach the object or by moving himself closer to his goal, then gradually adopting certain means to attain his goal. The constitution of the object is "un premier exemple de ce passage de l'égocentrisime intégral primitif à l'élaboration finale d'un univers extérieur."[9] Or we might say this indicates the gradual differentiation and coordination that will take place between the subject and his environment.

Intimately connected with the construction of the object is that of space and time (which are due primarily to the coordination of movements) and causality. Although this is the period wherein activity and movement are mastered, causality as such is identified with the causality proper to the subject. For the young child his own activity seems to cause all. For instance a child who has learned to pull on a

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[6]Six études de psychologie, p. 19.

[7]Ibid., p. 20.

[8]Ibid., p. 21. Cf. La psychologie de l'intelligence, pp. 138-139.

[9]Ibid., cf. Inhelder, B. cited in Handbook of Research Methods in Child Development, p. 428.

cord to shake a string of toys will continue this same activity to make any interesting sight or sound continue.[10]

Because of the priority of activity Piaget claims that the sensorimotor period consists in a veritable conquest, by perception and movement, of the whole practical universe surrounding the child. That is to say, these schema of activity are to be equated with a mode of behavior[11] rather than possessing intelligible content. These sensorimotor schema are in no way reflective. The only verification of which the child is capable at this time is a type of success and not of truth.[12] However it is from such activity that Piaget sees a veritable copernican revolution taking place.

> Or, cette "assimilation sensori-motrice" du monde extérieur immédiat realise en fait, ... toute une révolution copernicienne en petit: tandis qu'au point de départ de ce développement, le nouveau-né ramène tout à lui, ou, plus précisément, à son propre corps, au point d'arrivée, c'est-à-dire lorsque débutent le langage et la pensée, il se situe déjà pratiquement, à titre d'élément ou de corps parmi les autres, dans un univers qu'il a construit peu à peu et qu'il sent désormais comme extérieur à lui.[13]

While it is of the very nature of the schema of assimilation to apply itself to everything and to conquer the whole universe of perception, this very generalization is what makes differentiation necessary.[14] Thus it is that as assimilation and accommodation separate or distinguish themselves from one another, two poles (self

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[10] Ibid., p. 22. Cf. La naissance de l'intelligence, observations 113, 121.

[11] La psychologie de l'intelligence, p. 119.

[12] La naissance de l'intelligence, p. 211.

[13] Six études de psychologie, pp. 15-16.

[14] La naissance de l'intelligence, p. 362.

and the external world) around which these activities gravitate, likewise, become distinguished one from another. Herein lies the first indication that globalism and confusion will be gradually dissipated. No longer is self and the external world "un bloc indissocié".

However, whatever the progress made during this period it must be put in proper perspective. This can best be done by regarding the categories formed during this period. An examination of the category of object furnishes a most striking example of both the progress and the limitation characteristic of this period.

> D'une part, la corrélation étroite avec la construction de l'objet, la conscience du "moi" commence à s'affirmer à titre de pôle intérieur de la réalité, opposé à ce pôle externe ou objectif. ... d'autre part, les objets sont conçus, par analogie avec ce moi, actifs, vivants, et conscients.[15]

It is precisely because of this transfer of life, activity and consciousness to all things that renders the notion of causality vague and confused. The child, having some awareness of his own efficient causality, fails to distinguish it from physical causality independent of him. For this reason Piaget labels the notion of causality during this period "magico-phénoméniste".[16]

Despite these limitations a decided advance has been made in the reduction of globalism and confusion in a most fundamental area: between the subject and the universe.

> Bref, dans tous les domaines nous retrouvons cette espèce de révolution copernicienne qui permet à l'intelligence sensori-motrice de sortir l'esprit naissant de son égocentrisme

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[15] Six études de psychologie, p. 24.

[16] Ibid., p. 22.