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# A POINT OF RAPPORT BETWEEN PIAGET AND ARISTOTLE

## FROM VAGUENESS AND CONFUSION TO CLARITY AND DISTINCTNESS IN THE ACQUISITION OF HUMAN KNOWLEDGE

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The impact of Jean Piaget's thought has been felt in a variety of disciplines and areas of learning — philosophy not to be excluded. Today one can hardly claim to be knowledgeable in the fields of psychology, education, mathematics, epistemology and philosophy without at least being aware of the genetic psychology and epistemology of Jean Piaget. The goal of this article is to suggest a certain rapport between a principle employed by Piaget in his developmental theory of concepts and a principle employed by Aristotle in his treatment of the common mode of procedure characteristic of the human intellect. Despite the fact that in a recent work *La sagesse et illusions de la philosophie* (1965) wherein Piaget advanced a very definite view regarding philosophy, its role and value, which would, in a certain sense, make one hesitate undertaking such a study, nevertheless after a careful examination of the principle such a rapport seemed warranted. In both these theories concerning the acquisition of human knowledge, although from different optics, a common principle seemed to be operative, namely, that in human knowing there is always a movement from the vague and confused to the clear and distinct.

### I. UNDERLYING PRINCIPLES OF PIAGET'S THEORY

The primary goal in the research of Jean Piaget has been to reveal the nature of intellectual activity by determining the conditions under which it develops in children. From the very outset of his investigations he has maintained that it is only by understanding how concepts are formed in the minds of children that one could explain intellectual activity in the adult. That is to say, there is only one way to understand mental functioning and that is genetically<sup>1</sup>.

<sup>1</sup> Piaget defines genetic psychology as the science that "cherche à expliquer les fonctions mentales par leur mode de formation". *La psychologie de l'enfant*, collection "Que sais-je ?"; (Paris : P.U.F. 1966), p. 6.

In a lecture given at Cerisy, France, in 1959 Piaget definitively set forth the basic principle upon which the entire theory of cognitive development rests. He said, "toute genèse part d'une structure et aboutit à une structure" and conversely "toute structure a une genèse"<sup>2</sup>. These two aspects : the structure that is formed and the successive steps in its formation, cannot be disassociated. They may be considered separately in the logical order but they co-exist in the temporal order<sup>3</sup>.

In that same conference given at Cerisy, Piaget declared that the intimate connection which exists between "structure et genèse" has been drawn from years of experimentation and is not to be considered a pre-established hypothesis which 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<sup>4</sup>.

To explain the relationship existing between genesis and structure Piaget advances his "equilibrium" hypothesis since he claims "la notion d'équilibre paraît avoir une valeur particulière pour permettre la synthèse entre genèse et structure"<sup>5</sup>. These terms then, "genesis", "structure" and "equilibrium" express Piaget's theory in its broadest dimensions.

In order to acquire some insight into the meaning of this basic principle there are two areas which must be examined. First, we must turn to the models upon which Piaget patterns his basic principle. Secondly, we must examine the principle which, he maintains, governs the passage from one structure to another. In *La construction de réel* Piaget sets forth the principle which governs the relationship existing between all phases of the assimilation - accommodation - adaptation 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'indifférenciation chaotique à un état de différenciation avec coordination corrélative<sup>6</sup>.

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<sup>2</sup> PIAGET, Jean. "Genèse et structure en psychologie de l'intelligence" cited in *Congrès et Colloques*, Col. 9 sous le titre : "Entretiens sur les notions de « genèse » et de « structure »", Mouton et Cie., (Le Haye-Paris, 1965), p. 40, p. 42.

<sup>3</sup> PIAGET, J. "Six études de psychologie". Genève : Gonthier, 1964, p. 169. "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".

<sup>4</sup> *Ibid.*, pp. 167-168 (content of parenthesis mine).

<sup>5</sup> *Ibid.*, pp. 173-174 ; cf. "Logique et équilibre" in *Études d'épistémologie génétique*, Vol. II, (Paris, P.U.F., 1957), pp. 95-96.

<sup>6</sup> *La construction du réel chez l'enfant*. (Neuchâtel : Delachaux et Niestlé, 1937), p. 309.

Concerning the models employed, Piaget claims that the biological model of assimilation – accommodation – adaptation adequately describes the process of development existing between structures and that the mathematical model known as the group describes the structures that are formed. For the purposes of this article, however, we will be concerned with the first model, i.e., the biological model, and with the principle stated above governing this passage or development. The biological model will be presented in a two-fold manner : First, an explanation of the model as Piaget sees it ; secondly, a sketch of the four major periods of intellectual development as the model is applied.

#### A. *Biological model*

Looking at the child with the eyes of an experimental scientist (trained in biology but tending toward psychology) Piaget saw a living organism situated in a given environment. He observed a child in the very early stages of life exhibiting no signs of intellectual life, but simply acting upon and reacting to his environment. This led him 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<sup>7</sup>.

Piaget maintains that awareness begins neither with the awareness of the object nor the awareness of the activity of the self but an undifferentiated state of knowledge of self and the knowledge of reality<sup>8</sup>. 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<sup>9</sup>. 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"<sup>10</sup>.

<sup>7</sup> *Ibid.*, p. 311.

<sup>8</sup> *Ibid.* To explain this fundamental idea as clearly as possible Piaget uses an example. "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 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".

<sup>9</sup> PIAGET, J. *La naissance de l'intelligence*, (Neuchâtel : Delachaux et Niestlé, 1936), pp. 363-364.

<sup>10</sup> *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

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 activité). On comprend alors que, à l'inter-pénétration 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<sup>11</sup>.

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 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<sup>12</sup>.

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<sup>13</sup>.

On the rational or intellectual level "l'intelligence est, en effet, assimilation dans la mesure où elle incorpore à ses cadres tout le donné de l'expérience. . . c'est-à-dire de structuration par incorporation de la réalité extérieure à des formes dues à l'activité du sujet"<sup>14</sup>. 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 schème antérieur, dans un système déjà élaboré d'implications"<sup>15</sup>.

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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", cited in *Thought in the Young Child*, vol. 27, no 2, p. 22.

<sup>11</sup> *La psychologie de l'intelligence*, (Paris : Colin, 1947), p. 14.

<sup>12</sup> *Ibid.*, p. 15.

<sup>13</sup> *La naissance de l'intelligence*, p. 358.

<sup>14</sup> *Ibid.*, p. 12.

<sup>15</sup> *Ibid.*, p. 359.

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"<sup>16</sup>. However, "l'accommodation n'est jamais pure mais se manifeste nécessairement à l'intérieur d'un schème d'assimilation"<sup>17</sup>.

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<sup>18</sup>.

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 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 in 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"<sup>19</sup>.

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"<sup>20</sup>. 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<sup>21</sup>. He explains in this fashion:

<sup>16</sup> *Ibid.*, p. 13.

<sup>17</sup> PIAGET, J., *La formation du symbole chez l'enfant*, (Neuchâtel: Delachaux et Niestlé, 1946), p. 290; *La naissance de l'intelligence*, p. 359.

<sup>18</sup> 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.

<sup>19</sup> *La naissance de l'intelligence*, p. 13.

<sup>20</sup> PIAGET, J., (avec FRAISSE), *Traité de psychologie expérimentale*, tome VIII: L'intelligence (Paris: P.U.F., 1963), p. 153; cf. *Logique et équilibre*, pp. 36-37.

<sup>21</sup> *Six études de psychologie*, p. 173. "La notion de mobilité n'est donc pas contradictoire avec la notion de stabilité: l'équilibre peut être mobile et stable".

Un système opératoire sera, par exemple, 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<sup>22</sup>.

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<sup>23</sup>.

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<sup>24</sup>.

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

Équilibre est synonyme 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<sup>25</sup>.

To this point the investigation of Piaget's basic principle has centered around 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. In the subsequent presentation of the four periods of intellectual development the model will be applied to show something of the genesis involved as well as something of the structures that are formed.

#### B. *Four major periods of intellectual development*

1° *Sensorimotor period.* It is during the sensorimotor period (birth - 1½ - 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<sup>26</sup>. This period begins with pure reflexes (that of sucking and moving arms and legs) and terminates in the first foreshadowing of intellectual life<sup>27</sup>.

<sup>22</sup> *Ibid.* ; cf. INHELDER, B. "Some Aspects of Piaget's Genetic Approach to Cognition", cited in *Thought in the Young Child*. Monographs for Research in Child Development. Yellow Springs, Ohio : The Antioch Press, vol. 27, no. 2, 1962, p. 28.

<sup>23</sup> *La psychologie de l'intelligence*, p. 12. Cf. "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".

<sup>24</sup> *Six études de psychologie*, p. 173.

<sup>25</sup> *Ibid.*

<sup>26</sup> *La construction du réel chez l'enfant*, p. 308, 312.

<sup>27</sup> *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.

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"<sup>28</sup>. 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<sup>29</sup>. 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<sup>30</sup>.

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 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<sup>31</sup>. 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<sup>32</sup>. 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 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<sup>33</sup> ; egocentric in

<sup>28</sup> *La construction du réel chez l'enfant*, p. 310.

<sup>29</sup> *La formation du symbole*, p. 87 ; cf. *La psychologie de l'enfant*, p. 11, footnote 1.

<sup>30</sup> *La construction du réel chez l'enfant*, pp. 312-313. Also *Six études de psychologie*, p. 19.

<sup>31</sup> *La naissance de l'intelligence*, observation 120.

<sup>32</sup> *Ibid.*, observation 180.

<sup>33</sup> *Ibid.*, observations 113, 121 ; cf. *La construction du réel*, p. 330.



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 ego-centric 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.

2° *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. 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<sup>34</sup>. 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<sup>35</sup>. 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<sup>36</sup>.

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'im-

<sup>34</sup> 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.

<sup>35</sup> *La formation du symbole*, p. 8; p. 92.

<sup>36</sup> *Ibid.*, p. 292. « La représentation naît 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" ».

médiat 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" <sup>37</sup>. 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") <sup>38</sup>. 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 "preconcept" 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 sensori-moteurs, est, en effet, un cadre notionnel n'atteignant ni la généralité (inclusion hiérarchique) ni l'individualité vraie (permanence de l'objet identique en dehors du champs de l'action proche) <sup>39</sup>.

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 réfléchie" <sup>40</sup>.

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 con-

<sup>37</sup> *Ibid.*, p. 286.

<sup>38</sup> *La psychologie de l'enfant*, pp. 41 ff. ; *La formation du symbole*, pp. 78 ff. and pp. 292-293.

<sup>39</sup> *La formation du symbole*, p. 298.

<sup>40</sup> *Ibid.*, p. 78. Or 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 », p. 68.

tradicts himself 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 où configurations statiques et néglige les transformations comme telles"<sup>41</sup> 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)<sup>42</sup>. 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 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<sup>43</sup>.

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<sup>44</sup>. What is needed

<sup>41</sup> *Six études de psychologie*, p. 93.

<sup>42</sup> 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.

<sup>43</sup> *La formation du symbole*, p. 306.

<sup>44</sup> It is interesting to note the reason why Piaget says this pre-operational period takes almost six years. "La réponse est simple: c'est que l'adaptation à des réalités 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.

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.

3° *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)<sup>45</sup>. This capacity permits the child to see an action executed in two senses (direct and reverse) 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. (The classical experiments attesting to the presence of conservation will be discussed in the following section). 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 use the notion of conservation in a variety of ways: he can classify, put into order or a series, and grasp the notion of number.

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<sup>46</sup>. These characteristics derive either from inversion (classes) or reciprocity (relations) but entail no general synthesis of the two forms of reversibility<sup>47</sup>. 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'en une structuration directe des données actuelles: classer, sérier, égaliser, mettre en correspondance"<sup>48</sup>. In contrast to this limitation the child operating on the formal level 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

<sup>45</sup> *Logique et équilibre*, p. 45. Cf. also, *Six études de psychologie*, p. 91.

<sup>46</sup> *La psychologie de l'enfant*, p. 79; *Traité*, p. 131.

<sup>47</sup> *De la logique de l'enfant à la logique de l'adolescent*, (Paris, P.U.F., 1955), p. 249.

<sup>48</sup> *Ibid.*, p. 218. "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 réalité sur laquelle il agit", p. 220.

proceeds from one area to another with a time lag. For instance, the child recognizes quantity, then length, then weight, and then volume<sup>49</sup>. 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<sup>50</sup>.

4° *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)<sup>51</sup>. 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<sup>52</sup>.

The perfection of this period is found in the child's capacity to work in the 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 réel qui se subordonne au possible"<sup>53</sup>.

<sup>49</sup> *La psychologie de l'intelligence*, pp. 175-176. *Six études de psychologie*, p. 140; *La psychologie de l'enfant*, p. 75.

<sup>50</sup> *La psychologie de l'enfant*, p. 104.

<sup>51</sup> *Ibid.*, pp. 104 ff.

<sup>52</sup> Cf. *Traité*, pp. 144-149; *Six études de psychologie*, pp. 144 ff; *La psychologie de l'enfant*, pp. 108-114; *De 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.

<sup>53</sup> *De la logique de l'enfant à la logique de l'adolescent*, p. 220. "La pensée formelle est, en effet, hypothético-déductive: la déduction ne porte plus directement sur les réalités

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 existing between the real and the possible. The operations and structures of this period, which have the characteristics of a mathematical group, can thus be formulated in terms of mathematical logic<sup>54</sup>.

## II. PRINCIPLE GOVERNING THE PASSAGE FROM ONE STRUCTURE TO ANOTHER

Having set forth the general theory and having sketched the major periods of intellectual development we are now ready to examine the very nature of the principle which governs every and all phases of the assimilation-accommodation-adaptation model. In *La construction du réel* Piaget sees the 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'indifférenciation chaotique à un état de différenciation avec coordination corrélative"<sup>55</sup>.

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. Then, having sketched in general these areas we will proceed to show the steps in transition from globalism and confusion to clarity and distinctness.

### A. *Areas of globalism and confusion*

1° *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 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 personnelle sentie

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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".

<sup>54</sup> It is at this point that the genetic approach of Piaget pins forces with modern symbolic logic. Cf. *De la logique de l'enfant . . .*, p. 276. *Piaget Rediscovered*, p. 33.

<sup>55</sup> *La construction du réel*, p. 309.

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<sup>56</sup>.

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 later 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 répétée et généralisée à des situations nouvelles est comparable à une sorte de concept sensori-moteur"<sup>57</sup>. 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.

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 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<sup>58</sup>. However, it is from such activity that Piaget sees a veritable copernican revolution taking place<sup>59</sup>.

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. Thus it is that as assimilation and accommodation separate or distinguish themselves from one another, two poles (self 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.

<sup>56</sup> *Six études de psychologie*, pp. 19-20, (underscoring mine).

<sup>57</sup> *Ibid.*, p. 19.

<sup>58</sup> *La naissance de l'intelligence*, p. 211.

<sup>59</sup> *Six études de psychologie*, pp. 15-16. "Or, cette « assimilation sensori-motrice » du monde extérieur immédiat réalisé 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 débute 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".

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<sup>60</sup>.

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"<sup>61</sup>.

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 sensorimotrice de sortir l'esprit naissant de son égocentrisme inconscient radical pour le situer dans un "univers", si pratique et si peu "réfléchi" que demeure ce dernier<sup>62</sup>.

Now just as the distinction between the two poles : self and the universe, grows more distinct, there still remains a certain degree of confusion surrounding each pole considered individually.

Within the self : action, representation, thought

In the early stages of the preoperational period (i.e., the symbolic period) the subject continues to tend toward activity. As a result play (an excess of assimilation) and imitation (an excess of accommodation) predominate. The symbols used by the child are often very personal. For example, a stone on a box may represent a cat on a wall, or a child might say, "Look, I am a church"<sup>63</sup>. However, it is precisely the ability to realize that one thing might symbolize another that indicates he is beginning to differentiate between simple practical activity and symbolic function. Thus representation at this period reaches its highest development in the formation of a mental image. It is with this structure that the child faces reality.

With the advent of language the child is confronted with a certain domain wherein differentiation and coordination must again take place : his private world and the world of other men.

He has already distinguished, to some degree, between things and people and his own place in the world of things, yet he has never distinguished his point of view from that of another. Up to this time this area has remained global as can be shown by numerous experiments one of which will be cited. Piaget presented a child with the following material — cardboard mountains, trees, river,

<sup>60</sup> *Six études de psychologie*, p. 24.

<sup>61</sup> *Ibid.*, p. 22.

<sup>62</sup> *Ibid.*

<sup>63</sup> *La formation du symbole*, pp. 295-296.



etc., set upon a small square table. The child was asked to pick from a series of pictures the view the doll would have from such and such a point as the doll moved around the table<sup>64</sup>. The child dominated by his own point of view, inevitably selected only the view that he saw even though he himself had made the actual tour of the table.

Return now to a consideration of the mental image, the most developed structure with which the preoperational child is equipped to face reality. The image is a static, particular, concrete representation of an object or a given situation. Piaget calls the image a preconcept for two reasons: absence of identity of a given individual on one hand, and the absence of a class on the other<sup>65</sup>. Thus the preconcept remains midway between an individual and the general class and oscillates continually between these two. The reason for such a situation is found in the fact that assimilation and accommodation have not as yet reached a state of equilibrium in this domain<sup>66</sup>.

Because of the very nature of the structure with which he has to work the child cannot make the necessary distinctions which would solve the problems facing him. He finds it difficult to distinguish certain things from one another as in the case of number and the space occupied, as well as recognizing different aspects of the same reality (for example: quantity and configuration, length and position). Likewise he is unable to integrate the whole and the part and to make an ordered series.

Now despite the limitations of this period there has been a certain reduction of globalism and confusion. First, the subject begins to recognize the difference between practical activity and the mental image, but he has not, as yet, coordinated them perfectly since he is unable to reproduce in thought what has transpired in reality. Thus Piaget says the child is always more advanced in the logic of action than in the logic of thought<sup>67</sup>. Secondly, the child has a certain grasp of his own efficient causality as distinct from external physical causality. However his notion is still limited since he attributes human qualities to all causes (i.e., a kind of "artificialisme"). For example, "Les adultes sont là pour 'nous soigner', les animaux pour nous rendre service, les astres pour nous chauffer et nous éclairer" . . . , etc.<sup>68</sup>.

Thirdly, he is no longer primarily interested in establishing a relationship between his body and the milieu but in recognizing relationships between one thing and another or between various aspects of the same thing.

<sup>64</sup> *La psychologie de l'intelligence*, p. 161; Cf. *La construction du réel*, p. 320.

<sup>65</sup> *La formation du symbole*, p. 240.

<sup>66</sup> *Ibid.*, p. 243. "... le préconcept étant assimilation à un objet privilégié, sans accommodation généralisée à tous, l'accommodation à cet objet, lorsque la pensée porte sur les autres, se prolonge alors nécessairement en image, celle-ci intervenant à titre de support nécessaire de l'assimilation, donc de signifiant privilégié et en partie de substitut".

<sup>67</sup> *Six études de psychologie*, p. 39.

<sup>68</sup> *La construction du réel*, p. 311.

2° *As the self sees the world: difference among things, different aspects of the same thing.* If one claims that the reason for the child's inability to dispel the globalism and confusion surrounding things is due to the nature of the structure with which he has to work (i.e., the mental image), then the question immediately arises: whether the advent of concrete operations with its characteristic of reversibility and the notion of an invariant suffice to reduce all globalism and confusion to clarity and coordination. Piaget replies in the negative. Experimentation indicates that in some areas the child will be capable of coordination and differentiation while other areas escape him and remain to be resolved during the formal operational period.

The area of success is that area which was a major source of difficulty for the preoperational child. With the constitution of the invariant and the reversibility of an operation the child has the tools to establish equilibrium between the various aspects of the problem. He can distinguish between the transformations involved and the successive states resulting therefrom and can coordinate these parts into an organized and harmonious whole. Granted that he can unite, separate, and order, his point of departure is in the real; he works primarily on things and not on propositions. That is to say, the child has not distinguished the content from the form.

En bref, les premières structures concrètes reposent toutes sur des opérations de classes et de relations (mais sans épuiser la logique des classes ni celle des relations...). Leur fonction essentielle consiste à organiser, l'un après l'autre, les divers domaines de l'expérience, mais... sans qu'il y ait encore de différenciation complète entre le contenu et la forme<sup>69</sup>.

Thus, Piaget claims, the notion of the invariant applies only in certain areas and it will gradually "thaw-out" so as to apply both in the real and the hypothetical order at the term of mental development. To illustrate: during the concrete operational period the child can distinguish number from plurality yet proportion escapes him; likewise he can distinguish and coordinate quantity and configuration, however weight and volume only appear later<sup>70</sup>; again, classification and seriation liberate the child from figurative collections while the notions of permutations and combinations are beyond his reach. The very fact that he still operates on concrete things prohibits him from grasping the logic of propositions and from formulating hypotheses.

The formal operational period marks the culmination of mental development. There is no longer any trace of globalism and confusion either on the side of the subject or in his view of reality. Operating on operations affords the possibility of harmonizing the real and the possible, of proceeding from hypotheses to experiential verification, of integrating all transformations in the real order under

<sup>69</sup> *Six études de psychologie*, pp. 142-143.

<sup>70</sup> *Ibid.*, pp. 175-176; Cf. *Six études de psychologie*, p. 140; *La psychologie de l'enfant*, p. 75.

the original INRC model of Piaget. Having distinguished between content and form enables one to reflect on his own activity so that during this period "la raison présente à la fois une organisation formelle des notions qu'elle utilise et une adaptation de ces notions au réel — organisation et adaptation d'ailleurs inséparables"<sup>71</sup>.

*B. Steps in the transition from confusion to distinctness*

Focusing our attention on the passage from one major period to another should enable us to see the principle which Piaget claims is operative during all phases of intellectual development, namely that there is always a movement from the vague and confused to the clear and distinct. We have chosen to examine the passage from the preoperational to the operational period since it marks the transition from the level of action to the level of thought properly speaking. One experiment will be cited which concerns the formation of one of the most fundamental of all invariants — that of quantity. We will examine the thought of a child who fails to resolve the problem ; secondly, the thought of one who is caught in a certain ambiguity, doubt and hesitation when faced with the problem and lastly, the thought of a child who successfully resolves the problem.

The experiment takes various steps. The young child (4-5 years old) is confronted with two balls (A and B) of plasticine of equal quantity. Ball B is transformed into a pancake before the child and he is then asked if Balls A and B have the same amount or does one now have more than the other. He will reply by saying : "No it (Ball B) has more because it is flatter" or "No, there is less here (Ball B) because it is thinner". Once Ball B is refashioned into a ball the child will again affirm the equality of A and B. However he will deny the equality if the ball is transformed into a sausage or divided into small pieces.

Piaget makes the following observations upon such reasoning. Since the child has only a mental image with which to meet the situation it prohibits him from taking into account any transformations. In fact for the child at this period, any transformation modifies all the given data of a problem. Since he is fixed on the successive states of the object as well as centering on one dimension or factor at a time, the child will unconsciously contradict himself. When B was refashioned into a ball one realizes that his judgment as to equality was based on a perceptual similarity only. He has confused the quantity which remains constant and the various configurations such quantity may assume.

During the transition period the child (5-6 years) recognizes the different dimensions, but only successively. He realizes that contradiction will ensue if he reasons on one dimension at a time, which leaves him in a state of ambiguity and doubt. It is precisely this transition from a single centering on one dimension to two successive centerings that heralds the beginning of operations, in Piaget's sense of the term. Once the child can reason with respect to both dimensions

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<sup>71</sup> *La naissance de l'intelligence*, pp. 358-359.

simultaneously that he can deduce the notion of conservation of quantity. During the transition these two relations are still seen alternately. A true operation is not yet present. It is only when the child can decentralize (i.e., recognize and coordinate all dimensions) that the invariant is formed and which is recognized by the child as a constant amid various transformations.

The child (7 years of age) indicates by his responses to the question that he has recognized the notion of quantity. From the analysis of hundreds of samplings, Piaget finds three basic ways which the child employs to handle the situation successfully : by reversibility, by compensation and by identity.

1° *By reversibility.* When confronted with Ball B transformed into a pancake the child may reply : "It is the same thing. You just made it into a pancake". Or again : "You only flattened it. If you put it back into a ball then they (i.e., A and B) would be the same". Piaget calls this type of reasoning reversibility (by conversion)<sup>72</sup>. The child can retain the notion of the original state as well as the subsequent state and thus realizes that it is the same reality in question (in this instance — a given continuous quantity). Foreseeing in thought the reverse process, without it actually taking place, assures him of the identity of these two balls.

In analyzing this type of reply (reversibility by conversion) Piaget claims that the child is grasping the notion of object (i.e., the reality in question). He can distinguish between the object itself (which remains stable) and the different states in which it may appear (i.e., as a pancake, sausage, little pieces, etc.). Having distinguished between a thing and its various appearances the child has made a profound discovery : the identity of an object is independent of the various states it may assume. Such a distinction is equivalent to recognizing the difference between the substantial and the accidental order (i.e., the order of configuration). At one and the same time a child is sufficiently "decentered" to recognize the invariant amid the transformations and can coordinate these various appearances with the invariant in question.

2° *By compensation.* A second justification is the argument by compensation. Faced with the problem the child may reply : "It is the same. It is longer but it is thinner" ; or "There are more pieces but they are smaller and that makes them the same". Piaget calls this the argument by compensation (or of reversibility by reciprocity of relations)<sup>73</sup>. The dominant factor in this mode of reasoning is no longer the object as such but the dimensions of the object in its original state and its transformed state. The child sees that there are two dimensions that must be reconciled in each instance. The ability to recognize these two and to realize that one compensates for the other provides him with the reason for declaring that the quantity remains unaltered. Again his capacity to "decentralize" has given him the power to move from one dimension to another and coordinate them

<sup>72</sup> *La psychologie de l'enfant*, p. 77.

<sup>73</sup> *Ibid.*

accordingly. Each dimension plays a role. The child is aware of this and can differentiate and coordinate simultaneously.

An analysis of this mode of justification reveals that the child has grasped certain changes in the accidental or configurational order which do not alter the quantity as such in any way. Here again is an indication of the profound distinction made by the child: the notion of quantity is independent of any given form. Correlatively, he is putting two elements or dimensions into a proper relationship<sup>74</sup>.

3° *By identity.* The third form of justification is found in the argumentation from identity. A child may reply to the demand for justification by saying: "You haven't added anything", or "You haven't taken anything away. It is just a sausage", or "It was a ball; now it is in little pieces". Once again the child seizes and harmonizes another aspect of the problem.

In such an argument the child recognizes the transformations which completely escaped the preoperational child. Not only does he recognize transformations but he can distinguish between a transformation which would involve a radical change (i.e., to add something or to take something away) and a transformation that only involves an accidental change (i.e., made into a pancake, or a sausage, etc.). Such a distinction enables him to see that the change in the form and figure of the quantity is independent of the changes in quantity as such. The correlative is equally true: the variations of quantity are independent of the variations in form.

Hence these three types of reasoning by: reversibility, compensation and identity attest to the fact that the child has reached the concrete operational level. These arguments may not all be given by any one child; however any one argument is sufficient to determine his attainment of the operational level. It often happens that having arrived at one or other of the justifications, the experimenter can, by asking precise questions, bring the child to the awareness of the other forms of justification. The ability to see the various aspects of the problem, to distinguish and coordinate them so that his knowledge and reality are, once again, in a state of equilibrium is what Piaget means when he says that the child "constructs" these notions.

Let this one experiment suffice to manifest the movement from vagueness and confusion to clarity and distinctness which Piaget claims is an integral part of the construction of any notion or invariant in the mind of the child.

### III. BASIC PRINCIPLES OF ARISTOTLE'S DOCTRINE

In describing the basic movement of the intellect in its search for knowledge, Aristotle says that the natural way is to start with those things which are clearer

<sup>74</sup> Recall again that the child on the concrete operational level can master two dimensions; however his knowledge is still, in a certain way, global because he neither recognizes nor distinguishes weight and volume as such. See *La psychologie de l'enfant*, p. 78.

and more obvious to us and proceed toward those things which are more knowable by nature. However he hastens to point out that those things which are more known and obvious to us are certain "confused wholes" so that we must advance from generalities to particulars.

Innata autem est ex notioribus nobis via et certioribus, in certiora naturae et notiora . . . . Sunt autem primum nobis manifesta et certa confusa magis : posterius autem ex his fiunt nota elementa et principia dividitibus haec. Unde ex universalibus ad singularia oportet procedere <sup>75</sup>.

In short, Aristotle's principle may be formulated in this fashion : the human intellect moves from the more known to the less known and in this movement one passes from a certain vague and confused knowledge to a knowledge that has a certain degree of clarity and distinctness. Hence two aspects of the principle deserve attention : first a consideration of the meaning of "more known to the less known" ; secondly, an examination of the passage from vagueness and confusion toward clarity and distinctness.

#### A. *More known to the less known*

To the question : what things are first known to us, common experience replies sensible material things. Those realities which are first known and known most clearly, are those things verified by sense experience, i.e., by touching, smelling, seeing, etc. However, this first knowledge, acquired by the senses, only provides a knowledge of the most external aspects of a given reality. Sense knowledge does not tell a man what things are in themselves since according to Saint Thomas, the "senses arrive at the *quia* but never at the *propter quid*" <sup>76</sup>. It is precisely the *propter quid*, what things are in their very nature, that the intellect seeks to know. However, accepting the principle that all our knowledge begins in the senses never led Aristotle, and St. Thomas following him, to identify the knowledge proper to the senses with the knowledge proper to the intellect. The knowledge of the senses bears on the singular while the knowledge of the intellect concerns the universal <sup>77</sup>. It is from the vast and varied data presented by the senses that the intellect "drawn

<sup>75</sup> Saint Thomas, *In I Phys.*, lect. 1, n. 2. (*Physics*, I, ch. 184 a 17-18 and 22-24). Due to the awkwardness of many English translations of Aristotle it would prove advantageous to keep the texts of Aristotle in the William of Moerbeke translation. However the standard references will be provided in parentheses immediately following the Latin reference.

<sup>76</sup> Saint Thomas, *In I Metaph.*, lect. 1, n. 30. ". . . sensus cognoscat quia, tamen, non propter quid cognoscit". Throughout this section texts from St. Thomas' commentaries will be used to interpret the often concise and brief explanations of Aristotle. Such a procedure seems admissible since Thomas is recognized as one of the great commentators on the treatises of Aristotle.

<sup>77</sup> Saint Thomas, *In I Phys.*, lect. 1, n. 8. "Quia sensus cognitio, quae est singularium, praecedit cognitionem intellectus in nobis, quae est universalium".

out", "abstracts" the intelligible content. For example the intellect recognizes "animal" when confronted with "elephant", "man" and "mouse". Such a position as this indicates that intelligibility exists in a twofold way: in individual sensible things as that which accounts for their specific nature and in the intellect as a universal. Hence it is that we begin with sense knowledge and proceed to intellectual knowledge.

B. *More known to us*

Now the briefest examination of the knowledge man possesses of even the simplest material reality reveals that what man first knows about the reality and what it is in itself are related one to another but are not necessarily identical. Hence a distinction is forthcoming in the term "more known" between that which is "more known to us" and that which is "more known in itself". Consider first the term "more known to us". In those things which are "more known to us" a twofold distinction can be made. We can know "that a thing is" and "what it is said to be" and still not know exactly "what the thing is in itself". Rather it is from knowing that a thing is and the knowledge which we possess in a nominal definition that we move toward a knowledge of what the thing is in itself, i.e., the knowledge afforded by a proper definition. An example will illustrate this point. In order to come to a definition of movement we begin with a certain common knowledge. That is to say, we are certain that movement is through the lived experience of seeing instances of motion, and secondly we have some vague knowledge of what implied by the name of the nominal definition. From this knowledge which is certain but confused we proceed to a knowledge which is more clear and distinct since it aims at discovering what the thing is in itself. For Aristotle there was no other mode of procedure. Does one not need to know "something" of the reality in question which would incite one to further inquiry? From the foregoing distinctions we can see that there is both continuity (between what we first know and the ultimate definition of the nature) and a genuine discovery or acquisition of knowledge (since we move from "that the thing is", and "that which it is said to be" to a knowledge of "what it is in itself").

C. *More known in itself*

Looking a second time at the distinction "more known to us" and "more known or knowable in itself" the term "to us" is not used without reason since that which is "first known" may be taken in two senses: first, as in the sense treated above "more known to us" and secondly, "in itself". Aristotle makes this distinction in the *Posterior Analytics* when he says that "prior" and "better known" are terms which need clarification because there is a difference between what is prior and better known in the order of being and what is prior and better known

to man<sup>78</sup>. A brief reflection on this distinction will reveal the relationship existing between the reality man first knows and the whole of reality in general.

Let us consider the distinction on the side of that which is known (i.e., the order of being or nature). Aristotle was aware that those things which are first and most known to us are not necessarily those things which are most knowable in themselves, and that those things which are more knowable in themselves are least knowable to us<sup>79</sup>. For him a thing was considered more knowable insofar as it was in act and not in potency. So that things further removed from potentiality had greater degrees of being and hence, of their nature, were more knowable in themselves. Such a position led Saint Thomas to say that man advances by beginning with those things least clear by nature but most certain to us, in order to arrive at those things which are most clear by nature yet less knowable to us.

... quae sunt magis nota quoad nos, accepit cognitionem intelligibilium, quae sunt magis nota secundum naturam, ita scientia naturalis procedit ex his, quae sunt nota magis quoad nos et minus nota secundum naturam<sup>80</sup>.

To illustrate the point let us go back to the example of movement. Movement with respect "to us" is more known because it falls within the sense experience of every man. And, as stated above, we begin by knowing "that it is" and "what it is said to be" and proceed to determining what it is "in itself". It is a consideration of this third area "what it is in itself" which reveals that movement, of itself, is less knowable than other realities since it is less in act because it marks the transition from potency to act.

#### IV. PRINCIPLE GOVERNING THE ACQUISITION OF ALL HUMAN KNOWLEDGE

At this point we are ready to examine the second portion of the principle which specifies the quality of this knowledge which proceeds from the more known to the less known.

##### A. *Remarks concerning the principle as found in the Physics*

The clearest formulation of the principle under consideration is found in Book I of the *Physics*. However, Aristotle's intention in this context was not to provide an explicit treatment of the principle as such. Rather he was intent upon accomplishing a very particular goal, namely, to determine the subject of the philosophy of nature. In order to accomplish this goal he employed the principle and, in passing, provided three signs which served to support the validity of such a claim. Thus, the primary aim was to show that the subject of the philosophy

<sup>78</sup> Aristotle, *Post. Anal.*, I, ch. 2, 71 b 33-72 a 4.

<sup>79</sup> Aristotle, *Physics*, I, ch. 1, 184 a 19-21.

<sup>80</sup> Saint Thomas, *Expositio super librum Boetii de Trinitate*, q. 6, a. 1.



of nature was "mobile being". Upon investigation "mobile being" was recognized as a reality which remains, in a certain sense, vague and confused, until all the elements, principles and causes have been studied with respect to every genus and species falling under that category of reality called "mobile being". Thus, "mobile being" can be considered as a certain whole which is vast, extensive and which remains known only vaguely and confusedly until all genera and species are known distinctly. Although Aristotle's intent was to determine the subject of the philosophy of nature as "mobile being", a second reflection on the matter reveals that this reality "mobile being" serves as a manifest illustration of the principle involved, namely, that it is always a whole which is first known but known only confusedly.

To discuss the principle as such surpasses the domain of the philosophy of nature. This principle is, in effect, the common and universal principle governing any and all modes of acquisition of human knowledge. Hence a discussion of the principle as such belongs primarily to the domain of metaphysics. The *ratio* (or reason) of the principle, as Saint Thomas points out in his commentary on the *Physics*, is found in the very nature of the human intellect itself. He maintains that the *ratio* is grounded in the nature of the movement characteristic of the human intellect, namely, a movement from potency to act. That is to say, the intellect acquires knowledge by moving from the imperfect to the perfect and from the confused to the distinct. Just as in the order of time and generation, the imperfect precedes the perfect so also in the order of knowledge this same law obtains: imperfect knowledge precedes perfect knowledge. Now as long as something is known indistinctly and confusedly, the knowledge remains imperfect. Perfect knowledge, to the contrary, demands a complete, distinct and clear knowledge of all the elements, principles and causes. To know something imperfectly implies that one's knowledge is partly in act and partly in potency, whereas perfect knowledge is in total act (i.e., the knower possesses a clear and distinct knowledge of all elements). Saint Thomas states this position as follows:

...quia cognoscere aliquid indistincte, medium est inter puram potentiam et actum perfectum, ideo, dum intellectus noster procedit de potentia in actum, primo occurrit sibi confusum quam distinctum; sed tunc est scientia completa in actu, quando pervenitur per resolutionem ad distinctam cognitionem principiorum et elementorum. Et haec est ratio quare confusa sunt primo nobis nota quam distincta<sup>81</sup>.

In this respect there is a striking resemblance between the perfection of nature and the perfection of the intelligence. The more a being is determined the more perfect it is, likewise with respect to the intelligence, the more the intellect seizes the differences in a being the more its knowledge is perfect.

As signs of the validity of this principle that what is first known is a "whole" but known only confusedly, Aristotle provides three examples. The first example,

<sup>81</sup> Saint Thomas, *In I Phys.*, lect. 1, n. 7.

stated very succinctly, deals with the very manifest reality, namely, a sensible integral whole.

Totum enim secundum sensum notius est : universale autem totum quoddam est. Multa enim comprehendit ut partes universale <sup>82</sup>.

The second is drawn from the mode of defining wherein one moves from a certain whole which is vague and confused to a definition that is clear and precise.

Sustinent autem idem hoc quodammodo et nomina ad rationem. Totum enim quoddam et indistincte significant, ut puta circulus. Definitio autem ipsius dividit in singularia <sup>83</sup>.

The third and last example or sign is drawn from the way in which children obtain knowledge. Again there is a manifest movement from that which is vague and confused to that which is clear and distinct. Aristotle says,

Et pueri primum appellant omnes viros patres et feminas matres : posterius autem determinant horum unumquodque <sup>84</sup>.

In the following section wherein the principle as such will be the subject of discussion we will see that these three signs are, in reality, aspects of the principle which indicate its absolute universality : in the domain of the integral whole be it sensible or intelligible, the mode of defining, and in the domain of common sensible knowledge. However, in the context of the *Physics* they are not presented as domains wherein the principle applies (thus indicating its universality) but rather they are presented as simple examples confirming the validity of the principle. Such is the case, since Aristotle's intention in the *Physics* was not to present an exposition of the principle as such but rather to determine the subject of the philosophy of nature.

#### B. *Presentation of the principle as such*

To present this principle in all of its universality we must turn to Saint Thomas' commentary <sup>85</sup>. Recall that the original statement of the principle as given by Aristotle reads as follows :

Sunt autem primum nobis manifesta et certa confusa magis : posterius autem ex his fiunt nota elementa et principia dividitibus haec <sup>86</sup>.

<sup>82</sup> Saint Thomas, *In I Phys.*, lect. 1, n. 3. (Aristotle, *Physics*, I, ch. 1, 184 a 24-25).

<sup>83</sup> *Ibid.*, n. 4 (Aristotle, 184 b 9).

<sup>84</sup> *Ibid.*, n. 5 (Aristotle, 184 b 12-14).

<sup>85</sup> An interesting study would be to compare the treatment of this principle as found here in the *Physics* with St. Thomas treatment of this same principle in *Ia*, q. 85, a. 3.

<sup>86</sup> Saint Thomas, *In I Phys.*, lect. 1, n. 2.

The analysis made by Saint Thomas brings out all that is implied in this cryptic statement of Aristotle. He first comments on the principle by presenting the *ratio* and then interprets the signs used by Aristotle. Mention has already been made of the *ratio* which is found in the very nature of the intellect itself which moves from potency to act. Any movement from potency to act is essentially a movement from the imperfect to the perfect, hence one can see that in human knowing vagueness and confusion would be equated with perfect knowledge. Likewise, if the intellect moves from potency to act then the quality of human knowledge would likewise be subject to the same conditions, i.e., knowledge would begin in vagueness and confusion and proceed to clarity and distinctness.

The point which interests us at this time is the word "whole" since the claim is made that it is the whole which is first known but known only vaguely and confusedly. Commenting on the aforementioned passage Saint Thomas draws out the distinction between two different kinds of "wholes": an integral whole (be it sensible or intelligible) and a universal whole (which may be called a universal *in praedicando*). He comments in this fashion:

Quorum primum sumitur a toto integrali sensibili: et dicit quod totum sensibile est notius secundum sensum; ergo et totum intelligibile est notius secundum intellectum. Universale autem est quoddam totum intelligibile, quia comprehendit multa ut partes, scilicet sua inferiora; ergo universale est notius secundum intellectum quoad nos<sup>87</sup>.

Note that in the passage above St. Thomas uses the same expression as Aristotle to describe the universal whole: "certain kind of whole" — "quoddam totum intelligibile". It is considered a whole insofar as it includes many things like parts. Hence our task is to grasp the meaning of the word "whole", then integral whole and subsequently "universal whole" (or universal *in praedicando*) in order to understand the principle Aristotle is using.

The term "whole" is analogical. In a most general way a whole first implies a certain perfection since it means that in which none of the parts are missing; secondly, that the parts become one in the whole<sup>88</sup>. Now the differences among "wholes" arises with respect to the way in which the "parts" are contained. If the parts are constitutive of the nature so that the whole would not be such a thing without each and every part then one has an integral whole, an "ipsum unum", be it sensible or intelligible. In this case, the whole cannot be predicated of any individual part but it is rather that all the parts together form the whole. A whole in this sense means one thing composed of parts in such a way that none of the parts are that one thing<sup>89</sup>.

<sup>87</sup> Saint Thomas, *In I Phys.*, lect. 1, n. 9.

<sup>88</sup> Saint Thomas, *In V Metaph.*, lect. 21, n. 1098.

<sup>89</sup> *Ibid.*, n. 1099. "Aut ex partibus constituatur unum, ita quod non quaelibet partium sit illud. Et haec est ratio totius integralis quod de nulla suarum partium integralium praedicatur".

In other words, an integral whole cannot be predicated of any of its own integral parts. Whereas, a containing whole which can be predicated of any one of its own parts (considered as subjective parts) is called a universal whole<sup>90</sup>. It would seem that the term "whole" belongs most properly to the integral whole and has been applied to the universal whole "per posterius". In proof of this we refer again to the notion that in both the texts of Aristotle and of Saint Thomas one finds the same expression "quoddam totum" — "a certain kind of whole", when referring to the universal whole. It will be by examining the signs which Aristotle employs that the application of the term "whole" to the universal will be made manifest.

The first sign is drawn from the domain of the sensible integral whole. Saint Thomas provides a concrete example, namely, a house. He shows that one can grasp the whole house, recognize it for what it is, without immediately grasping all the parts. The knowledge of the parts are virtually contained in the knowledge of the house as house but they are not alluded to in a clear and distinct way. It is on this point that he proceeds to draw a parallel with the universal whole.

Dicendum est autem quod totum integrale et universale conveniunt in hoc, quod utrumque est confusum et indistinctum. Sicuti enim qui apprehendit genus, non apprehendit species distincte sed in potentia tantum, ita qui apprehendit domum, nondum distinguit partes : unde cum ratione confusionis totum sit prius cognitum quoad nos, eadem ratio est de utroque toto<sup>91</sup>.

Looking at this comparison between the sensible integral whole and the universal whole we may make the following observations. The "house" is a sensible integral whole since this term cannot be applied to the parts considered as parts, that is to say, to the roof, mortar, bricks, etc. Rather it is the "house" taken as a whole which bears the name "house". Now insofar as one recognizes the reality "house" without having a distinct knowledge of the parts one has the basis for a certain similarity to a universal whole wherein one knows the genus while the knowledge of the species remain vague and confused.

The second example, in the domain of the integral intelligible whole, is drawn from the mode of defining. Aristotle claims that when one forms a definition one begins with a name which can be considered as a certain integral whole which is confused and indistinct as to content that is to be made explicit by a definition. To do this demands that one find the principles of the thing to be defined. Granted that the principles needed for the definition are themselves known before the definition is formulated, they are not known as the defining principles. For instance "animal" and "reasonable" are both ideas known before one embarks on a proper definition of "man". However, the term "man" is known confusedly and indis-

<sup>90</sup> *Ibid.*, n. 1100. "... dicitur quasi sit aliquod unum totum ex hoc quod praedicatur de unoquoque, sicut universale, quasi multa continens ut partes, in eo quod praedicatur de unoquoque. Et omnia illa sunt unum in toto universali, ita quod unumquodque illorum est illud unum totum".

<sup>91</sup> Saint Thomas, *In I Phys.*, lect. 1, n. 9.

tinctly until the analysis reveals that it is precisely "animal" and "reasonable" that mark his defining principles. Saint Thomas states the case in this fashion :

Definitum enim se habet ad definitia quodammodo ut totum integrale, in quantum actu sunt definitia in definito ; sed tamen qui apprehendit nomen, ut puta hominem aut circulum, non statim distinguit principia definitia ; unde nomen est sicut quoddam totum et indistinctum, sed definitio dividit in singularia, id est distincte ponit principia definiti<sup>92</sup>.

We might rephrase this idea by saying that the intellect would not seek knowledge if it had not already found, in some manner, that for which it was searching. The example, afforded above, claims that one knows something of "man" before one formulates a proper definition. That is to say, one knows something of "animality" and "rationality" but one does not see them as constituting the defining notes of man. Or again, one who seeks to know the definition of man already knows what the word signifies, recognizes something of the reality in question while remaining ignorant of the precise definition. Saint Thomas presents this doctrine in his commentary on the *Boetii De Trinitate*<sup>93</sup>.

From the foregoing remarks we see a certain parallel between an integral intelligible whole wherein one has a certain knowledge of the reality in question without knowing all the elements and principles distinctly, and the universal whole wherein one has a certain knowledge of the genus without a clear and distinct knowledge of all the species.

The third and last sign used by Aristotle concerns common sensible whole. Saint Thomas provides three examples to illustrate the case in question. First, he recognizes, along with Aristotle, that there is a certain evolution in our knowledge even in the domain of the common sensible. According to sense perception it is evident that man grasps the more common element prior to the grasp of the specific element : "ita communius sensibile est prius notum nobis secundum sensum, ut puta hoc animal quam hic homo"<sup>94</sup>.

The same condition prevails when perceiving something at a distance. The object seen at a distance is indistinct and vague and in the measure in which one approaches it one can discern a living thing, then man and finally Socrates.

Secundum locum quidem, quia cum aliquis a remotis videtur, prius percipimus ipsum esse corpus quam esse animal, et hoc prius quam quod sit homo, et ultimo quod sit Socrates<sup>95</sup>.

<sup>92</sup> *Ibid.*, n. 10.

<sup>93</sup> Saint Thomas, *In Boetii de Trinitate*, q. 6, a. 3. "... definita sunt praecognita partibus definitiones. Oportet enim scientem, hominem esse, et quarentem, quid est homo, significat. Nec hoc esset nisi aliquam rem quoque modo conciperet, quam scit esse quamvis nesciat eius definitionem. Conceptit enim hominem secundum cognitionem alicuius generis proximi vel remoti et aliquorum accidentium, quae extra apparent de ipso. Oportet enim definitionum cognitionem, sicut et demonstrationum, ex aliqua praeeexistente cognitione initium sumere".

<sup>94</sup> Saint Thomas, *In I Phys.*, lect. 1, n. 11.

<sup>95</sup> *Ibid.*

Now this same evolution with respect to distance can be compared with a certain evolution from the point of view of time. A child first learns to distinguish man from non-man, before distinguishing one man from another, eventually enabling him to recognize this man, Plato, who is his father.

Et similiter secundum tempus puer prius apprehendit hunc ut quendam hominem, quam ut hunc hominem qui est Plato, qui est pater eius<sup>96</sup>.

#### V. CONCLUDING REMARKS

From the foregoing presentations, it would seem that grounds for the original intent of this article have been made manifest ; to indicate a certain rapport between the theory of Jean Piaget and the doctrine of Aristotle.

Piaget's theory concerned the concrete manifestation of intellectual life in the child ; Aristotle's doctrine concerned the common mode of procedure characteristic of the human intellect as such. In both instances, however, we have seen that the same principle plays a fundamental role in the acquisition of knowledge, namely, that there is always a movement from vague and confused knowledge to clear and distinct knowledge. It was precisely the recognition of vague and confused knowledge as an integral part of human knowing that caught the attention of this writer. It seemed worth noting that these two great thinkers, one from the ancient and one from the contemporary world and engaged in different disciplines, would maintain the same principle governing the acquisition of human knowledge.

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<sup>96</sup> *Ibid.*