By JEAN PIAGET

GENETIC PSYCHOLOGY AND EPISTEMOLOGY

Specialists in genetic psychology, and especially in child psychology, do not always suspect what diverse and fruitful relationships are possible between their own subject and other more general kinds of research, such as the theory of knowledge or epistemology. And the converse is even more true, if that is possible: that child psychology has for long been regarded as a collection of case histories of infants. The necessity has not always been recognised, even in the field of general psychology, of considering all problems from the standpoint of development, and it is still true, in certain countries, that 'child psychologists' are a group apart, having no contact with the main currents of experimental psychology. Even less, as a rule, do students of the theory of knowledge suspect that, within reach as it were, in the field of psychogenetic experience, they can sometimes find solutions to the most general questions on the formation of ideas or on the analysis of intellectual activity. Yet they have been known to show inexhaustible patience when trying to reconstruct some unknown passage from the history of science for the sake of its epistemological significance.

But there is a chapter in the history of science which for a long time past should have served as an analogy to facilitate the closer connection which we are advocating: the relationship which embryology has gradually been called upon to establish first with comparative anatomy and then with the theory of evolution as a whole. Such a comparison deserves much attention, for there is no doubt that child psychology constitutes a kind of mental embryology, in that it describes the stages of the individual development, and particularly in that it studies the mechanism itself of this development. Psychogenesis represents, moreover, an integral part of embryogenesis (which does not end with birth but rather with the final stage of equilibrium which is the adult status). The intervention of social factors and elements of individual experience in no way detracts from the accuracy of this statement, for organic embryogenesis is itself also partly a function of the environment. On the other hand, it is clear that epistemology, if it is not to be restricted to pure speculation, will devote itself more and more to such purposes as the analysis of the 'stages' of scientific thought and the explanation of the intellectual mechanisms used by science in its various forms to conquer reality. The theory of knowledge is then essentially a theory of the adaptation of thought to reality, even if this adaptation in the end discloses, as after all it must, an unavoidable interaction between subject and objects. To consider epistemology, then, as a comparative anatomy of the function of thought and as a theory of intellectual evolution or of the adaptation of the mind to reality, is not to belittle the magnitude of its tasks. Above all, this is not to prejudge the solutions which it will be led to adopt, nor to advocate beforehand the necessity of a certain realism. If, in Lamarckism, the relationship between the organism and its environment showed the same simplicity as that of the mind and objects in classical empiricism, this same relationship in the field of biology has become complicated in direct proportion to our knowledge of the internal variations of the organism, until there is to-day a kind of isomorphic relationship between the different evolutionary and anti-evolutionary hypotheses on the one hand and, on the other, the varying explanations of intellectual adaptation given by epistemologists.

Once we admit comparisons of this kind, the history of the relations between embryology and other biological studies throws considerable light on the possible and, to a certain extent, the actual relationship between child psychology and epistemology. Indeed it is well known how embryology has shown the way to the solution of a number of problems which remained unsolved by comparative anatomy because of the lack of

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information about the structure of certain organs or even of whole organisms. Thus for a long time barnacles were classified as belonging to the Mollusca until the study of their larvae showed them to be genuine Crustacea, passing through certain stages common to all members of this group. In the same way, the division of tissues, as specified in embryology, into ectodermal, mesodermal, and endodermal has enabled us to confirm our conclusions concerning a great number of organs and has provided very valuable information about the significance of certain organic systems. (We have only to think, for instance, of the ectodermal origin of the nervous system, which could serve as the basis of an entire philosophy!) As for theories of evolution, even if the parallel between ontogenesis and phylogenesis has been exaggerated (it is still far from being precisely detailed) there is no doubt that embryology has revived the prospects of evolutionism and that its contribution, considered from an adequately critical standpoint, is of great help in the study of a problem to which after all no definitive solution has yet been found.

Although science became concerned with the development of intelligence in children, from infancy through adolescence, much later than with the embryonic phases of a variety of animals the most alien to man's rational nature, genetic psychology, as yet a young science, has nevertheless made contributions to the solution of the classical problems of epistemology which may be compared, *mutatis mutandis*, with those we have been discussing. To see this more clearly, however, we must first dispel a possible misunderstanding. Genetic psychology is a science whose methods are more and more closely related to those of biology. Epistemology, on the contrary, is usually regarded as a philosophical subject, necessarily connected with all the other aspects of philosophy and justifying, accordingly, a metaphysical position. In these circumstances, the link between the two subjects would have to be considered either as illegitimate or, on the contrary, as no less natural than the transition from any scientific study to whatever form of philosophical thought, less by way of inference than by inspiration and involving, moreover, the addition to the latter of subject considerations beyond its scope.

But apart from the fact that contemporary epistemology is increasingly the work of scientists themselves who tend to connect the problems of 'fundamentals' with the practice of their own branches of learning, it is possible to dissociate epistemology from metaphysics by methodically limiting its subject matter. Instead of asking what knowledge is in general or how scientific knowledge (similarly taken as a whole) is possible, which naturally presupposes a complete philosophic system, we can make a habit of confining our questions to the following 'positive' problems: How do different forms of knowledge, rather than knowledge itself, develop? By what process does a science pass from one determinate form subsequently held to be inadequate, to another determinate form afterwards held to be superior by the common agreement of the experts on this subject? All the epistemological problems are again encountered, but now in an historical and critical rather than an immediately philosophical perspective. It is of this genetic or scientific epistemology[1] that we shall speak here to illustrate to what extent it may look to child psychology for a helpful contribution to its problems, a contribution which may perhaps prove far from negligible.

I.

Let us begin at once with a very important problem: Can a comparison be drawn between mathematics and physics, or are they two irreducible types of thought and understanding? It is well known that both points of view have been, and continue to be, defended. The logistic school in general favours the theory of duality, and the logical positivists of Vienna have even introduced a radical distinction between two kinds of truths: the truth of 'tautological' propositions, characteristic of logic and mathematics, whose contradictions are 'propositions without meaning', for this first type of truth depends upon an equation; and the truth of empirical propositions, characteristic of physics (or biology, etc.), whose contradictions are false propositions, but which carry a meaning (for instance: water does not freeze at 0° centigrade). On the other hand, some authors, such as Brunschvicg earlier and Gonseth to-day, consider that mathematical truth can be assimilated to physical truth because it exhibits a similar blend of deductive principles and empirical statements.

Such an argument depends partly on genetic psychology, for everyone will agree that the development of mathematics has been preceded by certain kinds of arithmetical knowledge (as, for instance, the idea of the integer, etc.) and that part of our knowledge of physics is similarly due to a pre-scientific common sense. But when mathematicians, physicists, or philosophers appeal to common sense and try to imagine how its ideas are developed, they are usually satisfied with an arbitrary reconstruction of its

[1] cf. Piaget, *Introduction à l'epistémologie génétique*, Paris: Presses Universitaires de France, 1949–50.

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workings (what might be called colloquially a 'slick' reconstruction) and admit by implication that, as common sense is universal, everyone is competent to know how it works. Even if we agree that every man is a psychologist, we must, nevertheless, take certain precautions when the question is one of origins or genesis. Moreover, without in any way neglecting ethnographical and sociological research, it is a good thing to consider in this connection how the bases of arithmetical and physical knowledge are in fact constituted in the mind of the young child.

Such an analysis will allow us at the outset to dispose of a fundamental misunderstanding, which has certainly contributed to the obscuration of our topic. There is no doubt that all knowledge presupposes an element of experience, and it seems undeniable that without first handling objects the child could not establish the correspondence between one unit and another which enables him to work out an idea of the integer nor discover that the sum of certain objects is always the same, in whatever order they are counted, and so on. Even such a truth as $2+2=4$, and particularly the inverse operation, $4-2=2$, depends upon an appeal to experience; and this is true also of the elementary logical argument exemplified in the transitive relations: $A=B$; $B=C$; therefore $A=C$, which is in no sense grasped as obligatory before the age of six or seven in the case of space measurements, nor even before the age of nine in the case of weights. We have often seen children of eight or nine admit, for instance, that a brass bar A weighs exactly the same as a brass bar B of the same dimensions and then, despite their contrary expectation, discover by weighing them that bar B weighs the same as a ball of lead C. When finally, the question was raised whether bar A weighed as much as ball C, it being understood (and this was insisted upon) that $A=B$ and $B=C$, they calmly replied: 'No, this time the lead will be heavier, because lead is always heavier.'

In short, we can grant the exponents of experience that even the simplest and most general arithmetical and logical truths depend upon empirical support before giving rise to a purely deductive operation. But what sort of experience is in question, and is it possible on this basis alone to assimilate logico-mathematical experience at pre-operational levels to physical experience at the same or subsequent levels?

The examination of the child's behaviour towards the objects shows that there are two kinds of experience and two kinds of abstraction, according to whether the experience is concerned with the things themselves and allows the discovery of certain of their properties, or whether it is concerned with relationships not inherent in the things but introduced by the action, making use of the objects for its own purposes.

In the first case (we say 'first' because this is what is currently understood by the term 'experience', not because it represents a genetically anterior type of experience) we have experience of the object leading to an abstraction from the object: this is the type of physical experience which is properly a discovery of the properties of things. Moreover, this discovery always presupposes some sort of action; but a particular action, with reference to a certain quality of the object, and not, or not merely, the general relations implicit in the action. For instance, when a child discovers the unexpected fact that a ball of lead can weigh the same as a brass bar, he submits to a physical experience and abstracts the information from the objects themselves while making use at the same time of the particular action of weighing, etc.

On the other hand, 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, which merely serve him as instruments, but with his own activities of arranging and enumerating. But these activities exhibit two characteristics which are quite distinct from the act of weighing. First, they are activities which confer properties on the object which it did not itself 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 objects as such. Second, they are general activities, or, more precisely, they are co-ordinations of actions: indeed, whenever we act, we introduce a certain order into our activities (we 'classify the problems to be solved') whereas 'weighing' is a much more particular action. Furthermore, these general acts of co-ordination quickly become transformed, after the age of seven or eight, into purely mental operations so that, at the next stage, the child no longer needs to experiment in order to know that ten will always remain ten, independently of a given order; he deduces it logically whereas he cannot deduce the weights of objects without adequate previous data.

In the same way, to discover that $A=C$ if $A=B$ and $B=C$, is an experience concerned with the general co-ordination of actions. It can be applied to weights as to anything else, but it does not amount to abstracting the transitivity from the objects as such, even if in general the objects confirm this law, which depends on action before becoming a law of thought. It is true that the child does not consider this transitivity as necessarily applicable except in fields where he already has some previous ideas of continuity: simple quantities (length, etc.) towards the age of seven or eight, weights about the age of nine to ten, and so on. But this does not mean that the transitivity of objects is derived from physical experimentation; we shall soon see that ideas of continuity are, on the contrary, the result of logical construction.

We may conclude in the meantime that child psychology throws at least some light on our first epistemological problem. It is not because our first approach to mathematics is experimental that mathematical knowledge can be assimilated to the knowledge of physics. Instead of abstracting its content from the object itself, it contrives from the outset to endow the object with relations which are originally the subject's. Before becoming laws of thought, these relations derive from the general co-ordinations of action; but neither this active character nor the fact that the subject must undergo a certain type of experience before he can understand the operation of deduction, detracts from the validity of the statement that these relations are the expression of the subject's constructive ability rather than that of the physical properties of the object.

II

Let us consider, as a second example, the ideas we hold on the concept of continuity. We know how Emile Meyerson, an unusually vigorous and scholarly thinker, has demonstrated the complex character of the principles of continuity. From an empirical point of view, i.e., where the content of what is continuous is provided by a physical experimentation which, however, is insufficient to impose the concept of the necessity of continuity, it may be called 'plausible'; but insofar as it is exacted by thought, it must be ascribed to the power of 'identifying' which, according to him, is characteristic of rational deduction alone. We should like to limit ourselves here to a consideration of the problem of knowing whether the contribution of the mind to the formation of our ideas of continuity is no more than this power of identification, or whether it is not equally a characteristic of thought to understand change. In other words, we should like to be able to decide whether what is 'different' is always irrational or whether reason is capable of activities other than identification pure and simple.

Let us begin again by observing the rather simple character of our ideas of continuity. If we had to wait for modern physics to discover the continuity of uniform, rectilinear movement (inertia) and the conservation of energy, etc., the Pre-Socratics certainly admitted the permanence of matter; and Meyerson himself examines the *schema* of the persistent character of objects when, as the first principle of continuity, it stands out from the field of perception. He even goes so far as to attribute awareness of this principle to animals (to a dog in pursuit of a hare) and to all forms of thought. The information provided by child psychology in this respect may thus have some significance.

This information is twofold. It concerns, first, the levels of development at which ideas of continuity are formed and, second, their precise mode of formation.

Regarding the stages at which ideas appear, we must beware of thinking that the idea of constants is formed as early as has been asserted. We must, moreover, distinguish two different cases: on the one hand, the sensory motor constants, such as the *schema* of the persistent character of objects, and the observed constants of size, shape, and colour; and, on the other hand, the constants derived from thought itself, such as the persistence of patterns, spatial measurements, physical quantities, etc. Although we do not yet know enough about the ages when observed constants are first grasped (according to Brunschvicg and Cruikshank constant size is not understood before the age of six months or thereabout) we know, on the other hand, that the persistent character of objects is grasped only during the second half of the first year (looking for an object which has completely disappeared behind a screen). The baby begins by showing no reaction at all to the vanished object. Then, during an intermediate phase, it looks for it but without allowing for its successive changes of position. Thus the idea of the persistence of the object in nearby space, which is a kind of group constant, is developed only in connexion with the idea of a series of observed changes of position, i.e., with the organisation of space as an integral whole. As for representative constants, dependent on thought itself, the formation of such concepts comes very much later and is not found earlier than the first logical operations with respect to classes and relations (towards the age of seven to eight).

Let us take as an example the continuity of a group of objects, such as a collection of ten to twenty beads in a small glass. The child is asked to put an equal number of blue beads in a glass *A* and of red beads in a glass *B* of the same shape and size. In order not to have to count the objects, he can put a blue bead in *A* with one hand while putting a red bead in *B* with the other. As soon as the two equal sets have been

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completed, the child is asked to empty the contents of glass *B* into a receptacle *C* with a different shape (a glass which is taller and narrower or shorter and wider, etc.). The child now should decide whether the number of beads in *A* still remains the same as the number in *C* (or, subsequently, in *D*, etc., varying the observed shapes). Now small children deny this group continuity or, at any rate, consider it in no way obligatory. For them, there are more beads in *C* than in *A* because they reach a higher level; or else there are fewer because the glass is narrower, etc. On the other hand, towards the age of six to seven, the collection begins to be thought of as a constant whatever the observed shape of the receptacle.

Let us now consider the reasons put forward in favour of the idea of continuity at the time when it is first formed. There are three types of argument, and they recur invariably, whatever problem of continuity we may think of (conservation of quantities of matter, such as the weight or volume of balls of modelling clay whose shapes can be altered in different ways; maintenance of lengths or surfaces, despite changes in the position of the elements, etc.). The first reason seems to confirm Meyerson's theory and to relate solely to the operation of identification: the child argues that, since nothing has been taken away or added, the number of beads must still be the same. There remains the question of why this idea of identity appears so late. In fact, small children also know quite well that nothing has been removed or added, and when they are asked where the beads which they think are in *C* come from when they have not been taken from *B*, or where the beads which are missing in *C* have gone if they are not to be found in *B*, they simply dodge the question. They merely insist on the statement that the final collection *C* seems to them larger or smaller than *B* was in the first place, though accepting the evidence that no beads were introduced from outside during the course of the operation nor taken away when a new glass was used. Why, then, are small children unable to realise this identification while bigger children can base their reasoning upon it? It is because the identity of the collections *B* and *C* is only the end or result of the child's reasoning, and not the starting point.

The second reason put forward, on the other hand, throws some light on the mechanism itself of the nascent sense of reasoning: it is the concept of simple reversibility. The collection has been emptied from *B* into *C*, says the child, but it is easy to transpose collection *C* back into *B*, and it will be seen that nothing has been changed.

The third reason, finally, is reversibility applied to the relations in question, i.e., the compensation resulting from the respective changes. The collection put into *C* reaches a higher level than in *B*; but *C* is narrower than *B*; one of the modifications thus compensates for the other, therefore the relative result is the same.

The grasp of this reversibility, the first signs of which are quite general at the age of seven to eight, in fact expresses the transformation of actions into mental operations. Elementary action is a one-way process, directed towards a single end; and the whole of the small child's thought, which is no more than the mental representation of actions in images, remains irreversible precisely in as much as it is subordinate to the immediate action. Mental operations, on the other hand, are actions co-ordinated in reversible systems in such a way that each operation corresponds to a possible reversed operation by which it would be cancelled. But such an idea of reversibility is to be found only late in the development of thinking, because it presupposes a reversal of the natural course of actions, if not of the natural course of events themselves, both external and internal (the stream of consciousness, which has been described as reflecting 'immediate' facts, is the pattern of all irreversible flux).

The absence of constants, so characteristic of the thinking of small children, thus is merely the consequence of the initial irreversibility of thought; the formation of the earliest ideas of continuity, on the other hand, is due to the grasp of reversibility which characterises the first concrete mental operations. From this point of view, identity is to be considered as a conclusion—the result of putting together direct and inverse operations—and not as a starting point. It is the group of changes as such (or any other reversible system analogous to a group) which is the origin of the principle of continuity, and identity (or more precisely the 'operation of identifying') is only one aspect of the pattern in question, an aspect inseparable from the changes themselves.

Thus we perceive at once the analogy between this way of forming elementary constants and that which is found in physics itself. The elaboration of every principle of continuity has been linked with the development of an operative system of unity and, granted such a system, it is particularly difficult to dissociate change from identity, as if the latter alone could be attributed to reason and every change necessarily involved an irrational factor. In fact, change and identity must always be associated, and it is the possibility of harmonising them which constitutes the proper task of reason. The genetic study of intelligence proves a decisive argument in this respect. Neither identification nor even comparison of resemblances precedes the comprehension of change or difference, and the mental operations capable of co-ordinating both sets of ideas are developed in conjunction with one another.

III

A third example will give us an idea of the diversity of the problems which can be considered genetically by epistemology with the help of child psychology: this is the problem of the logical character or intuition *sui generis* of the integer. We know indeed that certain mathematicians—the most famous among them being Poincaré and Brouwer—are of the opinion that the integer cannot be reduced to any logical construction but that it is the object of a direct and independent rational intuition. The logistic school, on the other hand, since Frege and Russell, claim to derive integers simply from the construction of logical classes and relations. The cardinal number would thus constitute a class of equivalent classes, the members of which corresponded term to term. For instance, the logical classes formed by Napoleon's marshals, the signs of the zodiac, the Apostles, etc., can all be classified under one head, if the members of one of the classes are arranged to correspond with those of the others; then the class of these classes forms the number 12, since the sole property common to the constitutive classes in this case is that of constituting the particular whole designated by the figure 12. Similarly, the ordinal number can be formed simply from the correspondence between asymmetrical transitive relations or serial relations. Thus the construction of the integer would depend exclusively on logical forms.

The problem we have before us, then, is to know whether the integer as the product of effective thought (i.e., of thought as mental activity and independently of its relations with formal deductive theories) verifies one or the other of these solutions. Doubtless, it will be objected that this 'natural' number is not that of mathematics, which means that, even if in 'reality' the mind spontaneously proceeds in a certain manner, formal theories can explain number in their own way. But, here again, it is clear that the idea of number preceded the construction of scientific arithmetic and that, if there is either an elementary intuition of number or an essential connexion between number and logical classes and relations, the question must first be verified in this pre-scientific field.

Once again, genetic psychology contributes a partial answer to this question, an answer, again, which could not have been anticipated without the evidence of direct experience. In reality, the conception of the idea of number depends neither on an extralogical method such as the intuition which Poincaré and Brouwer advocate, nor on pure logic in the sense in which Frege and Russell use it. It depends instead on an operative synthesis of both: the elements are completely logical, but the operations which result from their co-ordination do not enter into the sphere of classes and relations. The solution suggested by psychogenetic research is not to be found in either of the theses we have been considering, but rather midway between the two.

The psychological difficulty of the thesis which supports a simple intuition of number is that the series of numbers characterised by the operation $n+1$ can be discovered only in conjunction with the logical construction of classes and relations. At the pre-operative level (before the age of six to seven) at which the child does not succeed in forming the constants necessary to reasoning because of the lack of the idea of reversibility, he is quite capable of forming ideas of the first numbers—which may be called figures because they correspond to simple, defined spatial dispositions—from 1 to 5 or 6, without the zero, just as he reasons by means of preconceptions corresponding to intuitive collective ideas. But even where groups of five or six objects are concerned, he is not assured of their continuity. When, for instance, a child aged from four to five is asked to put on a table as many red counters as there are in a spaced-out row of six blue counters, he begins by making a row of the same length, independently of the correspondence between each term in the series; then he makes a row which exactly corresponds, but continues to rely on an exclusively perceptual criterion. He confidently places one red counter for each blue one; but if the component parts of one of the two rows are spread out or closed up a little, he no longer believes in the continuity of the numerical equivalence and supposes that the longer row contains more counters. It is only towards the age of 6½ or 7, i.e., in connexion with the formation of the other ideas of continuity, that he comes to admit the invariability of the total number independently of their spatial position. Thus it is difficult to speak of an intuition of the integer before this later stage of development; and it is clear that an intuition which is derivative is no longer an intuition.

How, then, do we form the idea of an equivalence between two groups and of the continuity of this equivalence? Operations of a logical character must intervene at this point, which seems to support Russell's thesis. It is, indeed, remarkable that the concept of a series of integers is formed at precisely the intellectual level (six to seven years old) which also gives rise to the two principal constructions of the qualitative logic of classes and relations: first, the system of subordination by inclusion, which is the basis of classification (classes A and A^1 are included in B: classes B and B^1 in C, etc.); and, second, the concatenation or seriation of asymmetrical transitive relations (A smaller than B, smaller than C, etc.). The first of these two constructions, in fact, necessarily comes into play in the perception of the continuity of wholes; for the continuity of a whole presupposes a set of graduated inclusions which links to this whole all the parts of which it is formed. As for seriation, it comes into play in the order of numbering the elements and, psychologically, is one of the conditions for the perception of their correspondence. Could we not, then, say that genetic psychology corroborates Russell's thesis of the logical character of number, since each of its component parts is definitively based upon a purely logical construction?

In one sense, yes. But the matter becomes complicated when it comes to determining the character of this operation of establishing a correspondence which guarantees the equivalence of the classes. There are, in reality, two ways of perceiving correspondence: one 'qualitative' and based on identity of the quality of the elements in correspondence; the other 'undefined' in which these qualities are abstracted. When a child draws a man from a model, he arranges the parts of his drawing to correspond with those of the model: head corresponds with head, left hand with left hand, and none of these parts are interchangeable. There is thus a qualitative correspondence, and each element is characterised by definite qualities and cannot be considered as a 'unit' whatsoever. On the other hand, when the same child arranges six red counters to correspond with six blue ones, any unit of the second group can correspond with any of the first providing there is a correspondence of unit with unit. Thus the correspondence has become 'undefined', since the qualities have been abstracted, and the elements, thus deprived of their distinctive characters, become transformed into interchangeable units.

Consequently, when a logician tells us that the class of Napoleon's marshals is equivalent to that of the signs of the zodiac and of the Apostles of Christ, the class of all these classes being the 'class of equivalent classes' which constitutes the number 12: are we dealing here with 'qualitative' correspondence or with 'undefined' correspondence? It goes without saying that it is 'undefined'. Marshal Ney, the Apostle Peter, and the sign of Cancer have no qualities in common; the members of each class correspond to those of the other classes insofar as they are interchangeable units and after their qualities have been abstracted.

Psychologically the explanation of the cardinal number in terms of the logical operation of classification depends on a vicious circle. We speak of a class of equivalent classes as if their equivalence depended on their being classes, when at the outset the 'qualitative' correspondence (which alone derives directly from the character of logical classes) has been jettisoned in favour of an 'undefined' correspondence, without being aware that this latter method itself first changes the individually characterised members of the class into numerical units. The class then has certainly been changed into number, but by the introduction of number from outside by means of an 'undefined' correspondence.

In reality the integer is certainly the result of logical operations (and it is only up to this point that child psychology confirms Russell's thesis); but it represents a combination of these operations in an original manner, which cannot be reduced to pure logic. We must therefore attempt a third solution going beyond those put forward both by Poincaré and Russell.

It is a very simple solution. Let us assume a whole made up of elements *A*, *B*, *C*, etc. If the child considers only the quality of these elements, he can begin by classifying them in different ways, i.e., he can arrange them according to their resemblances (or differences) but apart from any order (if *A* is equivalent to *B*, the one neither precedes nor succeeds the other). Or else he can order them according to their relative size or position, etc., and ignore their resemblances. In the first case the units are assembled insofar as they are equivalent. In the second case, insofar as they are different. But elementary logical operation does not allow us to link together two objects simultaneously in terms of equivalence (class) and difference (relation of order). The transformation of these logical operations into numerical operations consists, on the contrary, in abstracting the qualities and, consequently, treating any two members of the class as being at the same time equivalent in everything ($1=1$) and yet distinct—distinct, because, whatever the order chosen, their enumeration always presupposes, failing all other distinctive criteria, that one of them should be indicated either before or after another. The integer is then psychologically a synthesis of class and asymmetric transitive relation, i.e., a synthesis of logical operations; but co-ordinated in a new way, through the elimination of distinctive qualities. This is why, finally, every integer simultaneously implies a cardinal and an ordinal aspect.

These few examples help us to see how the genetic analysis of a set of ideas or operations sooner or later gives rise to epistemological problems.

The importance of such problems can naturally be under-estimated insofar as we forget that fully developed thought is the result of a long process. 'We are no longer children', replied a mathematician, after hearing an exposition of the confusion of the two kinds of correspondence operations which allows Russell to pass from qualitative resemblance to numerical equivalence. But if, with the biologists, we remember that the embryonic differentiation of the tissues governs the whole of adult anatomy, we shall no longer regard the larval state of knowledge as a situation devoid of theoretical significance, and we shall make use of the new method of analysis offered by genetic psychology as a supplementary source of epistemological information. We must agree, certainly, that it is a method without relevance to a considerable number of special questions, but it is an indispensable instrument in dealing with the most general questions: for these are concerned with the most primitive concepts, i.e., just those which are most accessible to genetic research.