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DIALECTIC OPERATIONS: THE FINAL PERIOD OF COGNITIVE DEVELOPMENT

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Abstract

Arguments for an extension of Piaget's theory of cognitive development have been derived from philosophical and historical consideration of modern natural sciences. Implicit contradictions, which characterize these sciences as well as common thought, can be systematically apprehended only through a dialectic reinterpretation. The dialectic basis of Piaget's theory is expressed in his assimilation-accommodation paradigm. But development is interpreted as a continuing alienation from this basis culminating in the noncontradictory thinking of formal operations. Although Piaget's interpretations capture a rich variety of performances during childhood they fail to represent adequately the thought and emotions of mature and creative persons. For an interpretation of adulthood and aging, a return to the dialectic basis is necessary. Such a reorganization can proceed from any of the four major levels of development. It introduces intra- and interindividual variations into Piaget's theory. Individuals may operate simultaneously or in short succession at different cognitive levels. The ceaseless striving toward formal operations becomes inappropriate and ineffective for the level of dialectic maturity.

Dialectic Operations: The Final Period of Cognitive Development[1]

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Natural sciences--not to speak of the behavioral and social sciences--have been plagued by implicit contradictions. Since Huygens it has been recognized, for example, that phenomena, such as interference and diffraction, are best explained by a wave theory of light. However, polarization (at least prior to Fresnel) is best explained by Newton's corpuscle or omission theory. Although attempts to synthesize both interpretations have succeeded, notably in Planck's quantum theory, modern natural scientists have come to accept and to live with coexistent, contradictory theories. Some have not hesitated to admit that these inconsistencies are basic properties of nature rather than insufficiencies in the knowledge acquired. "Wave theory of light and corpuscle theory are both reliably substantiated through experiments and both represent unescapable conclusions from experience. But both contradict each other. . . . Today, we can no longer doubt that the dualism of wave and corpuscle represents a very general physical lawfulness [Jordan, 1943, pp. 84-85]."

The antagonism between such different interpretations could reach its distinctiveness only because both groups of scientists succeeded in eliminating from their experiments the participatory role of the subject. "It is impossible to deny that, so far, all acquisition of knowledge in physics has, in principle, aimed at the widest possible separation of processes in the outer nature and processes in the realm of human sensations [Planck, 1934, p. 45]." The importance of the subject was unadmittedly retained outside of the context of experimentation only, namely in the selective preference

for one theory or the other, and in the selective performance of particular series of experiments. By separating the subject from the object of these observations their theories became abstract.

Modern scientists have realized that the activities of the observers are intimately connected with their scientific investigations. When dealing with subatomic particles, for example, it is in principle impossible to observe, with equal precision, both their location in space and their movement in time. Since each measurement exerts a causal effect upon the process observed, the investigator is prevented from separating these conditions from the measurements chosen. Both location and movement, or mass and velocity, have to be studied in their mutual dependence and in their dependence upon the observations. This recognition implies nothing else but to admit that the object is influenced by the subject.

The abstract status of classical natural sciences, for which the theory of mechanics represents a prototypical example, was achieved through a strict adherence to the postulate of identity and the rejection of explicit or implicit contradictions.[2] The laws of classical mechanics--as well as those of any of the other theories of classical natural sciences--"represent idealizations at which we derive by considering only those portions of our experience, in which we can achieve an order with our concepts of space, time, etc...[but] ...such a conceptualization of a world proceeding in objective space and time is, again, only an idealization of nature, carried out in the desire to objectify as much as possible [Heisenberg, 1942, pp. 41 and 94]."

The theory of mechanics was built upon the traditional logic, the most important property of which is that observations, definitions, or postulates should be noncontradictory, i.e., A should always equal A, but not A at one

time and B at another. It was inconceivable, for example, that light could be a wave and a particle at the same time. Only one of these alternatives could be true.

The issue of identity and contradiction separates Hegel's dialectic logic from the formal logic of his predecessors, especially Aristotle and Kant. Hegel compares his own with traditional logic in the following manner: "But it is one of the basic prejudices of traditional logic and of common-sense conception that contradiction is not such an essential and immanent determination as identity; indeed, if we were to consider a rank order and if both determinations were to be kept separated, contradiction would have to be accepted as deeper and more essential. For identity, in contrast to it, is only the recognition of the single immediate, the dead being; but contradiction is the source of all motion and vitality; only in so far as something contains contradiction does it move, has it drive and activity [Hegel, 1969a, p. 545, own translation]."

The adherence to the principle of identity and noncontradiction characterizes both the scientists who are founding their inquiries upon the viewpoints of philosophical realism and those who prefer the experiential basis of positivism. The former believe that their observations represent the objective conditions in space and time of the "real" world (most commonly within the Newtonian frame of reference). The observer can err or lack precision and sophistication but, ultimately, these shortcomings can be overcome and, thus, "true" answers can be "detected." The task for the philosophical realists is not to determine those principles which "...we are projecting into things in order to make them comprehensible and practically accessible to us, but those which can be detected by us in the things themselves [Bavink, 1940, p. 273]."

The positivists do not subscribe to the metaphysical notion of "real" space and time in which "things" exist and "objective" processes take place. They exclusively attend to the sensory-perceptual basis of knowledge and did not consider it the task of sciences to detect "explanations for processes in nature but to describe them as simply and as completely as possible. The genuine object of sciences are only the immediate observations and experiences themselves [Jordan, 1935, p. 37]." But like the philosophical realists, they emphasize the need for noncontradictory statements. Thus, the first group reaches the abstractness of its interpretations through a belief in an objective world and by its disregard of the subject. The second group emphasizes the subjective nature of our knowledge but, by clinging to the principle of noncontradiction, advances toward the same abstract theories as the realists.[3]

A dismissal of the principle of identity and noncontradiction synthesizes both philosophical bases. Any theory derived from such a synthesis will be concrete rather than abstract. Abstract theories are disengaged from the observer. Concrete theories take the intimate interdependence between subject and object into account. By abandoning the principle of identity, these theories also allow for the coexistence of different interpretations. Dialectic interpenetration of subject and object and of contradictory theories is not only possible but positively necessary for science and knowledge. However, they dissolve much of what, hitherto, has been clear and firm.

In the following pages we will demonstrate that dialectic conceptualization characterizes the origin of thought in the individual and in society. More

important, dialectic conceptualization represents a necessary synthesis in the development of thought toward maturity. In particular, we examine Piaget's theory which, too, depicts cognitive development as originating from a dialectic basis. But, all of the remaining explications in Piaget's theory characterize development as a progression toward abstract thought. Thus, development represents an alienation of the subject from the object and a denial of contradictions. Since Piaget fails to emphasize that, ultimately, all thought has to return to its dialectic form, we are led to propose a fifth stage of cognitive development, the period of dialectic operations.[4]

Dialectic Operations

Our introduction relied on the insightful essay by the late Max Wundt (1949), philosopher and son of Wilhelm Wundt. In particular, we emphasized the dialectic reinterpretations of coexisting theories, the subject-object relation, the realism-positivism controversy, and the distinction between concrete and abstract thought. The dialectic solutions, as proposed by Hegel, rest upon a reconsideration of the identity principle. It has not been Hegel's intention (nor is it ours) to dismiss this principle out of hand and once and for all. For the purpose of special logical constructions, mathematical models or measurement systems, scientists will rely on it for formal explications. The blind adherence to the identity principle and, thus, to classical logic, hinders, however, the understanding of the contradictory nature of human thought, especially during its very early stages during maturity and old age.

Hegel's dialectic theory.[5] Contradictions, in Hegel's dialectic theory, are not conditions of error and insufficiencies, but are the most basic property

of nature and mind. Rational thought (in distinction from reason) separates different attributes and, then, by connecting them in a systematic manner, tries to reconstruct the phenomena (such as those of optics or mechanics, learning or cognition) in an unequivocal manner. The concurrent acceptance of alternative theories reduces the unequivocality. But contradiction is not only a principle applicable to show the supplementary nature of such abstract theories, it is a necessary condition of all thought.

Every thing is itself and, at the same time, many other things. For example, any concrete object, such as a crystal, is itself but is also of many different properties. By selecting some and disregarding others we might develop one or another abstract notion (theory) about the crystal, as indeed the crystallographer, the glassgrinder, the watchmaker, or a housewife will do. But only when we conceive all properties in their complementary dependencies do we reach an appropriate, concrete comprehension. But what is, then, the thing itself? It is the totality of all the different, contradictory notions about it to which the thing itself stands in contradictory relations. Dialectic thinking comprehends itself, the world, and each concrete object in its multitude of contradictory relations. As Lenin would put it many years later: "Every concrete thing, every concrete something, stands in multifarious and often contradictory relations to everything else: ergo it is itself and some other [1929, p. 124]."

Hegel's discussion of "master and slave" in his Phenomenology of Spirit, provides another example of dialectic thinking. The master is independent and therefore enjoys for his own sake; the slave is dependent, he does not partake in enjoyment but has to carry the load of labor. But the master becomes dependent upon the labor whereas the slave, through his labor, gains consciousness and, thus, independence. Each side can be described unambiguously and

without contradiction. Such a description would be abstract, however. Only a description of both in their mutual relation provides a concrete representation of the totality without covering up one or the other. Such a description represents dialectic thought with its intrinsic contradictions.

The dialectic nature of our conceptualization, both in our everyday and in our scientific efforts, can be demonstrated through numerous other examples. Concepts like being and becoming, cause and effect, passivity and activity, structure and transformation cannot be thought of in isolation but only in their mutual dependence. For additional demonstrations, we turn our attention to the concepts of element and (simple) relation as well as to those of class and general relation. All of these have developmental implications which will be discussed in some of the following sections.

If we conceive of elements as represented by points in a geometrical space and of simple relations as represented by lines or vectors, we realize their dialectic interdependence: Points are defined as the intersection of two (or more) lines; lines are defined as the (shortest) connection between two points. The same holds for classes and the general relations between them both of which, according to our interpretations (Riegel, 1970, 1973b), can be deduced from the former. But here again we are confronted with dialectic ambivalence. On the one hand, we might derive classes from sets of simple relations, such as the class of "actors" and the class of "actions." Conjoining them, we can, subsequently, define the general relation of "activity," i.e., the general relation of "acting actors." On the other hand, we might consider this general relationship as given. Subsequently, we define the classes of "actors" and "actions" on the basis of this relationship. In either case, we unravel the interpenetration of elements and relations as well as those of classes and general relations.

Thereby, we derived abstract descriptions; concrete thought considers both explications in their mutual determination.

On the following pages we will elaborate the implications for developmental psychology of the notion of dialectic interpenetration and of the dismissal of the identity principle. In particular, we demonstrate these implications in regard to the development of logical operations with classes and of linguistic operations with explicit relations, i.e., comparative terms. In a third section we discuss some of the difficulties encountered when one tries to apply Piaget's theory to the study of maturity and aging. In a fourth section we summarize the necessary modification and extension of Piaget's theory of cognitive development.

Development of logical operations with classes. In considering Piaget's theory and observations of cognitive development, we recognize its dialectic basis. This dialecticism is most clearly revealed in the accommodation-assimilation paradigm leading to adaptation and readaptation. Accommodation denotes the changes of the subject to the object, for example the observing or eating child. Assimilation denotes the changes of the object to (for the benefit of) the subject, for example, the shifting into focus of the object visually searched or the physical and chemical changes of the eaten food. In the dialectic sense, both accommodation and assimilation are complementary; they are standing in contradictory, mutual relation.

While Piaget's theory is based upon such a dialectic foundation, critics have often wondered how the accommodation-assimilation paradigm is carried forward into the interpretations of the higher stages of cognitive development. Undoubtedly Piaget uses this paradigm skillfully and convincingly for depicting basic biological interactions as well as early cognitive differentiations, such as those of sucking, grasping, touching, as well as the coordination and

sequencing of these early schemata. In this regard, Piaget's descriptions resemble those operations denoted as syncretic by Werner (1926). As soon as the child reaches the second major period in Piaget's theory, the period of preoperational intelligence, and as soon as Piaget shifts from a methodology of observational interpretations to those of experimentation, the dialectic paradigm of accommodation and assimilation is slowly abandoned or, at least, disregarded and the interpretations are proposed in terms of traditional logic.

For our discussion of the major periods in Piaget's theory, we rely on a much simplified interpretation of cognitive development by McLaughlin (1963). This interpretation deals exclusively with the operation of classes and regards development as a consecutive addition of dimensions of categorical judgments. At the sensory-motor period the child recognizes object permanency but is not yet able to classify within a dimension; he is able to attend to only one concept at a time. In order to categorize he would need to attend to at least one other concept or to negate the former, the attended concept.

The sensory-motor child focuses upon distinct singular objects that happen to come into his field of attention. Neither does he discriminate any of these objects against others nor against negative instances of the same object. For example, the child is able to focus upon a block, but he does not discriminate this block from beads and marbles or nonblocks in general. All that he is able to do is to achieve a figure-ground differentiation. The dialectic character of the early form of cognitive operations is expressed by the fluidity with which the attention of the child might switch from item to item or from figure to ground and from ground to figure.

The dialectic character is also revealed at the next higher level of cognitive operations corresponding to Piaget's period of preoperational thought.

At this level the child attends two concepts simultaneously. Thus he is able to sort items by color into those that are red and those that are green or, more generally, into those which show the presence of an attribute, such as the color red, and those which show its absence, i.e., nonred. The positive and negative instances of an attribute are mutually dependent. Red determines as much that which is not red, as not-red determines red. Both together define the attribute or dimension of discrimination, i.e., color. Such a dimension, at different situations or at higher levels of development, might be contrasted with new alternatives, such as form or materiality. Moreover, the mutual determination of an instance and a noninstance of one attribute are not fixed but variable. In one case, red might be contrasted with all other colors; in another case, red might be contrasted with all other reddish colors. The determination of the kind and the range of a dimension is dependent upon extra-attributional and contextual factors.

The discussion of the remaining two developmental periods, the concrete and the formal operational periods, can be relatively brief. In McLaughlin's simplified interpretation, the child becomes able to operate simultaneously with two attributional dimensions and four concepts, or with three attributional dimensions and eight concepts. Both steps imply important expansions of the child's conceptualization. At the period of concrete intellectual operations, for example, the child succeeds in double classifications and thus can form the logical products A and B, A but not B, B but not A, neither A nor B. At the period of formal operational thought, still further reaching expansions occur.

All of these operations could be interpreted in a dialectic form if the mutual determination of a class and its inverse, i.e., of the classes A and

non-A, were consistently emphasized. While this seems to be obvious enough from a theoretical perspective, in the reports of his research observations, Piaget searches systematically for contradictions in the child's judgments, and thereby undermines his own dialectic interpretations as well as he degrades the dialecticity of the child. Of course, Piaget merely reports these contradictions and, thus, the dialectically minded reader could use this information adequately to substantiate his own interpretations, but since Piaget's theory subsequently progresses to higher and higher levels at which earlier contradictions are formally resolved, his theory becomes antidialectic and the progress of the child as described by Piaget is one of increasing alienation of thought. Through the following examples we will show the continuing dialectic character of the child's thought and, later on, we will claim that the older, alienated child, in order to reach maturity, will have to return to a dialectic basis of thinking.

Piaget's theory of cognitive development as a theory of alienation. Various research reports (see, for example, Piaget, 1962, 1963, 1965; Piaget & Inhelder, 1967) provide rich sources for demonstrating the dialectic character of the child's thought. The following example shows shifts in the identity concept of a child at an age of two years seven months: "J. seeing L. in a new bathing suit, with a cap, J. asked: What's the baby's name? Her mother explained that it was a bathing costume, but J. pointed to L. herself and said: But, what's the name of that? (indicating L's face) and repeated the question several times. But as soon as L. had her dress on again, J. exclaimed very seriously: It's Lucienne again, as if her sister had changed her identity in changing her clothes [1962, p. 224]."

At an early age the child is not embarrassed by his own contradictory judgments as shown in the following example on a numerical comparison of sets of items at an age of six years and nine months: "Are there more wooden beads or more brown ones?--More brown ones.--If we make a necklace with the wooden beads and a necklace with the brown ones, which would be longer?--The one with the wooden beads (without hesitating).--Why?--Because there are the two extra white ones [1965, p. 176]."

Regardless of whether one attributes these contradictory judgments to a change in the child's opinion, to a lack of short-term retention, or to disability to operate simultaneously with two attributional dimensions, development is seen by Piaget (as well as by almost all developmental psychologists) as removing these inconsistencies and as reaching toward a coherent, noncontradictory mode of thinking. These examples also show, however, that thinking originates from a dialectic basis and, as we will try to demonstrate, creative and mature thinking returns to its dialectic mode or rather fails to separate itself clearly and firmly from this foundation.

Additional support for our interpretation comes from a recent study by Miller (1972) with the specific purpose of examining children's reactions to the violation of their own expectancies concerning the conservation of weight.[6] Eight- and ten-year-old nonconservers and conservers were studied under conditions where the outcome of the weighing of two clay balls could be overridden by the experimenter thus creating results inconsistent with the experience of at least the conserving children. Contrary to the investigator's expectation, observable surprise was infrequent and changes in judgment were readily made. Contrary to some earlier findings, active resistance to change was apparent in about half the conservers but older conservers did not show resistance more often than young conservers.

Miller derives the interpretation of his findings from Piaget's notion of the "logical necessity" for the persistence of cognitive structures. This notion, in turn, derives from the concept of disequilibration. If a conflict is created through new experiences or cognitive changes, the organism tends to resolve such an incongruity. If such an equilibration is not successfully achieved, the child, especially the younger one, might simply state his observation without persistent attempts to consolidate it with his earlier conceptualization. In Piaget's theory, such a solution represents a regression toward an earlier level of operation. To us, it indicates that the thoughts of the child are flexible enough to tolerate and to exist with ambiguities. Eventually, through alienating training and abstractions, the child will be induced to consolidate these contradictions for the sake of educationally accepted interpretations. In principle, however, these contradictions remain to coexist even within the superimposed structures of later interpretations as demonstrated in the following report by Zaporozhets and Elkonin (1971).

These authors asked children to test whether some small objects would float in a pan filled with water. At about 3 1/2 years of age, a child will successively propose various alternative reasons whenever his previous answer becomes incongruous with new experience. Thus, he will switch his interpretation from "It doesn't hold itself on water" (brass disk), to "It is small" (needle), to "It doesn't know how to swim." At an age of four to five years, a child is able to produce compounded answers, e.g., "A splinter swims because it is little and it is light." Subsequently, he will be faced less often with contradictory experience. In emphasizing with Piaget the necessary development toward abstract and general structures, Zaporozhets and Elkonin conclude:

"The child is so convinced of her own judgment that it is difficult for her to refute it even in the light of contradictory facts. However, does it mean then that the child is not aware of the contradictions, that she ignores reality whenever it does not correspond to her understanding? The observations show that this is not so [1971, p. 240]."

The interpretations by the Soviet investigators agree with those by Piaget: The thoughts of the young child are founded upon dialectic contradictions. But increasing with age and experience, he acquires stable structures that consolidate contradictory evidence into consistent interpretations. In regard to floating objects, the child, at first, considers either the attribute small or the attribute light as criterial; later he begins to realize that objects have to be both small and light at the same time; still later he might relate their weight to their volume in form of a ratio, and he might consider whether the objects are hollow or solid, the type of liquid they are placed on, etc.

But as the child apprehends increasingly complex structures which consolidate all the contradictory evidence experienced, the different concrete observations remain to coexist, i.e., a small object floating, a small object sinking, a heavy object floating, a heavy object sinking, etc. Each new situation demands transformation of the experience into the consolidated structure. Each new situation remains contradictory as each thought remains tied to its dialectic basis. As for a student puzzled by an ambiguous multiple choice item (and which item fails to be ambiguous), it matters little for an understanding of the student's thinking whether or not he finally finds the "correct" answer; what matters are the ambiguity and the contradictions that he experiences. Thinking, in the dialectic sense, is the process of transforming

contradictory experience into momentary stable structures. These structures consolidate the contradictory evidence but do not represent thinking; they merely represent the products of thinking.

Development of linguistic operations with relations. Recently, several studies explored the acquisition and use of comparative terms, such as "more" and "less" or "tall," "taller" and "tallest." These investigations have been conducted and summarized either by emphasizing a linguistic (Clark, 1970) or a perceptual-cognitive basis (Huttenlocher & Higgins, 1971). Undoubtedly, the study of comparative terms is intimately related to Piaget's work. In particular, his interpretations of conservation have been criticized for failing to take account of the child's ability to operate and comprehend such terms as "more," "less," "same," etc. (Griffiths, Shantz & Sigel, 1967; Donaldson & Balfour, 1968; Bickford & Looft, 1972).

According to the available evidence, simplified to a considerable extent, the following stages in the development of comparative terms may be distinguished. At level 1, when the child is producing single words only, expressions such as "more" are sometimes used by the child as imperative demands without comparative implications. Paraphrasing his expression, the child seems to say "I want this here!" At level 2, when the child operates simultaneously with two terms, he might use such words as "more" in an absolute, dichotomizing manner, contrasting it with "not more" but not implying a gradiation of magnitudes. At level 3, when the child operates simultaneously with three terms, true transitivity and, subsequently, comparativity is established. For instance, the child might apply terms like "small, medium, tall" or "tall, taller, tallest." By dropping off either one of the extreme items of such a series, e.g., $A < B < C$, he is able to extend it without limitation.

Level 3 represents an important step in an additional sense. All previous comparisons implied absolute anchor points. In one-term expressions, the condition and desire of the speaker himself serves as an absolute point of reference. In the two-term comparison, the expression "more" serves as the positive instance; "not more" represents merely its negation. At level 3, the anchor point becomes variable. Applying a spatial representation, usually the left hand term, as in "tall, taller, tallest," serves such a function, but can always be modified by adding a new element, such as "less tall," or--more radically--by extending the sequence into the opposite direction, i.e., "tall," "less tall," "least tall."

At level 4, when the child operates simultaneously with four terms, he ought to be able to make comparisons between two dichotomized variables and perform class multiplications such as between "wide and narrow vs. short and tall." This performance is one of the logical prerequisites for conservation tasks. Similar performances, although they do not represent any new form of operation, consist of hierarchical comparisons. For example, the child might, first, classify objects into large and small items and, then, subdivide each class in the same manner. This operation, when executed repeatedly, may result in a series in which all items are ordered transitively. Finally, we might expect level 5 and level 6 children to compare simultaneously items along three or more dimensions.

Our discussion demonstrated the use and development of comparatives within a conceptual framework related to Piaget's developmental model, especially to the simplified version proposed by McLaughlin (1963). In general, it related to the traditional logic of classes and relations. But

development does not only consist of continuous refinements of gradiating comparisons nor does it only consist of the compounding of an ever larger number of dimensions, but also involves an increasing relativization of standards in comparative expressions. The necessity of applying alternate evaluations in judging, for example, some event as fortunate but, from another person's view, as unfortunate, characterizes already the behavior of older children in role playing activities. It characterizes more clearly the mediating and compromising operations of adult persons, as well as--in a general sense--modern scientific notions of the relativity of movements in space.

If an object is fast, when compared within a fixed system of coordinates, but slow, when compared with another moving object, we recognize, once more, the dialectic principle of contradiction. This principle implies that a thing has a given quality and, at the same time, does not have it. In regard to comparatives, the statement that something is tall and at the same time small, namely when viewed within two different frames of reference, is equally characteristic of mature judgments. Such a statement cannot be captured easily within a logic of classes and relations.

Dialectic thinking emphasizes the interdependence of form and content. In its narrow sense, it deals with the interrelationship between methods and results, in its most general sense, between subject and object. As one person pronounces a judgment, he externalizes a standard which will direct and modify another person's judgment, which, once it too has been pronounced, will produce further modifications. Thus, these interactions set a process in motion which is in continuous flux and only temporarily at rest, namely at

those moments in which a pronouncement takes place. Such a process of evaluation and reevaluation characterizes the thoughts and judgments of adult persons.

In regard to aged persons it has been proposed that processes of simplification and rigidification have altered their mode of conceptualization (and action). But such an evaluation holds only if their thinking is considered to be preceded by all four periods of Piaget's theory and compared against the standards set for the last of these periods, i.e., of formal operations. If dialectic thinking emerges directly from any of the earlier levels of operations, an interpretation of cognitive aging will result which is free of the negative and prescientific notion of deficiency. Uncritical adherence to traditional educational and academic goals have made us firmly believe, however, that development has always to proceed through all of the four periods; the further a person advances in his progression, the more successful his development is considered to be. The option to be proposed, which allows that dialectic or mature thinking might emerge from any one of the succeeding periods, opens new perspectives for the study and understanding of adult thinking and successful aging (Riegel, 1972 a, c). As the following review reveals, previous investigations of cognitive and linguistic development have failed to provide adequate interpretations.

Cognitive changes during adulthood and aging. Thus far only two studies of normal aged subjects have been conducted with tasks taken from the rich repertoire of Piagetian investigations. A few have been made with senile older subjects by de Ajuriaguerra (see Hooper, 1972); several others are in preparation (see Papalia, 1972).

The two studies reported (Sanders, Laurendeau & Bergeron, 1966; Kominski & Coppinger, 1968) investigated the conservation of surface areas by means of

two green cardboards, described as meadows, on which two cows could graze. By placing blocks in various positions upon the cardboards, subjects were asked whether equal amounts of grass were available to the cows. According to the evidence obtained, older adults do not conserve area as we would expect them and as older children do. They rather seem to have regressed to judgments based on their immediate perceptual impressions, much like those exhibited by younger children.

These results raise the puzzling question of the disappearance of personal knowledge. Let us consider the knowledge of the conservation of matter. Is it conceivable that a person, once he has realized that an amount of liquid remains the same when poured from one beaker into another one of different shape, can ever lose this insight? Don't we always keep knowing what we know?

In one of the two theoretical discussions on cognitive changes during adulthood and aging, Flavell (1970) argues for the "disappearance of knowledge" under conditions of serious neurophysiological damage. According to available information, such changes are not necessarily affecting all aging persons to a sufficient extent. Arguments against the "disappearance of knowledge" are based upon the distinction between competence and performance as introduced into linguistics by Chomsky and as translated into cognitive developmental psychology by Flavell and Wohlwill (1969), though with an emphasis congruent with the traditional distinction in psychology of theoretical constructs and observable behavior.

For Chomsky, competence refers to the knowledge about language; it is intuitive, immediate, and ideal. Performance refers to the execution of

linguistic tasks; it is acquired, incomplete, and concrete. This distinction reflects (as well as it fails to overcome) the mind-body dualism of Descartes: in its idealistic extension it argues for the immutability of competence or knowledge; in its mechanistic extension it proposes that competence is innate.

Chomsky himself has stayed somewhat aloof from these elaborations. If he were to stress more strongly the interactional, i.e., the transformational aspects of his model, he could escape from these two traps. He would still fail, however, to account for the interactions of the organism with the cultural-historical conditions of the environment and, moreover, of the dialectic changes of the individual and society.

A second theoretical discussion, focusing upon the transition in cognitive operations between adolescence and adulthood, has been published by Piaget himself (1972). Here Piaget seems to weaken his earlier interpretations by giving more attention to individual and societal differences in speed of development, developmental diversification, and professional specialization.

Originally, the four major periods in the cognitive development of the child were regarded by Piaget as universal progressions through which all children would move at about the same pace. Studies of cross-cultural and subcultural variations have often failed to confirm such an interpretation and led Piaget to suggest that the speed of progression is not the same under all social conditions, but may produce retardation in deprived and accelerations in stimulating surroundings. Differences between groups are especially marked at the later periods of development; during the early periods, the progression seems to be most uniform.

Developmental diversifications in regard to types of tasks also seem to affect least the early developmental periods. Even operations that are not successfully performed before an age of 10 or 12 years, such as conservation of matter, weight, or volume, seem to have universal significance; few differences have been observed across cultures or social groups. When dealing with the propositional logic of formal operations, however, marked differences exist. Most of Piaget's tasks use constructs from mathematics, physics, or chemistry. Probably, such topics are not only inadequately handled by subjects from lesser developed countries, but also well trained students in advanced countries, having other areas of specialization, e.g., business, medicine, or law, often fail to do well on them.

Professional specialization produces variations within a culture. Here, Piaget argues that carpenters, plumbers, or mechanics might be well able to apply formal operations within the contexts of their specific occupational activities but might fail in laboratory settings and with material unfamiliar and irrelevant to them. Thus, factors of interests and motivations, practical and social significance codetermine operations, originally thought of as being universal qualities.

Piaget's statements on the transition from adolescence to adulthood provide concessions to individuals and social groups who "fail" to progress all the way through to the elaborated structures of formal thought. But his statements neither indicate the cultural-historical implications of such "failures" nor do they elaborate in positive terms the types of intellectual operations which "failing" individuals will have to choose or with which they are bound to end up. Piaget describes cognition and its development as it "ought to be" and, therefore, his interpretations have been criticized as a cognitive theory of "law and order" (Wilden, 1972).

Piaget's concessions in regard to individual and social differences are most appropriate. It has never been shown convincingly that the highest level of operation, i.e., formal operational intelligence, characterizes the thinking of mature adults. Only under the most exceptional conditions of logical argumentations and scholastic disputes is it conceivable that a person would engage in such form of thinking. In his daily activities logics and operations of much lower power will be applied. Indeed, even in their scientific activities researchers will very rarely engage in the propositional logic of the fourth period in Piaget's theory and, for example, systematically calculate all possible outcomes in their search for a solution. Such forms of thinking merely provide the last straw in the process of a scientific inquiry which is applied after intuitive thought is exhausted. Creative scientific activities are dominated by playful manipulations of contradictions and by conceiving issues integratively which have been torn apart by formal operational thinking. The same type of intuitive conquest characterizes even more appropriately the performance at levels below those of formal operational intelligence.

For all these reasons, Piaget's theory describes thought in its alienation from its creative, dialectic basis. It represents a prototype reflecting the goals of our higher educational system which, in turn, are reflecting the nonartistic and noncreative aspects in the intellectual history of western man (Riegel, 1972b, d). Although, Piaget's theory is founded on a dialectic basis, it fails to make the transition from the formal intellectualism of Kant to the concrete dialecticism of Hegel. Thus, his theory is not only incapable of interpreting mature thinking but, in his interpretation, also the cognitions of children (increasing with age) lose their dialectic character

and, thus, their creative features. A commitment to Hegel enables us to reinterpret Piaget's theory with due consideration of mature and creative thinking. It leads us to an extension and modification of Piaget's model of cognitive progression.

A modified model of cognitive development. In a recent publication (Riegel, 1972e), we discussed three models of qualitative, developmental changes. These models were derived from the earlier work by Van den Daele (1969). In both publications, Piaget's theory of cognitive development was considered to represent the simplest of all three models, the single sequence model. In this model qualitatively different sets of operations or behavior succeed each other in temporal sequence; no provisions for difference in progression between persons or between skills were made nor any statements on the transition and accumulation of behavior across stages. Undoubtedly, this representation oversimplifies the richness of Piaget's theory but, at the present time, there are insufficient reasons for assigning either one of the other models, the multiple sequence or the complex sequence model, to represent Piaget's theory.

In view of such an assignment the question arises as to what happens, at later stages, to the behavior or operations acquired and representative of the earlier stages? Are the schemata of the sensory-motor period lost or are they modified and transformed into those of the preoperational and of the higher periods? Moreover, is it conceivable that an individual operates simultaneously at different levels of cognition; perhaps, switching back and forth between them or choosing one for one area of activity and another for another area?

Recently Furth (1973) has maintained that Piaget does not "pretend that stages of thinking reached in one domain will necessarily be found in the

thinking of the same person in another domain [p. 8]." But Piaget does not state explicitly the conditions under which such switching across stages might or has to occur. Even if we consider the simplified interpretation by McLaughlin (1963), we fail to derive any definite conclusion. The progression depicted in this model represents, as we have seen, a successive increase in the number of attributional dimensions and, thus, in the number of concepts with which a child operates simultaneously. But if a child at the level of pre-operational thinking categorizes items according to the presence or absence of one attribute, is he, then, also able to dismiss the attributional dimension altogether and to conceive items "as such" without any categorizing efforts, i.e., in the manner of the sensory-motor child?

Presumably the further the child has advanced in his development, the harder it will be to "regress" to the "naive" mode of early conceptualization. For this reason, the growth of cognitive organization, as depicted in any of these models, represents an alienation from original thought. Dialectic operations represent a further step forward and, at the same time, a return to early thinking which, in the opinion of many writers (e.g., Stern, Werner, Freud, Zeininger, Levi-Strauss, et al.), is dialectic in nature.

As shown in Figure 1, we propose that an individual at any developmental level may directly progress to its corresponding mode of dialectic operations, reaching thereby a mature stage of thinking. This provision introduces interindividual variation at the level of maturity. Persons might reach dialectic maturity without ever having passed through the period of formal operations or even through that of concrete operations. This provision also

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Insert Figure 1 about here

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introduces intraindividual variation. The skills and competence in one area of concern, for instance in sciences, might be of the type of formal dialectic operations; those in a second area, for instance in everyday business transactions, might be of the type of concrete dialectic operations; those in a third area, for instance in artistic activities, might be of the type of preoperational dialectic intelligence; finally, those of intimate personal interactions might be of the sensory-motor and therefore of the original dialectic type.

In his discussion of equilibration and disequilibration, Piaget touches most explicitly upon the issue of optional, multi-level operations. At the same time, his discussion reveals clearly that his conception of development is one of consecutive alienation. According to Piaget as well as to Lewin (1954), organisms inherently tend toward equilibrated states. Disequilibrium represents conflict and contradiction which the organism tries to overcome through his activities. The state of disequilibrium is especially marked prior to the transitions from any one into the next higher levels of operations.

If Piaget admits--as Furth has declared--that an organism might have implicit or explicit options to operate at different stages of thinking, dependent upon the area of activity with which he happens to be concerned at a particular time, the emphasis upon the principle of equilibration is weakened if not abandoned. Any concurrent or closely successive operations at different developmental levels ought to create by themselves a state of conflict which ought to be equilibrated. Such an equilibration can only mean the progression to the higher and later developmental level of operation. In other words, the option for multi-level operations contradicts Piaget's notion of equilibration since it reintroduces dialectic conflict; the emphasis

upon equilibration would tend to resolve this conflict at the expense of the thinking at the earlier stage. Our own modification recognizes dialectic conflicts and contradiction as a fundamental property of thought. In contrast to Piaget, we maintain that at the levels of dialectic operations at maturity, the individual does not necessarily equilibrate these conflicts, but is ready to live with these contradictions; stronger yet, the individual accepts these contradictions as a basic property of thought and creativity.

Conclusion

The purpose of our discussion was to reintroduce dialecticism into Piaget's theory of cognitive development. According to our interpretation, Piaget's theory is founded upon dialectic thinking but, successively, each higher level of operation leads to further alienation from this original mode of thinking. Dialectic operations represent mature thought to which an individual might progress from any one of the four stages in Piaget's theory, i.e., without necessarily progressing first through all four of them in their proper order. This option to operate simultaneously or in short succession at different levels also implies that an individual might perform in one area of concern at one level of thinking and in another area at another level. It implies contradiction and is dialectic in character.

Our modification and extension of Piaget's theory to the level of dialectic operations is concerned with intrapsychic processes. At other occasions (Riegel, 1972b, 1973a), we have called attention to the need for expanding Piaget's theory in at least two other directions.

First, the interaction between psychic activities and their biological basis need to be explored more fully. Undoubtedly, Piaget's orientation is basically a biological one but it is evolutionary-systematic rather than

analytic-experimental. In our opinion, the modern version of Pavlov's reflexology comes closest to fulfilling our expectations by exploring an interactive, dialectical model which relates psychic activities to their biological and (in its narrower explication) material foundation.

Second, the interaction between psychic activities and the cultural-historical conditions need to be explored more fully (see Meacham, 1972). For Piaget, the individual, through his own activities, creates his conceptual world. But the activities of and within the environment are disregarded. These activities exert their effects upon the individual through their specific structures (which, through ceaseless efforts of mankind have produced widely differing cultural-historical conditions), as well as through the participatory efforts of parents, siblings, teachers (which, as much as the developing child, ought to be considered as active organisms). A developmental theory emphasizing the interactions between psychic activities and those of the cultural-historical conditions has been proposed by Soviet psychologists, notably Vigotsky, Luria and Leont'ev. A theory integrating both interaction systems and, thus, regarding psychic activities and development in their joint interaction with both inner biological and outer cultural historical conditions has been proposed by S. L. Rubinstein (see Payne, 1968; Riegel, 1972b, 1973a; Wozniak, 1972).

Hegel's dialectic idealism, from which most of our present interpretations were derived,[7] has been followed and superseded by the historical and dialectic materialism of Marx, Engels, and Lenin. For two reasons it seems appropriate, however, to wait and contemplate before one were to rush in following up on these historical developments. First, Hegel's philosophy, especially his Phenomenology of Spirit, provides an exceptionally rich source

and a distinct model of the development of the mind both in regard to the individual and society. To this author's knowledge, Hegel's theory has never been explored for the purpose of psychological interpretations. Second, Hegel, much more than the dialectic materialists, has preserved the conception of an active developing organism, or more precisely, he has proposed a developmental model in which activities (labor) and products (material) remain in dialectic dependency. It seems a regression, indeed, if we were to abandon this delicate notion too readily in order to obtain a material underpinning the utility of which was recognized in a theory of labor, products, and economy, but not in a theory of a developing organism within a developing world.

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FOOTNOTES

[1]This manscript was completed during the author's appointment as a Visiting Scholar at the Educational Testing Service, Princeton, N. J. The author is grateful for many constructive comments by Nancy Datan, Walter Emmerich, Jack Meacham, Ruth Riegel, Lee Van den Daele, and Bill Ward. A sufficient extension of the manuscript in full justification of their contributions has not yet been achieved.

[2]The concept of identity has been expressed in three forms, traditionally called "laws" of: Identity ($p \supset p$; if p then p); Contradiction ($\sim \cdot p \sim p$; it is false, p and not p); Excluded Middle (tertium non datur) ($p \vee \sim p$; p or not p but not both). In a more general sense, the following interpretations of these "laws" are given; Identity : A term must preserve the same denotation in all its occurrences within a given context. Contradiction: A sentence and its negation are not both true. Excluded Middle: Either a sentence or its negation are true. Traditionally, these "laws of thought" were regarded as a sufficient foundation for the whole of logic; Kant's analytical judgments, for example, are those for which the law of contradiction suffices as proof.

[3]The adequacy of positivistic thinking for modern natural sciences has been emphasized by Petzoldt (1912) in his epilogue and extension of Mach's "Analyse der Empfindungen."

[4]Our occasional critique of Piaget is exclusively directed toward the interpretations advanced during his "structural" period of the early 50's and represented by such books as: The Psychology of Intelligence, and

The Origin of Intelligence in Children. Our remarks neither concern Piaget's earlier period of the late 20's which might be called "functional" and is represented by a publication such as: The Language and Thought of the Child, nor his most recent "transformational" period represented by his book Structuralism. A genetic interpretation of Piaget's work, like that provided for Aristotle by Wilhelm Jaeger (1923), needs to be written.

[5]For the preparation of this article, I have relied upon Hegel's Science of Logic (1929) and his Phenomenology of Mind (1967). As introductions to Hegel's philosophy, the following books are recommended to the reader of English: Soll's Introduction to Hegel's Metaphysics (1969) and Kaufmann's more extensive work, entitled Hegel: Reinterpretation, Text, and Commentary (1966). Finally, Bergmann's discussion (1973) of some developmental implications of Hegel's philosophy deserves special recommendation.

[6]Recently, Elkind (1967), Hooper (1969), and Papalia and Hooper (1971) proposed and investigated the theoretical distinction between identity and equivalence judgments in conservation tasks. The first is assessed by presenting two objects which are equal both in physical appearance and criteria content, such as weight, the second by deforming the appearance of one of the objects. The above-mentioned authors have argued that lack of conservation is, generally, tested by demonstrating failure in equivalence judgments without prior assessment of identity judgments. The conceptual distinction proposed and the results reported do not need to be elaborated here. Our own discussion is exclusively concerned with the identity relation. In contrast to formal interpretations, we emphasize that under deformation the two objects are identical (e.g., in regard to their substance) but, at the same time, are not identical (e.g., in regard to their form).

[7]Hegel's developmental theory is based upon the same paradigm from which Rubinstein's interpretations have been derived. It starts with the delineation of three, essentially, cognitive stages but, then, continues with the description of stages of social interactions. Most notably, cognition and social processes are not as firmly separated in Hegel's theory as modern psychologists have come to make us believe.

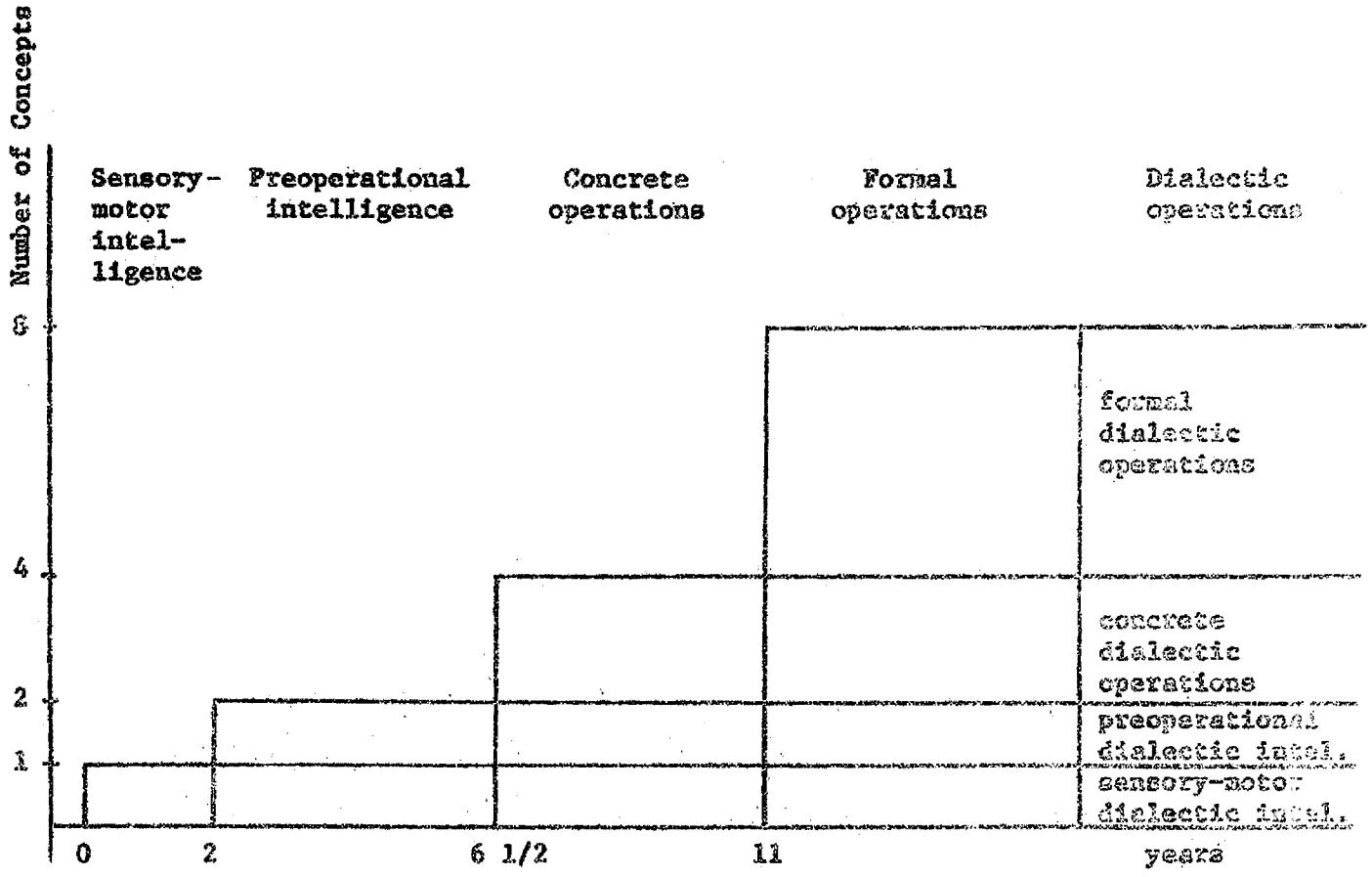

Figure 1. Schematic Representation of Five Developmental Periods for Piaget's Extended Theory of Cognitive Development.