THEORETICAL STATEMENTS

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The Journal of Genetic Psychology, 1980, **136,** 121-136.

THEORIES OF PIAGET, BRUNER, AND AUSUBEL: EXPLICATIONS AND IMPLICATIONS*

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SUMMARY

A comparison of the major tenets shared by the three cognitive theories of *Piaget, Bruner,* and *Ausubel,* as well as variations in the description of cognitive development unique to each, provides a basis for a global phenomenological dialectical scheme of psychological development in the spirit of *Werner.* These theories represent points on a dimension from Piaget's particular organismic world-view to Ausubel's tendency towards a mechanistic orientation. Each theory, however, adopts a structuralist approach towards theory and explanation assuming qualitative change in *structure* over time. Cognitive growth is seen as qualitative changes in thought systems though the source of change is seen variously to be either the properties of the internal structural system itself or the organized system provided by the external environment. Each theory proposes a form of conflict resolution as a critical mechanism of change in thinking, though the form of such change-mechanisms varies from Piaget's stages of internal organization to Bruner's notion of *external amplifiers* and Ausubel's *subsumption* process. The unique and complementary implications these theories have for education are examined. It is proposed that fundamental similarities in accounting for cognitive growth suggest an integration of each

* Received in the Editorial Office, Provincetown, Massachusetts, on September 29, 1978.

special contribution is plausible and useful to educationalists. At the same time, a comparison of the unique and diverse viewpoints of intellectual development which each theory provides may serve to clarify by contrast the particular contribution of each to education.

A. Introduction

The theories of Piaget, Ausubel, and Bruner form a somewhat paradoxical trio in the area of cognitive development. On the one hand, they can be viewed as basically equivalent and as complementing or extending one another wherever one theory is more specific than the others or addresses itself to a different aspect of development. Such a view focuses on the set of fundamental beliefs common to all three and regards differences as resulting largely from levels of theory construction and specificity in explanation. On the other hand, when one focuses on specific explanations and applications, the theories can appear to be either incommensurable or totally contradictory. Which of these views one adopts depends largely on the perspective one takes and the kinds of translation one makes between theories.

Three general issues provide the framework used in this paper for examining potential conflict or complementarity among the theories. Each theory offers varying explanations for (*a*) exactly what it is that develops in cognition, (*b*) what counts as developmental change, and (*c*) what mechanisms are involved in developmental processes. Translation efforts focus on the uses of the terms "structure" and "knowledge" in relation to the different accounts given.

The framework we suggest is designed to enable one to pursue either of two options. One can adopt Werner's (18) suggestion to take a global look at psychological theories in order to integrate insights from each into a new, more comprehensive theory; or, one can focus on specific "local" issues and eliminate alternative explanations for particular phenomena. At the level of educational implications, the first option would involve the integrated application of all three theories to an educational setting (with specification of when and how to apply principles from each). The second option suggests separate accounts of educational programming based on individual theories and the comparison of differential outcomes.

Before turning to the different positions taken on the three general issues, it is important to establish the shared assumptions and beliefs which provide the background for the different interpretations of cognitive development. Each major theory affirms the existence of qualitative change in cognitive

development and relates these to the differences between action, perception, and conception. Major tenets shared by all three theories include the beliefs that adaptation to an external reality plays a crucial role in development, that it is theoretically fruitful (if not essential) to postulate an internal structure that affects whether and how various aspects of knowledge are acquired, and that "structure" changes as humans mature.

The structuralist approach inherent in these beliefs provides a common attitude towards theory and explanation. All three theories adhere in some degree to methods which seek to discover those latent organizational properties of an object or phenomenon which can explain both their momentary stability and their constant variation [see Wozniak (19)]. The types of stability and variation to be explained, however, vary with each theory; and accordingly, different types of internal structures are postulated. The shared structuralist perspective, then, does not imply that the three theories all analyze identical entities. Indeed, in large part, the theories seem to address themselves to different aspects of reality.

First of all, then, let us look at what it is that each theory describes.

B. The Structure of What

Two major problems for any theory of cognition are accounting for how we humans get information through contact with the environment and how we mentally manipulate that information. As Fodor (7) has pointed out, mental manipulation presupposes some kind of a representational system which specifies the type(s) of representation available (e.g., symbols, pictures, internalized actions), the rules for establishing relationships among representations, and possibly the specific content in the system.

A theory of cognitive *development* goes one step further and attempts to explain systematic changes in behavior by pointing to mental changes—to changes in the representational system and/or in the way we get information from the environment. The mental changes themselves, of course, must also be explained. The structuralist tendencies in the theories under discussion are reflected in their descriptions of such changes in terms of organization or structure. The organization may refer to what is done with content after it is acquired, to the properties of the kinds of content to which humans have access, or to the way in which content is acquired.

Piaget's major concern has been with a structural analysis of what is done with content when it is available. A structure, in Piaget's theory, consists of a system of possible transformations of content (regardless of its specific nature) and a set of laws which applies to the whole system. Each structure

is defined by particular processes (operations, mental actions) for establishing relationships among bits of information rather than by any of the following: the particular pieces of information known, the existing organization of what is known, or the abilities to acquire bits of information. These latter are certainly influential and must be considered in explanations of behavior, but they are not part of the structures that are of major concern in Piaget's theory. His theory uses the inferred organization of what an individual knows to indicate the structure of the organization rules used by that individual. Similarly, abilities to acquire information reflect the structure but are not themselves a part of that structure.

In contrast, Ausubel's theory views the organized content itself as the basic unit for structural analysis. For Ausubel, cognitive structure is seen as a "hierarchically organized system of facts, concepts and generalizations" (1, p. 143) and refers to the totality of knowledge in any given subject matter area. With this view, it makes no sense to distinguish content from organization. Content is only meaningful as part of an organization. Likewise, there is no organization without something (content) that is organized. Ausubel must, of course, account for the acquisition of such organized content, and he does so with the process of subsumption (to be discussed later). But it is the organized content and not this process which is the source of the structuralist tendencies he shares with Piaget and Bruner.

In Bruner's theory, structures are akin to problem-solving strategies and methods for acquiring concepts. Like Piaget's theory (and unlike Ausubel's), this view emphasizes a structural analysis of process variables. The processes examined, however, are those used in acquiring information (facts and concepts) rather than those used in establishing networks of relations for information already acquired. For Bruner, the smallest psychologically meaningful unit for analysis is a combination of strategy plus the content to be acquired. The structures he examines, then, consist of irreducible fusions of content and strategy. As he points out (4, p. 1), "one does not account for or explain a train of intellectual activity by describing its underlying logic." From this point of view, although one might be able to describe the structure of a content-less transformational system as Piaget has proposed, this will not contribute to psychological explanation.

Thus, "structure" refers to different entities (or constructs) depending on which theory one uses. For Piaget, it refers to processes for establishing relationships between bits of information already at one's disposal. In Ausubel's theory, it refers to organized systems of concepts and propositions. For Bruner it refers to a single unit made up of a fusion of content and concept acquisition rules in a representational system. Structures are present

as organizational factors in each theory, but what form this stability in cognitive functioning assumes, the changes it undergoes, and the variations in function at different levels of development are points of contention.

These different views of structure are intimately connected to the meaning of "knowledge" in each theory. In most of Piaget's writing, the term "knowledge" has been reserved for the designation of processes—the very processes, in fact, which change in the course of development. Thus the meaning of the term is relative to the developmental level of the individual to whom it is applied. Like Piaget's notion of "intelligence" with which it is practically synonymous, "knowledge" refers to schemas for interpreting the environment. Self-construction is a necessary condition for such knowledge, though not a sufficient one. Interactions with the environment are crucial in Piaget's theory, but the interactions must lead to internal constructions and transformations if they are to affect one's knowledge.

The requirement for self-construction is not of a part of "knowledge" as Bruner and Ausubel use the term. They share the view that knowledge first exists *outside* the organism and is then internalized by certain psychological mechanisms. For Ausubel, knowledge is a "substantive phenomenon rather than a problem solving capability" (e.g., 2, p. 12). For him, the term can include general problem solving strategies, but only when these are viewed as learned propositions rather than as underlying capabilities. Bruner goes a bit further than Ausubel and includes "generic rules"—i.e., concepts, problem-solving strategies, and basic principles—as important components of knowledge. His position here follows easily from his view, stated previously, that the smallest psychologically meaningful unit of analysis must be a fusion of strategy and content.

Differences in the kinds of structures postulated and in the kinds of knowledge described lead to different theoretical emphases. These differences have a strong bearing on both the kinds of explanations considered acceptable and on the kinds of phenomena explained. Piaget's theory, for example, does not attempt to explain performance variables in any systematic way, and neither Bruner nor Ausubel elaborates on explanations for competence—i.e., on the functional characteristics of various psychological processes. Given these differences it is not surprising that the theories offer dissimilar accounts of what changes in development.

C. Cognitive Growth—What Changes in Development?

From the Piagetian perspective, cognitive growth involves changes in the actual systems of thought. Piaget has attempted to represent those systems in terms of mathematical logic and set theory (with appropriate modifications

in line with psychological evidence). The logic that describes a particular stage of development might be visualized as a set of rules which acts as a central coordinator. All information must be processed through the coordinator before it can be made accessible to other content areas or situations. Insofar as learning in a particular area adds to the set of rules, it adds to cognitive growth. One recognizes growth when changes in capability allow one to infer the presence of new rules or operations, such as reciprocal implications, logical addition of classes, etc. (10).

Growth is not, however, the simple addition of new rules in an arithmetic sense. When new rules become available to the individual they actively change the quality of previous ones. Old rules are modified in accordance with the constraints of the network of relations to which they are tied, but they are not lost. Thus, in the progression from the perception-bound, preoperational stage to the level of operational thinking, conceptions enter into perceptual judgments more than before, but the perceptual way of solving problems remains useful. Quantitative change becomes qualitative as the continuous addition of new rules affects the system as a whole (2, p. 239).

In Ausubel's theory, the notion of cognitive growth is closely tied to the continuous accumulation of organized content in a variety of areas. To contribute to development, however, the content must be meaningfully related to previously established hierarchies of concepts within a given domain. To apply here the analogy used in describing Piaget's model, one might speak of an open access system rather than one with a central coordinator. Each content area has a direct line of access to the information in another. In this model, cognitive growth refers to an increase in the speed and ease of communication between hierarchically organized content areas. Growth is seen in the individual's increasing ability to manipulate relationships between conceptual structures (externally organized content which has been internalized) with a decreasing reliance on concrete props.

In addition, the individual gradually acquires a "working vocabulary of "transactional or mediating terms" (1, p. 191). These terms may refer to representations of concrete empirical props or to symbolic representations. In any case, they enable the individual to relate concepts into meaningful propositions and to incorporate the latter into ideational structures. As Ausubel and Robinson put it, "actually, what distinguishes the various stages is not so much the kind of logical process involved as the degree of abstraction involved in the data upon which this process rests" (1, p. 188).

Bruner's position lies somewhere between those of Piaget and Ausubel. He

denies the usefulness of the continuity-discontinuity distinction and focuses instead on progressive changes in choice of strategy—i.e., in preferred modes of operating. His claim is that all of the basic structural attributes of cognition are established in the first four years of life. Enactive, ikonic, and symbolic modes of thinking are developed early and encompass all of the basic reasoning processes (or "ideal strategies"). A young child tends to be constrained by the immediate stimulus but has the ability to solve problems correctly when misleading perceptual cues are removed. Cognitive growth refers to the increasing facility in the use of various ideal strategies and to predispositions for choosing particular ones from the range of those possible. Although growth is characterized by an increasing dependence on the symbolic mode, the individual can use any of the three representation systems according to the task demands.

In sum, cognitive growth in Piaget's theory refers to qualitative changes in the property of the system as new rules are constructed; for Ausubel, cognitive growth reflects the increase in accumulated information and increased ability to take in information at high levels of abstraction; in Bruner's view, it involves the successive acquisition of three forms of representation (4) and continuing qualitative and quantitative changes in their form and usage.

Despite their differing views on just what cognitive growth *is,* all three theories recognize and attempt to explain a number of the same indicators of growth. Among these are (*a*) the increase in ability to internalize events into a storage system or model of reality which enables one to make predictions—to go beyond the information at hand, (*b*) the increase in capacity to deal with several alternatives simultaneously, and (*c*) the increase in capacity to say to oneself or to others what one has done or what one will do (this might be "said" verbally or through some other kind of symbolism). The explanations given, however, differ from theory to theory according to where structural analysis fits into the picture and which aspects of development are assumed to be discontinuous. Each theory postulates mechanisms to account for the kind of change assumed to underlie the observed growth. In the section to follow, some of the variations in proposed mechanisms will be explored.

D. Mechanisms of Change

Each theory posits certain invariant processes which are used in the same way regardless of an individual's developmental status and which serve as mechanisms for both development and learning. Given the shared view that the human is actively engaged in transforming information presented by the

external environment, it is not surprising that each theorist postulates a kind of an adaptation process as an important and invariant mechanism in development. Differences arise in the kinds of environmental demands considered most important by each theory and in the emphasis placed on these demands, but there is general agreement that demands are effective because of a drive for competence or a will to learn. In essence, each approach proposes a structure, specifies key environmental variables and structural processes, attempts to demonstrate that the environmental variables proposed do effect changes in the structure, and then offers tentative explanations for how such variables could have an influence on the internal structure. Each theory specifies a form of conflict resolution as the means for altering internal structure.

For Piaget, the tendency to resolve conflict is expressed in the notions of equilibrium and equilibration. Each stage of intellectual development is characterized by the construction of a coherent system of rules and possible actions. An innate tendency to resolve conflict causes the rules and actions available to the individual to be organized into a coherent (logically consistent) system. Each stage of development represents the progressive construction of such a system which, when completed, is said to be in equilibrium. The conflict between reality and systems in *equilibrium* stimulates an *equilibration* process. That is, the demands of the environment force the organism to abandon an internally consistent system and to adopt new components more closely matched to reality. When these new components are not consistent with the previously existing internal system, the tendency to resolve conflict leads to the construction of a new system, once again in equilibrium but also in closer harmony with reality (16).

For Ausubel, there is a natural tendency to resolve real or apparent inconsistencies by organizing information into hierarchical structures, a process called "integrative reconciliation." The individual resolves conflicts arising from the demands of the environment by reorganizing information.

Bruner's position is consistent with Piaget's view that development proceeds through increasingly valid models of reality and by a mechanism for decreasing conflict. In part, Bruner's theory can be viewed as an attempt to identify the specific psychological mechanisms that mediate the growth described and characterized in terms of a formal logic, by Piaget. Bruner rejects Piaget's "pormanteau theory" of cognitive growth for its lack of specificity and its circularity of prediction. Although overcoming the mismatch between one's models or representations and the environment is one aspect of seeking competence (of seeking a more successful interaction with

the environment), "there are many cognitive conflicts of this kind," he points out, "that do *not* lead a child to grow" (5, p. 4). The conflict which does lead to growth, he claims, is that which exists between modes of representation. Reconciliation efforts move one into the use of the symbolic mode, "which finds its first and fullest expression in language" (5, p. 44) as the primary tool for structuring experience.

These varying forms of conflict and conflict resolution play different roles in each theory. This is because each theory takes a different stance on the nature of the adaptation process and regards different aspects of development as continuous or discontinuous.

In Piaget's theory, change mechanisms must be able to account for qualitative change. Piaget's theory presupposes a tendency towards organization in thought and distinguishes developmental levels or stages of organization. The adaptation process assures that the organism move from one level of organization to another. The highest levels of organization are stable, are permanent, have a wide field of applicability, and consist of very mobile operations. In meeting environmental demands the organism is forced to change; the tendency towards organization makes the long-term change systematic; and together these tendencies towards organization and adaptation result in the construction of an organization which is well matched to the external world.

The adaptation process has two components which may be distinguished conceptually but which are indistinguishable in actual occurrence. Assimilation designates a process of transposition and deformation that prevents any direct reading of properties in the external environment. Learning new information, however rudimentary, involves altering the new information to fit an existing organization. However, in order for elements to be assimilated, the organism must adjust itself; it must modify its existing structure so as to adapt to the new situation. As Piaget has said, "Assimilation can never be pure because by incorporating new elements into its earlier schemata and intelligence constantly modifies the latter in order to adjust them to new elements" (14, pp. 6-7). This process of modification within the organism is referred to as accommodation.

The notion of adaptation must be redefined in the context of Ausubel's theory. Ausubel's concept of assimilation refers to the subsumption process whereby the individual incorporates new knowledge (facts, concepts, and generalizations) into his hierarchical arrangement of existing ideas. During the process of assimilation the new input is modified in order to be subsumed under existing hierarchical knowledge structures, which in turn be-

come modified as prior and subsequent learned information becomes integrated. Further, for this process to work, it is necessary, but not sufficient, for new information to exist first in some appropriate and external hierarchical organization. From Ausubel's point of view, the fact that cognitive development may be influenced by the physical environment, as well as by the culture and direct teaching, is due to the hierarchical arrangement of the *external* world.

Since knowledge initially exists outside the organism, it is, in principle, possible for external agents to organize new knowledge so as to maximize the potential for meaningful learning throughout the course of experience. General, more inclusive ideas, can be introduced first so that categories are ready and waiting for specific information when it is introduced. Thus, the individual can relate new knowledge in a nonarbitrary fashion to previously learned abstract ideas.

According to Ausubel two invariant processes dominate meaningful learning at any level and also serve as mechanisms for intellectual development. These are the retention and transfer of organized structures of concepts and generalizations. In other words, there are innate propensities to take in and remember *organized* information and to generalize previous learning to new situations. Not all information retained by the individual is useful in subsequent learning. The innate ability to generalize is eventually improved upon by the acquisition of transactional terms. Unless the individual has a system to which information can be assimilated, the information is relatively meaningless. It may be taken in and remembered, but it remains isolated. Knowledge in this form remains apart from the hierarchical structures.

Bruner shares with Ausubel the view that heredity contributes to development through a number of species-specific capacities for taking advantage of external organization (for "exploiting experience," as Ausubel says). The undifferentiated brain of the human neonate, Bruner stresses, is uniquely suited to conform to external demands provided by cultural amplifiers such as language, cultural norms, technological advances, and so on. As he puts it, "given the nature of man as a species, growth is as dependent upon a link with external amplifiers of man's powers as it is upon those powers themselves" (5, p. 6).

According to Bruner, the adaptation process consists of a species-specific tendency to orient to classes of external events. The tendency consists of an inference testing procedure for approximating reality—a procedure used in each mode of representation. The individual creates a model to represent the

world, tests it partially and intermittently against input, and from such a limited sample, accepts the model as either confirmed or disconfirmed. Given an appropriate environment, this procedure leads human action towards patterns which free it from the serial linkages characteristic of lower animals. The transcendence of serial linkage, however, can only occur as the individual resolves conflicts between the models generated in the different modes of representation.

The culture provides the source of the modes of representation (and the classes represented), as well as generating conflict among them. Language provides a particularly powerful amplifier of the primitive or protosymbolic system unique to man—of the capacity humans have for taking advantage of opportunities to develop a symbolic system. The symbolic system of representation, flexible, conforming to cultural demands, and of wide applicability, is used to resolve conflicts between the modes. As new knowledge is acquired, this representational system undergoes change, but it is the enactive and ikonic modes which change the most.

E. Some Implications for Education

The theories in question all have significant and unique contributions to make to education. The kinds of potential contributions depend on the varying roles each theory designates for external agents in cognitive growth, the degree of theoretical sophistication concerning instructional and performance variables, and the theoretical implications for the functions and goals of a formal educational system.

The adoption of any of the theories as a guide for educational practice requires a number of commitments which go beyond the explanations and descriptions provided by the theory. Each theory recommends a set of permissible value systems (either explicity or implicitly), eliminates some values and goals as simply inappropriate, and denounces others as actually detrimental to the best interests of the developing intellect. Piaget's theory is the farthest from providing a ready-made system for education on a detailed statement of educational goals, but even this theory makes some clear-cut demands on practice.

The application of any developmental theory to education is a complex and difficult task. It involves a thorough understanding of the theory used, as well as sound knowledge of educational needs and practices. What follows in this section is only a brief discussion of the kinds of contributions offered by each theory. We have attempted to specify the nature of educa-

tional implications rather than to exhaustively describe what a program committed to each theory would look like.

Although Piaget has never made a concerted effort to develop a theory of instruction, he has been interested throughout his career in the educational implications of his theory. He has expressed views on educational methods in an early work (12), as well as in subsequent works (e.g., 13, 15, and 17). He views educational implications, however, as secondary concerns of a developmental theory—concerns to be explored after a well-defined theory of intellectual development has been worked out. Both Bruner and Ausubel, in contrast, have proposed that a theory of development ought to go hand and hand with a theory of classroom learning and instruction. Bruner takes the stronger stand on this issue and regards a theory of knowledge constructed apart from an account of performance variables (i.e., a theory of instruction) as necessarily incomplete. Such a theory could not, except by some remarkable coincidence, be an accurate picture of reality. It must therefore be expected to undergo extensive revision when confronted with the law-like relationships between the organism and the environment.

Piaget's theoretical concerns have led him far from explanations for the most efficient acquisition of specific content or an account of the potential effects of varying methods of instruction. In fact, to the extent that the theory is successful in its original intent, it has specified developmental universals which although they depend on experience in general, are immune to *specific* experiences. If one has any commitment to the theory, then, applications to education would involve global reform rather than specific techniques.

Necessary reforms will involve a major theoretical effort. Applications of Piaget's theory involve new ways of analyzing content and a strict adherence to the premise that learning is enhanced by social interaction with peers, as well as through interaction with the physical environment. Ways to stimulate the appropriate kinds of interaction must be devised, and content must be analyzed in terms of the types of intellectual actions it enhances. The resulting theory of instruction will specify ways to stimulate the child to construct his own knowledge and ways to recognize the construction in progress.

Although much of the work in this area is yet to be done, attempts have been made to specify those teacher-child interaction techniques most likely to be thought-provoking, ways actively to encourage the appropriate kinds of peer interaction, and an approach to the analysis of materials and activities in terms of their potential for actions involving classification, seriation,

spatio-temporal understanding, number concepts, and experimentation with the physical environment. Descriptions of programs heavily influenced by Piagetian theory can be found, among other places, in Furth and Wachs (8), Hooper and DeFrain (9), Kamii and DeVries (11), and Ershler, McAllister, and Saunders (6). In general, such programs must forego quick increases in performance in order to concentrate on the long term goals of self-contructed knowledge.

Bruner and Ausubel put more emphasis on the positive effects of receptive learning and the possibilities for highly efficient transmission of information, even to very young children. Bruner has dealt quite specifically with the effects of various constraints, particular perceptual cues, and types of instruction of the acquisition of content and on performance. He has attempted to explicate how (or whether) various aspects of cognitive functioning change with age, experience, and exposure to the instruments of culture.

Bruner contends that the most important type of learning is discovery learning: i.e., using problem-solving techniques for acquiring knowledge. "The most uniquely personal of all that (man) knows is that which he has discovered himself" (3, p. 22). He draws considerable attention to the notion of "real knowledge" as opposed to pseudo specific learning in *The Process of Education* (3) where he provides suggestions for education. Perhaps the most important educational implications from his point of view are that (*a*) the underlying principles that give structure to subject matter should be used to determine curricula, (*b*) concepts should be developed and redeveloped in a "spiraling" sequence towards greater levels of abstraction to facilitate the acquisition of generic codes, and (*c*) efforts should be directed towards improving the individual's ability to recognize the plausibility of guesses. The most important single factor expected to influence real learning is the individual's system of generic codes—and education can facilitate the development of this system. Such codes supposedly lead to the highest degree of transfer and to a lasting retention of information.

Ausubel also places a major emphasis on the pedagogic facilitation of transfer—i.e., on "the possibility of enhancing transfer within the mainstream of subject-matter learning by utilizing principles of cognitive organization on the one hand, and the unifying principles of a subject matter discipline on the other" (1, p. 142). Though Ausubel sees a role for meaningful discovery learning, he proposes that, given that the individual can cope with this type of learning procedure, it is likely to account for only a relatively small proportion of time actually spent in school learning [see Ausubel, Novak and Hanesian (2, chap. 7)].

Ausubel identifies three principles which he hypothesizes can be applied to the efficient programming of the content of any subject-matter field. First, the most general and inclusive ideas of the discipline must be identified and presented to the learner. Then the ideas can be *progressively differentiated* in terms of detail and specificity. These ideas serve a subsuming role and ensure that new information is learned most efficiently. Ausubel bases this principle on two assumptions: (*a*) a learner will find it easier to grasp the differentiated aspects of previously learned general ideas, rather than have to formulate abstract concepts and generalizations from previously learned detail; and (*b*) the learner quite naturally tends to organize data in his mind in the form of hierarchical structures, where the more conclusive members subsume less inclusive concepts, generalizations, and factual data.

Secondly, Ausubel states that there must be an explicit attempt to identify significant similarities and differences between sequentially presented ideas. In the first two principles, Ausubel presents a fundamental law of development: concomitant increases in differentiation along with hierarchical integration. Finally, he contends that the availability of the learner's relevant, established ideas can be maximized by taking advantage of natural sequential dependencies. Thus the conditions are set for meaningful learning to take place.

Certain fundamental similarities between the three theories discussed in this paper suggest that applications to education ought to integrate the specialized contributions of each. The personal perspectives of each theorist, though providing overlapping, in-depth studies of features of development (such as assimilatory functions in learning, variant and invariant factors affecting intellectual growth, competence/performance distinctions, structures of intelligence, and the role of transfer) also provide idiosyncratic versions of cognition. A comparison of such similar, yet diverse, viewpoints may serve to clarify by contrast the potential contributions each can make to education.

Each theorist provides a somewhat unique view of the application of a theory of intellectual development to educational practice. Piaget (17) has espoused an "activity school," which seems to be compatible with many aspects of traditional, child-development oriented nursery schools. Bruner advocates a system which emphasizes the teaching of basic concepts and principles of a subject area and which, from that basis, encourages the learner to attempt to test intuitive, self-directed formulations [e.g., see Bruner (4)]. Ausubel argues that the most effective and economical teaching is of a prescriptive nature. He does not exclude "meaningful discovery

learning," but claims that not all learners are competent in this regard. In addition, he maintains that no significant portion of learning is usually of this type.

All three approaches suggest a place both for autonomous thinking and discovery and for direct teaching. Neither the extremes of empiricism (total dependence on direct teaching) nor the exclusive use of self-discovery methods is in contention. The integration of these two methods of teaching facilitates dialectical tension between the existing structures of the individual's knowledge and new learning—a tension which results in transformations of the individual's knowledge.

The reasoned arguments of these three theorists provide useful general statements of relationships among cognitive variables and predictions regarding expected tendencies in cognitive development. The best use we can make of such statements and predictions is in the generation of hypotheses to be tested and refined by investigations conducted in the classroom. Such an approach to educational practice will need to be concerned with a critical analysis of aspects of intellectual development based on an eclectic view towards theories of cognition, establishing links between psychological theory and pedagogy, devising appropriate methods of instruction and related curriculum development, and identifying an effective method for teacher education. A rewarding objective in the application of theories of cognitive development to educational settings may be to create a "rapproachment" between theories such as those discussed here.

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