Developmental Psychology
1974, Vol. 10, No. 5, 590-600

Inducing Development Experimentally: Comments on a Research Paradigm[1]

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The extremely popular "training" studies, virtually all of which have been devoted to the attempt to experimentally induce conservation in nonconserving subjects, were discussed with respect to the logic underlying the method and surrounding theoretical and methodological difficulties. The following major difficulties were discussed: (*a*) ambiguity as to the intent of many of the studies; (*b*) lack of agreement on methodological criteria for inferring change, and ambiguity in actual application of even the most stringent (Genevan) criteria; (*c*) a related lack of theoretical agreement as to what a conservation judgment reflects; and (*d*) the difficulty of inducing cognitive restructuring by means of brief interventions. It was argued that whether the intent of conservation training studies has been to elucidate Piaget's view of conservation attainment or to refute it, results have been similarly ambiguous and inconclusive, and, hence, researchers' interest in performing such studies has declined. Several suggestions for modification of the training study research strategy were made.

Piaget first reported his discovery of the conservation phenomenon in the context of a theory of the development of concrete operations (Piaget, 1952). The appearance of conservation, Piaget claimed, marks the organization of early mental actions into a coordinated system that he termed "concrete operations." (See Piaget, 1950, pp. 129–147, for an explication of how conservation reflects presence of the underlying thought structure he refers to as the concrete operational "grouping.")

Only shortly after Piaget's work became well known in this country, experimental "training" studies were initiated. Virtually all of these studies have been devoted to the attempt to experimentally induce conservation in nonconserving subjects. Such studies have increased steadily until recently when one notes a slight decline in the number of journal articles devoted to conservation training.

There are three possible motives that might be attributed to the conservation training studies. The most noble is summarized in the adage that to understand a phenomenon we should try to change it. Thus, conservation training studies might shed light on the precise capacities, and perhaps mechanisms, involved in the development of the conservation concept. The least noble is what Piaget has called the American preoccupation with accomplishing things in the least possible time. A third possible motivation is to disprove Piaget's assertion that the attainment of conservation indicates an underlying cognitive reorganization by demonstrating that conservation can be "taught."

The current leveling off in the production of training studies marks an appropriate time for some interpretive review and reflection. Has the number of studies declined because we have answered the questions these studies were intended to answer? Or has the number declined because researchers have begun to doubt the capacity of training studies to answer these questions?

One extensive review of conservation training studies has appeared (Brainerd & Allen, 1971). The present article does not attempt to duplicate this review but rather to further the discussion of the issues that

[1] Preparation of this article was supported in part by National Institute of Mental Health Grant 5-R01-MH20729-02 to the author.

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Brainerd and Allen's review raised. Brainerd and Allen concluded that the evidence strongly supports the view that conservation can be induced by short-term experimental means. Their sole criterion for success of a training study, however, was statistical significance of the posttest difference between experimental and control groups on whatever index of conservation the experimenters employed. Other researchers, as we shall note, have insisted on quite different criteria. The issue thus remains at least open for debate.

There are two major questions that must be addressed in evaluating any training study. First, it must be decided what the training experience consisted of from the subject's point of view. In other words, what was the functional, or effective, stimulus that can be considered responsible for any observed pretest–posttest change? Second, we must decide on criteria for evaluating the effects of the training experience. The question is, What, precisely, changed from pretest to posttest, or, put in its popular form, has the subject "really" attained conservation? We shall take up the second issue first.

Assessing Success: Has Anything Really Changed?

The Genevan group studying the experimental acceleration of development (e.g., Inhelder & Sinclair, 1969) formulated an explicit set of criteria for evaluating experimentally induced change. To be considered as having genuinely attained conservation, a trained subject must make responses that (*a*) include appropriate explanations, (*b*) persist over time, and (*c*) generalize to nontrained material. In addition, the subject should resist a nonconservation countersuggestion. Many of the American training studies have included, as part of the posttest, assessments of explanations, of responses to new (nontrained) material, of durability of responses (via a delayed posttest), and occasionally of resistance to countersuggestion, rather than limiting themselves simply to a posttest assessment of conservation choices (i.e., subject reports "same"). In this section we develop the argument, however, that even with judicious employment of these criteria, given our present knowledge and methodological techniques, the evaluation of any training intervention necessarily remains ambiguous.

Before doing so, it is necessary to consider the cases in which the preceding criteria are not employed because the researcher either explicitly or implictly holds the view that these criteria are either unnecessary or inappropriate. In a separate publication, Brainerd (1973) argued that explanations are in fact inappropriate criteria for assessing the presence of cognitive structures. Drawing on Piaget's assertion that language is dependent on operativity such that a cognitive operation may develop prior to the individual's being able to express that operation in language with the reverse never occurring, Brainerd argued that assessing a subject's cognitive operations by a method that requires him to express those operations linguistically (i.e., explanations) entails the possibility of Type II errors. In other words, some subset of subjects may actually possess the cognitive operation(s) being assessed but fail a test that requires their expression in language. The preferred criterion for assessing cognitive structures, Brainerd claimed, is a subject's simple dichotomous choice, for example, yes–no or same–different. Such a criterion, he asserted, is not subject to any known source of error.

Brainerd's (1973) discussion rested on a critical, unexamined assumption. This assumption is that for any given cognitive operation(s), a method of assessment can in actuality be devised that both unambiguously assesses the presence or absence of those operations and entails nothing more from the subject than a choice between two alternatives (e.g., same versus different). Any dichotomous choice method, in fact, is subject to the equally, if not more, troubling probability of Type I errors. Some subjects, in other words, may make the appropriate choice for idiosyncratic or extraneous reasons and be assessed as possessing the operation(s) in question when they in truth do not possess it. In the context of a training study, this source of error becomes critical. If either training or assessment itself provides the subject with any cues that

enable him to make correctly the requisite two-choice discrimination, he is likely to "pass" the posttest, though his basis for the choice is irrelevant to the concepts or operations being assessed. As Brainerd (1973) noted, stimulus refinements can gradually eliminate many such cues, reducing the probability of "false positive" responses (Type I errors). All dichotomous choice methods devised to date, however, fall far short of having eliminated all possibilities of false positive responses. More fundamentally, whether methodological improvements alone can ever lead to an accomplishment of the objective is debatable. If a subject does nothing more than choose between two alternatives presented by the experimenter, can the judgment that underlies his choice ever be known for sure? Overall, the generalization seems warranted that the most trustworthy methods for assessing the attainment of a given cognitive structure are those that elicit a variety of responses, both verbal and nonverbal, and make an inference based on this constellation of responses.

At the opposite extreme from studies that rely on a simple dichotomous choice to assess posttest conservation are studies in which posttest assessment is judiciously based on a variety of indicators including explanations, obtained both over a range of materials and over several occasions, and resistance to countersuggestion. If these criteria are all fulfilled in such a study, is it not warranted to regard the subject as having attained conservation? To answer this question, we must turn to the problems involved in actually applying these criteria.

Explanations

If a trained conserver has genuinely attained conservation, his explanations ought to closely resemble those given by natural conservers. There arises a critical problem, however, in the use of appropriate explanations as a criterion. Most training methods, as the summary in the next section indicates, entail as part of the training some presentation of conservation explanations either implicitly or in the form of explicit verbal rules. Thus, conservation explanations cannot retain their status as indexes of the understanding of the principle of conservation in posttraining assessment. For example, "You can put them back the way they were," is the explanation often given by natural conservers. Most training procedures involve the repeated empirical demonstration of this fact often accompanied by the experimenter's verbal description ("You see, we can put them back the way they were"). Thus, once a subject has been exposed to such a procedure, his mention of the possibility of rearrangement during a posttest can no longer be considered a reflection of his understanding of the principle of conservation in the way it might in the case of a natural conserver. Appropriate explanations, then, may be considered as a necessary but not a sufficient criterion to permit a judgment of genuine change.

Duration

If conservation has really been attained, the attainment should be a lasting one, as it is for natural conservers. The assessment strategy is to present one or more additional posttests some period of time after the initial posttest. Most studies using delayed posttests have found some loss from first to second posttest, but in many cases subjects' responses have remained at a level significantly above pretest level.

Such a result, however, remains equivocal. Whatever factors were present during training or first posttest leading a subject to make conservation responses should continue to operate during a second posttest. Thus, a subject might during a second posttest a week or month later make the same responses he did during the first posttest because (*a*) he had interpreted those responses as the desired or correct ones for that situation (cf. Kuhn, 1973) and (*b*) he found himself in the situation a second time. All this might conceivably occur in the absence of any understanding of conservation on the subject's part. Like the explanation criterion, then, the duration criterion should be considered as necessary but not sufficient.

Resistance to Countersuggestion

If a subject has genuinely attained conservation, it has been argued, he should resist

countersuggestions of nonconservation. Smedslund (1961b), however, who did the original experimentation attempting to extinguish conservation, found that some natural conservers could be influenced to change from conservation to nonconservation judgments, a finding that subsequently has been replicated by a variety of investigators (Miller, 1971). Hence, yielding to countersuggestion is not a valid indicator that a subject's trained conservation is not genuine.

Generalization

From several points of view, the generalization criterion deserves the status of the critical one. Procedurally speaking, if a subject makes correct responses to items that were not a part of the training, it seems evident that he must have acquired something more than a set of specific rote-learned responses. From a more theoretical viewpoint, the generalization criterion is intricately tied to Piaget's "structured whole" concept of development. If, as Piaget suggested, development consists of a series of major transformations in the organization of an individual's cognitive operations, the attainment of a given stage (e.g., concrete operations) should be marked by a whole constellation of behavioral acquisitions. Thus, the presence of other nontrained concrete operational behaviors should be the critical indicator of whether a trained subject has actually reached a concrete operational level of development.

It is now well established, however, that all of the behaviors thought to reflect Piaget's stage of concrete operations do not emerge synchronously (Pinard & Laurendeau, 1969). The various conservations (e.g., number, length, area, mass, weight), in particular, emerge only gradually over a period of several years. Thus, if a subject is trained in conservation of length, it may not be reasonable to expect him to also display conservation of area, not to speak of other less closely related concrete operational concepts, since a child who has attained length conservation naturally might not possess area conservation. The limiting case of such a claim is represented in a theoretical position like Gagné's (1965, 1968). In Gagné's view, conservation represents the end point in a long sequence of skills, rules, and concepts, which a child progressively masters. Hence, Gagné would view the entire criterion of generalization an unreasonable one: If we want a child to know something, we must teach it to him.

If conservation does reflect some kind of cognitive reorganization, on the other hand, the critical question in the assessment of training interventions becomes this: How much generalization to nontrained items is necessary to infer genuine structural change? There has been no satisfactory answer to this question. Thus, for every investigator who pronounces his study a success, another investigator may point to any absences of generalization and claim that subjects didn't really attain the concept. Until the generalization question is satisfactorily answered, then, pronouncing any given training study a success remains equivocal.

The first step toward solving the problem just posed seems clear. We must obtain detailed normative data regarding the natural patterns of development of those behaviors thought to be relevant to attainment of the cognitive structure in question. Such data would enable us to know precisely the natural ontogenetic relationship between any two such behaviors. Do the two behaviors, for example, always emerge synchronously; does one always precede the other; or is there some other more variable relationship (Flavell, 1972)? The relevance of such data for training studies is taken up again in the concluding section.

Training Methods: What Is It That Needs to Get Changed?

The lack of agreement among researchers as to the appropriate criteria for inferring the presence of conservation reflects a lack of agreement as to what, precisely, conservation consists of. This same lack of agreement is reflected in the diversity of techniques that have been employed in an attempt to induce conservation. These techniques can be placed into five broad categories, based on the underlying conceptualization of conservation that the technique reflects. These categories are briefly outlined below with references to one or two of the most well-

known studies in each category (for a complete bibliography of studies, see Brainerd & Allen, 1971).

Types of Conservation Training

Training attention to relevant task dimensions. The assumption underlying this type of method is that subjects who show nonconservation on classical conservation tests really do understand conservation; that is, they understand that substances remain the same in amount when their appearance changes unless material has been added or subtracted. They fail to make conservation responses, however, because of misleading factors, either perceptual or semantic, present in the test situation. Accordingly, training consists of focusing the subject's attention away from misleading cues and toward the relevant cue of amount. Three kinds of strategies have been used, stemming from three different conceptualizations of what the misleading cues are that the child must overcome in order to exhibit his true understanding of conservation.

1. Verbal training: Braine and Shanks (1965) claimed that the nonconserver has not learned the appropriate language for discriminating between real and phenomenal size. He is thus confused by the experimenter's question (e.g., Which is bigger?) and tends to answer in terms of phenomenal size, even though he understands that in terms of real size the objects are equal. Braine and Shanks thus trained subjects via an explicit reinforcement procedure (the subject received a reward for each correct response) to discriminate between two questions, "Which *looks* bigger?" and "Which is *really, really* bigger?", and to give a same response only to the latter.

2. Perceptual training: The assumption in this case is that young children fail to exhibit conservation responses because their attention is distracted in the direction of irrelevant perceptual dimensions of the situation, for example, shape, height, width, water level. Thus, training is designed to focus the subject's attention away from these irrelevant dimensions and toward the relevant dimension of amount. Gelman (1969), for example, presented subjects with sets of three stimuli and over a large number of trials asked them to choose either the two that were the same or the one that was different. The two actually alike in amount (for number conservation) or length (for length conservation), rather than in any of the other perceptual attributes, were the ones the subject was always rewarded for choosing.

3. Perceptual screening: Bruner's (1966) view of conservation is that the young child understands conservation but in order to respond correctly he must be "saved" from his ikonic, or perceptual, representation of the situation, which leads him to respond in terms of perceptual appearance. Thus, in several experiments training consisted of asking the subject the conservation question when the actual transformation was shielded from him by means of a screen.

Providing information. The conceptualization of conservation underlying this type of method is that a nonconserver has not yet acquired certain specific information or knowledge that is necessary for a judgment of conservation. When this information is acquired, the child will show conservation. According to one view, the child simply needs to be given the information that quantities remain the same through certain kinds of transformations. The method (explicit reinforcement) consists of giving the subject information ("right" or "wrong" depending on whether the particular transformation preserves quantity or does not) about each of his responses, sometimes accompanied by tangible rewards for correct responses (Wohlwill & Lowe, 1962). A somewhat different view is more in the direction of the child's discovering for himself the invariance properties of objects. Thus, Smedslund (1961a) had subjects weigh objects on a scale before and after successive deformations and discover for themselves their equality (*empirical reinforcement*).

Teaching a verbal rule. The conceptualization underlying this kind of method is that

the child who attains conservation learns not just a set of empirical facts but rather a principle, or concept, pertaining to the invariance of objects through perceptual transformations. Training, then, is designed to teach the principle that enables the subject to make conservation judgments. A verbal rule, stated to the subject whenever he makes an incorrect judgment, has been either of the following types: "it stays the same even though it looks different. See, I can put them back the way they were, so they haven't really changed [Beilin, 1965, p. 326]"; or, "If we start with an object like this one and we don't put any pieces of plasticine on it or take any pieces away from it, then it still weighs the same even though it looks different [Smith, 1968, p. 520]."

An elaborated version of this method is Gagné's learning hierarchy method (Kingsley & Hall, 1967). As stated earlier, Gagné regards conservation as the end point in a sequence of discriminations, skills, rules, and concepts that the child must progressively master in order to master conservation. Training thus consists of a graded sequence of tasks or experiences involving measuring, counting, explicit and empirical reinforcement, presentation of verbal rules, and demonstrations of reversibility (see below).

Training the cognitive operations underlying conservation. Underlying this kind of method is the view that there are certain cognitive operations that are involved in a judgment of conservation. A young child does not exhibit conservation because he has not yet acquired the necessary cognitive operations. There has been considerable theoretical controversy, however, over precisely what set of operations underlies conservation (cf. Wallach, 1969). Training studies, aimed at providing an experience that instills the presumably critical operation(s), have dealt with two, reversibility and compensation of dimensions. (Sigel, Roeper, and Hooper, 1966, also attempted to teach multiple classification and multiple "relationality," as they considered these operations prerequisite to the understanding of compensation of dimensions.)

Most studies have been devoted to teaching reversibility. While the method has many variants, it basically consists of demonstrating to the subject that deformed displays can be returned to their original state (Wallach & Sprott, 1964). The demonstration is usually accompanied by a verbal description ("You see, we can put them back the way they were"). A more elaborate method includes addition–subtraction (Gruen, 1965; Smedslund, 1961a, 1961c; Wallach & Sprott, 1964; Wallach, Wall, & Anderson, 1967; Wohlwill & Lowe, 1962). On some trials, material is added to or subtracted from one stimulus in addition to deformation, and the subject must learn to make a judgment of inequality on these trials.

A few studies have dealt with compensation of dimensions (e.g., longer but thinner). Sonstroem's procedure was most explicit. After an incorrect response, the experimenter said, "O.K., the pencil is *longest,* but the ball is *fattest;* now tell me, does one of them have more clay than the other or do they have the same [Sonstroem, 1966, p. 217]?"

Inducing cognitive conflict. This is the only method that is based explicitly on Piaget's theory of the mechanisms of cognitive development. According to equilibration theory (Piaget, 1971), structural change occurs when the results of the individual's actions feed back to his existing structure in a way that is discrepant with that structure. The resulting disequilibrium may then lead to reorganization and progressive change. Experimental work based on this theory has involved the attempt to artificially induce such disequilibrium through the introduction of external perturbations (Langer, 1969). In the area of conservation, one method has consisted of asking the subject to predict liquid levels prior to transformation and then confronting him with his incorrect prediction by actually performing the transformation (Inhelder, Bovet, Sinclair, & Smock, 1966). The nonconfirmation of the child's prediction, it is thought, may induce some internal disequilibrium that in turn may lead to cognitive reorganization.

The Piagetian View of Conservation Attainment

There clearly has been little consensus as to what kind of presentation or experience might be critical in inducing a judgment of conservation. It is thus interesting to note that Piaget has been particularly explicit as to what he believes a conservation judgment reflects and what factors he believes lead to the attainment of conservation in the natural course of development. He described the process as follows:

> there always comes a time (between 6½ years and 7 years 8 months) when the child's attitude changes: he no longer needs to reflect, he decides, he even looks surprised that the question is asked, he is *certain* of the conservation. What has happened then? If we ask him his reasons, he replies that nothing has been removed or added; but the younger children also are well aware of this, and yet they do not infer identity. . . . Or else he replies that the height makes up for the width lost by the new glass, etc., but articulated intuition has already led to these decentrings of a given relation without their resulting in the simultaneous coordination of relations or in their necessary conservation. Or else, and this especially, he replies that a transfer from A to B may be corrected by a transfer from B to A and this reversibility is certainly essential, but the younger children have already on occasion admitted the possibility of a return to the starting-point, without this "empirical reversal" yet constituting a complete reversibility. There is, therefore, only one legitimate answer: the various transformations involved—reversibility, combination of compensated relations, identity, etc.—in fact depend on each other and, because they amalgamate into an organized whole, each is really new despite its affinity with the corresponding intuitive relation that was already formed at the previous level [1950, pp. 140–141].

As for the question of precisely what causes this organized whole to be formed, Piaget said the following:

> Intuition, at first dominated by the immediate relations between the phenomenon and the subject's viewpoint, evolves towards decentralization. Each distortion, when carried to an extreme, involves the reemergence of the relations previously ignored. Each relation established favors the possibility of a reversal. Each detour leads to interactions which supplement the various points of view. Every decentralization of an intuition thus takes the form of a regulation, which is a move towards reversibility, transitive combinativity and associativity, and thus, in short, to conservation through the coordination of different viewpoints (1950, pp. 138–139].

Thus, Piaget has made it clear that in his view conservation reflects a reorganization of cognitive structure and it is not the attainment of any specific information or any single capacity, such as reversibility of operations, that leads the child to this reorganization in the natural (nonexperimental) situation but, rather, a unique coordination of capacities based on a progressive amalgamation of experience and reflective activity.

In the case of training studies undertaken from a Piagetian point of view, then, the question becomes, Can we hope to simulate the process Piaget described in a short-term experimental setting, and if so, how should we go about it? First of all, it seems appropriate to regard this requirement that mental operations be applied and consolidated over a period of time in order for reorganization to occur as constituting the essential limitation of short-term training endeavors. We return to this issue in the concluding section. Regarding the kinds of training strategies that are likely to be of value in simulating, even in some partial sense, the process Piaget described, one assumption seems warranted, based on his description of the process. A training technique can be effective only to the extent that it forces the subject to reconstrue the way he has conceptualized the problem being presented to him. If such reconstruing does not occur, no structural change has taken place. Thus, it is essential that we consider exactly what a training presentation consists of from the child's point of view.

In this light, the true enormity of the problem of devising an effective training technique quickly becomes evident. In a word, what the experimenter regards as a discrepant or anomalous presentation, hence requiring some reconstruing, may not be at all disturbing to the child. A number of investigators have, in fact, labeled their conservation training procedures as conflict inducing when it is not at all clear that a subject would always or ever experience such a procedure as conflictual. For example, Murray (1972) placed a nonconserving subject in a group with two conserving children and required the group to reach a joint decision on a standard conservation problem. It is most uncertain what this experience might entail for the subject, especially in that a

description of the interaction (training) portion of the experiment was not included in the study. The earliest procedure to be referred to as conflict inducing was the one used by Smedslund (1961d, 1961e) and later by Gruen (1965) and Winer (1968) as well as others who, however, did not always refer to it as conflict inducing. The subject witnesses a deformation of one of two standard stimuli in addition to a subtraction from or addition to one of the stimuli, all in randomized order. If, after deformation, the subject considers one stimulus as more than the other and a subtraction is then made from the one he considers more, it is reasoned, this event should put the subject's addition–subtraction and deformation schemas (Smedslund, 1961d) into conflict with one another. Because training trials are not matched to an individual subject's judgments, however, it is not assured that all trials will be of the desired form. For example, an addition may be made to the stimulus the subject considers more. Moreover, even when trials are of the desired form, there is no guarantee that the procedure puts the subject into conflict; if the experimenter continues to remove elements from the rearranged array that a nonconserving subject claims is longer (i.e., "more"), the subject may simply change his response at whatever point in the procedure the array ceases to appear longer to him.

Those studies that focus on reversibility as the critical aspect of training provide the best illustration of the problem being raised here. Based on their review, Brainerd and Allen (1971) concluded that all successful studies included in the training presentation a demonstration of reversibility (of the deformation) in verbal and/or visual form. The first problem in accepting Brainerd and Allen's conclusion consists of the fact that they regarded a very wide range of phenomena as constituting the demonstration of reversibility. They included Gelman's (1969) procedure in this category, for example, on the grounds that every displaced element appearing in a given triad reappears in its original position in a triad presented at some later point. While this fact may constitute the presence of reversibility of position from a logical point of view, it seems highly unlikely that from the child's point of view such a fact serves to illustrate the possibility of a return to the starting point.

The most serious theoretical difficulty with considering the child's recognition of the reversibility of a deformation as underpinning his understanding of conservation is the fact that such reversibility of the material's arrangement is only analogous to the reversibility of mental operations that characterizes the concrete operational structure. It is the reversibility of operations, not, as commonly misinterpreted, the operation of reversibility, which constitutes concrete operations. Thus, as Piaget (1967) pointed out, many subjects are aware of the possibility of a return to the starting point (empirical reversal, or "renversabilité," as he termed it) and yet do not show the reversibility of operations that would lead them to a judgment of conservation.

It is possible, nevertheless, that the repeated empirical demonstration of reversibility of the deformation might at least in some cases introduce the kind of perturbation that would lead the child to some reorganization. The most basic problem for reversibility training, however, consists of the fact that for both the conserving and nonconserving subject, the conservation question is essentially a trivial one. The conserving child knows there are the same number in each row, while the nonconserving child knows that a shorter row "has less." The truly nonconserving child is not put into conflict by the fact that when the objects are returned to their original positions, there will again be the same number in each row. This is in fact the defining characteristic of the nonconserver: He does not conserve quantity through a series of reversible transformations. We are thus led to the conclusions of Inhelder and Sinclair (1969) and Strauss and Langer (1970). If the child himself has some even rudimentary sense of the conflict, it may be possible to devise interventions that may heighten his awareness of this conflict. It is extremely difficult to induce change, however, unless the child has spontaneously begun the transition.

The Future of Training Studies

Despite the diversity among training studies in their intent, underlying conceptualization, and techniques, there is some convergence with regard to their implications for training research.

For those researchers who accept Piaget's view of conservation as the manifestation of an underlying cognitive reorganization and whose aim is to partially or totally induce this reorganization experimentally, the training study strategy has severe limitations, as we have just discussed. Children (and adults) are evidently quite efficient at securing that stimulation which is necessary for them to further their own development. It is extremely difficult for us as experimenters to devise a brief presentation that is exactly the one the child can make use of at that point to reorganize his thinking and thus accelerate his development.

For those researchers whose intent is to disprove or at least put to a critical test the preceding view of conservation, the training study technique is likewise severely limited. To provide a definitive demonstration that conservation has been acquired requires general agreement as to what this concept or behavior consists of and the criteria for judging its presence—in other words, general agreement as to "how we'll know when we see it." At the moment there is no such agreement. In its absence, any demonstration that conservation has been taught remains inconclusive. Using the extreme case as an illustration, consider the researcher who holds the view that a conservation judgment reflects simply the attainment of specific empirical information (e.g., "water remains 'the same' when it's poured.") This researcher undertakes a training study in which nonconservers are supplied this information, and quite understandably, he uses a simple "same" verbal response as the criterion for having attained conservation. In so demonstrating that conservation can be taught, he demonstrates to himself and others of his persuasion what was self-evident, given their definition of conservation, and persuades no one who has a different view of what a conservation judgment reflects.

In the present author's view, it is for these two very different sets of reasons that researchers' interest in undertaking conservation training studies has declined. Note that this is a very different interpretation of the decline than the interpretation implied by the Brainerd and Allen (1971) review—namely, that interest has declined because we have discovered the factor that induces conservation (demonstrations of reversibility, in their view). If the present analysis is correct, turning our efforts toward applying the training study strategy to some other concept than conservation, as a few researchers have begun to do, will eventuate in a similar lack of conclusiveness. Clearly, we first need to turn our attention to the method itself. In the remainder of this section, several suggestions are made for improvement of the training study as a method of research in developmental psychology.

First, it is suggested that every training study should be undertaken as a part of a research program that has as its foundation a careful longitudinal assessment of the natural development of that concept and any concepts thought to be closely related which are to be studied experimentally. For example, all of the concrete operational behaviors (the various conservations, class inclusion, seriation, etc.) might be assessed. This would be accomplished by means of repeated, periodic assessment of a group of subjects. Assessment would begin at an age when some or all of the assessed behaviors were just beginning to appear and would continue throughout the period of development until all subjects exhibited all behaviors. (Such a design, of course, entails the necessity of evaluating repeated assessment as a possible contaminating variable by means of a series of posttest-only controls.) Such data would enable us to know (*a*) the length of time the development being studied naturally takes and (*b*) most important, the patterns of development across the various behaviors involved. In other words, do the various behaviors always emerge in an invariant sequence, in a variable sequence, or synchronously? What are the overall patterns of emergence?

Learning the natural history of the con-

cept to be studied experimentally can serve two purposes. The first is providing researchers, regardless of their theoretical persuasion, with an unambiguous criterion by means of which they can judge whether an intervention has been successful. The critical test is this: Do the patterns of relative advancement of experimental subjects (over the range of behaviors initially assessed) remain comparable to those of the nontrained (longitudinally assessed) control subjects? To the extent that they did, the researcher would have confidence in regarding any observed advancement of experimental subjects as reflecting an acceleration of a natural process of developmental change. The ambiguities of what kinds of explanations or how much generalization a trained subject should be required to exhibit are thus eliminated. To the extent that development has been genuinely induced, the argument is made, the trained subject should exhibit patterns of behavior identical to those of subjects who have reached a comparable level of development naturally.

Intervention, then, would not take place until the second phase of the proposed research. The first step would be an assessment of experimental subjects in terms of their progress in the developmental sequence established by means of the longitudinal assessment program just described. After this initial assessment, interventions that it was thought might induce progress could be introduced. Natural history data might potentially become useful at this point in a second way—as a source of ideas for interventions likely to be successful. To be useful in this second way, naturalistic longitudinal analysis would have to incorporate the much more difficult task of analyzing the child's environment in addition to the less difficult task of analyzing the child. In other words, what are the common experiences that accompany every child's natural development of the concept(s) being studied, and which of these experiences are likely to be relevant to that development?

Whatever the researcher's source of ideas as to the nature of the intervention to be attempted, it is suggested that the intervention program proceed as follows. An intervention would at first be introduced only on a single occasion at some given point in the subject's developmental history. Based on the findings from previous studies (e.g., Inhelder & Sinclair, 1969), the most appropriate point for initial experimentation with intervention is during the subject's transitional stage. Only subsequently should the more difficult task be attempted of designing interventions for subjects who initially show no advancement with respect to the concept being trained.

In subsequent experiments, the number, frequency, and duration of intervention sessions would gradually be increased. Most importantly, and in marked contrast to existing studies, the interventions would be spaced out over the period that the development in question normally occurs. We thus eliminate the severe (and self-imposed) limitation of existing training studies, their confinement of intervention to a single occasion.

Each attempt at intervention, varying in number, duration, or frequency of sessions, would constitute a separate experiment, requiring the appropriate posttest assessments. Increasing the number and frequency of interventions, however, should proceed only cautiously. The initial attempts, involving only one or two interventions over the entire developmental period, would probably not be sufficient to induce significant change. In each case, though, the primary objective would be to preserve the natural patterns of attainment of experimental subjects. Thus, the strategy might be viewed as an attempt to discover how slowly, rather than how rapidly, we can accelerate development, still preserving its natural characteristics.

The spacing of intervention sessions over the period of natural development would increase the likelihood that genuine development might be induced. Modeling proposed interventions on experiences that are a part of the child's natural environment, if this were included as part of the research strategy, would serve this same objective. Attempting to approximate the natural developmental process as closely as possible should bring us closer to what is the most

worthy objective of training studies, understanding this process itself.

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(Received February 22, 1973)