TASK ORDERS AND STAGES OF DEVELOPMENT

IN CONSERVATION TRAINING

by

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Abstract

The relationship between order of presentation of training tasks and stage of development on conservation concept acquisition was assessed. One hundred and twenty-six kindergarten and first grade children from 4 middle class schools participated in the conservation training study. The experiment was conducted in four phases: administration of a pretest, two training sessions approximately three days apart immediately followed by a posttest, and a delayed posttest two weeks later.

Children were assigned to one of 6 treatment conditions on the basis of their pretest score on 4 conservation tasks (length, number, mass substance, and liquid volume). Also included in the pretest were continuous length and class inclusion tasks.

The study attempted to 'standardize' the self-discovery method of training laid out by Inhelder, Sinclair and Bovet (1974) in their chapter on conservation of length. The training task consisted of presenting a child with one of 3 stimulus layouts which varied in difficulty. The child's task was to construct a straight pathway below the layout with match sticks that were sometimes smaller

than those used to construct the standard.

Training conditions varied according to the order in which the three layouts were presented. In the 'Fade' condition items were presented in an easy-to-hard order. In the 'Loop' condition the same items were presented in a hard-to-easy-to-hard sequence. Items in the 'Change' condition were alternated in an easy-to-hard order i.e. easy, medium, easy, medium hard, hard. Two control groups were included to control for possible repeated testing effects. The 3-test control group received the pretest and immediate and delayed posttest at the same intervals as the trained subjects. The 2-test control group received the pretest and delayed posttest only.

Subjects trained with the Fade and Change orders were found to perform significantly better than the Loop or control group subjects on the immediate posttest criteria. This performance was maintained to the delayed posttest 2 weeks later and was hypothesized to be the result of far transfer. Loop trained and 3-test control subjects showed substantial improvement between the immediate and delayed posttests. It was proposed that this improvement was the result of near transfer in which the immediate posttest criteria and experimenter served as training.

While relatively the same percentage of non conserving and partially conserving children benefitted from Fade and

Change training, only partial conservers in the Loop and Control group improved as a function of repeated exposure.

If one looks at frequency (the per cent of subjects who improve) the present data indicate strong differences in favor of those children who are more advanced on the pretest, thus supporting the stage theory. However, analyses of the magnitude or mean incremental changes for non conservers and partial conservers reveals no differences. This indicates that those non conservers (however many) who improve, show just as much improvement as their more advanced peers.

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Introduction

For years Piagetians have relegated learning to a secondary role subordinate to development. For them, cognitive development is a spontaneous process that is governed by its own unique principles (equilibration, adaption, organization etc.), which control concept acquisition. According to this view, the child's ability to learn a concept is subject to the constraints of their stage of cognitive development. Each stage is governed by its own unique set of cognitive structures. Thus learning a concept belonging to any one stage consists of learning how to apply cognitive structures to new content. Piaget suggests that those investigators claiming success in teaching operational structures (such as conservation) have most likely achieved some learning by external reinforcement but have not established logical structures.

In their book *Learning and the Development of Cognition*, Inhelder, Sinclair, and Bovet (1974) emphasize that progression between the stages does not stem from maturation alone but an interaction between maturation and the environment. " . . . it is possible, through adequate exercises, to shorten the intervals which 'normally' . . . separate the successive cognitive stages . . . " (p. 266). However, only if the structures appropriate to a given stage are present can learning processes operate to induce the concept. That is, if a child is in that part of his stage development where a new concept will soon develop spontaneously, he is likely to benefit from training, if he is not, training is useless. Further, the process by which stage transition is induced must be the same as that by which this transition would occur spontaneously.

In spontaneous problem solving the child's own activity is the chief cause of progress. As a child who holds some incorrect belief "discovers" contradictions between his beliefs and his environment, disequilibrium occurs which leads him to adopt a more appropriate concept.

A majority of the experiments designed to test the Genevan position on learning have focused on the concrete operational period, specifically the conservation concepts which mark entrance to this stage of cognitive development. Conservation refers to the fact that quantitative relationships between stimili do not change across certain perceptual transformations. A typical conservation task involves presenting a child with two stimuli that are both perceptually and physically equal with respect to some quantitative property (number, length, mass etc.). The child is asked an equivalence question and then one of the stimuli is transformed in such a manner that the perceptual (not quantitative) relationship is changed. The child is questioned to see if he or she conserves the relationship.

According to Piaget, there are three stages to conservation development. In the first stage, the child cannot conserve at all and is said to be in the intuitive preoperational period of cognitive development. The cognitive structures of the Stage III child are the grouping structures of the concrete-operational period. A Stage III child conserves consistently. Stage II represents the transition phase between the two periods, therefore cognitive structures of this stage are a mixture of the intuitive and grouping structures. The child in this stage can conserve on some tasks but not others.

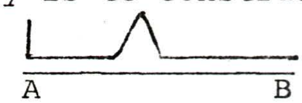
To summarize the Genevan position, cognitive development can be accelerated only if (a) the structures appropriate to a given stage are present and (b) the training treatment incorporates the strategies of spontaneous development. What follows is a discussion of the process of spontaneous stage transition as exemplified by the problem solving strategies explored by Inhelder and her collaborators (1974). Alternative orders of item presentation in their training method are proposed. The controversial issue of the effect of stage of development and learning is discussed. Finally, a comparison is made between the relative effectiveness of the self-discovery method of training versus what Genevans refer to as "tutuorial" approaches to concept development.

Stage Transition and Training Order

Piagetians attribute the spontaneous transition from one stage to another to equilibration (an innate mechanism for the coordination of schemes) and the multitude of schemes which situations activate. According to Inhelder et al., (1974):

> Both in especially contrived situations and in normal everyday life conflicts can arise between different conceptual schemes, some of which are more developed than others. A first effort to combine and reconcile the conflicting schemes results in inadequate compromises, which indicate a beginning of coordination between certain previously unconnected schemes. Subsequently, the various schemes are integrated into a new more advanced cognitive structure. (p. 166)

It was the goal of Inhelder and her collaborators to demonstrate the process of spontaneous cognitive conflict resolution. In their chapter on length conservation they trained children (who could conserve on number but not length) with a sequence of tasks which varied in difficulty. The children were presented with the following layouts (A) , (B) , and (C) , which had been constructed with matchsticks. The subjects' problem was to construct a straight pathway below the layout with matchsticks that were smaller than those used to construct the standard. Conflict was introduced into the procedure by confronting the subjects with the discrepancy between their predictions and the experimental outcome.

Pascual-Leone (1976) gives an explicit explanation of the equilibration process for items A, B, and C. He hypothesized that item A, the most complex, was the hardest and item C the easiest of the three layouts; and that the factors producing this difficulty were different. Therefore the qualitative strategies they elicited would be different. In item A the dominant strategy is to construct the straight-line pathway A-B as follows: 

(Inhelder et al., 1974, refer to this as the "going just as far" strategy). According to Pascual-Leone, children are induced into this strategy by the strong (Gestaltist) organismic factor which Genevans call figural (F) factor or "pregnance figurale." The equilibration process in layout A takes the form of a conflict between this misleading F strategy and the much weaker strategies based on the number or length of the matches in the standard.

Layout B does not tend to produce the same manifestations of the organismic F factor. Because the direction of the to-be-constructed straight line is "horizontal" while the global direction of layout B is "vertical," the organismic F factor compels the subject to notice the horizontal segments of the layout as distinct and separate from the other two segments. Thus layout B tips the equilibration process toward activating the executive scheme (or strategy) of counting. And indeed the majority of children in the Inhelder et al. study did spontaneously count the segments in layout B and construct their pathways using the same number of matches, even though their sticks were shorter.

In layout C, the subject experiences the same F facilitative tendency to construct C, so that its ends coincide with the ends of the layout. However, unlike item A, this F tendency leads to correct solution of the problem.

According to Inhelder et al. (1974),

> . . . the child has to realize the necessity of compensation between the length of the individual matches and their number, and he has to become aware of the insufficiency of the "going just as far" principle. The comparison between the lengths of the different matches suggests the idea of measurement. Layout B suggests the counting of units that make up a length. Layout A demands the co-ordination of these aspects of comparisons of length. (p. 160)

Pascual-Leone (1976) maintains that the order in which these items or layouts are presented is "crucial" to the problem solving learning method which he calls the method of "Graded Learning Loops." This method consists of presenting the layouts in the order of hard (A) to medium (B) to easy (C) and back to hard, such that the easy "item is often spontaneously solved resulting in intrinsic feedback which facilitates the learning of schemes useful to the solution of the harder items" (p. 272).

It is interesting to note that this order of presentation (hard to easy) is the reverse of the order which has been so successful in discrimination learning. As early as 1920 Hull found that when subjects learned several concept learning problems in succession, learning was facilitated when the problems were presented in simple to complex order. In concept identificiation, subjects learn to classify patterns along a single relevant dimension. Problems usually consist of presenting the subject with a number of irrelevant stimuli as well as the relevant one. The likelihood of the subject selecting a dimension is dependent upon the saliency of that dimension. It has been found that attention can be directed to the relevant cue through a procedure called stimulus emphasis. Any stimulus which makes the subject more attentive to a relevant cue is an emphasizer (Trabasso, 1963). To teach discrimination, the relevant cue should be emphasized as strongly as possible in order to elicit the appropriate coding response. Once the coding response is established, the emphasizer may be withdrawn. This has been found for discrimination learning in general, not just concept identification. Investigating what he called "transfer on a continuum," Lawrence (1952) found that the best way to teach a simultaneous discrimination was to start out with a very easy discrimination and then gradually shift to the more difficult test stimuli. This procedure was superior to one in which the hard stimuli were used from the beginning, and it was also better than starting with the easy problem and suddenly shifting to the difficult problem. The same principle appears to be behind the "easy-to-hard effect" reported by Singer, Zentall & Riley, (1969). In some learning texts this phenomenon is treated as a variation of "cue fading" technique (Hall, 1976; Kintsch, 1977). In light of these studies, Kintsch (1977) concludes " . . . it seems the maximally inefficient strategy for discrimination learning would be to start with the most difficult version of the problem first" (p. 402).

While it is true that the order effect used in discrimination learning may not generalize to the quantity conservation tasks dealt with by the Genevans, a third approach should also be considered. May and MacPherson (1971) and Franken (1967) suggest that the major variable may not be the difficulty of the items presented, rather the successive presentation of discriminably different items. Franken (1967), using rats as subjects, extended Lawrence's 1952 experiment and found that the beneficial effect of prior training on relatively easy problems was not entirely due to experience with the easy tasks per se but the temporal change involved in shifting from one level of difficulty to another. He found that trial-to-trial alternation between easy and medium difficulty levels of the problem during acquisition led to better positive transfer than did an easy-medium-hard transition or an equal number of preliminary trials on the hard task. May and MacPherson (1971) extended the results to quantity discrimination in children and found that alternating between easy and hard tasks on successive trials led to better performance than did the other task orders presented. May and Tisshaw (1977) successfully applied these ideas to improvement of conservation in preschoolers as a result of variations in learning set training.

The order of item presentation used by Inhelder et al., (1974) although adjusted to the "subject's needs," generally followed the sequence: A (hard), B (medium), A, B, C (easy), B, A. In a subsequent study the order of presentation was reversed and layout C was presented first. Although they thought this might make the solution of layout A simpler this is not what they found.

> In the correct solution to layout A, the straight road "goes so far beyond" the layout model that even if the necessity of a compensation between length of the

> units and their number is already understood many children cannot apply this principle. When they are led to make several comparisons between the different situations these children can overcome this difficulty, but the order in which the comparison is made is immaterial. (p. 161)

This last statement can be interpreted to mean that the alternation of the items could be a crucial factor rather than the difficulty of the items. This is consistent with the interpretation of temporal contrasts given by May and Tisshaw (1977).

Stage Effects and Learning

Inhelder et al., (1974) point out that it is possible, particularly with the easiest of their tasks, that the child realizes that his solution is wrong, and why, but cannot solve the problem in other situations unless a certain competence in the coordination of schemes (comparing different ideas and their respective results) is already present. This is in keeping with the Piagetian view that a child's ability to learn a concept is subject to the constraints of the developmental stage he is in. This is because learning the concept does not consist of learning per se but of learning to generalize the mental structures appropriate to a given stage. They would argue that children cannot be taught a given concept unless they already understand the concept to a certain degree. "The situations most likely to elicit progress are those where the subject is encouraged to compare modes of reasoning which vary both in nature and complexity, but which all, individually, are already familiar to him" (Inhelder et al., p.265). According to this reasoning it would be impossible for a child functioning at one stage of development, such as preoperational, to learn concepts from a subsequent stage (e.g. concrete operations). However, if the child was in the transitional phase between these two operations, he should possess a mixture of the cognitive structures of both stages. For this reason, the subjects in Inhelder's experiment were all children who could conserve on two or three number (but not length) conservation tasks. These children were classified as "Non Conservers" if they gave wrong answers to two continuous length test items. If the child gave the correct answer to one of the two items he was classified as "Intermediate - ;" and if he gave correct answers to the second item as well, but could not give five full explanations he was classified as "Intermediate + ." A non-Piagetian might consider all of these children as partial conservers; they passed number tasks but failed continuous length tasks.

Based on the results of their training study, Inhelder et. al., (1974) concluded that in the majority of the cases, "the nature and extent of the subject's progress was always, in fact strikingly so, dependent upon their initial developmental level" (p. 244). Further,

> . . . in the posttest the hierarchical classification of the subjects is preserved, while the differences in development are accentuated. The more advanced a child is, the more he will gain from the exercises and the information they contain. (p. 268)

This is in sharp contrast to recent studies and analyses by Brainerd (1977) which have led him to suggest " . . . there is no evidence that a child's susceptibility to conservation training is closely related to their pretraining stage classification" (p. 929).

Most of the studies between 1965 and 1974 (cf. Brainerd's review, 1977) based their support of Piaget's readiness theory on the high pretest-posttest correlations obtained before and after various types of training. In reviewing these studies, Brainerd (1977) points out that posttest performance is a function not only of what may have been learned during training, but also what was known prior to training. Further, if a test is reliable, there should be a high correlation between two administrations of the test even with no intervening training. In light of this, Brainerd reanalyzed several of these experiments by comparing the mean improvement score of Stage I preoperational subjects and stage II transitional subjects. He found the differences between these mean scores to be quite small. In 5 cases, the differences were in favor of Stage II subjects. In 12 cases, the differences were in favor of Stage I subjects. Although there was insufficient information to apply significance tests, it was hypothesized, in light of the small differences, that there would be no statistical differences.

Brainerd (1977) attempted to include the data reported by Inhelder and her collaborators, however, interpolations of the data were necessary because of anomalies in the execution and reporting of the experiment. In the Inhelder studies children were not assigned summary scores after each test, but were stage classified. This is in keeping with the general Genevan antithesis toward summarizing the performance of children in numerical indices. Unfortunately, data in the form of arrow related tables can reveal co-variation between pretest and posttest but provides little information concerning whether the transitional children benefitted more from their "guided experience" than their more naive peers.

Thomas (1980) has proposed a methodological solution which eliminates the problem of numerical assignment. Children are viewed as a "count" or "observation" in a cross-classification table with ordered rows and columns reflecting the classification hierarchy for pretest and posttest performance. He treats the problem of evaluating differential posttest gains for intermediate and non-conserving children with a probabilistic interpretation:

> . . . the central idea is that if intermediate children acquire more knowledge during training than nonconserving children they should be more likely to show a change in classification and become conserving children on the posttest. Nonconserving pretested children should, correspondingly, be less likely to become intermediate at posttest since they would not be expected to have profited as much from training. (p. 7)

Feeling that the question of how a child's pre- and posttest training performances are related was still unresolved, Thomas (1980) attempted to apply his probabilistic interpretations to the Inhelder data. He concluded:

> There certainly is but marginal support in the above analysis for the Genevan position. Yet given the inherent weaknesses in the data and more specifically the way certain data were not reported, it seems best to withhold judgement regarding the Genevan position. (p. 14)

Self-Discovery vs. Tutorial Training

The Genevans maintain that cognitive development can be accelerated only if the training resembles the kind of situation in which progress takes place outside an experimental set-up. Inhelder et al., (1974) sum up this position:

> Training procedures in which one type of reasoning is artificially isolated and exercised, as is often the case in certain programmed learning projects, are not in our opinion, very useful since they

> eliminate the element we consider necessary for progress, i.e., the dynamics of the conflict between schemes. (p. 265)

Recall that in spontaneous problem solving the child's own activity is the chief cause of progress. As the child who holds some incorrect belief "discovers" contradictions between his beliefs and his environment, disequilibrium occurs which leads him to adopt a more appropriate concept. This position is reflected in the design of the Genevan learning experiments.

In their chapter on length conservation (Chapter 6) where the child has to realize the necessity of a compensation between the length of the individual matches and their number, emphasis was on the child discovering the principle for himself. The child constructed the road by himself (for Piagetians, manipulation of concrete objects plays a large part in concept learning); and although the experimenter asked the child to make comparisons or give jutifications, the children were not told whether their answers were correct or not. Thus direct accuracy feedback was not given.

North American experimenters have attempted to train conservation utilizing such manipulations as instructing subjects to look at appropriate cues, providing them with verbally stated rules, or providing social modeling and verbal reinforcement of correct responses. While many of these manipulations have resulted in a remarkable degree of success (cf. Bucher & Schneider, 1973; Gelman, 1969; Zimmerman & Rosenthal, 1974), most Piagetians are not interested in maximizing learning in ways which they feel may decrease the need for active problem solving. They make a distinction between training treatments that incorporate a provision for self-discovery and those that do not. Piaget and his collaborators view the latter as offshoots of North American learning theory and refer to these treatments as "tutorial methods."

It should be noted that the Piagetian's only empirical grounds for rejecting tutorial methods were two early studies by Smedslund (1961) and Wohlwill (1959) both of which had flaws in their design which probably mitigated against learning. In addition to the tutorial methods utilized by Smedslund and Wohlwill, there are at least four other tutorial methods (simple correction, rule learning, observation learning, and conformity training) on which extensive evidence is now available. Each of these four methods have produced improvements in the trained concepts that satisfy the Genevan learning criteria of (a) observable differences in the level of operation of the child before and after training, (b) generalizability to other tasks, and (c) stability over time.

In light of the success of these studies, Brainerd (1978) argues that "there is no reason to suppose . . . that the best procedures for training Piagetian concepts are those which imitate processes operating in everyday life" (p. 84). He proposed instead that the most natural procedures for learning these concepts are the ones that are the most effective.

A direct comparison of the relative effectiveness of the tutorial and self-discovery procedures is difficult in that there exist no direct comparison of the two types of training. The only option is to compare the tutorial method with what little self-discovery data is available. This data comes in the form of the six experiments reported by Inhelder et al. (1974). Unfortunately, these experiments, which involved very small numbers of subjects, suffer from methodological anomalies common to the "clinical" approach (e.g. nonstandardized training, no control group, "data" in the form of arrow-directed tables, etc.).

As mentioned earlier, Brainerd (1978) attempted to include the data reported by Inhelder and her collaborators in his reanalyses of the stage learning literature. He found it difficult to place much faith in the stability of findings from 5 to 10 subjects and pointed out that the fact that the steps in their training trials varied from one subject to another meant that their studies could not be replicated with any precision. In summary he concluded:

> . . . the data presented by Inhelder et al., (1974) suggests that their self-discovery procedures are moderately successful techniques for teaching subjects who already possess sufficient knowledge of the to-be-trained concept. However, the effectiveness of self discovery procedures with subjects who have no prior knowledge of the to-be-trained concept appears minimal. (p. 91)

To recapitulate, the Genevan position is that learning occurs when two conditions are met. First, the training treatment incorporates the opportunities for spontaneous development. Second, the subjects who are to be trained already possess the to-be-learned concept to some measurable extent. It is apparent that this position cannot be evaluated with the restricted data that has been made available, specifically because of the lack of adequate methodology inherent in the "clinical" method espoused by the Genevan experimenters.

The purpose of the present study was to provide data that would be amenable to critical analyses of the Genevan position. It represents an attempt to "standardize" the discovery method laid out by Inhelder and her collaborators (1974, Chapter 6) while retaining those aspects Genevans hold crucial to self discovery, such as manipulation of the training material by the subject and absence of direct feedback. At the same time standardization of number of trials and number of sessions, increased sample size, the inclusion of two control groups, and the inclusion of both total nonconservers as well as partial conservers were incorporated into the present study.

Another purpose of the present study was to examine the effects of task order on active problem solving utilizing the task laid out by Inhelder et al., (1974) and discussed by Pascual-Leone (1976). These tasks were presented to one group of subjects in the "hard-to-easy-to-hard" order recommended by Pascual-Leone, which is referred to as the "Loop" condition. A second group of subjects was presented with the items in an "easy-to-hard" sequence referred to as the "Fade" condition. And the third group of subjects were presented with the items in an alternating "easy, medium, easy, medium, hard, hard" order; this last group is referred to as the "Change" condition.

Of special interest was how the trained subjects would perform on the posttest criteria. Would the effects of learning on layout training transfer to conservation and other dependent variables? There are three types of transfer in conservation concept learning. The first, "near transfer," involves utilization of a posttest for the trained concept using a different format (e.g. different color stimulus material). In "far transfer," the posttest is on concepts not specifically trained. In the third type of transfer, referred to as "non specific," the posttest is for some concrete operation stage other than conservation (transitivity, class inclusion, etc.).

In the current study subjects were not trained specifically on the concepts that were tested. Therefore, any transfer of training would be considered far transfer. In the case of class inclusion, transfer would be non specific since this concept has been found to develop later than conservation, at about 9-10 years of age (cf. Brainerd, 1973).

In summary, the relation between order of presentation of training tasks and stage of development (independent variables) and conservation acquisition (dependent variable) was assessed. In light of any emperical evidence to support the "Graded Learning Loop" method of training, it was hypothesized that the "Fade" and "Change" training orders would be more effective than the "Loop" condition. If the Genevan Stage Learning position is tenable, gains for partial conservers should outstrip corresponding gains for nonconserving children.

Method

Design. The experiment was conducted in four phases: (a) administration of a pretest and selection of experimental subjects, (b) first training session, (c) second training session immediately followed by a posttest, and (d) a delayed posttest. The pretest was comprised of 4 conservation tasks of 2 items each (length, number, mass substance, and liquid volume), 2 class inclusion items and 2 continuous length items.

Training consisted of two sessions, twelve trials per session. The pretest was repeated at the conclusion of the second training session and again two weeks later. There were 6 groups, 3 experimental and 3 control. The first control group received the pretest and delayed posttest at the same intervals as the experimental subjects. The second control group was run to test for repeated testing effects. This group received the pretest, and the immediate and delayed posttests to establish whether repeated conservation testing in itself leads to improvement in performance. The third control group was comprised solely of conservers who received the pretest, and the immediate and delayed posttests. To eliminate the possibility of expectancy effects, the pretest and delayed posttest were conducted by one experimenter, the training and immediate posttest by another. Neither experimenter was informed of the child's performance during any other phase of the experiment.

Subjects. A total of 228 children were pretested. These children were enrolled in kindergarten or grade 1 in four middle class schools in Victoria, B.C. The final sample consisted of 126 children 58 to 82 months old (mean age, 67.7 months). Upon completion of the pretest these children were assigned to one of 6 treatment conditions. Non conserving children were assigned to one of the 3 experimental or 2 control groups on the basis of their pretest score on the 4 conservation tasks. As closely as possible, an equal proportion of children who scored 0, 1, 2, 3, 4, 5 or 6 (out of 8 possible) were assigned to each group (see Table 1B). In addition the groups were matched (again as close as possible) by age and sex. As mentioned earlier the 6th group from the same sample and also matched by age was comprised of conservers (children with a score of 8/8 on the pretest). A description of the subjects in each condition is given in Tables 1A and 1B.

Stimuli. Conservation materials and transformations were nearly identical to those used by May and Tisshaw (1977) and are described in Table 2. The eight conservation items

TABLE 1a

Description of Subjects by Treatment Group

	Treatment					
	Fade	Change	Loop	Control (3 test)	Control (2 test)	Control Conserver
Mean Pretest Score (8 possible)	2.55	2.86	2.76	2.72	2.16	8.0
Age Range (months)	58-82	59-78	59-82	59-79	62-72	60-82
Mean Age (months)	67.3	67.7	67.4	67.3	67.7	70.1
% Boys	60	63	79	40	77	56
N	20	22	21	22	18	23

TABLE 1b

Pre Score* and Age in Months
for Subjects by Condition

	Treatment					
Pre Score	Fade	Change	Loop	3-test Control	2-test Control	
0	65	68	60	60	62	
	66	69	61	63	63	
	68	74	61	75	68	
	78	78	69			
1	62	64	69	60	68	
	69	65	65	61		
				79		
2	58	59	59	61	63	69
	61	65	66	62	64	69
	62	67	68	63	66	71
	67	69	68	64	67	71
	67	72	69	71	69	72
					69	
3	65	73	64	66		
			76	68		
4	59	61	61	68		
	63	62	63	72		
	69	64	64	74		
	70	65	79	76		
	82					
5	61	61	62	68	62	
	75	69	80	69	62	
		71		78		
		77				
6	79	66	62	59	66	
		71	72	64		
			81			

*Prescore is the total conservation score (out of 8) on the pretest.

TABLE 2

Stimulus Materials and Transformations Used in Conservative Tests

Conservation Task	Materials	Transformation
Length	2 round yellow sticks 23.5 cm long	E's stick to right of and perpendicular to S's stick; S's stick parallel to but below E's stick
Length	2 rectangular black sticks 10 cm long	
Length*	2 triangular orange sticks 23 cm long	
Length*	2 rectangular red sticks 20 cm long	
Number	2 rows of 6 black wooden checkers 1 cm apart	E's row spread out to 2 cm spacing
Number	2 rows of 5 erasers 2 cm appart	
Number*	2 rows of 5 bolts 1 cm apart	S's row constricted to 1 cm spacing
Number*	2 rows of 6 red plastic chips 2 cm apart	
Mass Mass Mass* Mass*	2 balls of blue Plasticine, 6 cm diameter	S's ball into cigar shape E's ball into cross (X) shape
Liquid Volume Liquid Volume Liquid Volume* Liquid Volume*	2 standard glasses, 13 x 6 cm; 1 tall narrow glass, 14 x 4.5 cm; and 2 short fat glasses, 8.5 x 8 cm.	Water from S's standard glass into 2 short glasses; Water from E's short glass into tall narrow glass
Continuous Length Continuous Length	2 Plasticine "roads" one 10 cm, one 15 cm placed with end points together	15 cm road is bent, becoming 10 cm end to end. 15 cm road is bent, becoming 5 cm end to end.

* Immediate Posttest only
E =Experimenter, S=Subject

Material and Transformation for Continuous Length were the same for all 3 tests.

were comprised of two length, number, mass-substance, and liquid-volume tasks. Class inclusion items consisted of "things to play with" (small plastic farm animals), and "things to eat" (smarties, raisins, carmels, peanuts). The continuous length task was performed with Plasticine. Stimulus materials used in the immediate posttest were similar to those used in the pretest varying only on irrelevant attributes such as color and shape.

The training stimuli consisted of three geometric configurations or "layouts" previously used by Inhelder et al., (1974) and discussed by Pascual-Leone (1976). These layouts (a) , (b) , and (c) ___________ were constructed of 3 mm square wooden sticks glued to the center of pieces of white cardboard 30 cm x 50 cm. Six examples of each layout were constructed with sticks that were 8, 7, 6, 5, 4, or 3 cm in length. A description of the stimulus layouts is given in Table 3. A 60 cm piece of orange insulated electrical wire was used to measure the length of the experimenter's stimulus layout and the child's estimated road.

Procedure. Each child was individually tested by a female experimenter either in a private room in the school or in a private room in a mobile laboratory located on the school grounds. The children were always seated at a table across from the experimenter.

TABLE 3

Description of Materials Used to Construct Training Layouts

Stick Length (cm) Layout	Subject's	Ratio	Number for Correct Response A	B	C	No. of Sticks Given Subject	Presumed Difficulty
6	6	1:1	5	4	5	9	Easy (E)
3	3	1:1	5	4	5	10	Easy (E')
8	4	2:1	10	8	10	11	Medium (M)
4	2	2:1	10	8	10	12	Medium (M')
7	5	7:5	7	6	7	10	Hard (H)
3.5	2.5	7:5	7	6	7	8	Hard (H')

Conservation. Two each of number and length tasks, randomly ordered, were presented followed by two mass-substance and two liquid-volume tasks which were also randomly ordered. At the beginning of each task, two stimuli (e.g. 2 rows of 6 checkers each) were presented to the subject so that they were perceptually equal. The child was asked an equivalence question. When he or she agreed that the items were the same in respect to the attribute in question one of the objects was rearranged (as described in Table 2). The child was asked if the two stimuli now had the same or a different amount of the relevant attribute. The words "same" or "different" were used alternately to avoid a response bias tendency toward responding "same" (Bucher & Schneider, 1973). The experimenter did not give the child any feedback about the correctness of his or her answer but proceeded directly to the next problem. Each response was scored 1 if correct, 0 if incorrect. While the first experimenter requested logical explanations of their judgements,in pretest and delayed posttest,scoring was based on the judgements alone.

Class Inclusion. The child was presented with two numerically unequal subclasses (e.g. 3 peanuts and 6 carmels) which both belong to one superordinate class (things to eat). The child was then asked to count the number of items in each subclass. If he did not arrive at the correct number he was asked to recount. Next the child was asked whether he believed that all of the items belonged to the superordinate class. Once the child agreed that they were indeed all part of the superordinate class he was asked the following questions: (a) Are there the same number of carmels (subclass 1) as "things to eat" (superordinate class)? (b) Are there more carmels (subclass) than things to eat (superordinate)? (c) Are there more things (superordinate) to eat than carmels (sublclass)? Although half of the children received the food items first and half received the play items first, the order of the three questions was fixed. The child was given 1 point if he answered all three questions correctly on a given set, thus total possible on class inclusion was 2 points.

Continuous Length. Two strips of Plasticine of different lengths (approximately 15 and 10 cm) and designated A and B respectively were laid out in front of each child. The child was told to pretend that these strips represented roads and was asked if it was just as far to walk on one of the roads as the other. After the child noticed the inequality and responded that it would take longer or more steps to walk on the 15 cm road, the experimenter responded "that's right" and proceeded to bend road A so that its end points coincided with those of B and asked, "Now is there just as far to walk on this road (A) as this road (B)?" After the child responded, the experimenter bent A in such a way that when the roads were laid out one directly below the other, A stopped short of B. Once again the child was asked which road would take longer to walk on. Feedback was not given following the two transformation questions. One point was given for each of the transformation questions answered correctly, for a possible 2 points.

Training. The first training session took place approximately one week after the pretest. As in the other tasks, the child and experimenter were seated across from each other at a table. The child was presented with a layout and told that it represented a road. He or she was given an appropriate number of sticks (see Table 3) and told that it was their task to build a road "just as long as" the stimulus layout, so that if an ant were to walk along the child's road it would have to take just as many steps as when it walked on the stimulus layout. There were two main differences between the stimulus layout and the child's road. First, the child's road was always to be built in a straight line (below the stimulus layout) and second, on two-thirds of the trials, the child's wooden sticks were shorter than those used to construct the model. The child was always given 1 to 5 more sticks than were necessary to perform the task correctly.

Each child was trained in two sessions approximately 3 days apart and asked to construct a total of twelve roads per session. For the first six trials the stimulus sticks and the child's sticks were in a 1:1 ratio. For the second and third set of 6 trials the ratio was 2:1, and in the last set of 6 trials the ratio was 7:5. The three treatment conditions were based upon the order in which the layouts varied across a 6 trial block. In the fading condition the order began with two easy layouts, followed by two medium layouts and ending with two hard layouts. The loop condition consisted of presenting the six layouts in the order hard, medium, easy, easy' medium', hard'. And in the change condition the presentation order was easy, medium, easy', medium', hard, hard'. The only difference between the first and second easy, medium, or hard task was the length of the individual sticks used to construct the layout (see Table 3).

The difficulty of the layouts as defined by Inhelder and her collaborators (1974) and Pascual-Leone (1976) was empirically examined in the current study. Their assumptions were that layout A was more difficult than layout B which was more difficult than layout C. They also assumed that within these layouts a 1:1 ratio would be easier than a 2:1 ratio and that the 2:1 ratio would be easier than a 7:5 ratio.

The responses of 149 children (kindergarten and first grade) were analyzed with a 3 (layouts) x 3 (ratios) design. The per cent of children who responded correctly to layouts A, B, and C were 27 per cent, 43 per cent, and 70 per cent respectively. Per cent of correct responses to the 1:1, 2:1, and 7:5 ratios were 72 per cent, 62 per cent, and 20 per cent respectively. These results support the assumptions made by Inhelder et al. and Pascual-Leone.

Any single training trial involved the following steps: the child was presented with a stimulus layout, given a supply of appropriate sticks and asked to make a straight road that was just as long as the stimulus layout. The child was given a chance to ask questions and instructed to tell the examiner when he was finished. Regardless of the accuracy of the child's response the experimenter proceeded to "measure" the stimulus model by fitting it with a pliable piece of electrical wire and asking the child if (1) the fitted wire (which was still being held on top of the model) was as long as the model, to which the child answered yes. Without letting go of the wire the experimenter lifted it approximately 3 cm above the model and asked if (2) it was still the same. At this point if the layout happened to be nonlinear (i.e. layout

A or B) the wire was pulled straight. If the child could not see that the lifted, straight wire was still the same length as when it was resting on the model, the process was repeated one time. Still holding the wire at the exact measured length of the stimulus-layout the experimenter held the straight wire next to the child's road and asked (3) "Is this how long your road is?" If the subject said "yes" and was correct, the experimenter said, "That's right." Sometimes, however, the subject would say yes when his road was not the same length as the wire. In this case the experimenter would simply say, "Is it? Does your road go from here (lifting right hand slightly) to here (moving left hand)?" Regardless of the child's response the experimenter proceeded to the next trial. This process was repeated on each trial. At the completion of the second training session (24th trial) the immediate posttest was administered. A delayed posttest (using the pretest stimulus material) was administered approximately two weeks later by the first experimenter.

Results

Training Effects

The mean correct responses on the pretest, immediate posttest, and delayed posttest appear by condition in Table 4. A multivariate analysis of variance revealed that there were no differences between the three experimental groups nor between the experimental and control groups on the pretests. The main analyses were multivariate analyses of covariance (MANCOVA) on the immediate posttest and delayed posttest scores in which the subject's pretest scores served as the covariate. The dependent variables were the Sum Conservation score (4 conservation tasks, 2 items each = 8 possible points), the Number of Concepts Conserved (number of tasks answered correctly on both items, 4 possible), Continuous Length (2 possible), and Class Inclusion (2 possible).

Immediate Posttest. A multivariate test of significance on the immediate posttest indicated a group effect $F\ (1,68) = 2.00$, $p < .03$. Examination of the univariate tests indicated that the group effect was significant on the Number of Concepts criteria, $F\ (3,68) = 2.65$, $p < .05$, and the Continuous Length criteria, $F\ (3,68) = 4.36$ $p < .007$.

TABLE 4

Mean Correct Responses on Pretest, Immediate and Delayed Posttests by Treatment*

Condition	Conservation Sum		Dependent Variables Concepts Conserved		Continuous Length		Class Inclusion	
Pretest								
Fade	2.4		1.00		.90		.15	
Change	2.8		1.14		.86		.23	
Loop	2.8		1.14		1.00		.43	
Control (3 test)	2.8		1.09		.94		.09	
					1.05		.17	
Control (2 test)	2.2		1.00					
Immediate Posttest								
Fade	3.9	(4.2)	1.7	(1.8)	.95	(.98)	.50	(.52)
Change	4.2	(4.0)	1.86	(1.8)	1.23	(1.28)	.32	(.31)
Loop	3.2	(3.0)	1.28	(1.2)	.62	(.61)	.33	(.27)
Control (3 test)	3.3	(3.2)	1.18	(1.2)	.71	(.88)	.09	(.13)
Delayed Posttest								
Fade	4.0	(4.3)	1.8	(1.9)	1.25	(1.3)	.55	(.58)
Change	4.4	(4.1)	2.0	(1.9)	1.18	(1.2)	.54	(.53)
Loop	3.7	(3.6)	1.76	(1.7)	1.00	(.9)	.76	(.66)
Control (3 test)	4.2	(4.0)	2.0	(2.0)	1.13	(1.3)	.36	(.46)
Control (2 test)	2.7	(3.2)	1.16	(1.2)	.83	(.8)	.56	(.58)

* Adjusted mean from ANCOVA are given in parentheses.

<u>Note</u>: Total possible scores: Conservation Sum = 8; Concepts Conserved = 4; Continuous Length = 2; and Class Inclusions = 2.

Of main concern was the a priori hypothesis that the posttest means for the Fade and Change conditions would be greater than the Loop condition, and of course greater than the control group. Special contrasts were included in the MANCOVA analysis to test these hypotheses. The results of these contrasts are shown in Table 5. The combined mean for the Fade and Change conditions was (significantly) larger than the mean for the Loop condition on the Sum Conservation score, the Number of Concepts Conserved, and the Continuous Length criteria. There was no significant difference between the Loop and Control group on any of the dependent variables, therefore the combined Fade and Change means were contrasted with the Loop and Control means. Again the combined Fade and Change mean was larger than the combined Loop and Control mean on Conservation Sum, Concepts Conserved, and Continuous Length.

Thus on the posttest immediately following training we find that the subjects in two of the trained groups (Fade and Change) show significantly more improvement than the Loop trained subjects on three of the four dependent variables. Moreover, the Loop subjects' performance is almost identical to that of the control subjects.

Delayed Posttest. Again a multivariate analysis of Covariance was utilized; this time on 5 (3 experimental

TABLE 5

Results of Special Contrasts on Adjusted Means for Immediate Posttest

Criteria	Contrasts Conservation Sum	Concepts Conserved	Continuous Length	Class Inclusion
Group Effect	NS	*	**	NS
Fade and Change vs Loop	*	*	*	NS
Loop vs Control	NS	NS	NS	NS
Fade and Change vs Loop and Control	**	**	**	NS

Note: * $p < .05$; ** $p < .01$; NS = Not Significant and 2 control) independent variables. As shown in Table 4, the means for the Fade and Change subjects were higher than the mean of the Loop trained subjects. While the performance of subjects in the 2-test Control group was similar to the 3-test group's performance on the Immediate posttest, the 3-test Control group was now (delayed posttest) performing comparable to the two superior trained groups (Fade and Change). A special contrast between the combined means of (Fade, Change and 3-test Control groups) and (the Loop and 2-test Control group) was moderately reliable ($p < .07$) on the Conservation Sum and the Continuous Length criteria.

The lack of significance for the Class Inclusion task (on both posttests) is probably due to a floor effect, note most subjects in each group perform poorly on this task. This is not surprising in light of (a) the age of the subjects, recall that class inclusion does not develop until 9-10 years of age; and (b) results from several studies (cf. Denney, Zeytinoglu, & Selzer, 1977; May & Tisshaw, 1977) which examined non specific transfer. The conclusions from both of the above studies were that nonspecific transfer could be facilitated by training but may be limited to conceptually easier tasks, tasks which develop prior to the trained task, or tasks which are similar to the trained problems in terms of difficulty.

Transfer of learning can also explain in part, the homogeneous performance of the trained groups and the 3-test control group on the delayed posttest. Recall that on the immediate posttest subjects in the Fade and Change conditions performed significantly better than the Loop trained subjects and the Loop and Control subjects on three of the four dependent variables and that their performance was maintained on the delayed posttest. It is proposed that the increment in performance for these (Fade and Change) subjects was the result of far transfer. These subjects showed immediate improvement on concepts not specifically trained, and maintained the improvement.

The Loop and 3-test Control subjects performed poorly on the immediate posttest but improved on the delayed posttest. It is hypothesized that their improvement on the delayed posttest was a function of near transfer. Specifically, exposure to the immediate posttest stimuli and experimenter served as "training" for these subjects who then transferred this learning to the delayed posttest. As shown in Table 4, subjects in the 2-test control group showed no transfer and their mean correct scores on the delayed posttest were almost identical to those of the 3-test group on the immediate posttest.

Stage Effects

While different types of learning tranfer can account, in part, for the homogeneous group performance on the delayed posttest, the homogeneity paradox can also be accounted for by looking at stage analysis. It will be recalled that each group was comprised of subjects who conserved on zero concepts as well as partial conservers.

Table 6 shows the percentage of subjects by pretest level and condition who improved, on the number of concepts criteria, from the pretest to each of the posttests. Improvement was defined as being able to conserve on one or more additional concepts on the posttest than on the pretest.

Table 6 indicates several things: First, an equal percentage of non conservers as well as partial conservers benefitted from the Fade and Change training methods. Non conserving subjects in the Loop and 3-test control group showed relatively little improvement. The 14.2 and 21.4% of non conservers who improved were all in the 3-test control group. None of the Loop trained non conservers improved from the pretest to the immediate or delayed posttest. This could reflect the fact that the method of Graded Loops was designed for partial conservers. However even for the partial conservers this method was no more, and sometimes less than the other two training orders or repeated exposure to the criterion tasks (3-test control group). Second, while the percentage of Fade and Change trained subjects who improved

TABLE 6

Improvement on Number of Concepts Conserved
as a Function of Pretest Level and Condition

Pretest Level[1]	N	Percentage who Increase[2] Fade/ Change	Loop/ Control	Total	Percentage of Max Possible[3] Fade/ Change	Loop/ Control	Total
		Immediate Posttest					
0	28	50.0	14.2	32.1	16.1	3.6	9.8
1	28	50	28.6	39.3	26.2	0	13.1
2-3	29	57.1	35.3	44.8	36.5	14.8	25.3
Total	85	54.2	25.6	38.8	23.8	4.7	14.2
		Delayed Posttest					
0	28	50.0	21.4	35.7	23.2	8.9	16.1
1	28	42.9	42.9	42.9	23.8	30.9	27.4
2-3	29	64.3	60.0	62.1	48.0	55.5	52.1
Total	85	57.1	41.8	45.0	28.6	25.9	27.3

[1] Number of concepts conserved (2/2) on pretest.

[2] Percentage of subjects on posttest who increased above pretest level.

[3] Percentage of maximum possible change which was achieved.

did not appear to change from the immediate to delayed posttest, there was a substantial increase in the percentage of Loop/Control subjects who showed improvement, partial conservers in particular. This would indicate that exposure to the immediate posttest items and experimenter had the same effect as training for partial conservers. Third, for all four groups the percentage of children who showed improvement on the posttests appeared to be relative to the number of concepts they conserved on the pretest. The higher the pretest level the greater the percentage of subjects who improved in all conditions on both posttests. And fourth, examination of the percentage of maximum possible change achieved also indicates differential change according to pretest level. On the delayed posttest, across all conditions, non conserving children improved 16.1% of their maximum possible compared with 27.4% and 52.1% of maximum possible improvement for those chileren who conserved on one or two-three concepts on the pretest. Low prescoring children did not achieve as great a percentage of their maximum possible as did higher prescoring children.

Inhelder, Sinclair, and Bovet (1974) classified their subjects (all of whom were partial conservers) according to whether they showed No Change, Partial Progress, or Complete Progress. Table 7 is a comparison of the data in the current study and the data reported by Inhelder and her collaborators. At the completion of the delayed posttest 37 per cent of Inhelder's subjects had become

TABLE 7

A Comparison of Percentages of Subjects Showing Regression No Progress, Partial Progress, and Complete Progress

	Immediate Posttest		
	Regression or No Progress	Partial Progress	Complete Progress
Inhelder et al.	38	31	31
Trained Partial Conservers	51	23	26
Trained Non Conservers	65	30	5
Total	51	28	20
Control Partial Conservers	79	14	7
Control Non Conservers	75	25	0
Total	77	19	35
	Delayed Posttest		
Inhelder et al.	26	37	37
Trained Partial Conservers	50	18	32
Trained Non Conservers	60	35	5
Total	45	30	24
Control Partial Conservers	54	25	21
Control Non Conservers	67	25	8
Total	60	25	14.5

complete conservers compared to 32 per cent of the trained partial conservers and 5 per cent of the trained non conservers in the present study. The slightly lower performance of the partial conservers in the current study is quite possibly due to the "standardization" of training (e.g., both the number of steps in the training trials and the "leading" questions varied from subject to subject in the Inhelder et. al. study). While a certain number or percentage of partial conservers (trained and control) regressed from the pretest to posttest(s), none of the 23 conserving control subjects showed any regression on the criterion tasks. It is interesting to note that Piaget attributes regression to the differences between the clinical and standardized approach to training.

If the current data is broken down further by number of concepts conserved on the pretest and delayed posttests as shown in Table 8, it can be seen that 5 per cent of the trained non conservers became total conservers compared to 18 percent, 37 per cent, and 80 per cent of those who were able to conserve on 1, 2, or 3 concepts on the pretest respectively. Thus it would appear that the probability of becoming a conserver on the criteria in question is a function of pretest level of performance.

The data on the stage effects of training must be interpreted very carefully. If one looks at the number or

TABLE 8

Per Cent of Trained Subjects Who Improve as a Function of Pretest Level

Number of Concepts Conserved on Pretest	0	1	2	3
Immediate Posttest				
Regression	0	24	25	20
No Progress	65	31	25	20
Partial Progress	30	36	12½	0
Complete Progress	5	9	37½	60
Delayed Posttest				
Regression	0	10	8	20
No Progress	65	50	37	0
Partial Progress	30	22	18	0
Complete Progress	5	18	37	80

percentage of non-conservers versus partial conservers who improve on the posttest criteria the difference is markedly in favor of the partial conservers. If, however, one looks at the amount of improvement between these two groups (e.g., the mean concepts increased) there is no significant difference.

Discussion

Training Orders

The goal of the training study was to make the child aware of the insufficiency of the "going just as far" strategy and to help him or her discover the necessity of compensation between the length of the individual matches and their number. Layout C should have made the child aware that his matches were shorter than those used in the stimulus layout, suggesting the idea of measurement. Layout B was designed to induce the counting of units that made up a length. Layout A supposedly demanded the coordination of these aspects of comparisons of length.

Analyses of the training order effects indicate that when layout C was followed by layout B then A, either in a graded presentation (Fade condition) or an alternated sequence (Change condition), learning was facilitated significantly more than when layout A was presented first as in the Loop condition. It would seem that in its early presentation, layout C operated as an emphasizer making the subject attentive to the measurement principle. Subsequent exposures to layouts B and A respectively could then facilitate the counting principle and eventually the notion of compensation. Presenting the layouts in the order of hard-to-easy recommended by Pascual-Leone (1976) did not seem to have the same facilitative effect.

Thus it would appear that when contrasts were made, either alternately or gradually in an easy-to-hard sequence, learning was facilitated. This is in keeping with the positions taken by Kintsch (1977) and May and his associates (May & MacPherson, 1971; May & Tisshaw, 1977). Subjects trained with these two orders (Fade & Change) showed improvement on the immediate posttest criteria which was maintained on the delayed posttest. It has been proposed that this "learning" was a function of far transfer.

Loop trained and Control subjects did not show immediate improvement but did improve considerably between the immediate and delayed posttests. It was hypothesized that for these subjects the immediate posttest stimuli and experimenter served the function of training and that their improved performance on the delayed posttest was a function of near transfer.

It is important to note that the Fade and Change training orders were facilitative for both non conserving and partially conserving subjects alike. As shown in Table 6, 43 per cent and 57 per cent of the non conserving Fade and Change trained subjects improved on the Number of Concepts criteria. By contrast, none of the non conserving subjects in the Loop condition showed any improvement on this criteria.

Self-Discovery vs Tutorial Training

As mentioned earlier, 35 per cent of the trained non conserving subjects improved on the delayed posttest Concepts conserved criteria, only 5 per cent of the non conserving children became conservers. North American experimenters utilizing such varied approaches as simple correction, rule learning, observation learning and conformity training (cf. Brainerd review, 1978) have produced substantially greater learning effects with non conserving subjects than those observed in the current self-discovery training study. Brainerd finds the superior learning effects produced by the tutorial methods "not surprising":

> When a child possesses no prior knowledge of a concept, common sense suggests that he probably will not suddenly "discover" it during a brief unstructured training session. It should be obvious that the experimenter will have to work to get such children to learn. Training trials will have to be carefully arranged in a sequence of progressive approximations to the target concept. (p. 103)

The current data does support the importance of the sequential presentation of stimuli: the Fade and Change orders of presentation were much more facilitative than the Loop presentation, even within the constraints of active self-discovery training.

Since the self-discovery training method was designed for subjects with some conserving ability, it would follow that partial conservers should profit more from training than their more naive peers. Fifty-one per cent of the trained partial conservers showed some improvement on the Number of Concepts Conserved criteria; 32 per cent of these subjects became conservers. Examination of the delayed posttest data indicates that control subjects who received repeated exposure to criterion stimuli showed relatively the same improvement as trained partial conservers. It is important to note that this "repeated exposure effect" did not manifest itself until the delayed posttest. Therefore, it is recommended that all training studies of this sort utilize at least two posttests.

Stage Effects

There are references in the literature to the "magnitude" of differences between achievement levels of children from pretest to posttests and there are observations that the frequency of advancement is relative to the child's initial stage of development. If one looks at frequency (the per cent of subjects who improve) the present data indicate strong differences in favor of those children who are more advanced on the pretest, thus supporting the stage theory. If, however, one examines the magnitude or mean incremental changes for non conservers and partial conservers, there are no differences. This indicates that those non conservers (however many) who improve show just as much improvement as their more advanced peers. To espouse either position in isolation gives an erroneous picture of the relationship between stage of development and learning. Inhelder's statement "the more advanced a child is, the more he will gain from the exercises and the information they contain" (Inhelder et al., 1974, p. 268) should be qualified as follows: The more advanced a child is, the greater the probability he will gain from the exercises and the information they contain.

Conclusions

In conclusion, the Genevan position on learning has been that a child's ability to learn a concept is subject to the constraints of the child's cognitive stage of development. That is, if the child is in that part of his or her stage of development where a new concept will soon develop spontaneously, he is likely to benefit from training; if he is not, training is useless. Further, the process by which stage transition is induced must be the same as that by which this transition would occur spontaneously. To date analysis of this position has been difficult with the limited data provided by the Genevans. The aim of the present study was to provide such data.

The current study found little support for the position that training treatments should incorporate the laws of spontaneous development. Only 23 per cent of all subjects who were trained had become conservers at the completion of the delayed posttest.

Analyses of the stage effects of learning were mixed. Children who could partially conserve before training were much more likely to improve on the posttest criteria; their incremental change scores, however, were no greater than those of the children who could not conserve on the pretest. It would appear that partial conservers may not learn more than their naive peers, but more partial conservers learn.

Children trained on the Fade and Change task orders improved significantly more on the immediate posttest than those trained on the Graded Learning Loop Method proposed by Pascual-Leone (1976). This was true for partially conserving and non conserving children alike. Repeated exposure to the criterion tasks was found to have a training effect for partial conservers, in the Loop and 3-test control groups. Non conserving children, however, appear to need and benefit from training in which the stimuli are gradually or alternately presented in an easy-to-hard sequence.

REFERENCES

Brainerd, C.J. Order of acquisition of transitivity, conservation, and class inclusion of length and weight. *Developmental Psychology*, 1973, *8*, 105-116.

Brainerd, C.J. Cognitive development and concept learning: an interpretative review. *Psychological Bulletin*, 1977, *84*, 919-939.

Brainerd, C.J. Learning research and Piagetian theory. In L.S. Siegel & C.J. Brainerd (Eds.), *Alternatives to Piaget: Critical essays on the theory*. New York: Academic Press, 1978.

Bucher, B., & Schneider, R.E. Acquisition and generalization of conservation by pre-schoolers, using operant training. *Journal of Experimental Child Psychology*, 1973, *16*, 187-204.

Denney, N.W., Zeytinoglu, S. & Selzer, S.C. Conservation training in four year olds. *Journal of Experimental Child Psychology*, 1977, *24*, 129-146.

Franken, R.E. Stimulus change, attention, and brightness discrimination learning. *Journal of Comparative and Physiological Psychology*, 1967, *64*, 499-501.

Gelman, R. Conservation acquisition: A problem of learning to attend to relevant attributes. *Journal of Experimental Child Psychology*, 1969, *7*, 167-187.

Hall, J.F. *Classical conditioning and instrumental learning*. Philadelphia: J.B. Lippincott, 1976.

Hull, C.L. Quantitative aspects of the evolution of concepts. *Psychological Monographs*, 1920, *28*, 1, (Whole No. 123).

Inhelder, B., Sinclair, H. & Bovet, M. *Learning and the development of cognition*. London: Routledge & Kegan Paul Ltd., 1974.

Kintsch, W. *Memory and cognition*. New York: Wiley, 1977.

Lawrence, D.H. The transfer of a discrimination along a continuum. *Journal of Comparative Physiological Psychology*, 1952, *45*, 511-516.

May, R.B., & MacPherson, D.F. Size discrimination in children facilitated by changes in task difficulty. *Journal of Comparative and Physiological Psychology*, 1971, *75*, 453-458.

May, R.B. & Tisshaw, S.K. Variations of learning-set training and quantity conservation. *Child Development*, 1977, *48*, 662-667.

Pascual-Leone, J. On learning and development, Piagetian style: l. a reply to Lefebvre-Pinard. *Canadian Psychological Review*, 1976, *17*, 270-296.

Singer, B., Zentall, E. & Riley, D.A. Stimulus generalization and the easy-to-hard effect. *Journal of Comparative and Physiological Psychology*, 1969, *69*, 528-535.

Smedslund, J. The acquisition of conservation of substance and weight in children: V. Practice in conflict situations without external reinforcement. *Scandinavian Journal of Psychology*, 1961, *2*, 156-160.

Thomas, H. Evaluating the stage learning hypothesis. *Journal of Experimental Child Psychology*, 1980, in press.

Trabasso, T.R. Stimulus emphasis and all-or-none learning in concept identification. *Journal of Experimental Psychology*, 1963, *65*, 398-406.

Wohlwill, J.F. Un essai d'apprentissage dans le domaine de la conservation du nombre. *Etudes d'Epistermologie Genetique*, 1959, *9*, 125-135.

Zimmerman, B.J. & ROsenthal, T.L. Conservational learning of rule-governed behavior by children. *Psychological Bulletin*, 1974, *81*, 29-42.

APPENDIX

RAW DATA

Raw Data

ID#	AGE	SEX	Pretest L	N	M	V	T	#	CI	CL	Immediate Posttest L	N	M	V	T	#	CI	CL	Delayed Posttest L	N	M	V	T	#	CI	CL	GP
542	58	F	0	1	1	0	2	0	0	0	1	2	2	0	5	2	1	0	2	2	2	0	6	3	1	0	F
458	59	M	1	2	0	1	4	1	1	1	1	2	0	1	4	1	2	2	1	2	0	1	4	1	2	2	F
547	61	F	0	2	1	2	5	2	0	1	2	2	0	2	6	3	1	1	2	2	1	2	7	3	1	0	F
456	61	F	0	2	0	0	2	1	0	2	0	2	2	0	4	2	0	1	0	2	0	0	2	1	1	1	F
259	62	F	0	1	0	0	1	0	0	1	1	2	0	2	5	2	0	0	0	2	0	0	2	1	0	1	F
457	62	F	0	2	0	0	2	1	0	0	0	2	0	0	2	1	0	0	0	2	0	0	2	1	0	0	[illegible]
557	63	M	0	2	0	2	4	2	0	2	2	2	2	2	8	4	0	1	2	2	2	2	8	4	2	2	F
560	65	M	0	2	1	0	3	1	0	0	0	2	0	1	3	1	1	1	0	2	0	0	2	1	0	2	F
447	65	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	F
252	66	F	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	1	0	0	1	0	0	2	F
565	67	M	0	2	0	0	2	1	0	0	0	2	2	1	5	1	1	1	2	2	2	1	7	3	0	0	F
253	67	M	0	2	0	0	2	1	0	1	0	2	0	0	2	1	0	0	0	1	0	0	1	0	0	1	F
263	68	M	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	F
250	69	F	0	2	2	0	4	2	0	2	2	2	2	2	8	4	0	2	2	2	2	2	8	4	0	2	F
454	69	M	0	1	0	0	1	0	1	2	0	2	0	0	2	1	1	2	2	2	0	0	4	2	1	2	F
256	70	M	0	2	2	0	4	2	0	0	0	2	2	1	5	2	0	0	2	2	2	2	8	4	0	2	F
444	75	F	0	2	1	2	5	2	0	1	0	2	0	1	3	1	0	2	2	2	0	0	4	2	2	1	F
443	78	F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	F
445	79	M	0	2	2	2	6	3	1	2	2	2	2	2	8	4	2	2	2	2	2	2	8	4	2	2	F
463	82	M	0	2	1	1	4	1	0	2	2	2	1	2	7	3	0	2	1	2	1	2	6	2	0	2	F
523	59	M	0	2	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	1	2	1	L
450	60	M	0	0	0	0	0	0	0	0	1	1	0	0	2	0	0	0	1	1	0	0	2	0	0	0	L
267	61	M	2	2	0	0	4	2	2	0	0	0	0	0	0	0	0	0	2	2	1	0	5	2	0	0	L
446	61	M	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	2	0	L
264	61	M	0	0	0	0	0	0	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	L
462	61	M	2	2	2	0	6	3	1	0	2	2	2	1	7	3	0	1	2	2	2	2	8	4	0	1	L
550	62	M	0	1	2	2	5	2	0	2	2	2	2	2	8	4	2	1	2	2	2	2	8	4	2	2	L
451	63	F	2	2	0	0	4	2	0	2	0	2	0	0	2	1	0	1	2	2	0	0	4	2	2	0	L
268	64	M	0	2	1	0	3	1	0	0	0	2	2	2	6	3	0	0	0	2	2	2	6	3	0	1	L
569	69	M	0	1	0	0	1	0	0	0	0	1	0	0	1	0	1		0	0	0	0	0	0	0	1	L
254	66	M	0	2	0	0	2	1	0	0	0	0	0	0	0	0	2	0	0	2	0	0	2	1	2	0	L
459	68	F	0	2	0	0	2	1	0	2	0	0	0	0	0	0	0	0	0	2	0	0	2	1	0	1	L
537	68	M	0	2	0	0	2	1	1	2	0	2	0	0	2	1	0	1	0	2	0	0	2	1	0	2	L
258	69	M	1	0	0	0	1	0	0	2	1	1	0	0	2	0	0	0	0	0	0	0	0	0	0	1	L
448	69	F	0	2	0	0	2	1	0	0	1	2	0	0	3	1	0	0	2	2	2	2	8	4	2	2	L
265	69	F	0	0	0	0	0	0	2	1	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	1	L
592	72	F	1	2	2	1	6	2	1	2	2	2	2	2	8	4	1	2	2	2	2	2	8	4	2	2	L
439	76	M	0	2	1	0	3	1	0	0	0	1	1	0	2	0	0	0	0	2	0	0	2	1	0	0	L
591	79	M	0	2	1	1	4	1	0	2	2	2	1	2	7	3	0	2	2	2	2	2	8	4	0	2	L
464	80	M	0	2	1	2	5	2	1	1	0	2	2	1	5	2	0	1	0	2	1	1	4	1	0	2	L
441	81	M	0	2	2	2	6	3	1	2	2	2	2	2	8	4	1	2	2	2	2	2	8	4	2	2	L

L= Length
N= Number
M= Mass Substance
V= Liquid Volume

T= total Conservation Score
#= Concepts Conserved
CI = Class Inclusion
Cl = Continuous Length

Cp = Group
F = Fade
Ch= Change
L = Loop
C3= 3-test Control
C2= 2-test Control

Sex M=Male
F= Female

Raw Data cont.

			Pretest					Immediate Posttest					Delayed Posttest					
ID#	AGE	SEX	L N M V	T	#	CI	CL	L N M V	T	#	CI	CL	L N M V	T	#	CI	CL	GP
559	59	F	0 2 0 0	2	1	0	0	0 2 2 0	4	2	0	2	0 2 2 0	4	2	0	0	Ch
558	61	M	1 1 0 2	4	1	0	0	1 0 0 1	2	0	0	0	1 1 0 0	2	0	0	0	Ch
255	61	F	2 2 1 0	5	2	0	1	2 2 0 1	5	2	0	1	2 2 0 0	4	2	1	1	Ch
561	64	M	1 2 0 1	4	1	1	2	2 2 2 2	8	4	0	2	2 2 2 2	8	4	1	2	Ch
260	64	M	0 1 0 0	1	0	0	1	0 2 0 0	2	1	0	2	0 2 0 0	2	1	0	2	Ch
540	65	F	0 2 0 0	2	1	0	1	0 2 0 0	2	1	0	0	0 2 0 0	2	0	0	0	Ch
460	65	F	0 1 0 0	1	0	0	1	0 0 0 1	1	0	0	1	0 0 0 0	0	0	0	2	Ch
266	65	F	0 2 2 0	4	2	0	1	2 2 1 1	6	2	2	1	1 2 1 2	6	2	2	2	Ch
449	66	F	2 2 0 2	6	3	0	2	2 2 0 0	4	2	0	2	2 2 0 0	4	2	0	2	Ch
452	69	M	0 1 0 1	2	0	0	0	0 0 0 2	2	1	0	1	2 2 2 2	8	4	0	0	Ch
455	69	F	1 2 2 0	5	2	0	1	2 2 2 2	8	4	0	1	2 2 2 1	7	3	0	1	Ch
461	67	M	0 2 0 0	2	1	0	0	2 2 2 2	8	4	0	1	2 2 2 2	8	4	0	0	Ch
262	68	M	0 0 0 0	0	0	2	0	1 2 0 0	3	1	2	0	1 2 0 0	3	1	2	0	Ch
251	71	F	0 2 2 1	5	2	2	2	2 2 2 2	8	4	1	1	2 2 2 2	8	4	2	2	Ch
442	71	M	0 2 2 2	6	3	0	1	2 2 2 2	8	4	0	1	2 2 2 2	8	4	0	2	Ch
257	69	F	0 0 0 0	0	0	0	0	0 0 0 0	0	0	1	2	0 0 0 0	0	0	0	2	Ch
601	72	M	0 2 0 0	2	1	0	1	0 2 0 0	2	1	0	0	0 2 0 0	2	1	0	2	Ch
435	73	M	0 2 0 1	3	1	0	0	0 2 2 2	6	3	0	2	1 2 2 2	7	3	0	2	Ch
605	74	M	0 0 0 0	0	0	0	0	0 0 0 0	0	0	0	2	0 0 0 0	0	0	0	0	Ch
577	77	M	0 1 2 2	5	2	0	2	1 2 2 2	7	3	1	2	1 2 2 2	7	3	1	2	Ch
440	78	M	0 0 0 0	0	0	0	1	0 2 0 0	2	1	0	1	1 2 0 0	3	1	0	0	Ch
261	82	M	2 2 0 0	4	2	0	2	1 2 0 0	3	1	0	2	2 2 1 0	5	2	0	2	Ch
566	59	F	1 2 2 1	6	2	2	1	1 2 2 1	6	2	0	0	2 2 2 2	8	4	2	2	C3
556	60	F	0 1 0 0	1	0	0		0 2 0 0	2	1	1		0 2 0 0	2	1	2	2	C3
564	60	M	0 0 0 0	0	0	0	0	0 0 0 0	0	0	0		0 0 0 0	0	0	0		C3
532	61	F	0 2 0 0	2	1	0	0	0 2 0 1	3	1	1	0	0 2 0 0	2	1	0	0	C3
528	61	M	0 1 0 0	1	0	0		0 0 0 0	0	0	0		0 2 0 0	2	1	0		C3
524	62	M	0 0 2 0	2	1	0		1 2 2 1	6	2	0		2 2 2 1	7	3	0		C3
555	63	M	0 0 0 0	0	0	0	0	0 0 0 0	0	0	0	0	0 0 0 0	0	0	0	2	C3
M34	63	F	0 2 0 0	2	1	0	2	0 2 0 0	2	1	0	2	2 2 0 0	4	2	0	0	C3
478	64	F	2 2 2 0	6	3	0		2 2 2 1	7	3	0		2 2 2 0	6	3	0		C3
548	64	F	1 0 1 0	2	0	0		0 0 2 0	2	1			0 0 0 1	1	0	0		C3
479	66	F	1 2 0 0	3	1	0		1 1 0 0	2	0	0		1 2 0 0	3	1	1		C3
M31	68	M	2 2 0 0	4	2	0	0	2 0 0 0	2	1	0	0	2 2 0 0	4	0	0		C3
M33	68	M	2 2 0 1	5	2	0	2	1 2 2 1	6	2	0	2	2 2 2 1	7	3	1	2	C3
M36	68	F	1 2 0 0	3	1	0	1	1 2 0 0	3	1	0		2 2 0 0	4	2	0	2	C3
M35	69	M	1 0 2 2	5	1	0	2	1 2 2 2	7	3	0	2	2 2 2 2	8	4	0	2	C3
574	71	M	0 0 1 1	2	0	0	0	0 1 0 0	1	0	0		0 0 0 0	0	0	0	0	C3
579	72	M	0 2 0 2	4	2	0	1	1 2 1 2	6	2	0	1	2 2 2 2	8	4	0	1	C3
572	74	F	0 2 1 1	4	1	0	1	1 1 0 0	2	0	0	0	2 2 1 2	7	3	0		C3
588	75	F	0 0 0 0	0	0	0	0	0 1 0 0	1	0	0	0	0 0 0 0	0	0	0	0	C3
581	76	F	0 2 0 2	4	0	0	0	0 2 1 2	5	1	0	2	0 2 2 2	6	3	0	2	C3
578	78	F	2 1 2 0	5	2	0	2	2 2 2 2	8	4	0	1	2 2 2 2	8	4	0	2	C3
584	79	F	1 0 0 0	1	0	0	0	1 0 0 0	1	0	0	0	2 2 2 2	8	4	1	2	C3

Raw Data Cont.

			Pretest								Immediate Posttest								Delayed Posttest								
ID#	AGE	SEX	L	N	M	V	T	#	CI	CL	L	N	M	V	T	#	CI	CL	L	N	M	V	T	#	CI	CL	GI
M45	62	M	2	2	0	1	5	0	2	2									2	2	2	2	8	4	0	2	C2
M37	62	F	0	0	0	0	0	0	0	0									0	0	0	0	0	0	0	0	C2
M39	62	M	2	2	0	1	5	2	1	2									2	2	2	2	8	4	2	2	C2
M43	63	M	0	0	0	0	0	0	0	0									0	1	0	0	1	0	0	1	C2
473	63	F	0	2	0	0	2	1	0	2									1	2	0	0	3	1	0	2	C2
469	64	M	0	2	0	0	2	1	0	2									0	0	0	1	1	0	0	1	C2
M42	66	M	2	2	2	0	6	3	0	2									2	2	2	1	7	3	2	2	C2
474	67	M	0	2	0	0	2	1	0	2									1	2	0	0	3	1	1	1	C2
477	66	M	0	2	0	0	2	1	0	1									0	0	0	0	0	0	0	0	C2
470	68	M	0	0	0	0	0	0	0	1									0	0	0	0	0	0	0	1	C2
472	68	M	0	1	0	0	1	0	0	2									0	2	0	0	2	1	1	2	C2
M44	69	M	0	2	0	0	2	1	0	2									0	2	0	0	2	1	0	0	C2
471	69	M	0	2	0	0	2	1	0	0									0	2	0	0	2	1	2	0	C2
475	69	F	0	2	0	0	2	1	0	0									0	2	0	0	2	0	0	0	C2
476	69	F	0	2	0	0	2	1	0	0									0	2	0	0	2	1	0	0	C2
M38	71	F	0	2	0	0	2	1	1	0									1	2	0	0	3	1	0	0	C3
M41	71	M	0	2	0	0	2	1	1	0									1	2	0	0	2	1	2	0	C3
M40	72	M	0	2	0	0	2	1	0	1									0	2	0	0	2	1	2	0	C3

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