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FACILITATION OF COGNITIVE DEVELOPMENT AMONG CHILDREN WITH LEARNING DEFICITS

THE INDUCEMENT OF NUMBER READINESS IN RETARDATES: STUDY I. CONSERVATION TRAINING

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July, 1969

U.S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

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Preface

This study represents the first of a series of studies attempting to facilitate cognitive development among children with learning deficits, particularly retardates. It would, however, be impossible to adequately carry out this study without the aid of many people. The regularly employed members of the project for this study were Merlyn Mondol, Kitty Keith, Carlton Cory, Tom Whalen, and Eileen Scheppele. Special acknowledgement must be made of the diligent work by Merlyn Mondol who also aided in the analysis of the results and writing of the method section. In addition, appreciation is expressed to Dr. Clessen Martin for his suggestion to add the control language group.

Appreciation is also expressed to the staff of the Lansing Public Schools. The following people have been very helpful in the carrying out of this study:

Dr. Ed Remick, Director of Research Planning

Dr. David Schulert, Director of Curriculum

Mr. Harold Butler, Director of Special Education

Mrs. Grace Ojala, Coordinator, Title I

Mr. David Stevens, Special Type-C Consultant

Altogether, this study represents the combined effort of many individuals who have made the task a much easier and pleasant one.

Abstract

Fifty educable retarded children who were determined to be non-conservers by means of three conservation pretests, discontinuous quantity, correspondence, and continuous quantity, were randomly assigned to one of five treatment groups, discontinuous quantity training, correspondence training, continuous quantity training, control and control language group. The four hypotheses were as follows: a) it is possible to train retardates to conserve quantity, b) one form of conservation training transfers to other forms of conservation, c) performance on conservation tests is related to MA, and d) discontinuous quantity conservation appears before continuous quantity conservation. In general, the results of the posttests were consistent with the four hypotheses.

Piaget has for many years expounded a theory of cognitive development (intelligence) which is at present becoming increasingly popular in the United States as its importance in the areas of child development, educational research, and mental retardation is being recognized. The theory consists of an invariant order of periods exhibiting characteristics as follows:

I. The sensory-motor period

   1. Preverbal
   2. Development of object permanence
   3. Construction of sensory-motor space
   4. Construction of temporal sequence
   5. Elementary sensory-motor causality

II. Pre-operational representation

   1. Beginnings of language, symbolic function, and thought
   2. Lack of operations (interiorized actions on objects)
   3. Lack of reversibility
   4. Centering (consideration of only one quality or aspect of an object)
   5. Lack of conservation (concept that quantity, weight, or volume is invariant unless something is added or taken away)

III. Concrete operations

   1. Appearance of conservations
   2. Decentering

3. Reversibility

4. Appearance of operations on concrete objects

   a. Ordering (seriating)

   b. Classification

   c. Counting

   d. Measuring

IV. Formal operations

1. Reasoning on hypotheses rather than on merely objects

2. Operations of prepositional logic

Each individual transverses through these periods of unchanging order from birth to adulthood. Not all individuals, however, reach the later periods of development. Retardates fixate at certain periods, depending upon the extent of retardation. For example, mildly retarded individuals appear unable to progress beyond the period of concrete operations.

Piaget does not fully discuss why some individuals fixate at certain periods. He does, however, discuss the mechanisms of transmission from period to period. These are maturation, experience, social transmission, and equilibrium. Maturation is defined as an interior maturation of the nervous system. Piaget differentiates the next two factors, experience and social transmission, by defining the former as the child's experience of objects and physical reality and the latter as linguistic or <u>educational</u> transmission. The fundamental factor in transmission, according to Piaget, however, is equilibrium--that is, balance between assimilation (changing reality so that it will meaningfully fit into one's cognitive structures) and accomodation (modifying one's cognitive structure in order to fit reality). Berlyne (1968) has succeeded in translating Piaget's system into stimulus-response terms (Hullian learning theory), and equilibrium can be then conceived of as internal reinforcements. Piaget (1964, p. 19) states:

> What are these internal reinforcements? They are what I call equilibration or self-regulation. The internal reinforcements are what enable the subject to eliminate contradictions, incompatibilities, and conflicts. All development is composed of momentary conflicts and incompatibilities, and conflicts which must be overcome to reach a higher level of equilibrium. Berlyne calls this elimination of incompatibilities internal reinforcements.

It appears that the factors influencing transmission form an interaction between maturation and learning, and the latter three factors may be subsumed under the general term learning. Consequently, training ought to be of significant value if it encompasses the three latter factors--that is, experience with objects, teaching or programing, and the inducement of conflicts, the resolution of which are internally reinforcing.

Several studies, most of them with normal children, have attempted to induce conservation (speed up cognitive development from the preoperational period to concrete operations) through training which consists of one or all of the three factors above. These studies are important from an educational viewpoint since, according to Piaget, children are not ready to understand the nature of numbers until they are able to conserve. Moreover, Piaget's book (1952) on the child's conception of number, describing the stages in the development of the concept of number and his general procedures for determining these stages, has stimulated much research.

The results of studies attempting to induce conservation by training have contributed conflicting results. Churchill (1958a; 1958b), Wallach and Sprott (1964), Eifermann and Etzion (1964), Sigel, Roeper, and Hooper (1966), Sigel and Shantz (1967), have found significant differences in favor of the groups receiving training. On the other hand, Wohlwill and Lowe (1962) and a series of studies by Smedslund (1961a; 1961b; 1962c) found no significant improvement. Other studies by Smedslund (1961d; 1961e), however, yielded significant differences favoring the training groups.

A study of particular relevance to the present study by Brison and Bereiter (1967) consisted of an attempt to train retarded, normal, and gifted children to conserve quantity. The children were all of approximately the same mental ages but, of course, differed in chronological ages. The IQ range of the retardates (62-75) indicated that these children were classifiable as mildly retarded. Interestingly enough, in spite of IQ differences, the groups did not differ significantly in acquisition of conserving responses and transfer to new materials. This study indicates that training is as beneficial to retardates as to normal and gifted children.

The present study was designed to train mildly retarded children to conserve discontinuous quantity, establish correspondence between units (conservation of number), and conserve continuous quantity. The method of training included experience with objects, teaching (programing), and inducement of conflicts. The specific hypotheses are a) retardates can be taught to conserve quantity or number, b) training in one form of conservation affects other forms of conservation, c) ability to conserve is related to mental age, and d) conservation of discontinuous quantity appears before conservation of continuous quantity.

Method

Subjects. The Ss participating in this study consisted of 51 educable (mildly) retarded children from elementary Type A classes in an urban setting. These children were selected from a sample of 103 testable Ss (11 children were nontestable) on the basis of performance on three Piagetian conservation pretests--discontinuous quantity, correspondence (number conservation), and continuous quantity conservation. Children were eliminated from further participation in the study if they were in stage three[1] on more than one of the three verbal pretests; 52 Ss were eliminated. The remaining 51 Ss were randomly assigned to one of five treatment groups, three training and two control groups.

The range of IQ for 45 Ss (6 Ss' scores were nonattainable) was from 51 to 91 (Mean IQ = 71.77), the range of CA, from 6.66 to 12.91 years (Mean CA = 9.77), and the range of MA, from 4.06 to 10.69 years (Mean MA = 7.04). The mean IQs of the five groups, discontinuous quantity (DQ) training, correspondence (Corr) training, continuous quantity (CQ) training, control (C) and control language (CL), were 73.77, 70.88,

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[1]The stages based on Piaget's criteria were determined for all three tasks above as follows: Stage one was complete failure by S to give any conserving responses to questions which were posed by E after each transformation performed on the experimental materials. Stage two was a stage of conflict where S was inconsistent in his responses, sometimes conserving and other times not. In stage three, however, S consistently conserved and responded confidently and correctly to all critical questions posed by E after transformations.

72.00, 70.67, and 71.50 respectively; the groups did not differ significantly in IQ.

Procedure. The experiment was conducted in a minimum of one pretest, one training, and one posttest session. Figure 1 shows the design of the study. All Ss received four pretests and were then randomly assigned to one of five treatment groups. All Ss, irrespective of treatment group, received the four posttests. The children were tested and trained individually by E; an observer (O) recorded all responses.

Figure 1. Design of the study showing the pretests which all Ss were given, the treatments to which each S was randomly assigned, and the posttests which all Ss received.

Pretest	Treatment	Posttest
Conservation of Discontinuous Quantity	Discontinuous Quantity Training	Conservation of Discontinuous Quantity
Correspondence	Correspondence Training	Correspondence
Conservation of Continuous Quantity	Continuous Quantity Training	Conservation of Continuous Quantity
Conservation of Continuous Quantity (nonverbal)	Control	
	Control Language	

Vocabulary pretest. The vocabulary pretest (see Appendix A) was administered first to establish that S knew the meaning of the words, "same," "more," "less," and "as many as." The pretest asked Ss to respond to verbal commands, such as "pour out the same (more, etc.)

amount of 'pop' as (than, etc.) I have in my glass, or "put out the same (more, etc.) number of chips as (than, etc.) I have here in my row." The tests assessed whether children understood words to be later used on the conservation pretest. Children not exhibiting knowledge of at least "same" and "more" were eliminated from participation in the study.

Conservation pretests. All Ss who were successful on the vocabulary pretests were then immediately given one nonverbal and three verbal conservation pretests in the same order: nonverbal continuous quantity (nCQ), discontinuous quantity (DQ), correspondence (Corr), and continuous quantity (CQ). An O recorded all Ss' responses. The pretests were also tape recorded.

Nonverbal conservation of continuous quantity (nCQ) pretest. This test was identical to task one given by Mermelstein and Shulman (1967). Their task, "the Magic Experiment," using specially constructed apparatus, consisted of a stand holding two 1000 ml. jars, only one visible to the child with the other hidden behind the stand. The jar behind the stand, placed higher than the visible jar, was filled with colored water and was connected to the visible jar by a plastic hose. A valve was used to control the flow from the hidden jar to the visible one. Each child established that there was an equal amount of colored water in two 150 ml. beakers. Then one of the 150 ml. beakers was left near the empty visible jar, and the water in the other beaker was poured in the visible 1000 ml. jar. The E with his free hand surreptitiously opened the valve as he poured the water. Consequently, the 150 ml. beaker of water appeared to fill the 1000 ml. jar. Mermelstein and Shulman (1967) scored responses as either stage three or stage one. "Gestures of surprise, puzzlement, smiles, 'chee, 'wow,' etc., were scored at stage three. The absence of observable changes in behavior was scored at stage one." In this study, however, to gain greater precision, S was also asked whether he noticed something funny. If S responded in the affirmative, E asked "What was funny?" An O, facing S, recorded all observable changes in expression and responses.

Conservation of discontinuous quantity (DQ) pretest. The exact procedure is given in Appendix B. The child was given his choice of yellow or green wooden beads. The E and S then each placed beads into two equal glass containers, one at a time, and S was asked if they both had the same number of, or if one had more, beads in the glasses. After equivalence was established, S was asked about the length of necklaces made from the beads. Then a series of transformations were made, i.e., S's beads were poured into different shaped glass containers and divided into two, and then four, containers. After each transformation, S was asked whether E and he had the same number of beads or whether the necklaces were the same in length. After each response, S was asked "why," and O recorded his response and any reasons given.

Spontaneous correspondence (Corr) pretest. The Corr pretest consistently used the word, number, similar to Wallach and Sprott, 1964 and Wallach, Wall, and Anderson, 1967, except that the test used by Wallach and colleagues was of provoked, rather than spontaneous, correspondence. According to Piaget (1965, p. 65), the former includes materials which suggest correspondence since they are qualitatively complementary (e.g., beds and dolls, flowers and vases, eggs and egg-cups, etc.) and the child generally is told to "put one A opposite (or into) B" or to "exchange one A for B." In spontaneous correspondence, on the other hand, the child is "compelled to find the correspondence on his own accord and make what use of it he can"; the child is asked merely to put out the same number of objects as in a model. The conservation test in this study was of spontaneous correspondence, but the training method was a provoked correspondence. The latter was used as a training method, since the materials appeared to produce correspondence more naturally, and Piaget found the same stages in development for both.

The exact procedure for the Corr test is given in Appendix C. The S was given his choice in color of plastic chips. The E constructed a series of models and asked S to "take the same number of chips from your pile and make the same thing I just did." After S was satisfied that he had the same number of chips, E spread out (transformed) the model and asked if they still had the same number. The models consisted of 11 chips as a random (unstructured) figure, two parallel rows of 6 chips each, and a rhombus of 12 chips, respectively. After S completed a model with chips, he was given small sticks, and the procedure was repeated. This was done for each model. The O recorded each S's response and any reasons given.

Conservation of continuous quantity (CQ) pretest. The exact procedure is given in Appendix D. The child was given his choice of a large white or yellow clay ball. The E then took the other ball of clay and asked the child if they had the same amount or if one had more. After equivalence had been established, E transformed S's clay into a sausage, a pancake, divided it into two balls, three balls, four balls, and finally transformed the four balls into a sausage, a pancake, a cube, and a cup. After each transformation, the child was asked whether E and S had the same amount or if one had more. Each S's responses and any reasons given were recorded by O.

Training. All Ss who were judged to be at stage three on no more than one of the above verbal conservation tasks were randomly assigned to one of five treatment groups. Three groups received training on conservation while two groups served as controls.

Figure 2 shows the cycles to which the training groups were exposed. Cycle one consisted of establishing equivalence between two quantities, transforming one perceptually in shape, having the child make a statement

Figure 2. Training cycles for discontinuous quantity, correspondence, and continuous quantity training.

Cycle One	Cycle Two
Equivalence	Equivalence
Transformation	Transformation
Reversing	Taking away or adding
	Reversing

about the equivalence of the quantities after transformation, and then checking by reversing the transformed quantity to its original shape. The reversing, of course, was designed to induce conflict in the child if he gave the incorrect response. If the child gave an incorrect response on cycle one, cycle two was carried out. In the second cycle, after equivalence had been established, one quantity was again transformed as in cycle one, but if the child still maintained that the two quantities were unequal, he was to take away or add some amount until he believed them equal. Following this, his response was checked by reversing the transform to its original shape. In this case, not only was the child shown that the quantities were no longer equal, but that they were unequal by the amount which he took away or added. This also served to induce conflict within the child.

The first group was given training on conservation of discontinuous quantity (number), the second, training on provoked correspondence (number), and the third, training on conservation of continuous quantity.

A control group spent the same amount of time with E as the training Ss, but their task consisted of making objects out of clay with E. Finally, another control group was added which was identical to the control group except that E asked the same types of questions as in the training session, i.e., the child was consistently asked if he had the same amount of, or more, clay than E as the objects were made.

Each treatment session was approximately one-half hour long.

Discontinuous quantity (DQ) training. The procedure for DQ training is included in Appendix E. There were two separate training units, one with erasers and boxes and the other with sticks and cans. For erasers and boxes, the materials consisted of three dozen erasers and six boxes of varying dimensions.

The S was presented with two rectangular wooden boxes, identical in size and shape, and a pile of rectangular erasers. The E placed one box before S and instructed, "everytime I put one eraser in my box, you put one in yours." This procedure was carried out until there were enough erasers in the boxes to cover the bottoms completely in a single layer. The two boxes had been deliberately constructed so that one layer of erasers fit neatly from side to side.

After equivalence of the erasers had been established, four boxes of different sizes and shapes were successively presented. The following steps, indicating training cycle one, were first carried out with each box individually; these steps were repeated after dividing S's erasers between two of the above varied boxes, and finally after dividing S's erasers among the four boxes:

a. Starting each time with the two equal boxes of erasers, S was asked to predict what would happen if his erasers were put into the other box(es). A forced choice, "same or more," type of question was posed to prevent S from acquiring a response set to answer "yes" or "no." Each response given by S was followed up by a question such as, "Why do you think so?" or "How can you tell?" All responses were recorded by O.

b. The transformation was then carried out, and S was asked about equivalence of the quantities. The disorderly arrangement of the erasers in the large box resulted in perceptual distortion generally leading nonconserving Ss to reply that there were more erasers in the transformed quantity. All S's responses were recorded.

c. A prediction about what would happen when the transformation was reversed was elicited from S in a manner similar to that described in (a) above.

d. The transformation was reversed as a check to see if S was right. The erasers were returned to the original box, one at a time, so that they covered the bottom of the box in a single layer as before.

If S failed to show conserving responses upon presentation of a particular box, training cycle two was carried out using the same box(es). The following steps were given:

a. Identical to (a) in cycle one.

b. Identical to (b) in cycle one.

c. If S said that he had more erasers after the transformation he was asked to remove the extra ones, counting them as they were removed. If he said that there were less erasers after the transformation he was asked to add erasers, keeping count of the added ones, until both E and S had the same number of erasers.

d. A reversal prediction was elicited from S with a question about his reasons for the predictions.

e. The reversal was carried out. If S had taken away some erasers, the remaining erasers would not have covered the bottom of the box. It was then stressed that the number of erasers S had removed and the number needed to cover the bottom were the same. On the other hand, if S had added erasers, there would have been more erasers than needed to cover the bottom of the box. It was then pointed out that the number of extra erasers and the numbers added were the same.

After completing the above with each box and combination of boxes, a similar training procedure was used with rhythm sticks and decorated tin cans of different sizes. The smallest (orange-juice size) cans of equal size were used to start with. Equivalence of rhythm sticks in _E_'s and _S_'s cans were first established. Exactly 12 sticks could fit into each can. After _S_ said that both cans had the same number of sticks, _E_ performed the various transformations by transferring _S_'s sticks into larger cans. The same training cycles that were carried out with erasers and boxes was used with sticks and each successive can, two cans together, and finally four cans together.

Training with erasers and boxes and then with sticks and cans was repeated for half hour training sessions until criterion was reached on both training tasks. The _S_ reached criterion when he was able to go through all transformations on a task without a single error. After _S_ had reached criterion on both tasks, he was given an immediate posttest, identical to the DQ pretest on discontinuous quantity.

Provoked correspondence (Corr) training. The full training procedure is given in Appendix F. Eight cans (35 mm film containers) were placed in a row on the table. Caps for the cans were placed in a pile before _S_, and _E_ directed _S_ to place a cap on each can; equivalence of caps and cans was then established. Next, _E_ asked _S_ to watch while _E_ took the caps off the cans and placed them before the cans but closer together so that at least one can was left without a cap in front of it. The _S_ was then asked a forced choice, "same" or "more," type of question regarding the equality of the number of caps and cans. The reversal (putting the caps back on the cans) was carried out to show whether he had responded correctly.

Upon failure, the above steps were repeated as cycle two, and if S failed to conserve again, he was asked to remove or add some cans/caps. Again S was asked to predict whether each cap would have a can if the caps were put back on each can, and the reversal was carried out to check S's response. It was then emphasized that the number by which the caps and cans were unequal was the same as had been removed or added.

The situations for each figure was as follows:

a. Caps closer together

b. Caps closer together, cans removed

c. Caps farther apart

d. Caps farther apart, cans added

e. Caps closer together

f. Caps closer together, caps added

g. Caps farther apart

h. Caps farther apart, caps removed

Each situation was repeated until the child made the correct prediction and confirmed it. Criterion was reached when S got situations a, c, e, and g correct in succession.

The entire training procedure was carried out to criterion with the following figures:

a. Single row

b. Open square

c. Closed square

d. Square outside (caps formed into a square away from the square made by the cans)

After S reached criterion on the last figure, an immediate post-test, identical to the Corr pretest, was given.

Continuous quantity (CQ) training. The complete training procedure is given in Appendix G. Two glass 600 ml. beakers with equal amounts of "pop" (colored water) were presented, one for E and one for S. Equivalence of the quantity of "pop" in the two beakers was first established.

A succession of glass beakers and containers was presented to S in the following order:

a. One 150 x 75 container

b. Two 250 ml. beakers

c. One 250 ml. beaker and two 150 ml. beakers

d. Four 150 ml. beakers

e. One 150 ml. beaker, one 250 ml. beaker, one 600 ml. beaker, and one 150 x 75 container

A series of steps were followed with each set of beakers. First, S was asked to predict what would happen if the "pop" from his container was poured into the newly presented container(s). The transformation was then carried out, and S was asked if the two quantities were equal. The S was then asked to predict what would happen if the operation were reversed, and the reversal was carried out to check whether S was correct.

The same transformation was carried out again if S failed on the first presentation. On the second presentation, or cycle two, if S maintained that the quantities were not the same, he was asked to take away the extra "pop," by pouring it into another jar, to make the compared quantities the same. This was again followed by a reversal prediction and then by the actual reversal. Upon pouring the "pop" back into the 600 ml. beaker, S would find that the quantities were not equal. E then asked him to pour some "pop" back from the amount he had taken away until both 600 ml. jars had the same amount of "pop" in them again. It was pointed out that the amount of "pop" taken away and the amount of "pop" S had to add were the same.

After going through the succession of beakers and containers once, the entire procedure was repeated with sand instead of "pop." The S reached criterion when he was able to go through all transformations for both sand and "pop" without a single error. After criterion was reached, an immediate posttest, identical to the CQ pretest, was administered on continuous quantity.

Control (C) group. Each control S was given approximately two one-half hour sessions with E, since this was the average time spent by Ss in the training groups. The E and S started with two balls of clay, and each S was asked what he would like to make. The S was allowed to do whatever he wished with his clay; however, E helped S whenever he appeared to wish it or interest lagged.

Control language (CL) group. The control language group, which was added in order to control for S's exposure to the terms, "more" and "same," used in training, also made objects of clay. Their procedure, however, was more rigorous than the control group above, since an attempt was made to equate the number and types of question with those of the training groups. These Ss spent also two one-half hour sessions, but E controlled the type of objects made and consistently asked questions using the terms, "more" and "same." Unlike the training sessions, there were no reversals, additions or subtractions of materials, or confirmations of the child's response. In other words, only the language was similar to that of the training groups in order that a control for frequency of use of words, "more" and "same," could be maintained.

Conservation posttest. After training, the three verbal conservation pretests were again administered to all five groups in exactly the previous manner.

Results

Each of the 103 children who were pretested were scored by two independent judges for the three stages of development in conservation. The scoring was from one to five, in spite of the fact that there were only three stages, in order to facilitate scoring transition between stages. The Spearman rank correlations between judges were .97, .94, and .94 for DC, Corr, and CQ pretests respectively. Any S who was in the third stage (scored as 4 or 5) on more than one of the three verbal pretests was removed from further participation in the study. Fifty-one children of the 103 tested Ss, participated in the study, but, because the school year terminated before training was completed, data from one child were deleted. Consequently, the results of this study are based on 50 Ss, except for MA and IQ data which were based on only 44 Ss; data for the remaining six were unavailable.

Because each test had a different number of questions, the number correct was scored as a proportion of the total possible correct in order to give equal weight to each test. Table 1 shows the mean percentage correct for the five groups on the pre- and posttest conservation tasks. Total pre- and posttest scores were obtained by totaling Ss' scores on the three pre- and posttests. Figures 3, 4, 5, and 6 illustrate the performance of the five treatment groups on the verbal conservation pre- and posttests (DQ, Corr, CQ, and total conservation respectively).

The posttest data were subjected to analyses of covariance, with pretest scores as the covariate. The analyses of covariance showed significant differences among the five groups on the DQ, Corr, and CQ conservation posttests and total score on all three conservation posttests ($F = 15.77$, $df = 4/44$, $p < .0005$; $F = 4.78$, $df = 4/44$, $p < .01$; $F = 7.85$, $df = 4/44$, $p < .0005$; and $F = 16.44$, $df = 4/44$, $p < .0005$ respectively for the above posttests).

Individual comparisons were made by means of Scheffé's test (.05 level). Table 2 indicates which groups differed significantly on the posttests. All training groups differed significantly from the control groups on the total (combined) conservation posttest scores. In addition, all training groups differed significantly from both control groups on the DQ posttest. On the CQ posttest, the DQ training group differed from the C and CL groups, but the Corr and CQ trainings differed only from the CL group. On the Corr posttest, the DQ and Corr training groups differed only from the CL group. The CQ training group did not differ from any control group.

The reliability of the three verbal tests was checked by examining the degree of relationship between the pre- and posttest scores for the two combined control groups by means of the Pearson product-moment

Table 1. Mean percentage correct on the conservation pre- and posttest for the five groups, including the adjusted means.

Training Group	Pretest				Posttest			
	DQ	Corr	CQ	Total	DQ (Adj.)	Corr (Adj.)	CQ (Adj.)	Total (Adj.)
DQ (n = 11)	.23	.34	.02	.59	.99 (1.09)	.80 (.78)	.86 (.94)	2.65 (2.92)
Corr (n = 9)	.41	.30	.09	.80	.88 (.85)	.74 (.75)	.83 (.87)	2.45 (2.50)
CQ (n = 10)	.41	.33	.28	1.07	.85 (.83)	.69 (.68)	.83 (.76)	2.38 (2.15)
C (n = 10)	.42	.34	.10	.86	.36 (.33)	.51 (.49)	.32 (.35)	1.19 (1.18)
CL (n = 10)	.43	.24	.27	.94	.50 (.46)	.34 (.39)	.28 (.22)	1.12 (1.03)

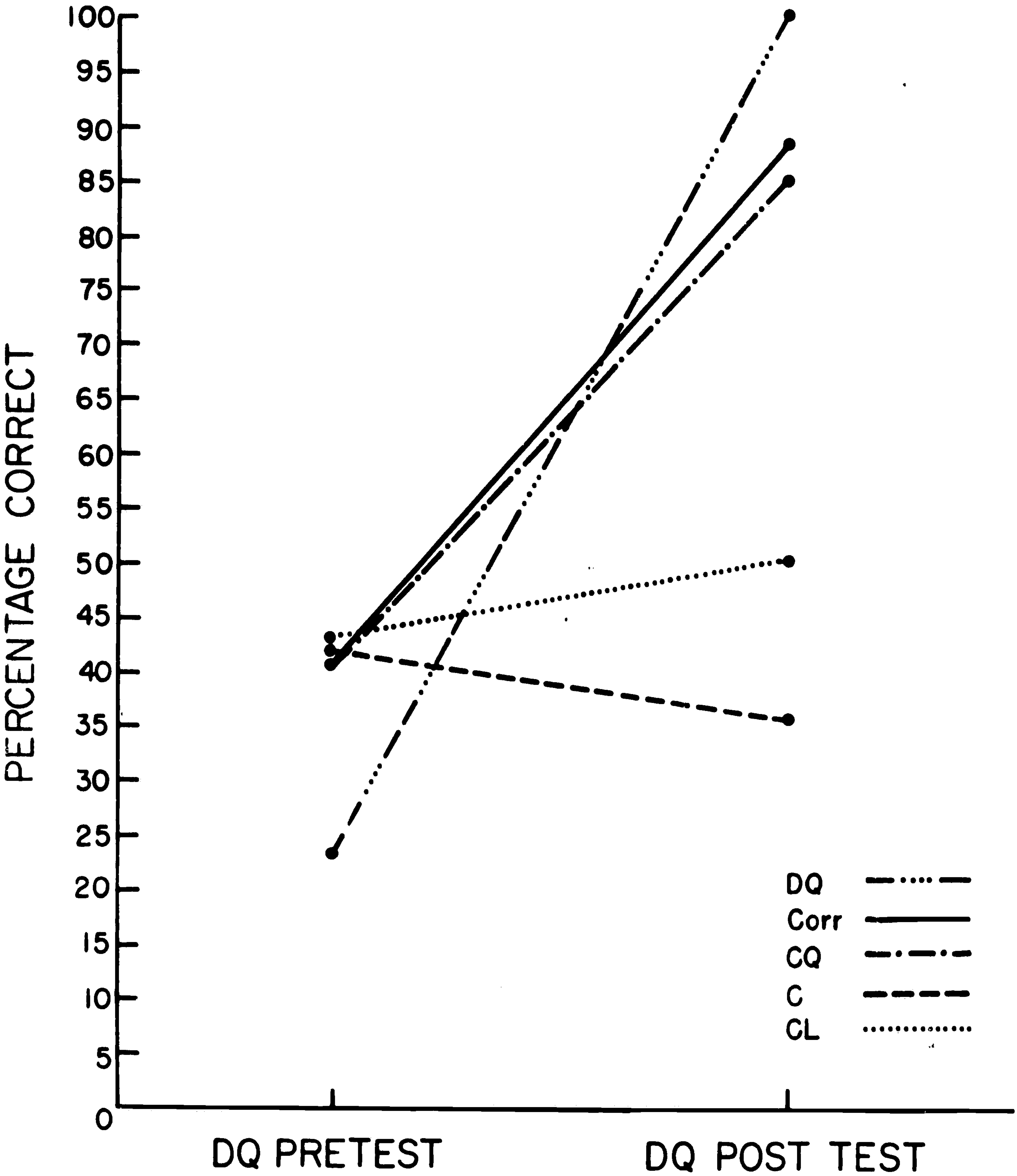

Figure 3. Mean percentage correct for the five treatment groups on the DQ pre- and posttests.

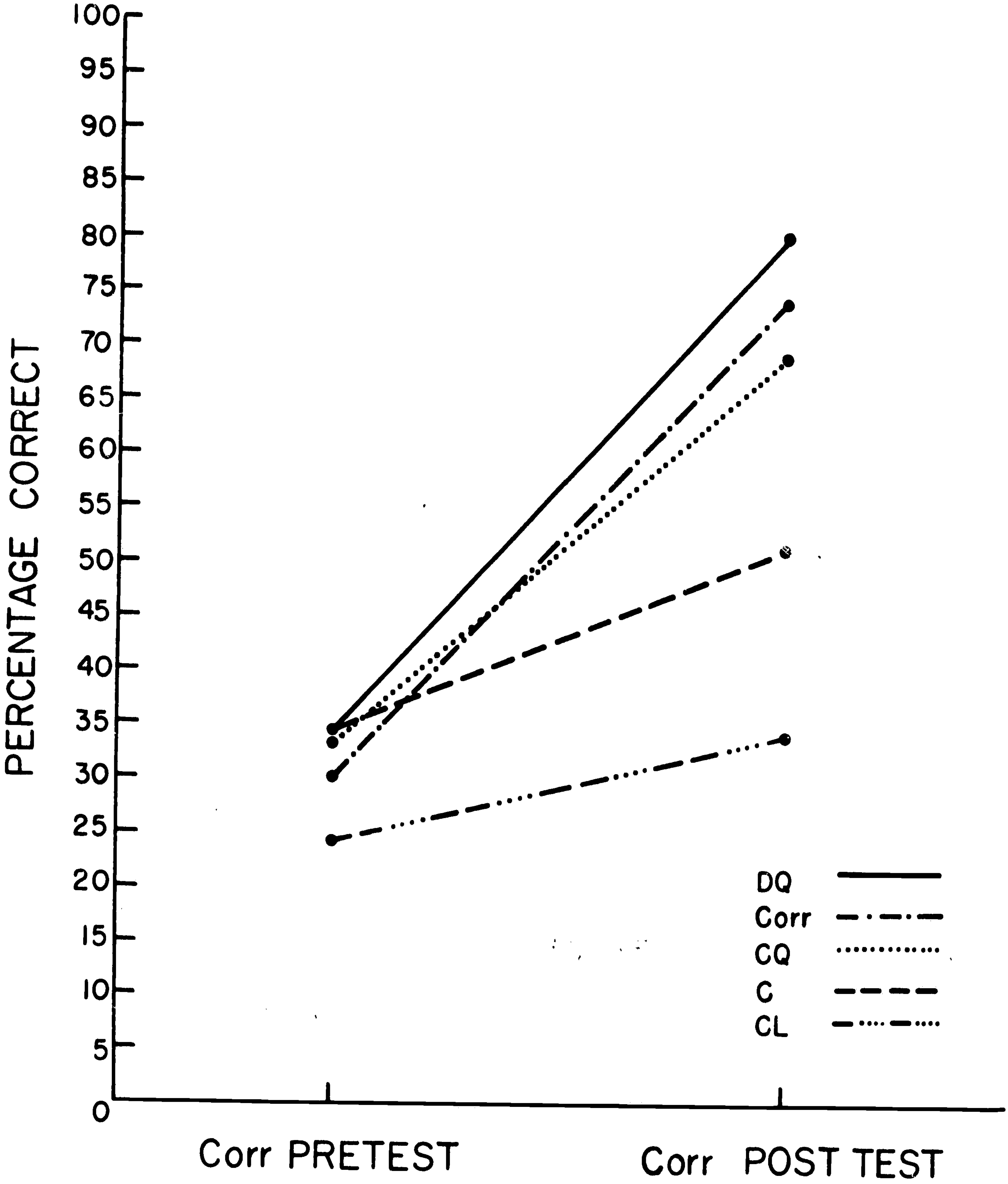

Figure 4. Mean percentage correct for the five treatment groups on the Corr pre- and posttests.

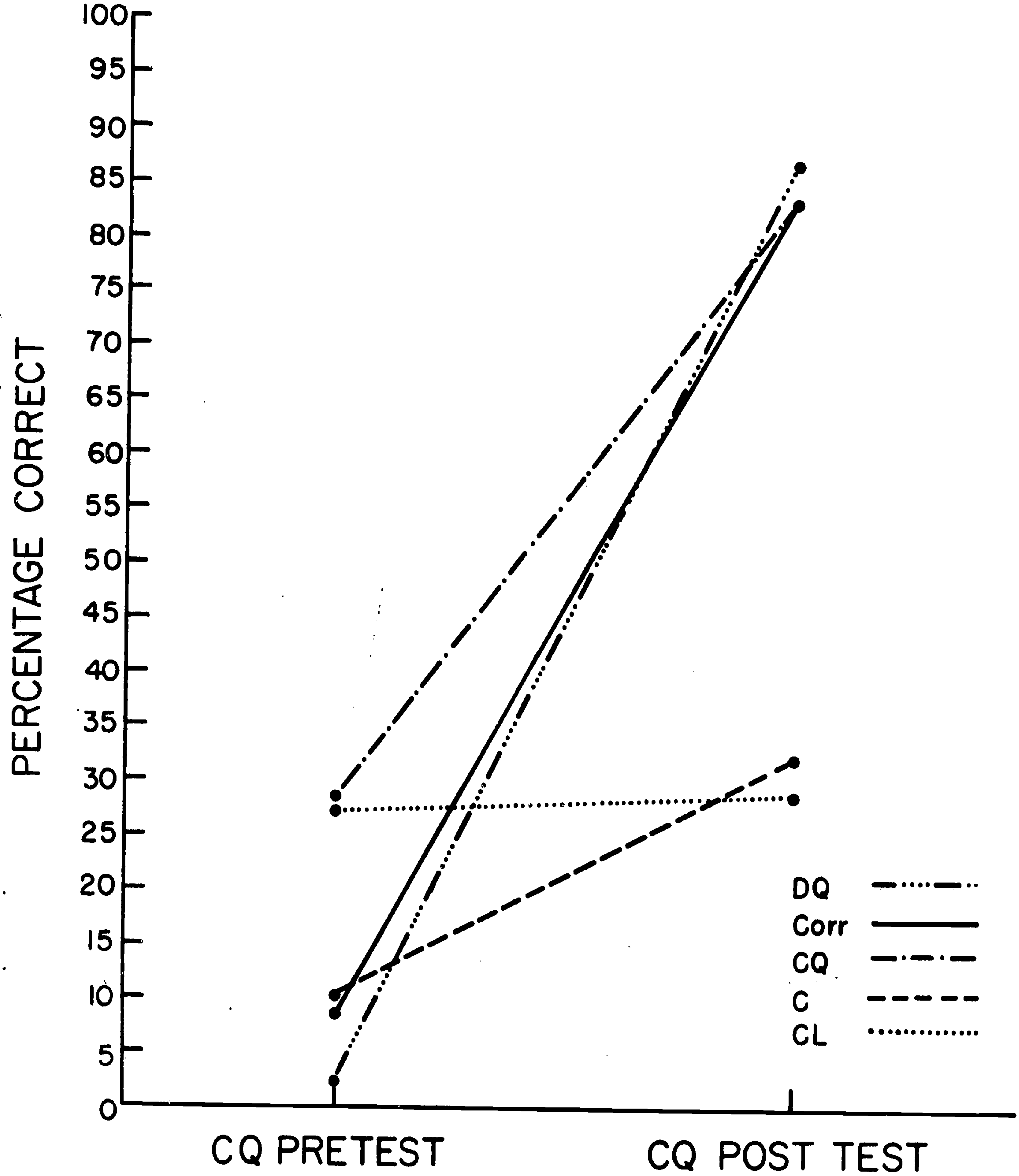

Figure 5. Mean percentage correct for the five treatment groups on the CQ pre- and posttests.

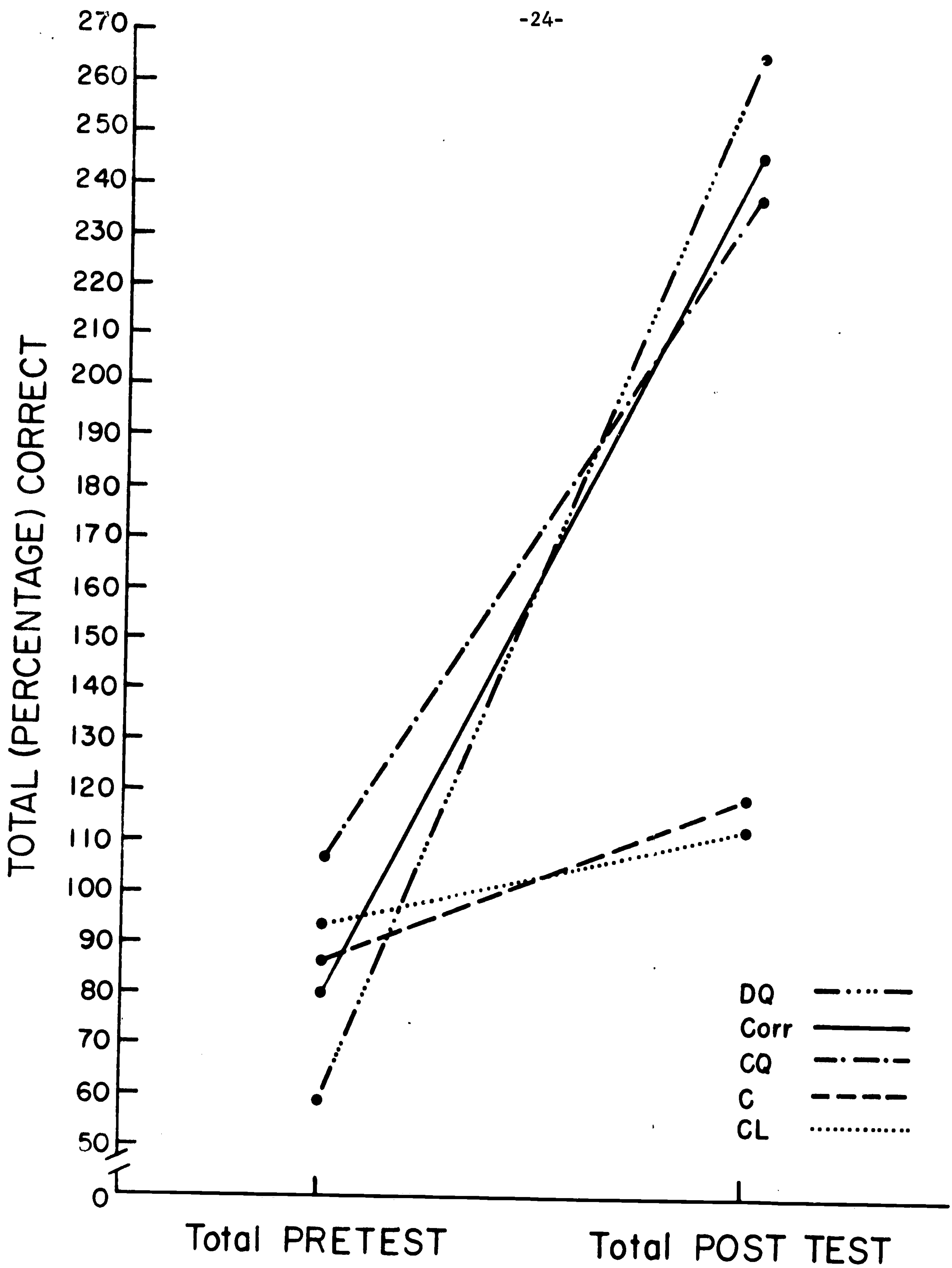

Figure 6. Mean total percentage correct for the five treatment groups on the three pre- and posttests.

Table 2. Individual comparisons by means of the Scheffe test.

Training Groups	DQ Posttest					Corr Posttest					CQ Posttest					Total Posttest				
	DQ	Corr	PQ	C	CL	DQ	Corr	CQ	C	CL	DQ	Corr	CQ	C	CL	DQ	Corr	CQ	C	CL
DQ	-			*[1]	*	-				*	-			*	*	-			*	*
Corr		-		*	*		-			*		-			*		-		*	*
CQ			-	*	*			-					-		*			-	*	*
C				-					-					-					-	
CL					-					-					-					-

[1] The asterick indicates that these groups differed significantly.

correlation. The correlations between pre- and posttests for the DQ, Corr, and CQ tests was .74, .80, and .51 respectively.

The relationship between the three tests were examined by means of the Pearson product-moment correlation of pretest scores. The correlation between DQ and Corr was .45, $\underline{df} = 48$, $p < .01$, between Corr and CQ, .29, $\underline{df} = 48$, $p < .05$, and between DQ and CQ, .18, $\underline{df} = 48$, $p > .05$.

Moreover, the relationships between the pretests and individual differences such as CA, MA, and IQ were examined by means of the Pearson product-moment correlation. The correlations between DQ and CA, MA, and IQ were .34, $\underline{df} = 42$, $p < .05$; .39, $\underline{df} = 42$, $p < .01$; and .24, $\underline{df} = 42$, $p > .05$ respectively. The correlations between Corr and CA, MA, and IQ were .27, $\underline{df} = 42$, $p > .05$; .44, $\underline{df} = 42$, $p < .01$; and .41, $\underline{df} = .42$, $p < .01$ respectively. The correlations between CQ and CA, MA, and IQ were .10, $\underline{df} = 42$, $p > .05$; .11, $\underline{df} = 42$, $p > .05$, and .08, $\underline{df} = 42$, $p > .05$ respectively.

An analysis of variance of repeated measures was used to determine which was the easiest, or first occurring, of the three types of conservation--discontinuous quantity, correspondence, and continuous quantity. In order to accomplish this, the pretest scores for all Ss were used. Means for the DQ, Corr, and CQ pretests were .37, .31, and .15 respectively. The analysis of variance yielded significant results ($\underline{F} = 14.539$, $\underline{df} = 2/98$, $p < .001$). The Scheffé test of multiple comparisons (.05 level) showed significant differences between scores on the DQ and CQ tests, between Corr and CQ, but not between DQ and Corr.

The nonverbal pretest of conservation of continuous quantity was analyzed separately from the other pretests. For the nonverbal test, S was scored as being at stage three if he showed a change in behavior and also reported that he noticed something funny. All other responses were scored as stage one. Of 85 nonconservers and conservers who gave clearcut responses[2] on this pretest, 19 only showed a change in behavior or only indicated that they noticed something funny. Of these 19 Ss, 12 showed no observable change in behavior but reported they noticed something funny. The other 7 indicated a change in behavior (smiled, etc.) but responded negatively when asked if they noticed something funny.

Since the nonverbal and verbal pretests of conservation of continuous quantity are thought to measure the same ability, the relationship between these two pretests was examined by means of the phi-coefficient. The chi-square test for independence and the phi-coefficient were computed successively for these data. A significant relationship was not found between the two continuous quantity pretests ($x = 3.43$, $df = 1$, $p > .05$; $\phi = .20$). Of the 90 Ss, for whom stages could be determined on both tests, 18 passed only the verbal continuous quantity pretest and 17 passed only the nonverbal pretest.

Because Mermelstein and Shulman (1967) found that the nonverbal continuous quantity test was easier than the verbal discontinuous quantity test, an attempt was made to determine whether one of these was easier in the present study. The data from both nonconservers and conservers who were at stage three on only one of the two pretests,

[2]Fourteen Ss either would not look at the apparatus while E was pouring or refused to give an answer when asked if they noticed anything funny.

nCQ or DQ, were subjected to McNemar's test. No differences were found ($x^2 = .13$, df = 1, $p > .05$) between number of Ss who passed the nCQ pretest only and the number that passed the DQ pretest only.

Discussion

In general, the first hypothesis that retardates can be taught to conserve quantity was supported. Multiple comparisons indicated that, when Ss' scores on the three posttests were combined to give Ss' total conservation scores, all three training methods were effective. In other words, the three groups receiving training were superior to the two control groups in total conservation scores. When group performances on the individual posttests were compared, however, DQ training appeared to be superior to the other two training methods. DQ training facilitated performance on the CQ posttest, and to a smaller degree, on the Corr posttest.

Corr training was effective to a lesser extent than DQ training. Corr training did not facilitate performance on the Corr posttest as much as expected, i.e., the Corr group differed only from the CL group. When one examines the testing and training procedures closely, however, it is noted that the testing procedure involved spontaneous correspondence whereas the training procedure involved provoked correspondence which is more structured and, consequently, may be less difficult than the test. Also of interest is what appears to be a spontaneous increase in performance by the C group on the Corr posttest. On the other hand, Corr training facilitated performance on the DQ posttest (the Corr group was superior to both control groups) and, to lesser extent, on the CQ posttest (the Corr group was superior only to the CL group).

The least effective training method appears to have been CQ training. Although this method facilitated performance on the DQ posttest (the CQ group was superior to both control groups), it was ineffective on the Corr posttest (no significant differences between the CQ group and the control groups). Moreover, CQ training was not as effective as expected on the CQ posttest, since the CQ group differed only from the CL group. An examination of the videotape taken during some training sessions revealed that the materials, "pop" and sand, used for training led to some difficulty in reestablishing equivalence after transformations. The Ss appeared overly concerned with drops of water or sand left on the transform jar. Any spilling, regardless of amount, also created difficulty. Moreover, the materials used may have been a factor contributing to the results on the CQ posttest. Findings by other investigators (Hyde in Flavell, 1963, p. 387; Bittner and Shinedling, 1968) indicate that the conservation of continuous quantity test with water is less difficult than that with clay. Since training used water and testing used clay in the present study, the results may have been due to switching to a more difficult task for the posttest. The fact that DQ training, facilitated performance on the CQ posttest, however, casts some doubt on this explanation for the CQ group's performance on the CQ posttest. An examination of data showed again an interesting spontaneous increase in performance for the C group on the CQ posttest, similar to that on the Corr posttest.

The second hypothesis that training in one type of conservation affects other types of conservation was also supported. As noted above, all training methods showed some transfer to other types of conservation. Corr and CQ training methods facilitated performance on the DQ posttest. DQ training facilitated performance on the CQ posttest. Moreover, the Corr group showed performance superior to the CL group on the CQ posttest, and the DQ group was superior to the CL group on the Corr posttest. The only complete lack of transfer occurred between CQ training and performance on the Corr posttest; the CQ group did not differ from any control group on the posttest.

When the coefficient of stability of the three verbal tests were examined, using the two control groups pre- and posttest scores, DQ and Corr tests showed a fairly high degree of reliability (r = .74 and .80 respectively). On the other hand, the CQ test showed only a moderate degree of reliability (r = .51). It must be noted, however, that most Ss were at stage one on CQ, and the range of scores was more limited than DQ and Corr. Moreover, a relationship was found between performance on the DQ and Corr pretests, but not between performance on the DQ and CQ pretests. Also a relationship was found between performance on the CQ and Corr posttests. It appears that the tests may measure several abilities, some which are common to the DQ and Corr tests and some which are common to the Corr and DQ tests.

The third hypothesis, that the ability to conserve was related to MA, was upheld by the significant correlations between the DQ and Corr pretests and MA scores. Investigators, such as Kooistra (1963) and Goldschmid (1967), have obtained similar results. In the present study, however, no relationship was found between MA and the CQ pretest.

Kooistra (1963) also found a relationship between CA and conservation. In the present study, a relationship between CA and the DQ pretest only was found. Moreover, Goldschmid (1967) found relationships between IQ and conservation scores. In the present study, a relationship between IQ and the DQ posttest only was found. No other relationships were found.

The fourth hypothesis that conservation of discontinuous quantity appears before continuous quantity was supported by the results of the analysis of variance for repeated measures. The DQ and Corr pretests were approximately the same in difficulty, or order of development, whereas CQ was more difficult, or appears at a later time in development, than both of the above pretests. The finding that DQ performance is higher than CQ performance is similar to the finding by Elkind (1961). The results of Goldschmid (1967), on the other hand, suggest that DQ conservation may be more difficult than CQ conservation. It must be kept in mind, however, that in the present study, clay was used for the CQ test whereas, in Goldschmid's study, water was used.

The results of the nonverbal conservation of discontinuous quantity test indicated that merely observing S for a change in expression may not be a precise method of measuring conservation. The nonverbal and verbal CQ pretests appeared to be equal in difficulty but no relationship was found between these pretests. Moreover, unlike the results of Mermelstein and Shulman (1967), the nonverbal CQ pretest was not easier than the DQ pretest. In the present study, the two pretests seemed to be approximately equal in difficulty.

In conclusion, the results of this study indicate that it is possible to train retardates to conserve quantity and that training on a specific type of conservation facilitates performance on other types of conservation. DQ training, however, facilitated conservation more than the other training methods and showed more transfer to other forms of conservation. In addition, performance on the DQ and Corr pretests appeared to be related to MA, although performance on CQ did not. Finally, DQ and Corr conservation appeared to develop before CQ conservation.

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APPENDIXES

APPENDIX A

Vocabulary Pretest

Materials: Some chips
Some colored water
Two 150 ml. glasses

Continuous Quantity:

Materials and Operations	Instructions and Questions
Pour some amount of "pop" into one glass. Point to other glass.	1. "Pour pop into this glass so that there is less is my glass."
	2. "Now make it so that we both have the same amount. Do I have as much pop as you?"
	3. "Now make it so that you have more pop again."

Discontinuous Quantity:

Materials and Operations	Instructions and Questions
Put out four beads in a row. Show S his beads.	1. "Here are some beads for you. Put some beads out here so that you have less beads than I do."
	2. "Now make it so that we both have the same number of beads. Do you have as many beads as I do?"
	3. "Now fix it so that you have more beads."

APPENDIX B

Conservation of Discontinuous Quantity Test

Materials: 2 sets of large, wooden beads, identical except for color
Containers of varying sizes and shapes

2A	600 ml.
1L	150 ml.
1M	150 x 75 dish
2B	250 ml.
4C	150 ml.

Establishing equivalence:

Materials and Operations	Instructions
1. Present two 600 ml. jars and beads.	1. "Here are two jars. One for you and one for me."
Present beads.	"Here are some beads for you and some for me."
	2. "Everytime I put a bead in my jar, you put a bead in yours, OK?"
3. Carry out operations. Fill jars to a given level--14 beads.	3. "Do you have the same number of beads in your jar as I have in mine or does one of us have more beads?" (If so, "Who has more?")
	4. "Why?"
	5. "If we made a necklace for me with my beads and one for you with your beads, would my necklace be as long as yours or would one necklace be longer than the other?" (If so, "Who would have the longest one, you or me?")
	6. "Why?"

Transformation 1:

Materials and Operations	Instructions
1. Pour A_2 into 1 (150 ml.)	1. "Now do you have the same number of beads there (pointing to L) as I have in my jar or does one of us have more beads?" (If so, "Who has more?")
	2. "Why?"
	3. "If we both made necklaces out of our beads, would your necklace be as long as mine or would one necklace be longer than the other?" (If so, "Who would have the longest one?")
	4. "Why?"

Transformation 2:

	1. "Let's pour your beads (L) into this jar (M).
2. Pour L into M (150 x 75 dish).	2. "Do you have the same number of beads as I do or does one of us have more?" (If so, "Who has more?")
	3. "Why?"
	4. "If we both made necklaces with our beads would they be as long or would one necklace be longer than the other?" (If so, "Whose would be the longest?")
	5. "Why?"
6. Pour M back into A_2 (150 x 75 back into 600 ml.)	6. "Now do you (point to A_2) have the same number of beads as I do (point to A_1) or does one of us have more?" (If so, "Who has more?")
	7. "Why?"

Transformation 3:

Materials and Operations	Instructions
1. Pour A_2 into B_1 and B_2 (two 250 ml. jars)	1. "Do you have the same number of beads as I do or does one of us have more?" (If so, "Who has more?")
	2. "Why?"
	3. "If you make a necklace with all your beads and I make one with all my beads, would they be as long or would one necklace be longer than the other?" (If so, "Whose would be the longest?")
	4. "Why?"

Transformation 4:

1. Pour B_1 and B_2 into C_1, C_2, C_3, and C_4 (4 150 ml. jars).	1. "Do you have as many beads as I do or does one of us have more?" (A_1 and C_1, C_2, C_3, C_4) (If so, "Who has more?")
	2. "Why?"
	3. "If we make a necklace for you with all your beads and a necklace for me with all my beads will they be the same or would one necklace be longer than the other?" (If so, "Whose would be the longest?")
	4. "Why?"

APPENDIX C

Spontaneous Correspondence Test

Materials: Two piles of different colored chips.
Twenty matchsticks.

Figure I - Badly-structured figure

Materials and Operations	Instructions and Questions
1. Take 11 chips from the pile of 40 and distribute them randomly in the form of a badly structured non-overlapping figure.	1. "Take the same number of chips as I have down here and make the same thing I just did."
	2. "Do you have the same number of chips there (point to his) as I have here (point to yours) or does one of us have more?" (If so, "Who has more?")
	3. "Why?"
4. Spread chips in the model.	4. "Do you now have the same number of chips there (point to his) as I have here (point to yours) or does one of us have more?" (If so, "Who has more?")
	5. "Why?"
If child fails spread question, go on to next figure. If child passes, use sticks.	
	6. "Do the same with these sticks as you did with the chips. Take the same number of sticks as I have chips and put them down here the same way."

7. "Do you have the same number of sticks as I have chips? Do you have more matches or do I have more chips?"

8. "Why?"

9. Spread out the chips.

9. "Now do you have the same number of matches as I have chips or are there more matches or more chips?"

10. "Why?"

Figure II: Open series - Two Parallel Rows

Take 12 counters from the pile and arrange them in two parallel rows having six counters in each.

Then follow steps from 1-10.

Figure III: Complex closed Unfamiliar Figure - Rhombus

Take 12 counters from the pile and make a rhombus.

Then follow steps from 1-10.

APPENDIX D

Conservation of Continuous Quantities Test

Materials: 2 lumps of clay identical except for color.

Establishing equivalence:

Materials and Operations	Instructions
	1. "Here is some clay for you and some for me."
2. Roll clay into balls.	2. "Do you have the same amount of clay as I have or does one of us have more clay?" (If so, "Who has more?")
3. If S says not same:	3. "Make them the same."

Transformation 1:

Materials and Operations	Instructions
1. Make one ball into a sausage.	1. "Now do you have the same amount of clay there as I have here or does one of us have more clay?" (If so, "Who has more?")
	2. "Why?"

Transformation 2:

Materials and Operations	Instructions
1. Make sausage into pancakes.	1. "Do you have the same amount of clay as I do or does one of us have more?" (If so, "Who has more?")
	3. "Why?"

Transformation 3:

1. Break pancake in half and make two medium balls of clay.

1. "Do you have the same amount of clay as I do or does one of us have more?" (If so, "Who has more?")

2. "Why?"

Transformation 4:

1. Break one medium ball of clay into two balls.

1. "Do you have the same amount of clay as I do or does one of us have more?" (If so, "Who has more?")

2. "Why?"

Transformation 5:

1. Break other medium ball into two.

1. "Do you have the same amount of clay as I do or does one of us have more?" (If so, "Who has more?"

2. "Why?"

Transformation 6:

1. Make cup, sausage, pancake, a cube out of the four balls.

1. "Do you have the same amount of clay as I do or does one of us have more?" (If so, "Who has more?")

2. "Why?"

APPENDIX E

Training Procedure: Discontinuous Quantity

(Sticks and Cans)

Materials and Operations	Instructions and Questions
Identical cans (like pencil holders) and (rhythm) sticks for E and S.	
1. Establish equivalence of cans.	1. "Here are two cans; see, they are the same size. Here's one for you and one for me. Here are some sticks for you and some for me."
2. Put sticks in cans one by one until no more can go in them.	2. "Let's fill the cans with sticks. When I put one in mine, you put one in yours, okay? Like this...(demonstrate) ..... Very good. Can we get any more in?"
3. Establish equivalence of sticks. Put rubber bands around sticks in both cans.	3. "Now, do we both have the same number of sticks? Why? How come? How can you tell? Let's fix mine so that none can be taken away and the can will always be filled. I'll put a rubber band around it, see? Let's put one around yours. You hold it and I'll put the rubber band around it."
4. Present next larger can.	4. "Here is another can. What do you think will happen if we put all of your sticks into this can? Will you still have as many sticks as I have here? Why? How come? How can you tell?"
5. Remove rubber band and put S's sticks into new can.	5. "Now do you think we have the same number of sticks? Does one of us have more?" (If so, "Who has more? Why? How come? How can you tell?")

If S passes on step 5, go through step 8 and then return to step 4 changing to next larger can.

If S fails, complete the series.

6. Prediction on reversal.	6. "If we put them back in your little can like mine, will they fill the can so that no more can get in? Will they all go in? Will one of us have more, or will we both have the same? Why? How come? How can you tell?"
7. Place rubber band around the stick for each transfer to the small can - remove when transferring to larger can.	7. "Let's put them back and see. We'll put a rubber band around these so that they can't change. You hold them, and I'll put the band around them. Now you put them in."
8. Confirmation.	8. "Is the little can full now? Do we have the same number or does one of us have more? Why? How come? How can you tell?"

Return to step 4.

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

9. Prediction again for the same large can. (Repeat can.)	9. "What will happen if we put them in this can again? Will you have (more/less) again? Why? How come? How can you tell?"
10. Remove rubber band and put S's sticks in can.	10. "Let's put them in here."
11. Establish equality.	11. "Do you still have the same number of sticks as I have? Does one of us have more?" (If so, "Who has more? Why? How come? How can you tell?")
12. If S passes - put back rubber band and go back to little can. (Reversal.)	12. "Let's put them back to make sure. Were you right? Good, they are the same."

If S fails, continue with series.
If S has more, according to S, go to series (a).
If E has more, according to S, go to series (b).

Series (a) - S has more.

	13a. "Did we add any to yours?"
	14a. "Make them the same. Take out the extra ones."
15a. Carefully put extra ones where S can see them.	15a. "Are they the same now? Do you have the same number as I do?"
16a. Reversal prediction.	16a. "If we put them back in your little can, will they fill it up like mine do? Why? How come? How can you tell?"
17a. Add rubber band. Return to little can. (Reversal.)	17a. "Let's check for sure by putting them back. We'll put a rubber band on to be sure we keep this many. Here, you hold them. Now put them in this can."
	18a. "Are they all in? Do they fill the can? Do you have the same number there as I have here? How can you tell? Can we get any more into mine?"
	19a. "Count the ones you took out. See how many will go in your can."
Count the sticks as S puts them in.	
	20a. "See, they all fit. Now your can is as full as mine."
	21a. "Do we both have the same number of sticks?"

Go back to step 4 and CHANGE CANS.

Series (b) - E has more.

13b. "Did I take any out of yours?"

14b. "Did I put any in mine?"

15b. Give S more sticks.

15b. "Here are some more sticks. Can you make your sticks the same as mine? Count each stick as you put it in."

16b. "Are they the same now? Now do you have the same number of sticks as I do? Why? How come? How can you tell?"

17b. "If we put them back in this little can, will they fill it up like mine?"

18b. Put rubber band around sticks and put back in little can. (Reversal.)

18b. "Let's put a rubber band around them so that we don't lose any. Here, you hold them while I put it on. Now put them in the other can."

19b. "Oh! Don't they fit?"

20b. "Let's put them in one at a time until it's full. Now, let's put a rubber band around them."

21b. "How many are left?"

22b. "Those are the same as the one's you put in before."

23b. "Now our cans are both full. Do we have the same number of sticks?"

24b. "That's right. When these cans are full, we have the same number of sticks."

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Go back to step 4 and
CHANGE CANS.

APPENDIX F

Training Procedure: Correspondence

Task: I II III IV

Use the entire procedure for each situation:

1. Caps closer together
2. Caps further apart
3. Caps closer together
4. Caps farther apart

Materials and Operations		Instructions and Questions
Present 8 cans in a straight line, with approximately 10 caps in front of them.		"Here are some caps and cans. Let's put a cap on each can."
	1.	"Are there the same number of caps and cans or are there more caps or more cans? Why? How come? How can you tell?"
Remove caps and place in front of cans according to the proper situation.		"OK. Now watch what I do."
	2.	"Are there still the same number of caps and cans, or are there more caps or more cans? Why? How can you tell?" (If fail: "Which are there more of?")
Reverse operation. Have child put a cap on each can.		
		"Let's check and see if you're right. Let's put them back on the cans and see."

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

If child fails:

Establish Equivalence again	"Now do you think they're the same, or are there more caps or more cans?"

"OK. Now watch what I do."

Remove caps as before.

2a. "Are there the same number of caps and cans, or are there more caps or more cans?"

If child fails:

"Which are there more of? How can you tell?"

(In situations 1a and 4a:)

"Take away the extra cans/caps."

(In situations 2a and 3a:)

(Or "Put in the extra caps/cans.")

"Now can you cover all these cans with these caps, or will there be some cans or caps left over?"

"Put them on and see."

"OH! Look! You have more caps/cans than you have cans/caps! How did that happen?"

If child doesn't know:

"How many cans/caps are left over? How many cans/caps did you take away/put in?"

"OH! They are the same number!"

"Did this happen because you took away/put in some cans/caps?"

"Put them back and see." ("Take it/them back out and see.")

"OH! The #___ caps/can that you took away/put in is the same as the #___ caps/can that was left over!"

Repeat entire procedure with caps spread, rather than closer together.

"Very Good! There is a cap for every can, and a can for every cap!"

After repeating all eight
situations for Task I,
continue with following
Tasks:

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(Task II) in an open rectangle:     o  o  o
                                    o     o
                                    o     o
                                    o
(Task III) in a square:  o o o
                         o   o
                         o o o

(Task IV) square removed:     o o o      o o o
                              o   o      o   o
                              o o o      o o o
                               cans       caps
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APPENDIX G

Training Procedure: Continuous Quantity

Materials and Operations	Instructions and Questions
Two 600 ml. beakers and "pop" (sand).	1. "Here are two glasses and here is some pop (sand). It is not real pop, but we will pretent it is. Okay? Let's pour the pop (sand) in these glasses."
Establish equivalence by pouring an equal amount of "pop" (sand) in both beakers.	2. "One is for you and one is for me. Do we both have the same amount of pop (sand) or does one of us have more?"
	3. (If more) - "Make them so that we have the same amount of pop (sand).
Present the following in succession: 1. 150 x 75 2. two 250's 3. one 250, two 150's 4. four 150's 5. one 150, one 250, one 600, and one 150 x 75	4. (1) "Here is another jar. If we put your pop (sand) in this jar will you still have the same amount of pop (sand) as I do? Why? How come? How can you tell?"
When presenting jars 2-5 give the following instructions:	(2-5) "Here are some other glasses. If we put your pop (sand) into these will you still have the same amount of pop (sand) as I do?" (If not, "Who has more? Why? How come? How can you tell?")
Pour "pop" (sand) into the other jar (jars).	5. "Do you still have the same amount of pop (sand) as I do or does one of us have more?" (If not, "Who has more? Why? How come? How can you tell?")
	6. "If we put your pop (sand) back in the jar like mine will we have the same amount or will one of us have more?" (If more, "Who will have more?")
E pours back (150 x 75) into 600 ml. S can pour others.	7. "Pour it back so we can check."

Repeat above with successive jars from step 4.

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If S fails:	8. "Now do we have the same amount of pop (sand)?"
Prediction and explanation	9. "If we put it in (this one/these) again will (I/you) have more again? Why? How come? How can you tell?"
Pour back into appropriate jar. (Repeat jar/jars).	10. "Let's put it back and see."
	11. "Do you have the same amount of pop (sand) as I do or does one of us have more? Why? How come? How can you tell?"
If S passes - do reversal. Return to step 4 and change situation.	12. "Let's put it back and check."

If S fails:	13. "Who has more?"
	14. (Less) "Did we pour it all in?" (More) "Did we pour any extra in?"
	15. "Make them the same. Take out the extra pop (sand) so that we'll have the same amount of pop (sand)."
Use smaller beaker as dipper for (150 x 75). Use another 600 ml. for extra "pop" (sand).	16. "Put the extra pop (sand) in this jar."
	17. "Now do we both have the same amount of pop (sand)? We'll put this extra over here. We can't count that now."
Indicate original 600 ml. jar.	18. "If we put it back in the jar like this one will we still have the same or will one of us have more? Why? How come? How can you tell?
	19. "Let's put it in and check."

Pour "pop" (sand) into 600 ml. beaker.

20. "Did we pour it <u>all</u> in? Do we now have the same? Why? How come? How can you tell?"

21. "If you put back some of the pop (sand) you took out will we have the same amount or does one of us have more? See how much you have to put in to make them the same amount."

Have <u>S</u> pour extra "pop" (sand) back.

22. "See you put it all back. Now do we have the same amount of pop (sand)?"

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

"Now do we have the same amount of pop (sand)? Very good. You are right. We have the same amount of pop."

Repeat procedure from step 4 with successive jars.