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In a program to facilitate the emergence of number conservation in preschool children, 45 middle class children and 64 Head Start and Title I children were trained to deal with perceptual confusions so that they could utilize this understanding to disregard irrelevant changes, such as spatial rearrangement, and thereby become aware of conservation of quantity. The children ranged in age from four to nine. The children were trained and tested under two experimental treatments for each of two conditions. In each age group, the children were categorized, on the basis of pretesting, as (1) conservers (who would receive no training), (2) nonconservers and transitional conservers (who would receive training), and (3) untestable. Incomplete data analysis indicated that middle class 7- and 8-year-olds were much better conservers, before training, than their Head Start peers. Both groups of children, however, at all ages, appeared to benefit greatly from the training sessions and were facilitated thereby in learning number conservation. (WD)

HEAD START EVALUATION AND RESEARCH CENTER

TRAINING FOR NUMBER CONCEPT[1]

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ABSTRACT

In order to study the emergence of number concept in preschool middle-class and disadvantaged children, two diverse samples were given training and testing in number conservation. Specifically, determination was made as to whether conservation of number emerges at different times and whether training procedures have differential effects. Subjects were tested under two treatments (manipulation of stimuli) and two conditions (correspondence). Differences were found between groups and as a result of training. Absence of interaction indicates that disadvantaged children are as amenable to training as their middle-class peers.

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TRAINING FOR NUMBER CONCEPT[1]

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The revival of interest in Jean Piaget's theories of child development is directly related to a revival of interest in cognitive development. Specifically it is based on the "need" to test and better understand his theory of the stages and processes involved in intellectual functioning. An important concommitant of the latter are attempts to develop new techniques and methods to facilitate the preparation for and learning of the basic tools and concepts related to specific school subject content.

This study which is concerned with the general area of emergence of number concept, specifically, investigates the attainment of the concrete operation of number conservation[4], and the efficacy of a training procedure to facilitate and "speed-up", age-wise, number conservation. As Piaget suggests, the child "does not first acquire the notion of quantity and then attribute constancy to it; he discovers true quantification only when he is capable of constructing wholes that are preserved". (1965, p. 5)

There have been a number of studies which have attempted to induce conservation or facilitate its emergence in a particular area of the concrete operations stage. Training in addition-subtraction failed to produce conservation of weight and substance (2,4). Although such conservation was induced by training involving "conflict" situations (4), it is not clear what variable accounted for the emergence

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2 Mrs. V. Carolyn Adcock is the research associate on this project, without whom this study would not have been possible. Our cordial appreciation is acknowledged to Mrs. Joan Needleman of the Wayland, Massachusetts School System, and to Mrs. Elaine T. Pelavin of the San Francisco School Department

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4 Broadly stated, a <u>concrete operation</u> is any representational action which is basic to, and integrated in an organized framework of related acts which are utilized by the individual to organize and manipulate the "realities" of the world around him. <u>Conservation</u> is the act of organizing perception so that any given physical dimension (in this case, quantity) is held constant despite any changes of irrelevant conditions, e.g. a given number of items is seen as equal to another set of items identical in number despite any change in spatial arrangement of either set of items.

of conservation or whether the training simply forced the child to "stop and think" about his answer.

On the other hand, counting and addition-subtraction training failed to produce number conservation in a study by Wohlwill and Lowe (1962). Similarly, Wallach, Wall, and Anderson (1967) found addition-subtraction training singularly ineffective in training for number conservation. In this same experiment, however, reversibility training did facilitate number conservation, although this ability did not transfer to conservation of discontinuous substances.

Interestingly, what is repeatedly cited as characteristic of non-conservers, the inability to disregard irrelevant perceptual cues, has not been investigated empirically. Yet, it is precisely this ability which may define conservation or non-conservation, for implicit in a child's attainment of conservation in general and number conservation in particular is the fact that he has stopped using the misleading perceptual cue of "how it looks." This would suggest that training which enables the child to resolve and ignore irrelevant perceptual cues may, in and of itself, facilitate the attainment of number conservation.

Specifically, this study hypothesized that both non-conservers and "transitional" children (Stage 1 and 2 children) could be trained to deal with perceptual confusions so that they could utilize this understanding to disregard irrelevant changes such as spatial rearrangement, thereby maintaining the notion of conservation of number (Stage 3). (Three stages in the attainment of conservation of number are outlined by Piaget: 1) No conservation. In this stage "judgments" involving quantity are purely perceptual, i.e., based solely on appearance." 2) Transitional stage. At this level concrete operations are used "off and on", i.e., conservation of quantity lacks consistency and/or permanence. 3) The stage of conservation number.)

As further assessment of the effectivenss of such a training procedure, two diverse experience groups were compared under differing conditions. The two subject populations were Headstart and Title I children and their "middle-class" age peers. Specifically the two populations were compared to determine 1) whether conservation of number emerges at different times for the two groups and 2) whether the training procedures have differential effects for the two groups.

METHOD

S's were 109 children, 45 "middle-class" youngsters and 64 Headstart and Title I youngsters. Ages ranged from 4;2 to 8;11, representing five age groups: Eights, Sevens, Sixes, Fives and Four-year-olds. Mean ages for the groups were 8;5 (N=21), 7;6 (N=21), 6;6 (N=21), 5;5 (N=38), and 4;9 (N=8).

S's were tested under two experimental treatments for each of two conditions.

The difference between the two experimental treatments was whether manipulations were made with S's or E's set of stimuli; the two conditions were "provoked correspondence" and "spontaneous correspondence."[5]

Only S's who demonstrated understanding of the concepts "more", "same", and "less" and were able to count to nine were tested for conservation. Presence or absence of conservation was determined by the classical Piaget-type pretest described below. All S's making one or more incorrect responses on either the provoked or spontaneous parts of the pretest received the training procedures or served as controls. To avoid making the sessions too long and repetitious, the second half of the pretest (spontaneous) was not administered if S failed to conserve on any part of the first half (provoked).

S's were administered the pretest and training sessions in each type of conservation the first day (pretest and training sessions were separated by an irrelevant "game" involving pictures of cats and dogs). On the second day S's received an additional training for each conservation and following another irrelevant "game" (involving colors and shapes), were post-tested for each conservation. Pre-and post test procedures were identical. With one exception, each session utilized different stimuli; no stimuli were used twice on the same day.

<u>Pre-and Post Testing Procedure</u>: After showing S the stimuli to be used for a particular session (in provoked sessions, S was asked to "put together" one pair of the stimuli; in spontaneous sessions, S chose which color he would like to play with), E made a row directly in front of S with one color or one half of the stimuli. S was then instructed to make a row "just like E's row (S was always given two pieces more than E used to construct his row). If necessary, after S constructed his row, E assisted S in making his row equivalent to E's row. When the rows were equal, E pointed to S's row and asked for example, "Are there more roofs, the same number of roofs or less roofs than there are (pointing to E's row) houses?" and after S's answer, "How can you tell?" Those few subjects who denied equivalence were eliminated from further testing.

E then either extended or condensed one of the rows and asked S again if there were: more, the same number or less pieces in his row and how he could tell. After the row had been returned to its original position and S had answered the questions, the opposite manipulation to what had preceded was made, followed by the row again in its original position.

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5 Piaget differentiates between "provoked" correspondence and "spontaneous" correspondence, noting that in the former there is a functional or complementary relationship between two equal numbered sets of objects which facilitates making correspondence and hence equivalence, while spontaneous correspondence simply involves identical sets of equal numbered objects. Provoked correspondence is said to emerge earlier.

Training: The training sessions differed from the above only in the use of "long," "neutral", and "short" spaces (cardboard pieces 2 1/2 inches, 1 1/2 inches and 1/2 inches, respectively) for constructing and manipulating the rows. After S demonstrated that he understood the concepts "longer," "the same length" and "shorter" E constructed his own row using the neutral spacers and had S also use them in the construction of his own row. Before putting other spacers into either row E asked for a prediction, "What is going to happen when I put these in your (my) row?" When an incorrect prediction was made, E said, "But I'm not changing the number, I'm only changing how long the row is." For each manipulation, extension, condensing or return to original, S was asked for his prediction in addition then to his judgment as to the equivalence or nonequivalence of the rows. If correct, S was asked how he could tell. If incorrect, E asked him to count the pieces in each row, then again asked whether the number of pieces in each row was the same. If S still asserted inequality, E said, "let's do this and see what happens," trading--pair by pair--the spacers in the two rows. If S answered the equality/inequality question incorrectly after this manipulation, he was again asked to count the pieces in each row and again was asked whether there were more, the same number or less. Whether correct or incorrect, E then went on to the next manipulation. Each step of this latter procedure was used only if S's previous answer was incorrect.

To serve as controls, nine Headstart and six M-class children who failed to conserve during pretesting performed a number-related task (matching cards with differing numbers of holes to peg formations of the same number) instead of receiving training.

Results

(Since this is an ongoing study the "results" are given in very unsophisticated form and are meant to be purely tentative and suggestive).

In each of the age groups for the two experience groups, children were categorized as conservers (no training), non-conservers and transitional conservers (to be trained) or as untestable (not meeting criteria for sample inclusion).

Table I presents a classification breakdown of the children in the two experience groups for each age group who were not part of the training or control groups.

TABLE I

CLASSIFICATION OF SUBJECTS

	MIDDLE CLASS				HEADSTART/TITLE I				
AGE	8	7	6	5	8	7	6	5	4
CONSERVERS	6	10	7	1	6	2	1	1	
ELIGIBLE FOR TRAINING		3	9	4	9	6		1	
EXPERIMENTAL N=	6	13	16	5	15	8	1	2	
DO NOT MEET SAMPLE INCLUSION CRITERIA			3	2			1	29	8
TOTAL SAMPLE N=	6	13	19	7	15	8	2	31	8

In Table I some interesting differences are found in conservation ability when we compare the two experience groups: at age eight all middle-class children are conservers whereas only 40% of the Headstart children indicate this ability and at age seven 77% of the middle-class children as compared to 25% of the Headstart children can conserve. (Differential Ns at the younger ages do not allow for sensible comparisons at this time).

Table I also shows that whereas only two of the seven middle-class five year olds did not meet the sample inclusion criteria (ability to deal with the concepts "more", "same", and "less") 29 of the 31 Headstart five year olds could not handle these terms.

Table II presents the results for trained and control Ss in the two experience groups. (It should be remembered that training was given only to those Ss who passed criteria and did not have full conservation). Because the N's are small, no attempt is made to analyze the data in terms of age groups but rather the performance of non-conservers and transitional conservers who did not receive training is compared.

TABLE II

TRAINING GROUPS

experimental

		MIDDLE CLASS				HEADSTART/TITLE I			
	AGE	8	7	6	5	8	7	6	5
PRE-TRAINING STAGE	POST-TRAINING STAGE								
NON-CONSERVERS	FULL CONSERVATION		1	2	3	2	1		1
	TRANSITIONAL			1			1		
	NONE		1	1					
TRANSITIONAL CONSERVERS	FULL CONSERVATION					1	1		
	TRANSITIONAL		1						
	NONE								

control

		MIDDLE CLASS				HEADSTART/TITLE I			
	AGE	8	7	6	5	8	7	6	5
PRE-TRAINING STAGE	POST-TRAINING STAGE								
NON-CONSERVERS	FULL CONSERVATION								
	TRANSITIONAL								
	NONE			4	1	4			
TRANSITIONAL CONSERVERS	FULL CONSERVATION						1		
	TRANSITIONAL			1		2	2		
	NONE								

It is quite apparent from Table II that the training sessions were successful in facilitating number conservation. Looking at all ages for both groups together, of those children who initially demonstrated no conservation, ten (71.4%) achieve full conservation on the post-test, two (14.3%) progress to the transitional stage and only two children make no progress. None of the nine non-conservers who were not trained changed their performance in any way.

Table II also indicated that two of the three transitional conservers (again looking across ages and groups) achieve full conservation while one does not change. On the other hand, five of the six transitional subjects not trained do not change in conservation ability while only one demonstrated mastery of conservation in the post-test. Finally, some interesting differences were found between the two experience groups in effectiveness of the training procedure with seven out of the ten middle-class children "changing" and seven out of seven Headstart children showing this "change".

Discussion

The training procedure developed for this study appears to be successful with virtually all ages and is successful with both middle-class and Headstart Title I children. It should be noted that the only trained youngsters, (1 transitional, 2 non-conservers; all middle-class), who failed to change their performance "toward" conservation were the first three subjects trained, raising a possible question of problems of administration.

That the training procedure "works" is important in and of itself since previous efforts have been, by and large, unsuccessful. Additionally, this study points to the generally known fact that "underprivileged" children are "behind" when they enter school but probably more important is the finding that such youngsters are as amenable to training as are their "more privileged" peers. As mathematics is part of school curriculum from the very beginning and conservation of number is basic to a concept of number, a very practical application of this training procedure would be to use it to erase or ease one of the differences that can only snowball into more insurmountable difficulties with time.

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