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ABSTRACT

A total of 186 kindergarteners were pretested on number conservation and two cognitive style measures representing Kagan's impulsivity-reflectivity dimension and Santostefano's leveling-sharpening dimension. From this sample 72 nonconservers were assigned to one of three conservation training conditions: reversibility training, discrimination training, or no training. Impulsive-reflective and leveling-sharpening children were represented in approximately equal numbers in each of the training conditions. Two posttests of number conservation and transfer conservation were administered, one immediately and another two weeks later. Results indicate that: (1) prior to training, natural conservers made fewer errors on the impulsivity-reflectivity measure than nonconservers; (2) impulsive children were more susceptible to reversibility training, and reflective children profited more from discrimination training; and (3) in the transfer tasks, reflective children improved their conservation status from immediate to delayed posttests while impulsive children did not. In contrast to the impulsivity-reflectivity dimension, the leveling-sharpening dimension did not seem related to conservation in any consistent manner. (Author/SH)

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The effects of conservation training upon children with different cognitive styles

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Abstract

The primary aim of this study was to determine whether children of different cognitive styles are more susceptible to different forms of conservation training. 166 kindergarteners were pretested on number conservation and two cognitive style measures representing Kagan's impulsivity-reflectivity dimension and Santostefano's leveling-sharpening dimension. From this sample 72 non-conservers were assigned to one of three conservation training conditions: reversibility training, discrimination training or no training. Impulsive-reflective and leveling-sharpening children were represented in approximatley equal numbers in each of the training conditions. Following training two post-tests of number conservation and transfer conservation were administered, one immediately and another two weeks later. The results showed several instances where style variables were associated with conservation acquisition. First, prior to training natural conservers made fewer errors on the impulsivity-reflectivity measure than non-conservers. Second, an anticipated style X training interaction occurred: impulsive children were more susceptible to reversibility training whereas reflectives profited more from discrimination training. Third, in the transfer tasks reflectives improved their conservation status from immediate to delayed post-tests while impulsives did not. In contrast to the impulsivity-reflectivity dimension, the leveling-sharpening dimension did not seem related to conservation in any clear or consistent manner.

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Introduction

The effect of training experiences upon Piagetian type tasks has been amply demonstrated. The various types of conservation (e.g., Brainerd & Allen, 1971), classification (e.g., Caruso & Resnick, 1972; Parker, Sperr & Reiff, 1972), transitive reasoning (e.g., Bryant & Trabasso, 1971) as well as a host of other cognitive skills are all amenable, in varying degrees, to acceleration. The fact that such skills can be accelerated, but only "in varying degrees" raised questions regarding the limits of such paradigms. Aside from poorly designed training procedures, it appears that the major factor which limits the effectiveness of training is the range of pre-existing skills and preferences which the child brings to the training session. The importance of such skills has been reflected indirectly in several studies where it has been shown that older children are more likely to profit from training experiences than younger children (Beilin, 1965; Inhelder & Sinclair, 1969; Peters, 1970). Other studies, either by controlling age or by manipulating age and training conditions have demonstrated the importance of specific skills, such as compensation (Curcio, Kattef, Levine & Robbins, 1972) or perceptual and motoric strategies (Whitman & Peisach, 1970), upon the effectiveness of training.

The extent to which cognitive style variables enhance or inhibit the effectiveness of various training techniques is less firmly established. Greenfield (1966) argued from data based upon American and Wolof children that the sets of experiences responsible for conservation acquisition may be somewhat different across the two cultural groups.

> The success of an instructional method in one group of children and its failure in another strengthens our conviction that differently enculturated children have basically different schemata for approaching conservation (Greenfield, 1966, p.249).

Unfortunately, the evidence provided by Greenfield was meager and subsequent study of similar groups of children has not substantiated her claim (Lloyd, 1971). In another investigation by Peters (1970) it was hypothesized that different forms of number conservation training would not have equivalent effects upon preconservers whose cognitive styles differed along dimensions of verbal level and analytic sorting behavior. Although suggestive trends were present, the results did not reveal significant style X training interactions.

Of course, the possibility remains that a style X training effect cannot be demonstrated in conservation training paradigms although it is not likely. In disciplines other than cognitive development which focus upon issues of behavioral change, such as education (e.g., Sanders, Di Vesta & Gray, 1972) or therapy (e.g., Moos & MacIntosh, 1970), the validity of a "trait X treatment" interaction effect has been frequently demonstrated. Moreover, cognitive style variables have been shown to relate to conservation status (Orpet & Meyers, 1970) and to influence the kinds of information which are processed in perceptual learning situations (Nebelkopf & Dreyer, 1970; Odom, McIntyre & Neale, 1971). One major problem in testing the validity of style X training models in cognitive development, particularly conservation acquisition, is that specific dimensions of cognitive style which might relate to processes of conservation training have not been clearly specified. Indeed, there is little consensus about the experiential processes involved in conservation acquisition itself.

The purpose of this study was to demonstrate that style X training effects do operate in conservation acquisition. To remedy certain problems which could have been contained in previous research, two specific features were incorporated into the research design. First, conservation training techniques were employed which (1) have proved to be effective inducers of conservation in previous research and (2) appear to induce conservation via rather different psychological processes. Reversibility training, first used by Wallach and Sprott (1964) and subsequently in a number of studies (Wallach, Wall & Anderson, 1967; Brainerd, 1972), and discrimination training (Halford, 1970; Halford & Fullerton, 1970) would seem to fulfill these criteria. In reversibility training, elements (e.g., checkers) in two numerically equal sets are arranged in one-to-one correspondence, a transformation on one set is performed (e.g., a row is elongated), the conservation question is asked, and then following the child's response, the transformed set is returned to its initial state where the elements of both sets are again in one-to-one correspondence. The technique is believed to facilitate a recognition in the child that rearranging elements does not effect a change in number and that perceptually transformed sets have the potential to be "reversed". In discrimination training, an attempt is made to have a preconserving child recognize that, in a row of elements, the length of the row or the density of elements within a row are not by themselves sufficient indices of number. The technique encourages a recognition that length and density jointly determine number and that attention to one without consideration of the other will give erroneous results. This technique is meant to correct one of the major reasons for nonconservation, namely, the child's tendency to center on one dimension of the conservation task to exclusion of the other. Contrasting the two training procedures, discrimination requires a great deal more stimulus scanning, dissection and comparing among sets of elements than reversibility training. A more extensive discussion of these procedures is given in the methods section.

A second feature of the research strategy in this study was that children were pretested on two separate cognitive style dimensions: Kagan's (1965) impulsivity-reflectivity scale and

Santostefano's (1964; 1969) measure of leveling-sharpening. An important aspect of both these dimensions is that the tests underlying them provide acceptable test-retest reliabilities. The impulsive-reflective dimension is believed to measure an individual's "conceptual tempo" or "the degree to which the subject reflects on the validity of his solution hypotheses in problems that contain response uncertainty" (Kagan & Kogan, 1970, p.1309). The most commonly used measure of impulsivity-reflectivity, the Matching Familiar Figures test, has a high degree of reliability and has been shown to generalize to many other tasks (Kagan & Kogan,1970). The second cognitive style dimension, leveling-sharpening, has been conceptualized mainly in terms of memory processes and the ability of an individual to maintain and compare discrete memory traces over time. Sharpeners tend to perceive and maintain discrete memories so that elements do not lose their individuality. Levelers tend toward more global perceptions and merge new experiences with memories of earlier experiences so that temporally ordered events are less distinct. Like the impulsive-reflective dimension, leveling-sharpening measures are fairly reliable and some evidence has been presented for their face validity.

The particular manner in which the training techniques will interact with one or both of the cognitive style dimensions was not predicted beforehand. As noted previously, the basic research strategy was to select two rather different conservation training procedures and apply them to children who were pretested on two reliable cognitive style measures. One might be tempted to predict, for instance, that discrimination training, because it appears to require more visual scanning and discrimination than reversibility training, would be more effective for reflective children who engage in such behavior more frequently. Reversibility training,since its demands for visual scanning and comparison are minimal, may be more effective for impulsives. While the predictions appear plausible, other research by Peters (1970) has shown a tendency for the most effective style X training interactions to be of a "compensatory" type rather than the matching of training to aptitudes. Specifically, the trend in Peters' study was that more verbally adept subjects profited most from non-verbal, perceptual training whereas perceptually analytic subjects were more responsive to training which emphasized verbal rule instruction of the conservation problem. Hence, in this study, an overall interaction of style and training was predicted but no specific prediction was made regarding which particular combinations of style and training would be most effective.

Method

The design of the investigation contained the following procedures. First, a pretraining assessment which included number conservation and two cognitive style measures was administered. Nonconserving children representing four combinations of two cognitive styles were identified and assigned to two conservation training groups and a control group. An immediate posttest of number conservation and four transfer tasks was administered and a month later a similar posttest was administered.

Subjects

The subjects for the study were the entire population of a centralized kindergarten located in a suburb of Boston. There were 196 children enrolled in the kindergarten at the beginning of the study; ten of these were not included in the final results, three had moved away, four had illness or absence which interfered with the timing or sequence of the study and three were unable to cooperate suffuciently for the measures to be considered reliable. Of the 186 children remaining in the study, there were 111 boys and 75 girls. No city-wide statistics on the sex distribution of the kindergarten population were available but the children were bused in by whole neighborhoods so that the preponderance of boys was not produced by a selection policy. The children were bused to the centralized kindergarten because of lack of classroom space for kindergartens in their own neighborhoods. All children were caucasian. The mean age for all the children was 5.78 years ranging from 5.18 to 7.07 years.

Procedure

A pretraining assessment over two sessions was conducted for all subjects. The procedures included number conservation tasks and two cognitive style measures. All testing was carried out by two female experimenters who took the children one by one to an unoccupied room a short distance from their classroom.

Number Conservation Pretest. Number conservation was tested in the following manner. The child was given a bag of checkers and the experimenter said, "Please take out five checkers for yourself." Nearly all the children were able to do this but occasionally it was necessary to say, "Is that five?". When the child's checkers were correct the experimenter said, "Now take five for me." The experimenter then formed a line with the child's checkers and opposite it, in one-to-one correspondence, another line with her own. The experimenter asked, "Do we have the same amount of checkers?" After the child replied that the rows were the same, the experimenter said, "Now watch what I do" and spread the child's row out. The experimenter then asked, "How about now? Do we have the same amount of checkers?" If the child said "No", the experimenter asked, "Which one?" and then "How do you know?" For the children who replied that the amount of checkers remained the same after the transformation, the experimenter asked, "How do you know?". All choices and answers were recorded.

Three additional transformations were carried out in the same manner. Between trials the checkers were returned to one-to-one correspondence and the child asked to confirm their equality. One point was recorded for each conserving response and most of the children (87%) were consistent in their responses, that is, they scored a total of either zero or four for the number conservation tasks. Explanations underlying conservation or nonconserving answers as well as other comments were also recorded.

<u>Leveling-Sharpening Measure.</u> The House Test, developed by Santostefano (1971), was used to assess leveling-sharpening. This test consists of a set of 60 cards containing line drawings of a house. Examples of these cards are given in Appendix A. Beginning with the fourth card and on every third card thereafter, some detail of the drawing is omitted. The cards were shown to the child one at a time with the instruction to stop the experimenter when he notices something has changed. There is a total of 19 changes so that ultimately 19 details disappear from the picture. The leveling-sharpening ratio is a score determined by both the number of changes observed and the length of time elapsing between the actual change and the child's report of it.

During the administration of the House Test the experimenter recorded the child's responses on a scoring sheet derived from one devised by Santostefano. Actual changes are marked on the scoring sheet so that a lag score can be obtained. That is, if the child said that the doorknob had disappeared on card 15 when it had actually occurred on card four, then the lag score for that item would be 11. For each item not observed by the child, a number is added to his score equal to the difference between the card number of the unobserved change and the total number of cards, that is, 60. For example, the doorknob disappeared at card four. If the child does not note this change at all, 56 points are added to his score. The total score is a ratio obtained by adding together all of the lag scores and all of the unobserved scores which are then divided by 19, the total number of changes. The mean for the entire sample was determined and subjects were classified as "levelers" who scored above the sample mean while subjects scoring below the mean were designated "sharpeners".

<u>Impulsivity-Reflectivity Measure.</u> The second cognitive style measure was derived from Kagan's Matching Familiar Figures Test (MFF, 1966). Since the children were rather young, Wright's Kansas Reflection-Impulsivity Scale (KRISP, 1971), a downward extension of the MFF, was selected for use. The MFF is made up of a series of twelve trials. Each trial requires that the child choose the correct picture from among six variants. These are line drawings containing considerable detail. The KRISP consists of ten trials. The line drawings are larger and less detailed than the MFF and the number of variants ranges from four to six. In addition to the determination of the subject's tempo, the KRISP also provides data on the subject's ability to discriminate among the details of a stimulus array presented simultaneously rather than serially as in the House Test. For the KRISP, a standard and four to six variations were shown to the child and he was instructed to "Find the picture down here which is just like this one up here".

(See Appendix B). The pictures were mounted in a three ring notebook in such a way that the standard appeared at the top. Both the time to the first response and the number of errors were recorded, as well as comments and observations such as whether or not a child corrected an erroneous response spontaneously.

Experimental groups. There were 114 children who had given two, three or four conserving responses on the number conservation test. These were designated as conservers and received no further tests. The 72 children who scored zero or one on the conservation tasks were designated nonconservers.

Among those children who scored above the sample mean in response time and below the mean error score were designated reflective. Children at the other extreme who score below the mean response time and above the mean error score were designated impulsive. About two-thirds of the subjects usually fall into these two categories. The remaining third of the subjects are either both fast in time and low in errors or slow in time and high in errors. Some researchers use only the time variable to determine impulsivity but considerable information is discarded by following that procedure (see for instance, Kagan, Pearson and Welch, 1966). Clearly, impulsive responses which are correct are different from those which are wrong. Therefore, in order to dichotomize the KRISP data, the time and error scores were combined into a single number. This was done by dividing the response time by the sum of the error score and a constant. Adding the constant provided a more uniform scale while leaving the rank order unchanged. Examination of the data showed that this method resulted in the highest scores for those identified as "pure" reflectives by the conventional means and the lowest scores for those identified as "pure" impulsives. Subjects above the median were designated "reflective" and subjects below the median were designated "impulsive" in a procedure similar to that used to classify levelers and sharpeners. Table 1 shows the distribution of the subjects classified by both impulsivity-reflectivity and leveling-sharpening.

TABLE 1

DISTRIBUTION OF SUBJECTS CLASSIFIED BY IMPULSIVITY-REFLECTIVITY AND LEVELING-SHARPENING

	Impulsive	Reflective	
Leveling	19	17	36
Sharpening	17	19	36
	36	36	72

The nearly even distribution of subjects indicates that these styles are independent. Santostefano (1969) found that leveling is associated with low motor delay and he also cites Klein's contention that the capability for delay is a "critical variable distinguishing levelers and sharpeners". Although motor delay may be different from cognitive delay, these data do not support the contention that impulsivity and leveling are associated. The children represented in each of the quadrants of Table 1 were assigned in order as they were identified to two training groups and a control group. This resulted in a very nearly equal distribution of the 4 cognitive style combinations among the three groups.

Training Sessions. The training sessions for all 72 nonconservers were initiated within a week of their identification and in most cases within a day or two. There were two training sessions in all experimental conditions. Most subjects received training on two consecutive days and the immediate posttest on the third day. The delayed posttest was administered within 25 to 30 days after the immediate posttest.

Situation and Materials. All training was conducted on an individual basis in a room close to the child's classroom. The same materials were used in all three groups. Two pieces of poster paper 14" x 22" were attached to a sheet of steel shim to form a surface suitable for magnetic mounting of figures. The figures were a set of identical dogs (resembling the cartoon character Snoopy) and a set of doghouses. All pieces were made from construction paper with a small piece of magnetic tape on the back. Thus the figures were held firmly in place but could be moved easily by the experimenter or subject. An easel was used to support and present the cards. For the first training session. there was a set in which each Snoopy was a different color and there was a doghouse of the corresponding color for each to provide an additional cue for establishing one-to-one correspondence. For the second session, a variety of colors was used but on any one trial all the dogs were the same color and in each row the houses were all the same color so that color was irrelevant but not misleading.

Discrimination Training. Ten cards each containing a standard row and two comparison rows were prepared in advance for each training session. In general, a standard row of dogs (4,5 or 6) were placed at the top of the card evenly spaced. After a blank space below, two rows of doghouses were arranged; one row contained houses equal to the number of dogs contained in the standard row. The remaining row of houses contained either one more or less than the standard row. Sample displays are shown in Figure 1.

In addition to varying the numbers of the elements in the various rows, the spacing varied so that the correct house row was sometimes the same length as the dog row and sometimes it was longer or shorter. The distractor row also varied in spacing and length. The correct house row and the distractor row were alternated in each trial with respect to the top or bottom position.

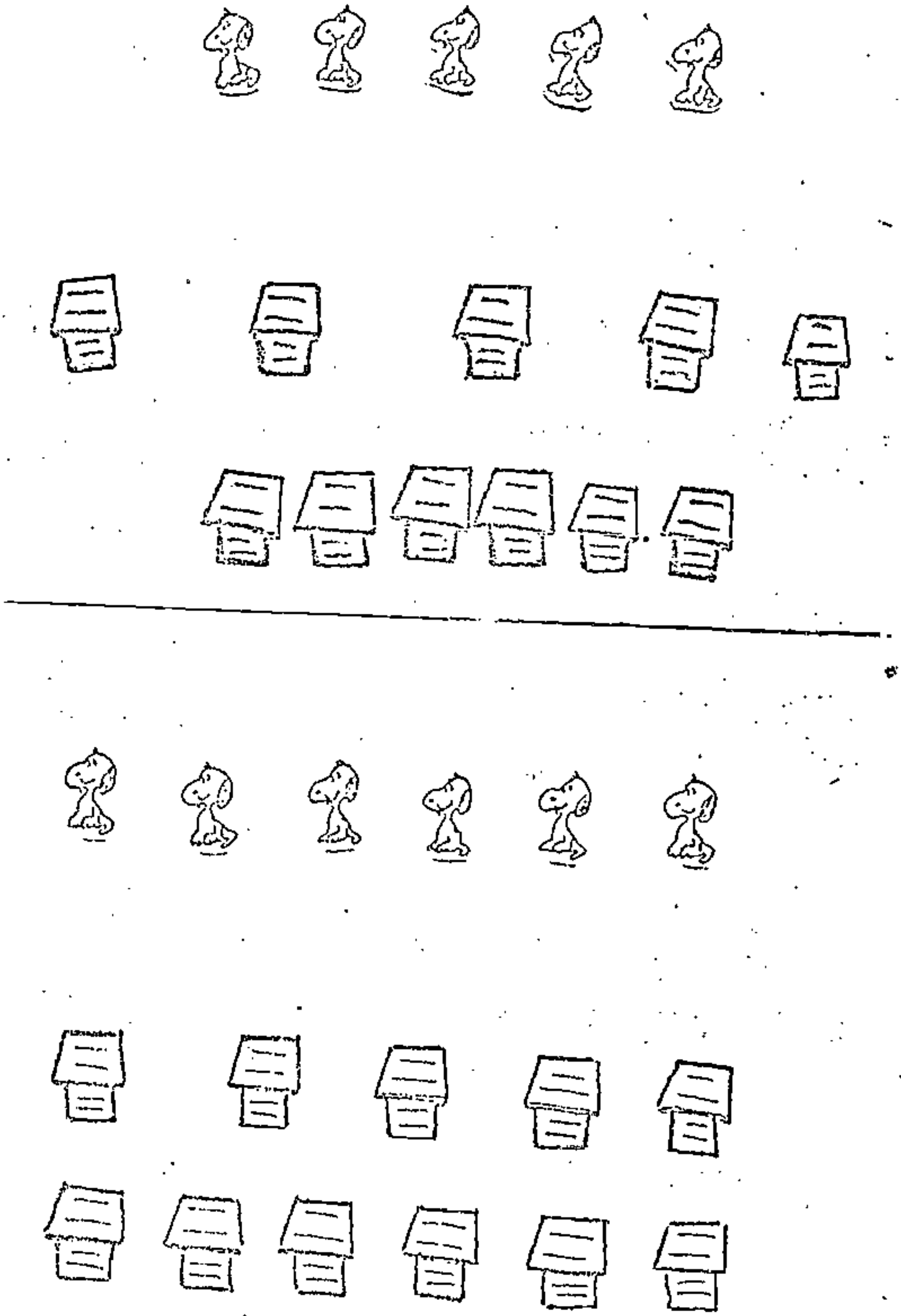


Fig. 1. Sample Cards Discrimination Training

The first card was exposed for the child and the experimenter said, "Here are some dogs and they are looking for their houses. Here are some houses down here. The game is to choose the row of houses so that every dog has a house and every house a dog. Will it be this row (running finger along row) or this row? You may count if you like".

After the child indicated a choice, the experimenter said, "You can move the houses. Put them with the dogs and see if you were right". The experimenter sometimes helped to move the first piece. After the houses were under the dogs, the experimenter asked, "Were you right?". If the child had chosen correctly and said that he had, the experimenter said, "Yes, you were right." If the child had chosen incorrectly and said that he was right then the experimenter pointed to the extra dog or house and asked, "What about this one?". In that case, instructions were repeated on the next trial. The criterion for terminating the training was four consecutive correct choices and a maximum of ten trials were given each day.

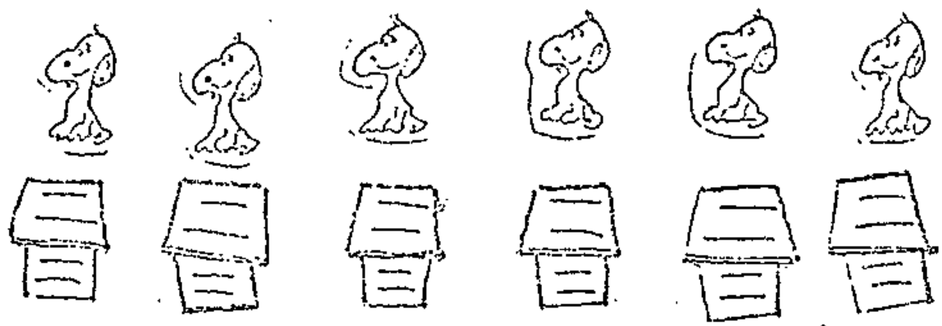
The second series of trials on the following day were conducted in the same manner except that, as previously noted, the color cue was removed. Also, the series of training trials progressed from small numbers of dogs and houses in the rows to larger numbers.

Reversibility Training. The child was shown a row of doghouses each with a dog sitting on top (see Figure 2). The experimenter asked, "Are there just as many dogs as houses? Does every Snoopy have a house?". After the child answered affirmatively, the experimenter moved the dogs away from the houses, spreading them out at the same time. The experimenter then asked again, "How about now. Are there just as many dogs as houses? Does every Snoopy have a house?". After the child responded, the experimenter said, "Put them back and see if your were right", and then, "Were you right?".

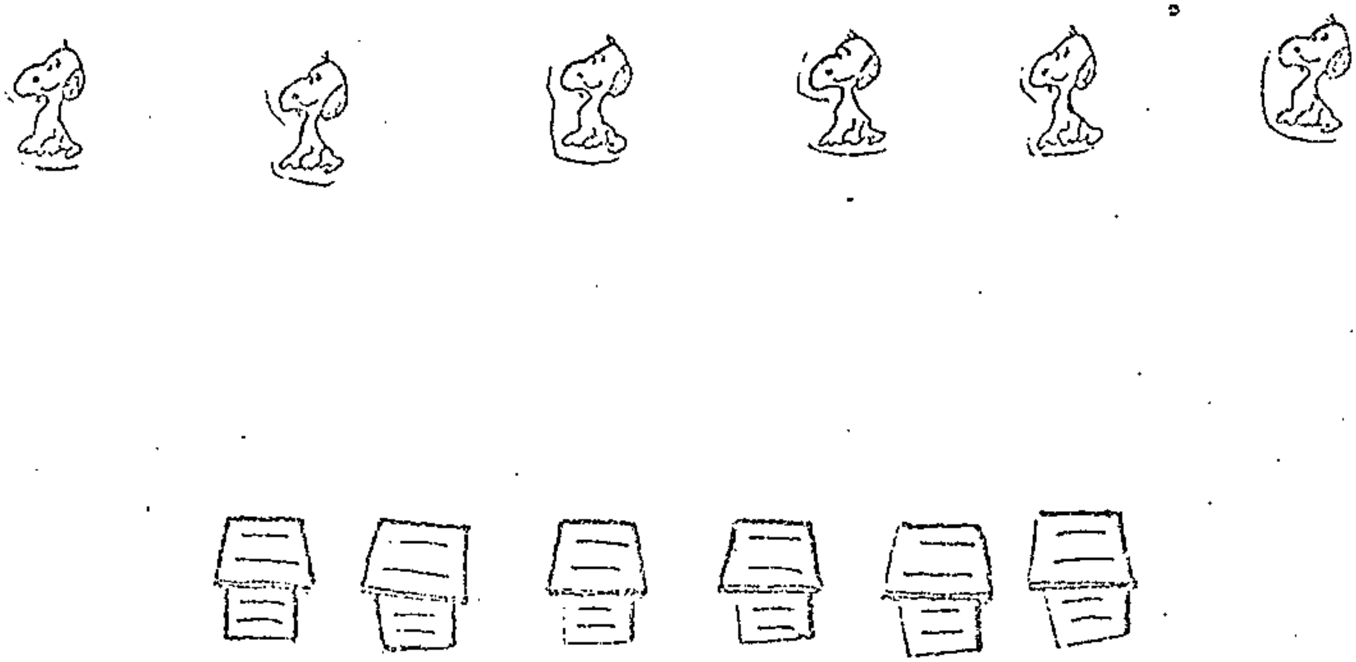
Ten trials of this type were designed and, as in the discrimination procedure they varied in number and type of transformation. For some trials the dogs were moved, for others the houses were moved. As in the discrimination training, the first series were aided by color cues which were eliminated in the second series. Again four consecutive correct responses were the criterion for terminating the training.

Controls. Like the training groups, the control group also was seen on two consecutive days. Each child was exposed to the training materials but did not receive any specific training.

Immediate Posttest. First, the same conservation of number tasks used in the pretest were readministered for the posttest. In addition, four other conservation tasks were administered to assess the transfer of the number conservation training to other types of conservation. The conservations assessed were mass, length, area and discontinuous quantity. Since number conservation is usually the first conservation acquired, additional con-



Starting Position



Dogs Moved Out

Fig. 2. Sample cards: Reversibility training

servation tasks had not been administered as part of the pretest. The order in which these four tasks were administered was counterbalanced across all subjects via a Latin Square design. There were two transformations for each conservation type. Questions were similar in form to the conservation of number questions.

To test conservation of mass, play dough was used. The experimenter divided a can of the dough into two pieces and rolled them into balls, adjusting them until the child agreed that they contained the same amount. The experimenter then rolled her ball into a long "hot dog" and posed the series of conservation questions. The child's responses and comments were recorded. After restoring the two balls and again obtaining a judgment of "same", the child's ball was broken into three pieces and the conservation questions repeated.

For length conservation, two 1/4-inch round sticks, nine inches long were displayed parallel to each other with ends aligned. The child was asked if they were the same length. The first transformation was made by sliding one stick to the right and the conservation questions were posed. After aligning the sticks again, the second transformation was made by placing one stick at a 45° angle to the other and the conservation questions were repeated.

Conservation of area was assessed using two identical sheets of green construction paper as "fields". A plastic toy horse was placed on each field and the child was asked if the horses had the same amount of grass to eat. Three barns were then added to each field. On one field the barns were placed side by side along one edge and on the other field the barns were placed in each corner and the child was asked if the horses had the same amount to eat now. The second trial was similar except that four barns were used and it should be noted here that each barn was a different color.

The final conservation task, discontinuous quantity, was given using transparent cylinders and sunflower seeds. The seeds were poured into two identical cylinders and adjustments made until the child agreed that the two cylinders contained the same amount of seeds. The contents of one cylinder were poured into another cylinder which was taller and narrower and the conservation questions posed. After establishing equality again, the second transformation was made by pouring the seeds into a cylinder which was shorter and wider and the conservation questions were repeated. As noted previously all of the child's answers and comments were recorded.

Delayed Posttest. The same materials and procedures were again employed for the delayed posttest. As before, number conservation was assessed first and the other four tasks were given in counterbalanced order across subjects. No subjects were lost between immediate posttest and delayed posttest so that complete data were obtained for 72 subjects.

Results

Pretraining Data

Table 2 presents the intercorrelations among the pretraining variables for the entire sample. As can be seen from Table 2, there were two significant correlations. They were (1) a negative correlation between the conservation score and errors on the KRISP ($p < .01$) and (2) a negative correlation between the time and errors on the KRISP ($p < .01$). None of the measures correlated with age, probably because the age range for this particular population was quite narrow.

TABLE 2

CORRELATION MATRIX: PRETRAINING VARIABLES, ALL SUBJECTS (N=186)

	AGE	CONS	L-S	KRISP TIME	KRISP ERROR
AGE					
CONSERVATION	0.0650				
LEVELING-SHARPENING	0.0094	-0.0350			
KRISP TIME	-0.1142	0.0392	-0.0196		
KRISP ERROR	0.0415	-0.2379*	0.0469	-0.2445*	

*p < .01

Correlations were also computed for the conservers and nonconservers separately. Tables 3 and 4 present these data. There was

TABLE 3

CORRELATION MATRIX: PRETRAINING VARIABLES, CONSERVERS (N=114)

	AGE	CONS	L-S	KRISP TIME	KRISP ERROR
AGE					
CONSERVATION	0.0486				
LEVELING-SHARPENING	0.0231	0.0378			
KRISP TIME	-0.1152	0.0332	-0.0149		
KRISP ERROR	-0.0589	-0.1309	0.1152	-0.2614*	

*p < .01

TABLE 4

CORRELATION MATRIX: PRETRAINING VARIABLES. NONCONSERVERS (N=72)

		AGE	CONS	L-S	KRISP TIME	KRISP ERROR
AGE						
CONSERVATION		-0.0673				
LEVELING-SHARPENING		-0.0070	-0.0691			
KRISP	TIME	-0.1232	-0.1436	-0.0234		
	ERROR	0.2077	0.1814	-0.0511	-0.2124*	

*$p < .10$

one significant negative correlation ($p < .01$) for the conservers (between KRISP time and error). For the nonconservers, no significant correlations emerged. The negative correlation between the KRISP time and error scores was marginally significant ($p < .10$).

In Table 5 the mean scores and standard errors on the pretraining variables for the conservers and the nonconservers are presented. Comparisons of the means by t-test for each sex sepa-

TABLE 5

COMPARISONS OF MEANS FOR CONSERVERS AND NONCONSERVERS

ON PRETRAINING VARIABLES

Variables	Conservers Mean	SD	Nonconservers Mean	SD	t
Age	5.80	0.35	5.75	0.40	0.8704
Lev-Sh	20.37	3.75	20.69	4.56	0.50
KRISP Time	4.82	1.78	4.67	1.53	0.6110
KRISP Error	2.36	1.75	3.26	1.92	3.2225*

*$p < 0.01$

rately did not yield any significant results and so the data for the sexes have been combined.

The largest difference between the groups is found for the KRISP errors, a finding which is reflected in the significant correlation between the conservation score and KRISP errors as previously mentioned. Without exception, the means for the conservers differed from the nonconservers in the expected direction, if one assumes that generally the conservers are developmentally ahead of the nonconservers. That is to say, even though the differences did not reach significance, the conservers were older, more sharpening, and took a longer time to respond but were more often right.

Justifications. The justifications offered by the natural conservers who scored four on the number conservation pretest were examined to determine if there was a relationship between the child's cognitive style and his choice of justification for the conserving responses. Four classificatory categories were established based on discussions by Piaget (1965), Hooper (1969) and Rothenberg (1969). The four categories were identity, reversibility, addition-subtraction and counting. Table 6 shows the number of levelers and sharpeners who gave justifications in each category. A child was assigned to a category on the basis of his first explanation if he offered more than one.

TABLE 6

JUSTIFICATIONS GIVEN FOR NUMBER CONSERVING RESPONSES

BY LEVELERS AND SHARPENERS

	Levelers	Sharpeners	All
Identity	18	15	33
Reversibility	1	0	1
Addition-Subtraction	2	2	4
Counting	30	29	59
Total	51	46	97

Table 6 shows that the majority of the children justified their conserving responses by counting. It is possible that this response was influenced by the nature of the materials and the experimenter's asking the child to "take out five checkers", as well as the counting activities fostered in the classrooms. There were no differences between the levelers and sharpeners in the type of justifications which they gave. A similar analysis of justifications according to the impulsive or reflective status of the child yielded a similar pattern of findings. Type of justification did not systematically relate to the child's cognitive style.

Post-test data

Effect of training compared to control group. To determine whether the training procedures, *per se*, were effective inducers of conservation (irrespective of cognitive style), an analysis of variance of the number of conserving responses which occurred in the two training groups and control group was performed. In addition to the training factor, two additional factors, immediate vs. delayed post-tests and number conservation vs. transfer conservation tasks, were included in the overall analysis. Since there were twice as many transfer tasks administered than there were number conservation tasks, the total number of transfer tasks passed by an individual child was divided by two. In effect this procedure equated performances over the two sets of tasks. The mean number of conserving responses according to training group and type of conservation task are given in Table 7.

TABLE 7

MEAN NUMBER CONSERVING RESPONSES FOR TRAINING

GROUPS ON NUMBER AND TRANSFER CONSERVATION TASKS

Training	Conservation Task Number	Transfer	Total
Discrimination	3.32	1.42	4.74
Reversibility	3.22	1.59	4.81
Control	.75	1.06	1.81
Total	7.29	4.07	

The analysis of variance revealed a significant training effect ($F = 5.13$, $df=2,69$, $p < .05$). The mean number of conserving responses (out of a possible 16) given by the reversibility and discrimination training groups was 4.81 and 4.74, respectively, while the control group mean was 1.81. Thus, the training procedures do appear to induce conservation, although differences between the two training groups are close to zero.

In addition a second marginal outcome was obtained in the comparison between the number conservation vs. the transfer conservation tasks ($F=2.81$, $df=1,69$, $p < .10$). A greater number of number conservation trials were passed ($\bar{x}=3.64$) compared to the transfer task ($\bar{x}=2.04$).

<u>Pretraining Data Related to Posttest Performance.</u> Out of the 48 children who received number conservation training, 21 subjects gave number conserving responses on the immediate posttest. There were 17 subjects who gave no conserving responses at all either on number conservation or the transfer tasks. These two groups can be examined to determine whether they differ from each other on any of the pretest measures. Table 8 presents the means and standard deviationfor these two groups on each of the pretraining variables.

TABLE 8

MEANS FOR POSTTEST CONSERVERS AND NONCONSERVERS

ON PRETRAINING VARIABLES

	Conservation of Number		No Conservation		t
	X	SD	X	SD	
Age	5.84	0.29	5.69	0.42	1.30*
Lev-Sh	20.87	4.46	20.32	4.92	1
KRISP Time	4.48	1.25	4.87	2.10	1
KRISP Error	2.81	1.40	2.77	1.73	1
Motor Base	3.21	2.00	3.44	1.40	1
Trials to Crit.	8.91	1.69	11.06	3.86	2.14**
n=	21		17		

* $p < 0.1$

** $p < 0.025$

Inspection of Table 8 indicates that, over all training, children who acquired conservation are not very different on the whole from children who did not benefit from training. Two exceptions were that those who acquired conservation were older ($p < .10$) and took significantly fewer trials to criterion (regardless of the type of training) than children who did not acquire conservation ($p < .025$).

One additional procedure was carried out with the data for the pretraining variables. The trained subjects were again divided into three groups according to whether they had made gains in conservation responses posttest to delayed posttest, stayed the same, or lost. There were no significant differences among the means for these three groups on any of the pretraining variables.

Relation of justifications to type of training. An analysis of the justifications of the "natural" number conservers, reported in Table 6, did not demonstrate a cognitive style influence. The justifications for number conservation offered by children who conserved after training were also examined. Table 9 records the number of conserving responses justified by counting strategies or non-counting strategies according to the type of training which the child received.

TABLE 9

JUSTIFICATIONS FOR CONSERVING RESPONSES ACCORDING TO TYPE OF TRAINING

	Training	
Justification	Discrimination	Reversibility
Counting	8	3
Non-Counting	3	7

($p = 0.0634$ by Fisher's exact test)

It does appear that the type of training affected the justification offered by the child. It can be argued that this finding provides some indirect evidence that the two types of training did have effects which were different from each other. And, children did acquire the strategies which the training techniques were designed to foster. Most of the children (8 out of 11) trained by the discrimination procedure either counted or said "five and five" without counting. The discrimination training did include the suggestion that the child could count. However, the objects and the form of the posttest items were quite different from the training trials so that the use of counting would seem to be a genuine transfer of strategy. Another child used addition-subtraction and, of the remaining two, one said, "We took out five for each" (previous equality) and the other described the operation performed, e.g., "you just spread them out". Among the children trained by reversibility procedures, three also counted but six either referred to the previous equality or described the operation performed. The remaining child said "still five", a troublesome response to classify because it does contain the number but there is not counting and the word "still" implies the recognition of an identity. These classifications were made on the basis of the first response and some eventually offered all the possible justifications, however, "still five" was not the first choice of the discrimination group. Generally, there was little change from posttest to delayed posttest, that is, most subjects gave the same justification.

Interaction of type of training and cognitive style. Table 10 presents the number of children who acquired conservation of number for each combination of the two cognitive styles on the immediate and delayed posttests.

TABLE 10

NUMBER OF TRAINED SUBJECTS ACQUIRING NUMBER CONSERVATION, COGNITIVE STYLES COMBINED, IMMEDIATE AND DELAYED POSTTESTS

	Immediate Posttest			Delayed Posttest		
	Impulsive	Reflective	Total	Impulsive	Reflective	Total
Levelers	8	2	10	7	2	9
Sharpeners	4	7	11	2	7	9
Total	12	9	21	9	9	18

It can be seen in Table 10 that while impulsive and reflectives have learned at about the same rate and so have the levelers and sharpeners, there is a clear advantage for impulsive-levelers and reflective-sharpeners over either reflective-levelers or impulsive-sharpeners. Also, the three subjects who gave conserving answers on the posttest but not on the delayed posttest were all impulsive.

To assess the manner in which this pattern of results interacted with different forms of training, two analyses of variance were carried out, one for the conservation of number and the other for the transfer tasks. For these analyses, the two training groups were retained as a factor but the control group was not, since at this point in the analysis it was known that an overall training effect was present and the primary interest now centered around the interaction of style types with training. Table 11 contains the mean number of conserving responses on conservation of number obtained from children classified according to both impulsivity-reflective scores and leveling-sharpening scores for discrimination and reversibility training.

TABLE 11

MEAN OF NUMBER CONSERVING RESPONSES: COGNITIVE STYLES BY TRAINING IMMEDIATE AND DELAYED POSTTESTS COMBINED

	Impulsive		Reflective		Combined I-R	
	Discrim.	Revers.	Discrim.	Revers.	Discrim.	Revers.
Levelers	1.58	2.79	1.33	0	1.46	1.63
Sharpeners	0.50	1.57	2.50	1.60	1.86	1.59
Combined L-S	1.15	2.18	1.92	0.80		

An analysis of variance of the data represented in Table 11 was undertaken. Two significant effects emerged. First, a two way interaction between the two cognitive styles emerged ($F=7.79$, $df=1,40$, $p < .01$). In effect this interaction is congruent with the pattern of results given in Table 10. Compared with impulsive-sharpeners or reflective-levelers the other two combinations of reflective-sharpeners and impulsive-levelers are much more responsive to conservation training. Second, a significant two way interaction occurred between the impulsive-reflective cognitive style dimension and the type of training administered ($F=7.41$, $df=1,40$, $p < .01$). The means relevant for describing this interaction appear in the bottom row of Table 11. Impulsives profit more from discrimination training whereas reflectives are more susceptible to reversibility training. There was no evidence that the type of training differently affected levelers as opposed to sharpeners ($F < 1$, n.s.). The last two columns of Table 11 indicate that the means are very similar. Finally it should be noted that there were no significant performance differences between impulsives and reflectives, between levelers and sharpeners, nor between the discrimination and reversibility training procedure (F's < 1.0, n.s.).

The transfer tasks from the immediate and delayed posttests were also examined to ascertain interactions of cognitive styles with different types of training. Table 12 contains the mean number of conserving responses on the transfer tasks for children classified according to both cognitive style components as well as type of training they received. To enable comparisons with data from number conservation, the total number of responses in the transfer task was divided by two. As noted previously, twice as many transfer tasks were given.

TABLE 12

MEAN OF TRANSFER CONSERVING RESPONSES: COGNITIVE STYLES BY TRAINING, IMMEDIATE AND DELAYED POSTTESTS COMBINED

	Impulsive		Reflective		Combined I-R	
	Discrim.	Revers.	Discrim.	Revers.	Discrim.	Revers.
Levelers	0.29	0.28	1.21	0.30	0.75	0.29
Sharpeners	0.44	1.58	0.78	0.95	0.66	1.30
Combined L-S	0.34	0.94	1.00	0.62		

An analysis of variance of the data represented in Table 12 revealed two significant outcomes as well as two marginally significant findings. There was a significant change in the number of conserving responses from the immediate to the delayed posttest ($F=4.77$, $df=1,40$, $p<.05$). An average of 0.62 conserving responses appeared in the immediate posttest compared to an average of 0.83 responses in the delayed posttest. Further, a significant interaction was found between the impulsive-reflective cognitive style factor and the immediate-delayed posttest factor ($F=4.47$, $df=1,40$, $p<.05$). The mean score for the impulsives on the immediate posttest was 0.64 and for the delayed posttest it was 0.64. The mean for the reflectives on the immediate posttest was 0.60, and for the delayed posttest the mean was 1.02. From these means it can be seen that the interaction effect was due mainly to the gains made by the reflectives from the immediate posttest to the delayed posttest.

Both of the marginally significant effects involved the interaction of the two cognitive style measures with the training variable. Regarding the interaction of leveling-sharpening with training ($F=3.25$, $df=1,40$, $p<.10$) levelers tend to profit more from discrimination training procedures while sharpeners profited more reversibility training. The last two columns of Table 12 depict this outcome. In the interaction of impulsivity-reflectivity and training ($F=3.20$, $df=1,40$, $p<.10$) the outcome was similar to the previous analysis involving number conservation. Impulsives were more susceptible to reversibility training whereas reflectives profited more from discrimination training. The bottom row of Table 12 shows this pattern of findings.

Discussion

Before considering the several findings which relate to cognitive style and conservation, some comments regarding the training effects independent of cognitive style will be offered. Both training techniques induced conservation relative to the control group. Nearly half of the children in the training groups acquired conservation while only one child in the control group did so. Thus, the present findings conform to the host of studies performed over the past decade (cf. Brainerd & Allen, 1971) which show that conservation is influenced by training. Moreover, the findings indicate, as in previous studies (e.g., Beilin, 1965) that the age of a child is a general factor which affects susceptibility to conservation training. Older children are more likely to profit from conservation training than younger children.

Since the present criterion for conservation was of a stringent type and required an adequate justification, it was possible to determine the relationship between type of training administered and type of justification given by the children in the post-tests. The results showed that children who received discrimination training gave predominantly counting justifications, whereas children who received reversibility training offered previous quantity (e.g., "You just moved them") and other non-counting justifications. By comparison, a majority of the natural conservers (60%), like the discrimination trained children, supplied counting as a basis for their justifications. The similarity between natural conservers and discrimination trained conservers, on the one hand, and their difference from the reversibility trained conservers suggests that there may be some important differences in the type of conservation which the two training procedures induce. Schnall et.al. (1972), for instance, suggest that some reversibility training techniques can result in a form of pseudo-conservation which is "preoperational" in character.

In addition, it was found that the acquisition involved in the two training techniques appeared to be somewhat different. The children who acquired conservation under discrimination training took significantly fewer trials to criterion than the children who did not acquire conservation under discrimination training ($p < .05$). Under reversibility training no clear relationship between trials to criterion and conservation in the post-tests was found. Most of the children supplied with reversibility training could predict equality on return starting with the first trial. Thus, compliance with reversibility training was less likely to result in conservation acquisition.

Given these differences between discrimination and reversibility training, an intriguing possibility for future research would be to determine whether training techniques provide rather different forms of conservation mastery. If so, such differences might be expected to appear in different performance (cf. Flavell & Wohlwill, 1969) and "generalizability" profiles across cognitive measures assumed to be related to number conservation (e.g., measuring, classification).

The findings show that cognitive style variables ~~are~~ related to the process of conservation acquisition in several ways. The major finding of the study was in support of the central hypothesis, i.e., a style X training interaction. On the number conservation task, impulsive children profited most from reversibility training while discrimination training was most effective among reflective children. There was also some evidence that a similar kind of interaction occurred in the transfer tests of conservation. Moreover, the interaction did not simply show that impulsives failed to profit from the discrimination training. It also showed the converse effect with reflective children. Reversibility training was a less effective inducer of conservation in this group. Thus, there appeared to be a genuine interaction whereby different training techniques are most effective in different cognitive style groups.

The most plausible explanation for this outcome was tentatively suggested in the introduction. Reversibility training which requires less stimulus scanning and dissection was more appropriately suited to the conceptual tempo and mode of information processing of impulsive children. Several investigators (e.g., Drake, 1967; Zelinker et.al., 1972) have examined characteristic information processing differences between impulsive and reflective children. These studies support the notion that reflective children engage in more visual scanning and point by point comparisons than impulsive children.[1]

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[1]It should be noted that these characteristic information processing styles appear to be closely related to the fact that reflectives are engaged for longer periods of time with these visual arrays.

While the foregoing line of reasoning may explain the inability of the impulsives to profit from discrimination training, it does not explain why reversibility training was much less effective among reflective children. Other than requiring less stimulus scanning and analysis, it is not clear what specific demands the reversibility technique contains which make it more difficult for reflective children.

In addition to its interaction with different training procedures, certain aspects of the impulsive-reflective dimension were related to processes of conservation acquisition in other important ways. First, natural conservers were found to make fewer errors on the KRISP than non-conservers prior to any training. Although no data were collected on the visual scanning patterns during exploration of the KRISP items, previous research supports the assumption that children who made more errors were less systematic in their search strategies (Zelinker et.al., 1972). Furthermore, other investigators (O'Bryan & Boersma, 1971) have shown that in the visual inspection of conservation problems (whereby two perceptually equivalent quantities are displayed and then one of these is transformed into another perceptual shape or configuration), natural conservers display more systematic exploration (decentrations) and comparisons (couplings) of the conservation items than non-conservers. From the present findings, it would seem that such systematic perceptual activity is not limited to the conservation problems per se, but extends to other arrays which bear resemblance to conservation tasks. In this sense, conservation acquisition appears to be associated with a fairly generalized shift away from "perceptual seduction". Of course, the directionality of these processes is not clear; that is, it is not known if perceptual activity is a condition for cognitive reorganization, if the reverse is true, or if each of the two processes reciprocally affect a change in the other.

Another finding, limited to the transfer tasks, showed that reflective children improve their performance from the immediate to the delayed post-test while impulsive children do not. Immediate to delayed post-test improvements have been noted several times in previous conservation research (e.g., Curcio et.al., 1971), although the reasons for such improvements have not been clearly understood. Goulet (1972) suggests that certain aspects of cognitive change are due to two types of skills, enactive and inhibitory. Enactive skills are skills which are used directly in the learning problem and they are positively correlated with the mastery of the task. Inhibitory skills are skills which make it possible for the individual to withhold a response or strategy which interferes with task mastery. Goulet assumes that performance is a product of both enactive and inhibitory skills and that inhibitory skills are developed later than enactive skills, an assumption which parallels a distinction between competence and performance offered by Flavell and Wohlwill (1969). Once enactive skills (such as discrimination, or perhaps in Piaget's terms, compensation and reversibility) have developed the crucial factor on a given task may be the ability to delay a response so that enactive skills can be utilized fully. This explanation is consistent with many observations (e.g., Piaget, passim) that children often possess the prerequisite skills for conservation, such as addition-subtraction, reversibility or compensation, but still they do not conserve.

Soulet explicitly suggests that the acquisition of conservation can be seen as dependent upon both enactive and inhibitory skills. Conservation training studies which emphasize the acquisition of component skills such as addition-subtraction, reversibility, etc. (e.g., Wallach et.al., 1967) have focused upon enactive skills while Bruner (1966) and others appear to suggest that training should be designed to inhibit the child's tendency to attend to illusory or misleading cues.

The ability to deploy these inhibitory strategies in the conservation problem may be one reason for the reflective's improved performance in the delayed post-test. Immediately after training the enactive rules for conservation provided by such training should exert their strongest influence. With the passage of time the importance of enactive processes relative to inhibitory influences may decline. As inhibitory skills become a more predominant aspect of the conservation problem, reflectives will perform that much better on conservation tasks than impulsive children. Although the foregoing explanation contains several unsupported inferences, it is plausible enough to warrant further investigation.

Finally, an interesting interaction emerged between the leveling-sharpening and impulsive-reflective dimensions on the number conservation post-tests. Certain combinations of these two styles (i.e., impulsive levelers and reflective sharpeners) were associated with a greater susceptibility to conservation training. Not enough is known about the relationship between the two cognitive style dimensions to speculate further upon the causes for such an interaction. Since no other tests of mental ability were administered it is not known, for instance, whether any overall I.Q. differences existed among the four cognitive style combinations.

In summary, the results showed several instances in which cognitive style variables interacted with processes of conservation acquisition. Style variables were associated with: (1) the conservation status of children before training; (2) the susceptibility of children to different forms of training, and (3) improvements in conservation status from immediate to delayed post-tests. Perhaps the most consistent and sensible interaction was the anticipated style X training interaction. In this interaction it was shown that impulsive children profit most from reversibility training and reflective children profit most from discrimination training. On the other hand, the leveling-sharpening dimension did not seem to interact with conservation acquisition in any consistent manner. The leveling-sharpening dimension is thought to tap heavily processes of memory and information retrieval. Perhaps such processes are less important in conservation than in other domains of cognitive development. For instance, it has been suggested (Bryant & Trabasso, 1971) that the ability to solve transitivity problems is strongly influenced by memory. If so, perhaps the leveling-sharpening dimension would be more clearly related to transitive reasoning tasks than it is to conservation tasks.

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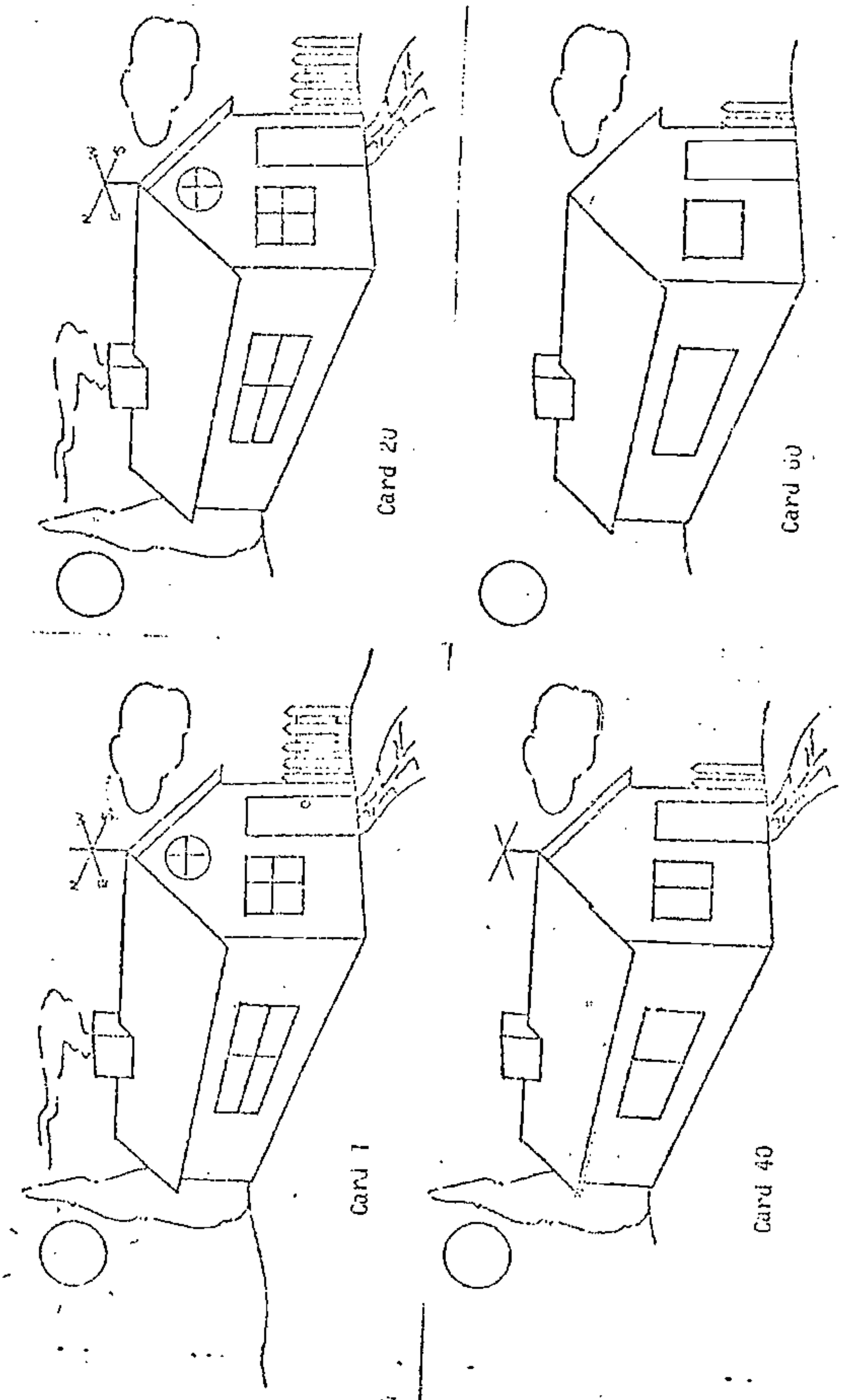

Sample cards from Santostefano's House Test

Appendix B

Sample Card Wright's Kansas
Reflection-Impulsivity Scale