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AN INVESTIGATION INTO THE USE OF DIFFERENT DEGREES OF FILMED VERBAL EXPLANATIONS ON THE ACTIVATION, GENERALIZATION, AND EXTINCTION OF THE CONSERVATION OF SUBSTANCE PROBLEMS IN CHILDREN.

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AN EXTENSION OF MODELING BEHAVIOR INTO COGNITIVE AREAS OF DEVELOPMENT WAS ATTEMPTED THROUGH THE USE OF FILM-MEDIATED MODELS FOR THE ACTIVATION AND GENERALIZATION PHASES OF THE CONSERVATION PROBLEM. FOUR HYPOTHESES WERE SET UP IN AN ATTEMPT TO QUESTION SUCH PREVIOUS EXPLANATIONS OF THE CONSERVATION RESPONSE AS THOSE OF PIAGET AND BRUNER. THE HYPOTHESIS THAT ACTIVATION OF THE CONSERVATION OF SUBSTANCE CAN BE FACILITATED BY THE USE OF FILM-MEDIATED MODELS WAS SUBSTANTIATED. THE HYPOTHESES CONCERNING GENERALIZATION AND EXTINCTION OF THE CONSERVATION RESPONSE WERE NOT SUBSTANTIATED. THE NEGATIVE RESULTS OF THREE OF THE FOUR HYPOTHESES RAISED SOME CENTRAL QUESTIONS CONCERNING PREVIOUS EXPLANATIONS GIVEN FOR THE CONSERVATION RESPONSE. FURTHER STUDIES SHOULD BE MADE ON THE SEMANTICS OF THE CONSERVATION PROBLEM AND ON VERBAL AND NONVERBAL METHODS OF EXPLORATION. (GD)

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by

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B.S., Saint Peter's College, 1960

ABSTRACT OF DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Psychology in the Graduate School of Syracuse University, July, 1966

Approved ______________________

Date ______________________

The purpose of this study was to investigate the activation, generalization and extinction of conservation of substance problems in children. Four hypotheses were tested. The first hypothesis was that the "activation" of the conservation of substance can be facilitated by the use of film mediated models. The activation was expected to operate equally well whether the models provide verbal explanations or not. The second hypothesis was that the "generalization" of the conservation of substance would be greater for subjects who see the film model give symbolic explanations (i.e., via verbal principles) than for those subjects who do not receive symbolic explanations. The third hypothesis was that the "extinction" of the conservation of substance will be greater for children who are acquired conservers than for children who are natural conservers. The fourth hypothesis was that the "extinction" of the conservation of substance would be greater for the activation group which does not receive the symbolic verbal explanation versus the group which receives it.

There were five phases to the present study: a pretest, a training phase, an activation phase, a generalization phase, and an extinction phase. One hundred children in the first grades of two urban school systems, ranging in age from 6 years, 4 months to 7 years, 10 months. The children were broken down into four different groups as a result of pretesting. Twenty-five children were assigned to each group. The four groups were as follows: 1) A Natural Conserver Group; 2) Verbal Principle Group; 3) No Principle Group; and 4) a Control Group. Except for the Natural Conserver Group, all of the children were non-conservers on the pretest and were randomly assigned to the different treatments. In Phase 1 the children were pretested on the conservation of wire substance and assigned to the above groups accordingly. In the second phase, the children received different treatments. Two experimental groups saw an adult model solve a conservation of water substance problem. The model in the Verbal Principle Group gave appropriate verbal explanations as reasons for conserving while the No Principle

Group model just conserved without giving a principled explanation. The Natural Conserver and Control Groups were given a free conservation period with the experimenter approximately equated to the film times. Phase 3 was the "activation" phase and all groups were tested on the conservation of water substance. In the fourth phase, the children were tested on the conservation of clay, which was generalization substance. Phase 5 was the extinction phase, in which the Natural Conservers, Verbal Principle, and No Principle groups received disconfirming evidence for conservation.

Hypothesis 1 was the only one of the four hypotheses substantiated. The two experimental groups performed significantly better on a conservation of water substance problem (activation) after seeing the film modeling, when compared with the control group who did not see the films. There was no significant difference between the two experimental groups in the generalization phase. Furthermore, the two experimental groups and the natural conservers did not differ significantly from one another in the extinction phase.

These results replicated previous experiments which have induced the conservation response in children who were originally non-conservers. Although there was no significant difference between the two experimental groups in the generalization phase, it was nevertheless demonstrated that the conservation response could be generalized, since both experimental groups performed better than the control group in this phase. The fact that there was no significant difference between natural conservers and induced conservers in the extinction was contrary to previous findings on the extinction of the conservation response.

The findings raised some interesting questions concerning the nature of the conservation response. Heretofore, the movement from nonconservation to conservation was felt to be an advance in cognitive development. This is an interpretation held by both Piaget and Bruner. The results of the present experiment, however, tend to support a "semantic" interpretation of conservation. It was suggested that the activation and generalization of the conservation response may not be a radical reorganization of cognitive structure, but moreso a learning of adult definitions of such words as same, more, and less.

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CHAPTER I

INTRODUCTION

For the past several years, a considerable amount of interest in cognitive development has been generated by Piaget's (1960) theory of intellectual development. In articulating his theory of intellectual development, he has been concerned with the formulation of coherent and meaningful stages, which reflect the direction and course of mental development. In discussing the evolution of intelligence, Piaget categorized intelligence into two main classes: 1) Sensori-Motor Intelligence (birth to 2 years) which refers to all those operations which are preverbal and are not mediated by signs and symbols, and 2) Conceptual Intelligence (2 years to maturity), in which the processes of adaptations are mediated by signs and symbols. A considerable portion of contemporary Piagetian research has concerned itself with the transition in cognitive processes that occurs as the child advances from sensori-motor intelligence to conceptual thought. Specifically, the research has centered around the transition from preoperational reasoning to reasoning at the concrete operational level. One of the most salient features of this transition is the acquisition of the various "conservations." Conservation refers to the "cognition that certain properties [quantity, number, and length, etc.] remain invariant [are conserved] in the face of certain transformations [displacing objects or object parts in space, sectioning an object into pieces, changing shape, etc.]" (Flavell, 1962, p. 245). The conservation problems have been utilized by Piaget to explore the development of higher order cognitive processes in the child (Piaget & Szeminska, 1952). The relevance of confronting children with problems of conservation stems from Piaget's (1965) contention that conservation is a necessary condition for all rational activity. Furthermore, the child's response to conservation problems is an indication of his present conceptual level.

Piaget (1965) has indicated three stages in the development of conservation. The first stage is characterized by the absence of conservation. The child considers it natural for the quantity of the liquid to vary according to the form and dimensions of the container into which it is poured. Perception of apparent changes is therefore not corrected by a system of relations that insures invariance of quantity. The second stage is a period of transition in which conservation gradually emerges. Here, conservation is recognized in some cases, but not in all cases. The third and final stage occurs when the child at once postulates conservation of the quantities in each of the transformations to which they are subjected. Several replication studies have been performed on Piaget's stages of conservation. Elkind (1961) investigated conservation of mass, weight, and volume in school children, and found as did Uzgiris (1964), that conservation of mass (substance), weight, and volume developed in the sequence Piaget postulated. Feigenbaum (1963) studied the problem of conservation of discontinuous substance and although his results were inconsistent with a stage theory defined by chronological age, he discerned general trends in the development of conservation. Kooistra (1963) studied gifted children with IQ's over 130 and found that conservation of substance, weight and volume occurs in a sequence of development consistent with Piaget's theory.

The conservation technique as employed by Piaget and Szeminska (1952) was used to test whether the child can conserve properties of matter such as substance, weight, and volume across transformations in appearance. The rationale of this kind of research, as described by Piaget and Inhelder (1956), is that children will be unable to conserve such properties until higher level cognitive operations achieve dominance over perceptual processes. The child who is "field dependent" (Witkin *et al*., 1962) is more responsive to changes in appearance than to the underlying stable properties of weight, substance, or volume. Smedslund (1961a) notes that the development from non-conservation to conservation may be seen as a transition from a perception bound concept to a concept liberated from the domination of current perception. The subject without conservation is dependent on the momentary physical perceptions whereas the subject with conservation ignores his perception and depends on inner symbolic representation.

Recent research in this area has been oriented toward the investigation of various ways of "activating" more mature conceptual operations which free the child from his "field dependence" so that more "field independent" (Witkin et al., 1962) or symbolic thought may operate in solving the problem. Bruner (1964) maintained that this "activation" can be achieved by two means; one way is to have the child "say" the descriptions of something before him that he must deal with symbolically, and the other is to take advantage of the remoteness of reference that is a feature of language and have the child "say" his description in the absence of the things to be described. With the first method of activation, it is hoped that the language will override the perceptual input, whereas in the second the perceptual input is temporarily inhibited so that more conceptual modes of thinking may initially gain dominance.

The first method (i.e., saying while seeing method) has been employed by Smedslund (1961a) and Sullivan (1963). Smedslund attempted to extinguish the visual components of the weight concept by presenting subjects pairs of objects of the same shape but extremely unequal in size, where the smallest object usually was the heaviest. This technique was not successful. Sullivan (1963) induced the phenomenon of conservation in previous non-conservers by using a technique derived from Smedslund's discussion of "cognitive conflict" (Smedslund, 1961a, d). Smedslund hypothesized that a crucial factor in maintaining conservation may be the induction of cognitive conflict. This conflict lies in the standard questions of the pre- and post-tests: "Do you think this one weighs more than, the same as, or less than that one?" Children who conserved showed longer reaction times looking back and forth, and occasional tension, thus indicating some inner conflict. Non-conservers did not ordinarily show this cognitive conflict. Sullivan's (1963) method was to induce "cognitive conflict" in the children by questioning them about the appearance of matter (clay) in full view of the materials themselves. The results indicated that a significant number of children shifted from non-conservation to conservation as a function of the induction of cognitive conflict. However, Sullivan pointed out that no provision was made to control for the possibility that subjects might simply repeat in the test phase solutions "suggested" in the training phase. Because of this difficulty, children may be simply verbalizing arbitrary empirical laws to please the adult experimenter, which have no inner logical necessity for them. This interpretation may be plausible since Smedslund (1961b) found that the children who have learned conservation through training, lose conservation when the problem situation is manipulated so as to counterindicate its validity.

The second of Bruner's (1964) methods (i.e., saying without seeing) of activation has been employed by Frank (Bruner, 1964). Frank demonstrated that the conservation of substance can be induced by utilizing a technique which encouraged children to rely on conceptual as opposed to more perceptual modes of thinking by putting a "screen" in front of the flasks while the transformations were taking place. The reason for this was to activate a verbal formula of solution when the perceptual cues were absent. The results indicated that the child was better able to resist the overwhelming sensory input and conserve substance subsequent to the screening procedure.

Both of these methods of activation hint at the possible importance of the role of language in facilitating more conceptual or symbolic modes of thinking. Luria's (1961) work on language development points to the important role that language plays in the regulation of other aspects of behavior (e.g., problem solving). Kuenne (1946) has demonstrated the utility of language in solving transposition problems. Ervin (1961) has demonstrated the transfer effects of learning a verbal generalization in solving new problems.

Bruner (1964) has proposed that the activation of language habits that the child has already mastered might improve performance on the conservation problems (e.g., Frank's experiment). Bruner and Kenney (Bruner, 1964) in a double classification matrix problem found that children who are more perceptually oriented use confounded language which is insufficient as a tool for ordering. Inhelder and Sinclair (1963) report similar results in Geneva, in that children who were able to transpose the matrix into a different orientation were the same ones who on prior testing, used the comparative form to describe height and diameter differences of vessels in the matrix. They also found that the less successful children were the ones who linguistically confounded two variables (e.g., that one is tall and that one is little). In this explanation a dimensional term (tall) is confounded with a global term (little). Inhelder and Sinclair (1963) have devised verbal training methods to reduce confounding and this has been found to improve performance on the matrix problem. It should be noted that Bruner's two methods of "activation" depend on already existing language habits.

The present experiment contrasts with Bruner's two methods of induction in that it proposed the possibility of teaching a child new verbal principles as opposed to ones that already exist in the child's repertoire. The purpose of this approach was to see if these new principles could be generalized to the problems of conservation. The verbal principles were learned through film modeling behavior.

The importance of modeling in the acquisition of behavior in children has been recently pointed out by Bandura and Walters (1963). Acquiring behaviors through imitation or modeling results primarily from the contiguity of sensory events. Bandura, Ross and Ross (1961) have demonstrated that children's aggressive behaviors have increased by previously being exposed to an adult aggressive model. Bandura and McDonald (1963) report that the exposure to an adult model produces changes in the moral judgments of children. Children have moved from Piaget's (1962) "moral realism" to "moral subjectivism" and vice versa by watching adult models make statements counter to the child's present conceptual state. Bandura and Mischel (1965) have demonstrated similar results in the modification of delay of reward through exposure to live and symbolic models.

The use of modeling or imitation for the learning of verbal principles that might facilitate higher order conceptual operations was chosen to eliminate one of the problems previously noted by Sullivan (1963). He noted that the success of the method of "cognitive conflict" may be due to verbal suggestions made by the experimenter in the phase which may carry over into training the test phase. Coercion or suggestion by adult questioning in the "cognitive conflict" method may be minimized in a modeling procedure since the child's non-conservation response is not directly confronted by an adult. A further precaution of guarding against this artifact has been proposed by Lee (1966) by introducing a generalized testing phase into the experimental design. He notes that if the subject maintains an induced principle of conservation in generalized tests which vary in incremental degrees from the training situation, greater confidence can be placed in the training procedure itself. This can be accomplished by using a generalized test which has a different substance than the one on which the subject was trained (e.g., clay to water).

A further question presented itself concerning the role of imitation film modeling. The question arose from the fact that the present research project stressed the importance of assimilating a verbal principle seen in the film to facilitate solutions to conservation problems. Thus, the amount of verbal material offered by the film model was considered an important variable for consideration. The present study attempted to vary the experimental conditions by having one modeling procedure simply maintain conservation of substance without an articulate verbal explanation, while another experimental condition has the model supply verbal principles. This would further point out the importance of the assimilation of the verbal principles, if it led to differential effects on the generalized task. It was expected that verbal principles can be applied to various related problems, and thus it was thought that the group receiving the condition where the verbal principles were supplied should be at an advantage on a related generalized problem.

Finally, the use of these two experimental groups plus the natural conserver group helped in answering the important question of how permanent were the advances in cognitive ability as a result of the modeling techniques. Smedslund (1961c) described two main theories which attempt to account for the conservation of weight as a result of his activation techniques (i.e., control balance). A learning theory explanation maintains that the principle of conservation is ultimately derived from some kind of reinforcement mediated by external stimuli. Piagetian theory maintains that the principle of conservation is derived primarily from the inner organization and mutual coordination of the subjects schemata. It was expected that the use of principled explanations in the Verbal Principle Group for conservation would be more likely to reorganize the subjects' schemata (i.e., cognitive structure) than an explanation which provided no articulate set of principles (No Principle Group).

Natural Conservers probably have the most organized and coordinated schemata in dealing with conservation since they have had a chance to practice this conservation previous to the experimental conditions. The present study predicted that the permanence of the principle of conservation would be different for the three groups. The Natural Conservers would be most resistant to extinction, then the Verbal Principle Group and finally the No Principle Group.

With the previous consideration in mind, this study attempted to investigate the following hypotheses:

H_1: The "activation" of the conservation of substance can be facilitated by the use of film mediated models. No difference was expected between the two experimental groups during this phase, but both were expected to perform better than the Control Group.

H_2: The "generalization" of the conservation of substance (e.g., water to clay) will be greater for subjects who see film models give verbal principle explanations (Verbal Principle Group) than for those who do not receive verbal explanations (No Principle Group).

H_3: The "extinction" of the conservation of substance will be greater for acquired conservers (i.e., maintained conservation after seeing film) than for Natural Conservers.

H_4: The "extinction" of the conservation of substance will be greater for the group which does not receive the symbolic verbal explanation (No Principle Group) versus the group which receives it (Verbal Principle Group).

CHAPTER II

METHOD

Subjects

The subjects in this experiment were 100 first grade boys and girls, ranging in age from 6 years, 4 months to 7 years, 10 months, and selected from two school systems. First grade subjects were used because a pilot study indicated that this was a transition age where both conservers and non-conservers could be found. The first school system tested was an urban school and the population of children was depleted before the Natural Conserver Group reached twenty-five in number. A suburban school system was then utilized to complete the sample size for the Natural Conserver Group.

Apparatus

The materials used in the conservation tasks were wire, water, and clay. Each substance had a neutral starting shape and then was modified according to substance. The neutral shape of the wire was in the form of a small coil. The modifications were induced by stretching the coil or compressing it (Uzgiris, 1964). The neutral shape of the liquid was two flasks of water of the same height and diameter, with the liquid poured in both to the same level. The shape of the water was modified by pouring it into a container of a different diameter (Frank in Bruner, 1964). The neutral shape of the clay was round like a ball; its modifications were flat like a pancake and elongated like a sausage (Smedslund, 1961b; Uzgiris, 1964).

Procedure

The procedure was carried out in five phases. All of the phases of the procedure were completed in one session which lasted approximately twenty minutes. The overall procedure is outlined in Table 1. Two experimenters were used. The first experimenter administered the Pretest and Experimental Conditions (Phases I and II). The second post-test experimenter administered the activation, generalization, and extinction tasks (Phases III,

Table 1

Summary of Procedure

Phase	Control Group	Experimental Group I	Experimental Group II	Natural Conservers
I Pretest	Pretest on wire	Pretest on wire	Pretest on wire	Pretest on wire
II Experimental Manipulation	Free conversation with experimenter	See modeling with verbal principle	See modeling without verbal principle	Free conversations with experimenter
III Activation	Conservation task with water beakers	Conservation task with water beakers	Conservation task with water beakers	Conservation task with water beakers
IV Generalization	Conservation task with clay substance	Conservation task with clay substance	Conservation task with clay substance	Conservation task with clay substance
V Extinction	No task	Extinction task	Extinction task	Extinction task

IV, and V). The post-test experimenter did not know the specific hypotheses of the experiment and also did not see the treatment films. This was to prevent any biasing of results as a consequence of knowing the hypotheses.

Phase I--Pretest Phase

Each subject was pretested on the conservation of wire substance in order to find a population of both natural conservers and non-conservers. The non-conservers, except for the resistance to extinction phase where the controls were not used, received all of the last three phases (III, IV and V) as a measure of the dependent variable of conservation. The natural conservers received all phases but were only analyzed in Phase V. Water or clay were not tested in Phase I in order to avoid practice effects in the pretest, since children usually conserve on wire material before water and clay (Uzgiris, 1964). It was considered plausible to assume that non-conservers on the wire material would also be non-conservers on the activation and generalized phase in view of Uzgiris' findings. This assumption was substantiated by comparing the control group with the two experimental groups on both the activation and generalized phases. Each subject was then assigned to the experimental groups or the control group, according to a subject roster which was randomly constructed.

<u>Phase II--Treatment Phase</u>

In this phase the two experimental groups, comprised on 25 subjects each, were shown the conservation films. There were two actors in the film; an interrogator, and an adult model who answered conservation questions after the interrogator made transformations. The adult model conserved water substance and used the principles of reversibility, identity, compensation, and a distinction between appearance and reality in the Verbal Principle Treatment or just conserved without explanation in the No Principle Treatment. The experimenter prepared the children for the film with the following statement:

"I am going to show you an interesting film. I want you to pay careful attention because after the film I am going to ask you some questions about it."

Both films were about 2 minutes and 45 seconds duration.

In this phase the adult modeling procedure for Experimental Group I (Verbal Principles) was the following:

Interrogator: I am going to pour orange drink into these two glasses and I want you to watch closely. (Both glasses are made equal in amounts.) (Pointing) Would you say that both glasses have the same amount of orange drink in them?

Model: (Pointing) Yes. This one has the same amount of orange drink as that one. (Point to them both.)

Interrogator: You mean to say if I drink this glass (B) and you drink that one (A), we will both drink the same amount of orange drink?

Model: Yes, we would both drink the same amount of orange drink.

Interrogator: Now I want you to watch closely. I am going to pour the orange drink from this glass (B) into this one (Glass C, which is thinner but higher). (Pointing) Is there the same amount of orange drink in this glass (C) as in that one (A) now, or are there different amounts?

Model: (Pointing to both) Both glasses have the same amount of orange drink in them.

Interrogator: But don't these glasses look like they have different amounts of orange drink in them?

Model: Yes, they look different but I still think they have the same amounts of orange drink (Principle of Appearance--Reality).

Interrogator: Why do you think they still have the same amounts of orange drink in them, even though they look different?

Model: (Pointing) Well, this glass here (A) has the same amount of orange drink as this one here (C) because you poured it from this glass here (B) and you didn't take away or add any orange drink (Principle of Reversibility). You see--this glass here (puts fingers around glass C) is narrower than this glass here (puts fingers on glass A) or, this glass (A) is wider than that one (C). When the glass is narrower like this (points to C), the orange drink goes higher (points to level). When the glass is wider like this (points to A) the orange drink goes lower (points to level). (Principle of Compensation). But both glasses still have the same amounts of orange drink in them.

In this phase the adult modeling "Treatment" procedure for Experimental Group II (No Principle) was the following:

Interrogator: I am going to pour orange drink into these two glasses and I want you to watch closely (both glasses are made equal in amounts). (Pointing) Would you say that both glasses have the same amount of orange drink in them?

Model: (Pointing) Yes. This one has the same amount of orange drink as that one (points to them both).

Interrogator: You mean to say if I drink this glass (B) and you drink that one (A) we will both drink the same amount of orange drink?

Model: Yes. We would both drink the same amount of orange drink.

Interrogator: Now I want you to watch closely. I am going to pour the orange drink from this glass (B) into this one (glass C which is thinner but higher). (Pointing) Is there the same amount of orange drink in this glass (C) as in that one (A) now, or are there different amounts?

Model: (Pointing to both) Both glasses have the same amount of orange drink in them.

Interrogator: But don't these glasses look like they have different amounts of orange drink in them?

Model: Yes, they look different but I still think they have the same amounts of orange drink.

Interrogator: Why do you think they still have the same amounts of orange drink in them, even though they look different?

Model: (Looking puzzled and nodding his head) I don't know why they look like different amounts of orange drink. I can't tell you why, but I think they both have the same amounts of orange drink in them.

Interrogator: What did you say again?

Model: I said that both glasses have the same amount of orange drink in them.

Interrogator: Why do you say that?

Model: Well because I think they have the same amounts. Pause: You know--the same amount is in both of them.

Interrogator: Could you tell me why you say that?

Model: Well, all I can say is that I think that they both have the <u>same</u> amounts.

The Natural Conservers and Control Groups were engaged by the experimenter in free conversation for this phase.

<u>Phase III--Activation Phase</u>

In this phase all four groups were tested on the conservation of liquid task. This task is the same as the ones given to the adult model in Phase II. The specific procedure and the standardized questions are given in Appendix B.

<u>Phase IV--Generalization Phase</u>

In this phase all four groups were tested on a generalized clay substance which was given immediately after Phase III. The neutral shape of the clay will be round like a ball; its modifications will be flat like a pancake and elongated like a sausage. The specific procedure and the standardized questions are given in Appendix B.

Phase V--Extinction Phase

The "extinction" phase was used with the two experimental groups and the group of natural conservers. In this phase the three groups were tested initially, and were given the conservation of liquid substance. This part of the task was the same as the ones given to the adult model in Phase II. The specific extinction task occurred after the child maintained conservation of substance. After the response to the previous question, the filled glasses are taken away and put behind a screen. The experimenter then explained that he had forgotten to ask a question and took two filled glasses from behind the screen. Unknown to the child, the transformation glass had been switched and it had more water (higher level) than the comparison beaker when it was poured back into the original glass. The child was then asked to predict if the two original glasses will have the same or different amount of water when the water is poured back from the transformation glass. After the water was poured back he was asked why the water levels are different.

Then the conservation question was asked again to see if the child resisted extinction.

Analysis of the Data

In categorizing the child's response to the conservation tasks, a modified version of Lee's (1966) manual was utilized (Appendix D). The performance of the subjects was rated on a two point scale, i.e., pass or fail. Lee (1966) found the interrater concurrence between two independent judges on a random sample of 30 responses to the conservation task was 29 out of 30 agreements.

A modified version for water substance, of Smedslund's (1961c) criterion for extinction responses with clay, was used in the present study (Appendix E). The pre-test experimenter rated the post-test data blindly, without any knowledge of the treatment group of the subject.

Table 2 shows the number of subjects in the sequential analysis of the conservation response during the three phases. The initial subject population was 100 with 25 subjects to a group during the activation phase.

Table 2

Number of Subjects in the Sequential Analysis of the Conservation Task in the Activation, Generalization, and Extinction Phases

Groups	Phases		
	Activation	Generalization	Extinction
Verbal Principle	25	21	18
No Principle	25	19	14
Control	25	0	0
Natural Conservers	25	23	22
TOTAL	100	63	54

There were various reasons why initial subject population was depleted in the generalization and extinction phases. For example, in the generalization phase several subjects were eliminated in the analysis of the generalization task because they did not initially activate. This eliminated 25 subjects in the Control Group, 4 subjects in the Verbal Principle Group and 6 subjects in the No Principle Group. In the extinction phase, only those subjects who activated and generalized were considered in the analysis. This was a control for confounding of the results due to differential outcomes during the previous phases.

CHAPTER III

RESULTS

Hypothesis 1

Table 3 shows the number of subjects who conserve versus those who do not conserve in the three different treatment groups. Three Fisher's exact probability tests for 2 x 2 contingency tables were performed to test hypothesis 1. The results were as follows: 1) the Verbal Principle Group performed significantly better than the Control Group on conservation in the activation phase (df 1 p .005); 2) the No Principle Group performed significantly better than the Control Group on conservation in the activation phase (df 1 p .005); 3) there was no significant difference between the Verbal Principle Group and the No Principle Group in the activation phase (df 1 p .05). Thus, hypothesis 1 was supported.

Hypothesis 2

Table 4 shows the number of subjects who conserve

Table 3

Number of Subjects Who are Conservers Versus Those Who are Non-conservers as a Result of Three Different Treatments in the Activation Phase

Group	Conserver	Non-Conserver	Total
Verbal Principle	21	4	25
No Principle	19	6	25
Control	0	25	25
Total	40	35	75

Table 4

Number of Subjects Who are Conservers Versus Those Who are Non-conservers as a Result of Two Different Treatments in the Generalization Phase

Group	Conserver	Non-Conserver	Total
Verbal Principle	17	4	21
No Principle	13	6	19
Total	30	10	40

versus those who do not conserve in the two experimental treatment groups. A Fisher's exact probability test for 2 x 2 contingency tables showed no significant difference between the Verbal Principle Group and the No Principle Group in the generalization phase (df 1 p .05). Thus, hypothesis 2 was not supported. The Control Group could not be compared with the two experimental groups in this phase, since none of the control subjects generalized. In order for generalization to occur the child must initially conserve in the activation phase. Since no control subjects conserved in the activation phase, they could not be considered in the generalization phase.

Hypotheses 3 and 4

Table 5 shows the number of subjects who resist extinction as a result of three different experimental conditions. Two Fisher's exact probability tests for 2 x 2 contingency tables were performed to test hypothesis 3. The results were as follows: 1) there was no significant difference between the Natural Conserver Group and the Verbal Principle Group on resistance to extinction (df 1 p .05); 2) there was no significant difference between the Natural Conserver Group and the No Principle Group on resistance to extinction (df 1 p .05). Thus, hypothesis 3 was not supported.

Finally, a Fisher's exact probability test for 2 x 2 contingency tables showed no significant difference between the Verbal Principle Group and the No Principle Group on resistance to extinction (df 1 p .05). Thus, hypothesis 4 was not supported.

Articulation of an Explanatory Principle of Conservation in the Two Experimental Treatments

Several other analyses were performed which were not related specifically to the four hypotheses. Table 6 shows the number of conserver subjects who use an articulate principle versus no articulation of a principle in the two experimental treatment groups, in the activation phase. A Fisher's exact probability test for 2 x 2 contingency tables showed significant differences between the Verbal Principle Group and the No Principle Group in the activation phase (df 1 p .005). Thus, the Verbal

Table 5

Number of Subjects Who Resist Extinction Versus Those Who Extinguish as a Result of Differential Treatments

Groups	Resists Extinction	Extinction	Total
Verbal Principle	8	10	18
No Principle	5	9	14
Natural Conservers	8	14	22
Total	21	33	54

Table 6

Number of Conserver Subjects Who Articulate a Principle Versus Those Who Do Not Articulate a Principle as a Result of Two Different Activation Treatments

Group	Principle Articulated	No Principle Articulated	Total
Verbal Principle	15	6	21
No Principle	5	14	19
Total	20	20	40

Principle Group gave significantly more principled explanations for conservation than the No Principle Group.

Table 7 shows the number of conserver subjects who articulate a principle versus those who do not articulate a principle, in the two experimental treatment groups, in the generalization phase. A Fisher's exact probability test for 2 x 2 contingency tables showed no significant differences between the Verbal Principle Group and the No Principle Group in the generalization phase (df 1 p .05). Thus, there is no significant difference in the occurrence of principled explanations for conservation between the two experimental treatment groups.

Sex Differences in the Conservation Response

Table 8 shows the relationship between sex and the ability to maintain conservation in the activation phase. A Chi-square analysis showed that there were no significant male-female differences on the conservation response in the activation phase (X^2 = f:389 for 1 df, p .05).

Table 7

Number of Conserver Subjects Who Articulate a Principle Versus Those Who Do Not Articulate a Principle as a Result of Two Different Treatments in the Generalization Phase

Group	Principle Articulated	No Principle Articulated	Total
Verbal Principle	12	5	17
No Principle	5	8	13
Total	17	13	30

Table 8

Number of Males and Females Who are Conservers Versus Those Who are Non-conservers in the Activation Phase

Sex	Conserver	Non-Conserver	Total
Male	34	18	52
Female	30	18	48
Total	64	36	100

$X^2 = f = .089$ for 1 df   Not significant

Table 9 shows the relationship between sex and the ability to maintain conservation in the generalization phase. A Chi-square analysis showed that there were no significant male-female differences on the conservation response in the generalization phase (X^2 = f.728 for 1 df, p .05).

Table 10 shows the relationship between sex and the ability to maintain conservation in the extinction phase. A Fisher's exact probability test for 2 x 2 contingency tables showed that there were no significant male-female differences on the conservation response in the extinction phase.

The Conservation Response as a Function of Age

Table 11 shows the relationship between age and the ability to maintain conservation in the activation phase. A Chi-square analysis showed that there were no significant age differences on the conservation response in the activation phase (X^2 = 1.32 for 1 df, p .05).

Table 12 shows the relationship between age and

Table 9

Number of Males and Females Who are Conservers Versus Those Who are Non-Conservers in the Generalization Phase

Sex	Conserver	Non-Conserver	Total
Male	26	19	45
Female	28	14	42
Total	54	33	87

$X^2 = f = .728$ for 1 df Not significant

Table 10

Number of Males and Females Who are Conservers Versus Those Who are Non-Conservers in the Extinction Phase

Sex	Conserver	Non-Conserver	Total
Male	15	14	29
Female	18	7	25
Total	33	21	54

Table 11

Number of Subjects Who are Conservers Versus Those Who are Non-Conservers as a Function of Varying Age Levels in the Activation Phase[a]

Age	Conserver	Non-Conserver	Total
High	32	13	45
Low	33	22	55
Total	65	35	100

X^2 = 1.32 for 1 df. Not significant

[a]Range for High Age Level was from 6 years, 11 months to 7 years, 10 months. Range for Low Age Level was from 6 years, 4 months to 6 years, 10 months. Range was derived by a median split.

Table 12

Number of Subjects Who are Conservers Versus Those Who are Non-Conservers as a Function of Varying Age Levels in the Generalization Phase[a]

Age	Conserver	Non-Conserver	Total
High	14	5	19
Low	16	5	21
Total	30	10	40

X^2 = .033 for 1 df. Not significant

[a]Range for High Age Level was from 6 years, 11 months to 7 years, 9 months. Range for Low Age Level was from 6 years, 4 months to 6 years, 10 months. Range was derived by a median split.

the ability to maintain conservation in the generalization phase. A Chi-square analysis showed that there were no significant age differences on the conservation response in the generalization phase ($X^2 = .033$ for 1 df, p .05).

Table 13 shows the relationship between age and the ability to maintain conservation in the extinction phase. A Fisher's exact probability test for 2 x 2 contingency tables showed that there were no significant age differences on the conservation response in the extinction phase.

Table 13

Number of Subjects Who are Conservers Versus Those Who are Non-Conservers as a Function of Varying Age Levels in the Extinction Phase[a]

Age	Conserver	Non-Conserver	Total
High	9	17	26
Low	12	16	28
Total	21	33	54

[a]Range for High Age Level was from 6 years, 11 months to 7 years, 9 months. Range for Low Age Level was from 6 years, 4 months to 6 years, 10 months. Range was derived by a median split.

CHAPTER IV

DISCUSSION

The results of the present experiment substantiated the hypothesis (1) that conservation can be activated in children who initially maintain non-conservation as a natural response through a film modeling technique. The findings on activation replicated previous experiments designed to foster conservation through experimental manipulation (e.g., Frank in Bruner, 1964; Lee, 1966; Smedslund, 1961a, 1961d; Sigel, Roeper & Hooper, in press; Sullivan, 1963).

The study also illustrated the generalization of the conservation response to different media (i.e., water to clay). This was indicated by the fact that there were no subjects in the control group who maintained conservation on the generalized task (e.g., clay), while 17 of 21 subjects in the Verbal Principle Group and 13 of 19 in the No Principle Group maintained conservation on the generalized task after conserving on the activation task (e.g., water). The findings on generalization replicated previous experiments designed to foster generalization of the conservation concept through experimental manipulation (Wallach & Sprott, 1965; Lee, 1966).

Hypothesis 2 concerning the generalization between the two experimental groups was not supported. It was expected that the Verbal Principle Group, who modeled on conservation with articulate verbal principles given, would show greater generalization when compared to the No Principle Group, who modeled on conservation but were given no verbalized explanation for the conservation response. This experiment showed no significant difference between the Verbal Principle Group and the No Principle Group.

This negative finding raises an interesting question concerning the mechnaisms for change from non-conservation to conservation. At least three interpretations have been advanced to explain why conservation appears as a response in the child's repertoire. The first interpretation from the Geneva (Piagetian) school of thought, is that conservation occurs because the child at a certain point in time (about 7 years) has at his disposal the prerequisite operational structures for the conservation. More specifically, the concrete operations of reversibility, compensation, etc., enable the child to maintain conservation. It should be kept in mind that Piaget's interpretation sees these operations as a necessary and sufficient condition for conservation. The second interpretation from the Harvard (Bruner) school of thought, places paramount importance on adequate linguistic experience. It is Bruner's contention that the child is capable of acquiring conservation provided he has certain linguistic experiences which enable him to control and manipulate perceptual input. More specifically, Bruner hypothesizes that the mechanism of transmission from non-conservation to conservation is the use of language as a program for ordering and integrating experience. Once language becomes a medium for the translation of experience, it is believed that the child is progressively released from immediacy. In the case of

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conservation, the child must be freed from the immediate perceptual input and language is seen as a control on the input. The third interpretation comes from various sources, and may be generally called the "semantic view" of conservation (Braine, 1962; Braine & Shanks, 1965; Carey in Bruner, 1964; Holt, 1966). This general approach of this viewpoint explains the notion of conservation as a learning situation in which the child assimilates adult "meanings" for the words used in the conservation response. Thus, the movement from non-conservation to conservation is no radical change in cognitive structure, as Piaget postulates, but more importantly it is learning the adult "definitions" for such words as equal (same) and difference (less than, more than).

It is important to reiterate that the present experiment was designed to foster conservation of substance by combining a verbal enrichment program described by Bruner while using the verbal counterparts of Piaget's operations. Thus, by employing the principles of reversibility and compensation, etc., as utilized by the model in the Verbal Principle Group, it was expected that the use of these principles would generalize more readily to new and different conservation problems when compared to a group (No Principle) who did not model on these principles. The results of the present study do not substantiate the Piagetian hypothesis that concrete operations are a necessary and sufficient condition for maintaining conservation. Several children, in both the activation and generalization phase, maintained conservation without articulation of an operational principle as demanded by Piaget. This study is a sequel to Carey's (Bruner, 1964) findings in which children who verbalized operations of reversibility and identity, etc., were unable to maintain conservation. Both these studies combined, put to question the necessity of Piaget's operational structures in the maintenance of conservation. This does not mean, however, that operational principles are not present in the conservation response. The findings of this experiment indicate that the children who see the model using verbal principles give significantly more principled (i.e., reversibility, etc.) explanations of conservation of substance when compared to the No Principle Group in the activation phase. A similar trend was found in the generalization group but was not significant. These findings, however, do not necessitate the inference that there is a reorganization of cognitive structures. In fact, the over-all findings tend to support the "semantic approach" to conservation in two ways. First, the explanation for the fact that many of the children can conserve with or without operational principles seems best interpreted from a semantic viewpoint. Thus, the children who conserve without verbal explanations may be said to have less adult, less articulate and less differentiated semantic definitions of the notions "same" and <u>more</u> or <u>less</u> when compared with the children who use principled explanations. The fact that children use principled explanation in both groups (i.e., Verbal Principle versus No Principle) is an indication that some of the children have probably assimilated an adult semantic definition of conservation in the Verbal Principle Group via the modeling, or in the case of the No Principle Group, have brought a previo sly learned semantic definition, learned from the natural adult environment to bear on the problem when conservation is hinted as the appropriate response by the model. The second reason tending to support the semantic hypothesis stems from the observation of no difference between the No Principle Group and the Verbal Principle Group on the ability to conserve in the generalization phase. Both Piaget and Bruner would have predicted that the Verbal Principle Group would perform significantly better on conservation in this phase when compared to the No Principle Group. Piaget would probably maintain that the group which assimilates the operational principles (e.g., reversibility) would be more likely to generalize to a different conservation experience because they have at their disposal the prerequisite operations to maintain conservation. The group which does not assimilate these principles (No Principle Group) learn only an empirical rule which is specific to the situation in which it is learned (e.g., water conservation).

Bruner would make similar predictions on the basis of the fact that the children in the Verbal Principle Group have greater language enrichment experiences which should increase their control over wider and more varied perceptual inputs. The "semantic view" of conservation makes no specific prediction on generalization but in terms of the present experiment, it offers the most parsimonious explanation for the lack of significant difference between the Verbal Principle and No Principle Groups. A pertinent observation to be noted here is that the questioning format for the conservation problems in this study are exactly identical in both the activation and generalization phase; the only difference is that the word "clay" is substituted for "water" in the generalization phase. The fact that there is no difference between the Verbal Principle Group and the No Principle Group in the generalization phase may be a result of direct transfer from the activation phase. To recapitulate, the child has learned definitions for the words "equal," "more" and "less," according to the semantic interpretation.

It might be hypothesized that the child sees the questioning format as exactly the same in the generalization phase and this transfers his definitions or meanings for the above words as learned in the activation phase to his present problems (i.e., clay generalization). From the semantic viewpoint, this transfer is on the basis of identical stimulus elements in both situations, rather on elaborate mediational responses as postulated by Piaget or Bruner.

Hypotheses 3 and 4 concerning the extinction of the conservation response were not substantiated by the present experiment. The extinction phase was intended to demonstrate the differential stability of the conservation as a result of naturally learning this response and also as a result of the two experimental treatments. Smedslund (1961c) had previously found that natural conservers were significantly more resistant to extinction of conservation than were activated conservers on a conservation of weight problem using clay substance. In explaining these results, he described two theories which attempt to account for conservation. Learning theory maintains that the principle of conservation is ultimately derived from reinforcement mediated by external stimuli. Piagetian theory maintains that the principle of conservation is primarily derived from the inner organization and mutual coordination of the child's schematic structure. Smedslund predicted that the natural conservers would be more resistant to extinction than the activated conservers because their notions of conservation are a result of a reorganized cognitive structure and not merely the result of an external environmental push which might characterize the activation group. The present study tried to replicate Smedslund's results and, in addition, offered the prediction of greater resistance to extinction in the Verbal Principle Group when compared to the No Principle Group. This prediction was based on the assumption that the Verbal Principle Group would be more in line with Piagetian theory, in that the principles in some way foster a change in cognitive structure. It was expected that the No Principle Group simply learn an empirical rule without having any elaborate change in congitive structure. The findings are contrary to Smedslund's (1961c) results and they also fail to substantiate the prediction that there would be a difference between the Verbal Principle Group and the No Principle Group. At this point, two questions should be considered. The first is, why do the activated conservers perform on the same level as the natural conservers, contrary to Smedslund's findings and hypothesis 3? The second is, why does the No Principle Group perform on an equal plane with the Verbal Principle Group contrary to hypothesis 4? One reason for the difference between Smedslund's findings and the present experiment could be the difference in the extinction procedures employed. The present experiment employed disconfirming evidence for conservation via water substance whereas Smedslund employed clay substance. It may be that the water substance is not as compelling in disconfirming conservation when compared to clay substance. The second reason may be the differential number of learning trials for conservation between the two experiments. Smedslund's induced conserver group undergo extinction after only two trials of activation. The present experiment employed the extinction procedure after the child has not only activated on conservation, but has also generalized to a new substance. In addition, they also saw the model conserve in the experimental phase. Thus, the child in this experiment has probably three learning trials on conservation when contrasted with the two trials used by Smedslund. A learning theory interpretation would predict greater resistance to extinction as a result of the greater number of learning trials. Several extinction trials might make these results congruent with Smedslund's findings on extinction.

The fact that the No Principle Group performs as well as the Verbal Principle Group (i.e., contrary to hypothesis 4) may again be explained from a straightforward semantic viewpoint. If we assume that both groups are learning semantic definitions for such terms as "same," "more" or "less," it might be predicted that both groups would be similar on extinction, since they are not significantly different from one another on either the activation or generalization phases. The differential learning trials before extinction, which attempted to explain the results of hypothesis 3, may also be considered as an explanation for the absence of substantiation for hypothesis 4. Again, this interpretation could be explored by increasing the number of disconfirming extinction trials for each child.

Evaluation of the Present Study and Suggestions for Further Research

The unique contribution of the present experiment was in demonstrating that the conservation response to substance could be activated and generalized through environmental inducement via a film modeling technique. Heretofore, experiments which induced conservation were through direct questioning methods (cognitive conflict) or screening techniques. One shortcoming of the direct method is that they may be inducing conservation by coercing the child into an adult notion of conservation without true understanding of the response. Holt (1966), in criticizing Bruner's methods, observed a Bruner movie where the conservation response was being explored and noted that most of the time the child was looking not at the clay but at the face of the questioner, as if to read there the wanted answer. In the present study, the inducement occurred while the child watched a film model instead of being directly questioned on his response, as in the cognitive conflict method. This study showed a further refinement, in keeping with Holt's criticism, by employing a post-test experimenter in the activation, generalization and extinction phase, who had no knowledge of the experimental hypothesis or the treatment group of the child being tested. By putting the experimental conditions on films, this helped to equate these conditions for all the experimental subjects.

The use of film mediated models for the activation and generalization of the conservation problems is an extension of modeling behavior into more cognitive areas of development. Previous to this study, experimental modeling was employed only in such areas as aggression

(Bandura, Ross & Ross, 1961), moral judgments (Bandura & McDonald, 1963) and delay of gratification (Bandura & Mischel, 1965).

An interesting aside concerning the film modeling technique is its closer approximation to a real life situation for the child. Previous studies have demonstrated that conservation is induced through environmental influences, but most of these attempts have been performed in strictly artificial experimental laboratory situations. The child's ability to conserve in real life situations, is learned probably more informally through the social environment (i.e., parents, teachers, and older peers). The film modeling procedure more closely approximates the social conditions in which this response is learned. Thus, many of the supposedly maturational changes which take place at the period of concrete operations may be a result of subtle learning situations which may be accruing in the child's school environment. The fact that the conservation response is correlated with age (i.e., 5 to 7 years) may stem from the fact that most children are starting school at approximately the same time.

The results of the present study question the previous explanations given for the conservation response. The negative results on three of the four hypotheses raise some interesting questions which provide the heuristic value of fostering new research. The negative results on the generalization hypothesis should encourage studies on the "semantics" of the conservation problem and force both the Geneva and Harvard groups to make further clarifications in their procedures. The speculation that the generalization for both the Verbal Principle and No Principle Group may be a function of the identical questioning formats in all phases should encourage exploration into the use of different formats at each phase. This, however, may affect the results in unknown ways and therefore should be controlled. The suggestion by Braine (1962) for the employment of both verbal and non-verbal methods may be of utility here.

APPENDICES

APPENDIX A

REVIEW OF THE LITERATURE ON

THE CONSERVATION TASK

The plethora of research efforts in child development carried out by Jean Piaget at the University of Geneva has revealed consistent age trends in diverse areas of problem solving activities in children and adolescents. His influence on child psychology and education has been increasingly felt in the United States in the past seven years. Stemming from his research efforts Piaget (1960) has outlined a theory of intellectual development which is presently stimulating research efforts by both psychologists and educators alike.

In articulating his theory of intellectual development, he has been concerned with the formulation of coherent and meaningful stages, which reflect the direction and cause of mental development. When studying children (who have been the vast majority of his subjects), he has not simply concerned himself with what the children do, but more importantly, how their observed behavior displays a coherent pattern of development. His theory then, is not primarily concerned with emotional or social evolutions, except insofar as they are related to intellectual development.

In discussing the evolution of intelligence, Piaget (1960) categorizes intelligence into two main classes:

1. Sensori-motor intelligence (birth to 2 years), which refers to all those operations which are preverbal and are not mediated by signs and symbols.

2. Conceptual intelligence (2 years to maturity), in which the processes of adaptations are mediated by signs and symbols.

Piaget (1960) maintains that there are three principal ways in which conceptual intelligence differs from sensori-motor intelligence:

1. Sensori-motor intelligence consists solely in coordinating successive perceptions and also successive overt movements; these coordinations can, themselves, be only successive in nature, linked by brief anticipations and reconstructions, but never arriving at simultaneous representation.

2. Sensori-motor intelligence acts like a slow motion film, in which all pictures are seen

in succession, but without fusion, and so without continuous vision necessary for understanding the whole.

3. Sensori-motor intelligence deals with only real entities, and each of its actions thus involves only short distances between subject and object. Conceptual intelligence breaks away from these short distances and physical determinants and deals with referents which may have no existence in the concrete world.

There are three essential conditions for the transition from the sensori-motor level to more abstract levels of intelligence. First, it is necessary to have an increase in speed, allowing the knowledge of successive phases of an action to be molded into a simultaneous whole. Secondly, there must be an awareness not simply of the desired results of an action, but also its actual mechanics. This enables a search for a solution to be combined with a consciousness of its nature. Finally, there must be an increase in distances, enabling actions affecting real entities to be extended by symbolic representations which thus go beyond the limits of near space or time.

Perception and overt responses will function the same essentially, but these perceptions and responses will be charged with new meanings and integrated into new schemas or programs. The child in the late sensori-motor phase may be able to perform complex problems, but he is restricted to concrete manipulation for solutions, verbalization of a solution being restricted to conceptual thinking.

Conservation Problems in Piaget's Theory

The conservation problems have been utilized by Piaget to explore the development of higher order cognitive processes in the child (Piaget & Szeminska, 1952).

Conservation refers to the "cognition that certain properties [quantity, number, and length, etc.] remain invariant [are conserved] in face of certain transformations [displacing objects or object parts in space, sectioning an object into pieces, changing shape, etc.]" (Flavell, 1962, p. 245).

A concrete illustration of a conservation problem is described by Piaget (1965) in outlining a method for conservation of substance problems. The problem of conservation of substance is centered around whether the child can conserve properties of matter across transformations in appearance. As Piaget describes it,

> the child is first given two cylindrical containers of equal dimensions [A1 and A2] containing the same quantity of liquid [as shown by the levels]. The contents of A2 are then poured into two smaller containers of equal dimensions [B1 and B2] and the child is asked whether the quantity of liquid poured from A2 into [B1 and B2] is still equal to that in A1. If necessary, the liquid in B1 can then be poured into two smaller equal containers [C1 and C2], and in case of need, the liquid in B2 can be poured into two other containers C3 and C4 identical with C1 and C2. Questions as to the equality between [C1 and C2] and B2, or between [C1 and C2 and C3 and C4] and A1, etc., are then put. In this way, the liquids are subdivided in a variety of ways, and each time the problem of conservation is put in the form of a question as to equality or non-equality with one of the original containers. Conversely, as a check on his answers, the child can be asked to pour into a glass of a different shape a quantity of liquid approximately the same as that in a given glass, but the main problem is still that of conservation as such (Piaget, 1965, p. 4).

Similar procedures are employed for conservation problems with clay and wire.

Stages in the Development of Conservation of Substance

Piaget (1965) reports three stages in the development of conservation. The first stage is characterized by the absence of conservation. The child considers it natural for the quantity of the liquid to vary according to the form and dimensions of the container into which it is poured. Perception of apparent changes is therefore not corrected by a system of relations that insures invariance of quantity. The second stage is a period of transition in which conservation gradually emerges, but although it emerges it is recognized in some cases, it is not so in all cases. The third and final stage occurs when the child at once postulates conservation of the quantities in each of the transformations to which they are subjected. Several replication studies have been done on Piaget's stages of conservation. Elkind (1961) investigated conservation of mass, weight, and volume in school children, and found, as did Uzgiris (1964), that conservation of mass (substance), weight, and volume developed in the sequence

Piaget had postulated. Feigenbaum (1963) studied the problem of conservation of discontinuous substance and, although his results were inconsistent with a stage theory defined by chronological age, he did discern general trends in the development of conservation. Kooistra (1963) studied gifted children with IQ's over 130 and found that conservation of substance, weight, and volume occurs as early as four years of age. The most relevant note of this study is that regardless of chronological age or IQ, the sequence of development was consistent with Piaget's theory. Thus, with qualifications, the sequence of development of substance, weight, and volume have been verified.

The responses of the child to the conservation of substance problems, indicate the course of development of intellectual activity during the latter parts of the sensori-motor period and the earlier phases of conceptual thought. The three stages of conservation of substance parallel the following stages in Piaget's general formulation of intellectual development:

1. Sensori-Motor and Preconceptual Intelligence (about 3 years)

2. Intuitive Thought (4 to 7 years)

3. Concrete Operational Thought (7 years to 11).

It should be noted that Intuitive and Concrete Operational Thought are the first two phases of Conceptual Intelligence. Thus, stage 1 is a combination of late sensori-development and early primitive conceptual thought.

Piaget's Explanation of the Mechanisms of Conservation

Piaget (1960) maintains that a stable and organized notion of conservation of substance appears at about 7 years with the stage of concrete operational thought. Conservation becomes a possibility because of the child's use of what Piaget calls operational structures. The stage of Concrete Operations is characterized by the child's ability to perform the following operations on his experiences:

1. Combinitivity: is an operation where two classes may be combined into one comprehensive class which embraces them both (i.e.,

A + B = C, or all boys + all girls = all children).

2. Reversibility: is an operation where logical or mathematical operations can be reversed (e.g., 4 + 3 = 7 reversed to 7 - 3 = 4). This is an example where subtraction is the converse of addition. Reversibility is also an operation where division is the converse of multiplication.

3. Associativity: where several operations are combined, it makes no difference which will be combined first (e.g., [A + B] + C = A + [B + C]).

4. Identity: is an operation which can be nullified by combining it with its opposite (e.g., + A - A = 0).

5. Tautology: is an operation related to logical classifications. Here, repetition of proposition, classification, or relation, leaves them unchanged (e.g., A B and A B A B).

Piaget (1965) maintains that the model of logical thought is a logico-mathematical one. He sees the same properties in thought structures that have been identified in algebraic structures. These logico-mathematical structures are seen as very good models of the actual organization and process of cognition in the middle and late years of childhood. One segment of these structures is the concrete operations which are said to appear at approximately age seven. Thus, the child at approximately age seven is able to maintain conservation, because he has at his disposal these operations which help him to structure the experience.

Several of these operations, either singly or combined, are seen in explanations given for the maintenance of conservation. The operation of identity is utilized when the explanation for conservation (i.e., water conservation) is, for example, "they are the same because you poured the thin glass in there and you didn't lose any." Here, the identity operation helps in the assertion that the amount of substance remains unchanged even though the shape is noticeably changed. The recognition here is that nothing is added or subtracted. The operation of reversibility is seen in the explanation that "if you poured the water back into the other glass, it would be the same." The reversible operation enables the child to cognitively reverse the transformation process, and recognize that the modified material could be changed back to its original shape.

Bruner's Notion Concerning the Nature of Conservation

Piaget, in explaining conservation, does not stress the importance of language mechanisms in the development of logical thought. Although Piaget stresses the importance of a flexible symbol system, especially during the period of formal operations (11 years), he nevertheless maintains that changes in cognitive structure (i.e., development) are not directly accomplished by verbal enrichment or sophistication. The development of more abstract forms of thinking, illustrated in the conservation tasks, comes through the alteration of logical thought structures (e.g., the use of concrete operations). For Piaget, the advent of concrete operations permits more meaningful usage of abstract language and not the converse.

Bruner (1964) has an alternative explanation concerning the acquisition of conservation which places paramount importance on adequate linguistic experience. Bruner sees cognitive development as a result of the acquisition of techniques of information processing. Although similar to Piaget in stage notions, he takes a different slant on the mechanisms of stage transition. Bruner maintains that these information processing techniques, through an interiorization process, form the basis for three information processing systems: the enactive, the iconic, and the symbolic representing different levels of cognitive functioning that are presumably correlated with cognitive development. These three systems are analogous to Piaget's sensori-motor, pre-operational and operational intelligence. For Bruner, the mechanism of transmission from iconic to symbolic thought, which is the difference between non-conservation and conservation, is use of language as a program for ordering and integrating his experience. Bruner states it tersely, "once language becomes a medium for the translation fo experience, there is a progressive release from immediacy" (Bruner, 1964, p. 14). In the case of conservation, the child must be freed from the "immediate" perceptual input and language is seen as a control on this input. Bruner reports a study by Frank which tests his hypothesis that "improvement in language should aid this type [conservation] of problem solving" (Bruner, 1964, p. 5). According to Bruner, the activation of language habits enables the child to be less dominated by perceptual forces (iconic) in the setting, less inhibited in using symbolic processes, and consequently more able to deal with the conservation problem. The child should "say" his description before seeing or in the absence of things. Bruner hypothesizes that it is in this way the child successfully conserves. Frank tested children from the ages of 4 through 7 on the classic paradigm of conservation of liquid quantity. In one condition the materials were in full view, and for several conditions the beakers were screened. In the screening conditions, the child is asked to verbalize what he sees with only the tops of the beakers visible. Under the screening conditions, there is an increase in the correct response for each age group 4 through 7. Moreover, 80 percent of the 5 year old subjects and virtually all of the 6 to 7 year subjects maintained conservation when the screen was removed. A post-test on an unscreened, transfer task revealed a marked increase in conservation response for the 5 to 7 year groups, when compared to pre-test norms. Bruner maintains that the experiment demonstrates the potential contribution of verbalization to conservation acquisition.

Semantic Interpretation of Conservation

Bruner, in stressing the importance of language, has questioned Piaget's explanatory notions. Reporting a study by Carey, he argues that conservation of quantity (liquid, etc.) cannot be explained by Piaget's "operations" hypothesis. Carey (Bruner, 1964) found that explaining conservation by the operations of identity, reversibility, or compensation proves inadequate. Her study found that children who do not conserve, frequently demonstrate the operations of reversibility, identity and compensation. This puts to question Piaget's notion that Concrete Operational structures are a necessary and sufficient condition for conservation. Halpern (1965) contends that even in the presence of operational structures, perception can govern thinking.

The Harvard group conclude from this study the necessity of studying the growth of the semantics of the expression "same amount." Carey proposes that children prior to achieving conservation have a definition of amount that is pegged semantically to the water level in the containers. Thus, the child focuses on height, to the exclusion of width, and maintains that the "higher the water the more the water." Bruner maintains that in five and six year olds there is not only a strong tendency to use a single property as defining, but to use a perceptual property and to avoid one that requires "computing" (e.g., increase in height, decrease in width).

A similar viewpoint is held by Braine (1962) and Braine and Shanks (1965). Braine (1962), in critically evaluating Piaget's methodology, seriously questions the adequacy of verbal methods in investigating the processes Piaget has treated. He points out that in a verbal situation we are asking the child to verbalize a rule, and in Piaget's experiments it may be the adult's understanding of a rule that is used as a standard. Romney (1962), in discussing Braine's observations, suggests that the child might develop a concept without acquiring the adult use of words designating the concept. Brown (1962) proposes that one fundamental research problem may be to differentiate the child's knowledge of reality from his use of the language. In a verbal experiment on conservation of quantity a child may generalize his use of "some," "less" or "more" according to the referents he has learned in the past. If the dimensions of change with which he associates "less" and "more" do not coincide with the transformations of the material used in the experiment, he may answer correctly that the amount of material has not changed without having actually achieved the thought operation of reversibility. Thus, the use of verbal techniques may, in some instances, lead to a confounding of results. In line with the above considerations an earlier study by Wohlwill and Lowe (1962) seems appropriate to discuss here. They utilized three experimental training conditions: reinforced practice, extinction of perceptual cues, and practice with addition and subtraction of objects, in order to activate conservation of number. They found that trained subjects performed better on a non-verbal post-test than on a non-verbal pretest. However, subjects were unable to transfer their training to a verbal post-test and it was concluded from this that the subjects learned an empirical rule rather than a general principle. Zimiles (1963) attempted to explain the difference between verbal and non-verbal results as a function of the set established by the experimenters. The non-verbal post-test fit the set to respond to number alone which had been established during the training phase, whereas the verbal post-test allowed the subjects to confuse the numerical and spatial aspects of the objects used. He concluded that the absence of verbal ability was a sign that the child was responding only to that dimension to which his attention has been called. Zimiles (1963) furthermore speculates that Piaget's developmental stages may be an increasing differentiation of an already existing concept. Thus, children who respond at the non-conservational level may have less stable, less differentiated, pre-numerical concepts of quantity. Braine and Shanks (1965) add credence to Zimiles' notion in three experiments on the conservation of size. They required correct differential responses to the questions "Which looks bigger?" and "Which is really bigger?" and one experiment required that the child answer the question "Which is bigger?" The experiments showed 1) that by about five years of age a majority of children are capable of a distinction between real and phenomenal size which is not at all task specific, and 2) that chilcren under seven construe questions concerning the word "bigger" as questions about phenomenal size, unless feedback information forces a "reality" interpretation. The data suggest that early stages of development are not amenable to study by traditional Piagetian procedures, which do not elicit the processes under investigation in the younger children.

In summary, the "semantic interpretation" questions many of Piaget's procedures on the grounds that they are not really indicating underlying cognitive development. The movement from non-conservation to conservation may be merely an advance in the child's verbal learning in which he learns adult definitions for such words as "same," "more" and "less," etc.

The controversy between these schools of thought still rages on. These points of view, when contrasted, provide heuristic value in generating new areas of research for a resolution. The present study will propose a combination of both the Bruner and Piaget approaches, in that it will attempt verbal enrichment via concrete operational principles. Before considering the specifics of the present study, it is necessary to consider the studies that have attempted to induce conservation.

Modification of Piaget's Stages of Intellectual Development

Kessen (1960), in discussing different notions of the term stage, makes an important distinction between the study of developmental states (i.e., stages) in themselves and the study of the rules of transition which account for the organisms movement from state to state. Most of Piaget's theoretical considerations have centered around the notion of stage as a state, while paying relatively minor attention to the rules of transition. Rules of transition refer here to the mechanisms or processes which move the child through the ontogenetic sequence. Piaget's postulation of concrete operational structures is one attempt to provide a rule of transition in accounting for the movement from pre-operational to concrete operational thought.

Flavell (1962) maintains that Piaget's main contribution to developmental psychology has been in demonstrating the existence of consistent sequential stages (or states) in a remarkable array of cognitive forms. He points out, however, that Piaget has not provided concrete evidence as to the conditions which are necessary and sufficient to induce transition from one stage to another.

Recent research done by others since the 1950's, however, has been directed toward demonstrating types of environmental conditions which induce transition from more concrete stages to more abstract stages of development. Specifically, these research efforts have centered around conservation problems. The most frequently used design is a transfer of training paradigm. This design involves first of all the establishment of a group of subjects matched on pre-test performance (e.g., all subjects failed to conserve substance). Secondly, the subjects are assigned to different training conditions, with one group assigned to a no training control. Thirdly, a post-test assessment of training effects is made on either the items in the original pre-test or some related generalized items (e.g., to find out how many subjects conserve on substance). The purpose of such studies is to find out what sorts of environmental experiences do or do not facilitate development of the concept under study.

Related Research Studies

Inhelder *et al*. (1966), in discussing the most recent studies on conservation at Geneva, has hypothesized that development from concrete to more abstract modes of thought occurs with age because "the regulatory mechanisms underlying the integrative coordinations of 'information' are time bound and tied to more synchronous developmental processes" (p. 163). This apparent emphasis on the relative importance of maturational structures has been open to much criticism and dissent. McV. Hunt (1961), in discussing Piaget, notes that the rate of development is in substantial part, but certainly not wholly, a function of environmental circumstances. Change in environment is required to force the accomodative modifying of schemata that constitute development. Thus, the greater variety of situations to which the child must accomodate his behavioral structures, the more differentiated and mobile the structure becomes.

Recent research on Piagetian theory has been mobilized toward assessing what McV. Hunt would call the experiential factors which can activate higher modes of cognition in pre-operational children, or in other words, to determine the parameters of significant previous experience. Smedslund (1961a) has been a pioneer in designing project studies to assess relevant experiential factors in Piagetian concept development.

Smedslund (1961a), using 5-7 year old non-conservers on weight, subjected them to two different conservation training conditions. One group was given reinforced trials on conservation of weight by seeing one of two plasticine objects altered, and then the child was asked to predict whether or not the two weighed the same. The prediction was tested directly by actually weighing the objects on a scale balance. The second group was also given reinforced practice on a scale balance, but in terms of the effects on relative weight of adding and subtracting small pieces of clay on the objects. A third group was used as a no training control. The effects of these training conditions were negative since there was no significant difference between the groups, even though all three groups showed some improvement on weight conservation from pre- to post-test.

The intent of the above experiment was to see if exercising related schema (i.e., addition-subtraction) would foster the acquistion of the conservation of weight.

Smedslund (1961d) took a different attack on the problem by trying to foster conservation in non-conservers by providing experience with the unreliability of perceptual cues, a well known source of non-conservation responses. The training condition provided the child with repeated opportunities to discover what larger objects are not necessarily heavier than smaller ones. The fact that no control condition was used here was not important, since there was no effect on the child's response orientation. Children in the post-test continued to rely on perceptual cues as in the pre-test.

The most interesting study attempted, however, involved a condition called cognitive conflict (i.e., competing cognitive systems). In this study Smedslund (1961e) reasoned that the creation of such conflict would activate cognitive reorganization. Two kinds of transformations were employed, i.e., deformation be changing the shape, and addition and subtraction of quantity. If, for example, the child was inclined to think that flattening out a piece of clay increased its size, and that subtracting a piece of it would decrease its size, the experimenter would do both at once and then pose the conservation question. This procedure was intended to give the subject pause, to induce him to vacillate between conflicting strategies. This cognitive conflict paradigm proved to be the most successful procedure in inducing conservation from pre- to post-test. A salient criticism of this study is the failure to employ a control group for comparison. Confounding could have occurred, since there is no clear cut indication that the results were primarily induced by the training condition, rather than merely experience in the pre-test. Sullivan (1963), however, clarified the procedure by employing a no training control and found similar results as Smedslund (1961e).

Several recent studies have utilized "cognitive conflict" in inducing conservation. Gruen (1964) compared verbal pretraining on number conservation, in combination with direct reinforced practice, against a verbal cognitive conflict model drawn from Smedslund's approach. A significant difference between verbal conflict training and control groups was demonstrated, although the training effects were generally small. Ojemann and Pritchett (1963) utilized "guided experiences" in the form of three one-hour training sessions in order to induce the concept of specific gravity in 5- and 6-year-old children. The guided experience was a mode of perceptual cognitive conflict which gradually exposed the subjects to problems of increasing difficulty. The results indicate that the "guided experience" group performed significantly better than the control group on post-tests which were derived from Piaget.

Beilin (1965) found a verbal-rule instruction method to be effective in the inducement of length and number conservation. Tests on an area generalization task revealed an absence of any transfer.

A salient feature of the "cognitive conflict" technique is that the activation training takes place in full view of the test materials.

Bruner (1964), in stressing the importance of language in controlling perceptual input, takes a different approach in activating conservation. Frank (Bruner, 1964), as previously quoted, demonstrated that the conservation of substance can be induced by utilizing a technique which encouraged children to rely on conceptual as opposed to more perceptual modes of thinking. In contrast to "cognitive conflict" methods where the materials were in full view, she placed a "screen" in front of the flasks (i.e., water substance) while the transformations were taking place. The reason for this was to activate a verbal formula of solution when the perceptual cues were absent. The results indicated that the child was better able to resist overwhelming sensory input and conserve substance subsequent to the screening procedure. Feigenbaum and Sulkin (1964) trained 5 to 6 1/2 year old children to conserve discontinuous substance by reduction of irrelevant visual stimuli. Their approach is similar to Frank's, in that they blindfolded subjects in order to block all visual perception of the task. They found that subjects by this method were able to transfer the conservation response to a slightly different conservation problem.

It appears that Bruner's most significant contribution to this area of study has been his stressing of the importance of language as a mediator for more abstract and symbolic thinking. The Geneva group has, of late, been exploring the role of language in more descriptive terms. Inhelder _et al_. (1965) found that conserving children use the comparative form of adjectives in describing quantity in contrast to the other children who use absolute terms. The more advanced children say of two things differing, say, in width, that one is "thicker" than the other or that one is "thinner" than the other. The non-conserving note, more primitively, that one of the pair is "thick" or "wide" as that one is "thin," without the use of the comparative form. A second characteristic of the more advanced children is that they form sentences to deal with two attributes at a time, while the less cognitively advanced ones will not (e.g., "This one is taller but thinner" in contrast to "this one is tall," and later, "that one is wide"). And, finally, failure of conservation appears to be associated with the tendency to confound the language dimension at one end. That is to say, the less advanced child is likely to say "that glass is wide and the other one little," and then, "that glass is tall and the other one little."

Adding emphasis to the above study, Furth (1964), for example, employed a non-verbal method of activation in training deaf and hearing children to conserve weight. He demonstrated through up-and-down movements of both hands the difference in metal weights, and found that hearing children of 6 1/2 years of age met the same criterion tasks as deaf children of 8 years of age. He attributed this 1 1/2 year gap to the restricted experience of deaf children, specifically to their lack of language.

It is apparent from the studies quoted thus far that language has implicitly or explicitly an important facilitating effect on more conceptual or symbolic modes of thinking. Earlier studies on language development have focused on its importance in the regulation of problem solving behavior (Vytgotsky, 1962; Luria, 1961). Kuenne (1946) has demonstrated the utility of language in solving transposition problems. Ervin (1961) has demonstrated the transfer effects of training a verbal generalization in solving new problems other than those given in the pre-test situation. The present study was designed as an attempt to provide language enrichment training in the form of verbal principles, etc., in order to activate conservation in children. In part, these principles are the verbal counterparts of some of Piaget's concrete operations.

The potential role of operational reversibility in mediating conservation development is indicated by Eifermann and Etzion (1964) for adult subjects, and by Wallach and Sprott (1965) and Sigel, Roeper and Hooper (1965) for young children. Wallach and Sprott (1965) found that training in the reversibility of the arrangements of objects induced number conservation in preoperational children. The training effects transferred to generalized tasks using new sets of objects and taking place 14 to 23 days after training.

Sigel, Roeper, and Hooper (1965) trained children in the operations of multiple classification, multiplicative relations, and reversibility. They were able to induce conservation of substance and weight in nursery school children, and concluded that early enrichment experiences accelerated the appearance of conservation in children.

The present study has proposed the possibility of teaching a child new verbal principles as opposed to ones that already exist to see if these new principles can be generalized to the problems of conservation. It should be noted that Bruner's method of "activation" (screening) depends on already existing language habits. The verbal principles could be learned through direct reinforcement or through modeling behavior. Specifically these principles were reversibility, compensation and appearance and reality.

The importance of modeling in the acquisition of behavior in children has been recently pointed out by Bandura and Walters (1963). Acquiring behaviors through imitation or modeling results primarily from the contiguity of sensory events. Bandura, Ross and Ross (1961) have demonstrated that children's aggressive behaviors have increased by previously being exposed to an adult aggressive model. Bandura and McDonald (1963) report that the exposure to an adult model produces changes in the moral judgments of children. Children have moved from Piaget's (1962) "moral realism" to "moral subjectivism" and vice versa by watching adult models make statements counter to the child's present conceptual state.

Bandura and Mischel (1965) have demonstrated similar results in the modification of delay of reward through exposure to live and symbolic models.

The use of modeling or imitation for the learning of verbal principles to facilitate more higher order conceptual operations was chosen to eliminate one of the problems in the cognitive conflict inducement training noted by Sullivan (1963). He noted that the success of the method of "cognitive conflict" may be due to verbal suggestions made by the experimenter in the training phase which may carry over into post-test phase. Coercion or suggestion by adult questioning in the "cognitive conflict" method may be minimized in a modeling procedure since the child's non-conservation response is not directly confronted by an adult. A further precaution of guarding against this artifact has been proposed by Lee (1966) by introducing a generalized testing phase into the experimental design. He notes that if the subject maintains an induced principle of conservation in generalized tests which vary in incremental degrees from the training situation, greater confidence can be placed in the training procedure itself. This can be accomplished by using a generalized test which has a different substance than the one on which the subject was trained (e.g., clay to water). Several studies have previously attempted generalization. Beilin and Franklin (1962) gave training sessions in measurement by superposition and unit iteration methods and also in conservation of length and area. These training sessions were not successful in generalizaing to materials of different size and shape from those used in the training session. Beilin (1965) trained children in conservation of length and number in an attempt to encourage the grouping of these operations. The hypothesis was that if length and number were grasped their presence should imply a grasp of conservation of area. The results indicate that no conservation learning transferred to the area task. The rigorous criterion task demanding that a child not only integrate operations recently acquired, but also that he extrapolate from them to a new operation, seems to account for the lack of results at this age level. Feigenbaum and Sulkin (1960) using a training method which reduced irrelevant visual stimuli found that subjects trained by this method were able to transfer the conservation response to a slightly different conservation problem. Wallach and Sprott (1964) and Gruen (1964), quoted previously, have also succeeded in inducing generalization. The present experiment employed a generalization task across materials (water to clay) but the criterion task was on conservation of substance as in the pre-test and training phase. The intent of this type of generalization was to prevent the overtaxing of abilities of subjects of this age.

A further question presents itself concerning the role of imitation film modeling. It should be kept in mind that the present research project is stressing the importance of assimilating a verbal principle seen in the film to facilitate solutions to conservation problems. Thus, the amount of verbal material offered by the film model may be an important variable for consideration.

The present study tried to vary the experimental conditions by having one modeling procedure simply maintain conservation of substance without an articulate verbal explanation, while another experimental condition had the model supply the verbal principles. This would further point out the importance of the assimilation of the verbal principle, if it led to differential effects on the generalized task. It is expected that a verbal principle can be applied to various related problems, and the group receiving the condition where the verbal principle is supplied should be at an advantage on a related generalized problem.

Finally, the use of these two experimental groups plus the natural conserver group helped in answering the important question of how stable and permanent are the advances in cognitive ability as a result of the modeling techniques. Smedslund (1961c) describes two main theories which attempt to account for the conservation of weight as a result of his activation techniques (i.e., control balance). A learning theory explanation maintains that the principle of conservation is ultimately derived from some kind of reinforcement mediated by external stimuli. Piagetian theory maintains that the principle of conservation is derived primarily from the inner organization and mutual coordinated of the subject's schemata. Learning theory maintains that any response which is acquired can also be extinguished.

It was assumed that the principle group would be more in line with Piagetian theory, since it was expected that the principle in some way changes the inner organization and mutual coordination of the child's schematic structure. Natural conservers probably have the most organized and coordinated schemata in dealing with conservation since they have had a chance to practice this principle previous to the experimental conditions. Mogar (1960) and Lovell and Ogilvie (1961) found that sheer experience of the physical world, coupled with repeated observations of a phenomenon may play an important role in the stability of certain concepts. In line with the above considerations, Smedslund (1961c) found that natural conservers were significantly more resistant to extinction of conservation than were a group of experimentally induced conservers.

With the previous considerations in mind this study attempted to investigate the following hypotheses:

H_1: The "activation" of the conservation of substance can be facilitated by the use of film mediated models. No difference was expected between the two experimental groups during this phase, but both were expected to perform better than the Control Group.

H_2: The "generalization" of the conservation of substance (e.g., water to clay) will be greater for subjects who see film models give verbal principle explanations (Verbal Principle Group) than for those who do not receive verbal explanations (No Principle Group).

H_3: The "extinction" of the conservation of substance will be greater for acquired conservers (i.e., maintained conservation after seeing film) than for Natural Conservers.

H_4: The "extinction" of the conservation of substance will be greater for the group which does not receive the symbolic verbal explanation (No Principle Group) versus the group which receives it (Verbal Principle Group).

APPENDIX B

DESCRIPTION OF PROCEDURE DURING

PHASES I, III, IV AND V

Conservation of Wire Substance

Two transformations were made. Two wires of equal length are rolled up into coils of equal length. The following question is then asked:

> "Do both wires have the same amount of wire or are there different amounts of wire?"

If the child does not state equality, wire is snipped off the coil judged larger until equality is stated by the child. The following question is then asked:

> "Then if I play with this wire and you play with that one, would we both play with the same amount of wire?"

If the child maintains equality the statement is made:

> "Now I want you to watch carefully. I am going to stretch this piece out like so (stretched transformation)."

In the case of the second transformation:

> "Now I want you to watch carefully. I am going to push this piece in like so (compressed transformation)."

The following question is then asked:

"Would you say that both pieces of wire have the same amount in them now or are there different amounts of wire?" "Why do you think that they have the same (different) amounts of wire?"

If the child maintains equality of substance:

"Then if I play with this wire here and you play with that one, would we both play with the same amount of wire?"

<u>Conservation of Water Substance</u>

One water transformation was made.

1. After pouring equal amounts of water into two 600 milliliter glasses the water from one of these glasses is emptied into a 300 milliliter (ml.) glass.

In each case the following procedure for questions will be followed:

"I am going to pour water into both these glasses and I want you to watch closely because then I am going to ask you some questions about the water."

Water is poured into the two 600 ml. glasses from a marked measuring cup so that the levels in both glasses are equal. The following question is then asked:

"Do both these glasses have the same amount of water or are there different amounts of water?"

When the child says that they have the same amounts he is asked the question:

"Then, if I drink this glass and you drink that one (pointing) would we both drink the same amount of water?

When the child agrees to the same amount the following statement is made:

"Now I want you to watch carefully again. I am going to pour the water from this glass here (600 ml.) into this one here (300 ml.)." It is now visibly apparent that the water level in the 300 ml. glass is higher.

The question is now posed:

"Do both these glasses have the same amount of water in them now or are there different amounts of water?" "Why do you think they are the same (different) amounts?"

If the child agrees to the same amounts the following question is asked:

"Then, if I drink this glass (600 ml.) and you drink that one (300 ml.) would we both drink the same amount of water?"

Conservation of Clay Substance

Two transformations were made. The experimenter first rolls two equal pieces of clay into ball shapes. The following question is then asked:

"Do both pieces have the same amount of clay in them or are there different amounts of clay?"

If the child does not state equality, clay is taken off the ball judged more and put on the ball judged less until equality is stated by the child. The following question is then asked:

"Then if I play with this piece of clay here and you play with that one, would we both play with the same amounts of clay?"

If the child maintains equality the statement is made:

"Now I want you to watch carefully. I am going to press this piece down like so (pancake shape)."

In the case of the second transformation:

"Now I want you to watch carefully. I am going to roll this piece up like so (sausage shape)."

The following question is then asked:

"Would you say that both these pieces have the same amount of clay in them now or are there different amounts of clay?" "Why do you think that they have the same (different) amount of clay?"

If the child maintains equality of substance:

"Then if I play with this piece of clay here and you play with that one, would we both play with the same amount of clay?"

Extinction of Conservation of Water Substance

Two water transformations will take place.

1. After pouring equal amounts of water into two 600 milliliter glasses the water from one of these glasses is emptied into a 300 milliliter (ml.) glass.

2. After pouring equal amounts of water into two 300 ml. glasses the water from one of these glasses is emptied into a 600 ml. glass.

In each case the following procedure for questions will be followed:

"I am going to pour water into both these glasses and I want you to watch closely because then I am going to ask you some questions about the water."

Water is poured into the two 600 ml. glasses from a marked measuring cup so that the levels in both glasses are equal. The following question is then asked:

> "Do both these glasses have the same amount of water or are there different amounts of water?"

When the child says that they have the same amounts he is asked the question:

> "Then, if I drink this glass and you drink that one (pointing) would we both drink the same amount of water?"

When the child agrees to the same amount the following statement is made:

> "Now I want you to watch carefully again, I am going to pour the water from this glass here (600 ml.) into this one here (300 ml.)." It is now visibly apparent that the water level in the 300 ml. glass is higher.

The question is now posed:

> "Do both these glasses have the same amount of water in them now or are there different amounts of water?"

After the response to the previous question, the filled 600 ml. and 300 ml. are taken away and put behind a screen;

there is another 300 ml. glass behind the screen unknown to the child. This 300 ml. glass contains more water than the 300 ml. just used in the experiment.

The extinction procedure starts out by the experimenter saying and doing the following:

"Oh I forgot--I have one more question to ask you."

While saying the above, the experimenter takes two of the glasses out from the screen in view of the child. The child does not know that the experimenter has switched to a 300 ml. glass which has more water than the 600 ml. glass. Three glasses are now in front of the child--an empty 600 ml. glass, a filled 600 ml. glass, and a filled 300 ml. glass. The child is asked to make the following prediction.

> "If I empty the water back into this glass again (empty 600 ml. glass) will both these glasses have the same amount of water in them--(2 600 ml. glasses)."

When the child sees that the water level in one of the glasses is higher he is asked:

> "Why is the water higher in this glass if they both have the same amount?"

APPENDIX C

DESCRIPTION OF APPARATUS

MATERIALS

Water

Three cylindrical, transparent glass beakers were used to hold the water. The standard beaker could hold 600 milliliters of water, and was 12 cm. in height and 10 cm. in diameter. The height of the water level in this container was 6 cm. The water was poured into the standard beakers from a marked (yellow) measuring cup placed at one and one-half cups of water.

The modification was induced by pouring the water from the standard into a container smaller in diameter. This container was 12 cm. in height and 7.5 cm. in diameter. The narrower diameter caused the water level to rise to 11 cm.

Clay

The standard ball of clay was 19 cm. in circumference and weighed 200 grams. The first modification was induced by pressing the clay into a pancake shape of 9 cm. diameter, 29 cm. circumference, and 1.5 cm. in height. The second modification was induced by rolling the clay in a sausage shape of 15 cm. in length and 10 cm. in circumference.

Wire

The coils were made of Reynold's Aluminum Craft wire, .035 inch gauge, by winding a 16.5 cm. piece of wire around a standard size pencil.

The standard coil was 4 cm. long. The first modification was induced by stretching the standard to approximately 14.5 cm. in length. The second modification was induced by compressing the standard to approximately 1 cm. in length.

APPENDIX D

MANUAL OF CONSERVATION AND

NON-CONSERVATION RESPONSES

The response measure in the present study was the verbal report of the child, modified versions of Lee's (1966). The present manual is for conservation. Piaget (1960) hints at two types of conservation responses. He maintains that the child in the Intuitional Stage (four to seven years) of Intelligence can maintain conservation without a clear cut principled explanation whereas the child in the stage of concrete operations (seven to eleven years) conserves by giving an operational principle. These two types of responses were distinguished in the present experiment for purposes of analysis and discussion. Thus, as soon as the subject decided whether or not the amount of substance was invariant after the material was transformed in appearance, he was asked to provide a rationale for his judgment. The response was then categorized as a principled explanation if any one of the following operations were present.

1. Reversibility: The ability to cognitively reverse the transformation process and recognize that the modified material could be changed back to its original shape, or,

conversely, to recognize that the unmodified material could be changed into the shape of the modified material.

2. Compensation: The ability to recognize that variation in one dimension of a material includes a reciprocal variation in another dimension.

3. Identity: The assertion that the amount of substance remains unchanged even though the shape is noticeably changed, the notion that nothing has been added or subtracted.

4. The distinction between appearance and reality: Although this is not specifically an operation according to Piaget, it constitutes a general statement of cognitive sophistication, of which conservation is a specific response.

Conservation Responses

A manual of conservation responses was compiled from the pilot study which preceded the present study and also a previous manual compiled by Lee (1966). The following are examples.

1. Conservation Responses without a Principle Given.

a. Clay: Both pieces have the same amount. I don't know why but I think they are the same.

b. Water: This glass has the same amount of water as that one. I can't tell why.

c. Wire: That wire is the same as this one. (No explanation) They're the same.

2. Conservation Responses with Principled Explanation.

a. Clay:

(1) Because you just pushed this one down . . . it was a circle and they were the same and you just pushed this one down. (Identity, Reversibility)

(2) The same clay . . . you just flattened it into a pancake. (Identity, distinction between appearance and reality)

(3) You didn't add or subtract any clay so they have to be the same. (Identity)

(4) It was like this ball before . . . it's no different now . . . all you did was push it down. (Reversibility, Identity)

(5) One is flatter and low, the other is skinnier and high. (Compensation)

(6) The same amount as before . . . but the shape changed when you pressed the clay down. (Identity, distinction between appearance and reality)

(7) If you flatten this one down, it'll be the same . . . so it must be the same. (Reversibility)

(8) Still the same . . . that one's just fatter, but it's not really different from that one. (Compensation, distinction between appearance and reality)

b. Water:

(1) Because before you had it in this glass and you just poured it into this one. (Identity, a hint of Reversibility) Why is this water higher? Because it's thinner. (Compensation)

(2) This is skinnier, so the water is higher . . . but it's still the same. (Compensation)

(3) You just poured the same water from this one to this one. (Identity)

(4) Because one glass is fatter and the other is thinner . . . their levels are different, but the amounts are the same. (Compensation, Identity)

(5) If you poured this water back into here, it would be as high as this. (Reversibility)

(6) 'Cause this one is thicker and the water gets lower. (Compensation)

(7) Because you poured the thin glass in there and you didn't lose any. (Identity) Why is the level different? The level is different because this glass is fatter. (Compensation)

(8) Because that one was the same as this one and it would be the same if you poured it in the big one. (Reversibility)

c. Wire:

(1) The same amount . . . all you did was pull it out. (Identity, distinction between appearance and reality)

(2) All you did was stretch it out . . . you didn't take any away. (Identity, distinction between appearance and reality)

(3) If you stretch this one it'll be the same as that one. (Reversibility)

(4) You didn't take any away . . . you just stretched it out. (Identity)

(5) It still makes the same that you stretched that (points to short coil) If you stretched that, they would be the same. (Reversibility)

(6) You just stretched this one out . . . if you pushed it back it would be the same. (Reversibility)

Non-conservation Responses

The following are a collection of non-conservation responses, categorized according to material. A short analysis of the non-conservation accompanies each sample response.

Clay

1. Because the one that isn't pushed down has more clay. (responds to the single dimension of height)

2. This one is flatter, so they are different. This one has more because it is further out (points to the flat one). (responds to the single dimension of width)

3. 'Cause one's flat . . . this one has more in it because it's bigger than the flat one. (responds to the single dimension of height)

4. This one you flattened out and it got smaller. This one you left alone. (responds to the single dimension of height)

Water

1. Because this one is more lower and that one is more higher. This one (points to narrow glass) has more water in it. (responds to single dimension of height of water level)

2. This glass has more water in it . . . because that glass is lower than the water in this glass. (responds to single dimension of height of water level, confuses container with water)

3. That one's skinny and this one's fat . . . they're not the same size. (Close to compensation, but responds to single dimension of diameter of the container)

4. This one's got more . . . it's higher. (responds to single dimension of height of water level)

Wire

1. Same amount of wire . . . 'cause this one is bigger. (Rationale contradicts judgment, responds to single dimension of length)

2. Almost the same . . . but you look like you have more because you stretched it out . . . there's really more in this one. (Close to conservation, but is perceptually drawn to respond solely to length)

3. I have more because yours is stretched out and mine is the way it's supposed to be. (May be responding to height, probably is responding to some arbitrary notion that any change reduces amount of substance)

4. Because this one is longer. (responds to single dimension of length)

APPENDIX E

MANUAL OF EXTINCTION RESPONSES

The present manual was adapted from Smedslund's (1961c) criterion for extinction responses. Smedslund noted that the typical behavior of children who do not resist extinction was to show little surprise and to switch rapidly back to non-conservation with explanations referring to the perceptual appearance of the objects (clay). "The ball weighs more because it is rounder and fatter," etc. The children who resisted extinction said: "You must have taken a little away from that one (the lighter object)." "I think you have taken away some clay." The present experiment used an extinction procedure with water substance (see Appendix B). The following are samples of items listed as extinction and resistance to extinction responses.

Extinction

1. They're different now because that one is higher.
2. That one has less now, it's lower.
3. They're different because you poured them different.
4. They're different but I can't say why.

Resistance to Extinction

1. They're different because you poured some water in that one (higher level beaker) behind there (screen).
2. You poured some water from one of the glasses (600 ml.) to the smaller one (300 ml.) so now it's higher.
3. They're different. One of these glasses must be thinner but it's hard to tell.

APPENDIX F

INTRODUCTION OF THE EXPERIMENT TO SCHOOLS AND STUDENTS

In introducing the present study to the administrators and teachers in the two school systems, the following sequence was observed.

In the Syracuse City School system, the study was introduced by submitting a formal report of the study to the coordinator of research. The coordinator then approved the study and sent it to the Superintendent for final approval. A letter was then received from the Superintendent who asked that I contact the Principal of the Franklin School and convey to her the specifics of the study.

In the West Genesee School system the school system's counseling service was contacted. Two of the counselors interviewed me and then gave me permission to test at Split Rock School. They informed the Principal of the study and all I did was meet him to give him specific instructions for the teachers.

The principals of both schools informed each teacher that I would be testing each child in her class for about a twenty minute period. She was asked to introduce me to the class by my name and then she was to say the following in my presence:

1. Mr. Sullivan will be taking each of you to the library for a little while.
2. He will be playing games with you, and possibly showing you a film. I think you will like that.

The teacher was not given specific information about the study, but they were told they would be informed of the study and its implications as soon as it was completed through the principal.

Each teacher was asked to respond to the child's question or comments about the experiment by saying the following: "Oh, that's nice. I'm glad you had a good time. It sure sounds like fun."

The principals said they would handle any parental inquiries, but it turned out that there were none.

When the child was taken from the class he was greeted cordially with a smile and engaged in informal conversation about school or play. When the experimenter reached the test room he asked the child to sit down across from him and said the following: "Well, we won't be doing anything like school-work. We are going to play with some things. This will be fun. You'll like this."

If the child was assigned to a treatment group the following statement was added: "We are also going to watch a film, and I want you to pay careful attention to it."

After the pre-test and treatments the child was brought to the post-test experimenter who was introduced to the child in a cordial manner. It should be added that the ice is already broken by the pre-test and all children readily went to the post-test experimenter.

The preceding procedure worked quite smoothly and there were no complaints issued by the children, the school personnel, or the parents.

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