THE UNIVERSITY OF MANITOBA

AN EXPERIMENTAL ANALYSIS OF THE ROLE OF EQUILIBRATION IN THE DEVELOPMENT OF CONSERVATION OF CONTINUOUS QUANTITY

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

WINNIPEG, MANITOBA

May, 1978

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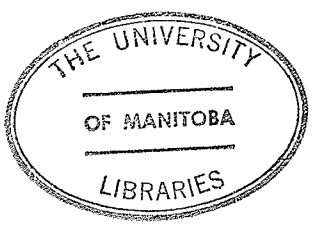

ACKNOWLEDGEMENTS

One who has the privilege of receiving a Ph.D. degree has many people to thank, for this degree cannot be gained without the help of many people.

I wish first to thank the chairman of my dissertation committee, Dr. Garry Martin. His generous friendship and support have always been extended to me. His fine analytic mind has helped me to discipline my mind and helped me to develop an appreciation for the real value of empirical research. I wish also to thank Dr. Lois Brockman, who has been my tutor on Jean Piaget's theory. Her understanding of the process of equilibration has been a great aid to my own intellectual development. Drs. Joe Pear, John Whiteley and Y. Lee have also served on my committee and I am thankful for their assistance.

It has been a privilege for me to have Dr. Hans Furth consent to be the external examiner of my dissertation. His scholarship and research have been an inspiration to me for many years.

The St. Vital School Board were generous in allowing me to do my research in one of their schools. I wish to thank Mr. A. Boyes, Assistant Superintendent, and Mr. H. Christie, Principal of Victor Mager School, and all the staff there who aided me. I have a special acknowledgement to give to the sixteen children who participated in the experiment. We had great fun playing the "games" together. I would also like to

thank Scott Paterson for his invaluable help as the second experimenter for this research.

I would like to take this opportunity to thank Dr. D. McCarthey for his friendship and teaching. Through him I have learned the love of knowledge and acquired the ideal of clear thinking (however, humbly I have approached either).

Last and most important to me are my wife, Vera and daughter, Naomi. Without Vera's committment, strength and support this degree would have been impossible for me. It was she who spent much of her free time over a two month period doing the interrater reliabilities off the tapes. Naomi (five and one-half years old) has also been a great help to me. We have spent so many hours together doing our "homework" in my study. She is such a joy to me. She has been so generous because she has asked for so little of my time. And yet we have been happy just being together.

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ABSTRACT

This research sought to test Piaget's postulate that the process of equilibration is of central importance in the development of intelligence. Specifically, the development of conservation of continuous quantity was studied. The design used was a single organism design. It incorporated four groups of subjects: a natural conserver and control group and two experimental groups. The last three groups were matched at four pre-operational levels of cognitive competence. One experimental group was given errorless discrimination training in an attempt to gain control over conservation verbal behavior in the absence of disequilibrium. The second experimental group was given disequilibrium induction training in an attempt to gain control over this behavior when disequilibrium was involved. Both methods were successful in this regard. Minimal disequilibrium occurred in the errorless group and a substantial amount occurred in the disequilibrium group. In general all the subjects were trained to criterion. However, on two delayed posttests, at one week, and five to six weeks, the errorless group displayed no conservation understanding while the subjects in the disequilibrium group were diagnosed at the following levels: one was operational, one was a consolidator, and two were borderline transitional. The results are interpreted as giving tentative support to Piaget's postulate.

CHAPTER 1

THEORETICAL INTRODUCTION

One of the central concepts of Piaget's theory of development is that of self regulation. For him self regulation occurs at all levels of development--genetic through to the intellectual level. He posits that the source of this self-regulation is the organization function which he defines as the general functioning of the organization of all the elements that make up the developing whole at any point in time (Piaget 1971a). The organization function operates upon all the sub-structures that make up the organism, in such a way that it guides the whole process of development along a path which is species-specific.

On the level of intellectual development Piaget usually refers to the organization function as the process of equilibration.[1] Here the influence of the whole of intelligence on its developing parts is such that given the proper social environment, intelligence will follow a developmental path that leads from sensorimotor to formal operational acts of knowing (cf. Crabtree, 1968; Furth, 1969; Gobar, 1968; Piaget, 1960a, 1960b, 1961, 1964, 1967, 1970, 1971a, 1972).

On the intellectual level equilibration can be activated by two different types of disequilibrium: adaptational

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[1]For a further discussion of equilibration see Appendix 1.

disequilibrium between assimilation and accommodation to the external world and organizational disequilibrium which can occur between the substructures within intelligence or between the whole of intelligence and one or more of its substructures (Brainerd, 1973; Piaget, 1972; Strauss, 1972).

Piaget's theory does not reject the processes of learning such as are described by the principles of operant conditioning (cf. Martin & Pear, 1978). Rather, it qualifies these by saying that their developmental effectiveness will be determined by the intrinsic processes of self-regulation which characterize each stage of development.

Given the centrality of the process of equilibration to Piaget's theory it is important that it should be studied experimentally. Brainerd (1973) has analyzed several methods for creating adaptational disequilibrium experimentally. He has labelled these as: dimensional discrimination, direct feedback, prediction-outcome and conformity training.

One of the areas where Piaget's theory has been put to an extensive experimental examination is the development of the understanding of conservation. Many different types of conservation ability have been examined--such as conservation of area, number, continuous and discontinuous quantity, length, weight, and volume. Take as an example conservation of continuous quantity (CCQ). Here a child is faced with two beakers of identical shape and size and containing the same amounts of liquid. After the child agrees that both contain the same amount of liquid, one of the liquids is poured into

a taller but thinner jar. A conserving child will understand that the amount of liquid is still the same as that in the unpoured jar, because even though it is higher, it is also thinner than the other (the compensation explanation). A nonconserving child will say that the transformed liquid has increased in quantity because it is higher (or in a few cases, decreased because it is thinner).

Appendix 2 present a summary of 71 different attempts to experimentally induce conservation ability. This summary is presented as Table 1. Several of the results of this review are relevant to the question of whether or not it is necessary to postulate the process of equilibration in explaining the development of conservation ability. First, all of the successful experiments either directly or indirectly utilized disequilibrium induction methods. By directly, I mean that the authors specifically attempted to utilize one of the methods cited by Brainerd and listed above, for creating adaptational disequilibrium experimentally. By indirectly, I mean that if you analyze their procedure you can see that the authors (either knowingly or unknowingly) may have created the possibility that one of Brainerd's methods for causing adaptational disequilibrium experimentally, was present. The criteria on the basis of which an experiment was judged successful were: (a) the presence of the correct judgement and explanation on the post-test as well as, (b) at least two of the following properties: specific generalizability, non-specific generalizability, resistance to countersuggestion, and

durability. Examples of successful experiments that deliberately used disequilibrium induction methods are: Brainerd (1972a, 1972b, 1974b, 1976), Brison (1966), Curcio, Kattef, Levine, & Robbins (1972), Halford & Fullerton (1970), Hatano & Suga (1969), Inhelder, Sinclair, & Bovet (1974), Lefebre & Pinard (1972), Murray (1972, 1974), and Sheppard (1974). Examples of experiments that indirectly used disequilibrium induction methods are: Bearison (1969), Boesma & Wilton (1974), Cooley & Martin (1972), Gelman (1969), Rosenthal & Zimmerman (1972), Zimmerman & Lanaro (1974), Zimmerman & Rosenthal (1974). Second, if we analyze the unsuccessful experimental groups across these experiments, 40 of these were exposed to disequilibrium induction methods and 18 were not. Examples of the groups that were exposed to disequilibrium methods and failed to acquire conservation are: Cooley, Braun, & Kerger (1977), Gruen (1965, gp. 2), Sjoberg, Hoyer & Olsson (1970, gp. 1, 2, 4), and Strauss & Langer (1970). Examples of the groups that were not exposed to these methods and did not acquire conservation are: Fleishman, Gilmore, & Ginsburg (1966, exp't. 1, gps. 1, 2; exp't. 2; exp't. 3), Hamel (1971), Overbeck & Schwartz (1970, gps. 3, 4), Strauss & Langer (1970, gps. 3, 4) and Wallach, Wall, & Anderson (1967, gp. 2). Third, all of the groups that were not exposed to disequilibrium induction methods failed to acquire conservation. Fourth, only 6 out of the 71 experiments attempted to assess whether or not disequilibrium was actually induced. Four of these did a qualitative assessment and

judged that there was some evidence for its involvement in cognitive development (Inhelder, Sinclair, & Bovet, 1974a, b, e, f). The remaining two did a quantitative assessment (Smedslund, 1963b; Winer, 1968). In only one of these cases (Smedslund, 1963b) was there any evidence of its involvement. Finally, none of the 71 experiments attempted to gain both a quantifiable measure of and an experimental control over disequilibrium, in such a manner that it would be kept at either a minimum or maximum during induction training.

These results make it almost impossible to make a data-based objective judgement about whether or not equilibration is a necessary factor in the development of conservation ability. The evidence for it is weak. Its necessity might be inferred from the fact that all of the successful experiments utilized, either directly or indirectly, a disequilibrium induction method and from the fact that none of the groups were successful in the absence of these methods. However, the fact that so many groups were exposed to disequilibrium induction methods and failed to acquire conservation render this inference weak. Further, the 6 experiments that attempted to objectively assess the presence of disequilibrium provide inconclusive evidence for its involvement in cognitive change.

The experiment which is reported here attempted to obtain evidence, which was more direct, concerning the process of equilibration. It did this in several ways. First, it defined some overt behaviors that could be taken as indices of the presence of cognitive disequilibrium. Second, it

utilized a sophisticated operant conditioning methodology to design two conservation training methods which might enable the experimental control of disequilibrium. The first method was an errorless training program designed to develop conservation ability while holding disequilibrium at a minimal level. The second method was a disequilibrium induction procedure, based in part on Inhelder, Sinclair, and Bovet (1974a), which was designed to develop conservation ability and induce a significant amount of disequilibrium.

In this way it was hoped that a more objective assessment might be made of the role of disequilibrium, and through it of the process of equilibration, in the development of liquid conservation ability.

CHAPTER II

METHOD

Subjects

Sixteen subjects were studied, including 12 who were non-conservers and 4 who were natural conservers at the start of the experiment (the procedures for testing for conservation behaviors are described below).

All the subjects were given two tests to determine that they understood the terms: same, more, and less, and one test for the terms: tallest, shortest, fattest, skinniest, lowest, widest, and narrowest. The method was to present them with two beakers with the relative amounts of colored water in them, that corresponded to the term being tested, and then to ask them to make the appropriate judgement. Children from two kindergarten classes were then given tests for conservation behaviors until 12 nonconservers[2] were obtained, following the Baseline Pre-Tests as described below. The four natural conservers were obtained from a grade 2 classroom. The 12 nonconservers ranged in age from 5 years 3 months to 6 years. All were in kindergarten in an elementary school and included seven boys and five girls. All subjects had a middle socio-economic status. The four conservers ranged in age from 7 years 6 months to 8 years 2 months and included two boys and two girls.

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[2]Unfortunately one of these subjects for the control group was initially misdiagnosed. A later analysis of his data revealed that he emitted some correct judgements on pretest one. However, his data is included because it shows the delayed structural elaboration referred to by Inhelder et. al. (1974).

Apparatus

The apparatus for the pretests, post-tests, and the errorless and conflict training procedures are listed in Table 2.

Insert Table 2 about here

Experimental Design

The sixteen subjects included four groups of four subjects each. Two groups were designated experimental groups and were given either the errorless or the cognitive conflict training procedures. Within each experimental group a single organism multiple-baseline-across-subjects design was used (e.g., see Martin and Pear, 1978). With this design baseline data are gathered on the dependent variable(s) across several subjects. The experimental condition is then introduced for one subject while the others remain on baseline. The experimental condition is then extended to include additional subjects, sequentially over time, thus providing a demonstration that the subject's performance does not change until he is included in the experimental treatment. This design was strengthened by the addition of two control groups who remained on baseline conditions throughout. One control group contained non-conservers while the other contained natural operational conservers.

In order to help control for experimenter bias, two

Table 2

Apparatus for Pretest-Posttest, and for Errorless and Conflict Training Procedures

Item				Dimensions (Where Applicable)	Volume (Where Applicable)
Pre-Posttest	Errorless	Conflict	No. Req'd.		
Flexible Wire			1	15 cm.	
Flexible Wire			1	10 cm.	
Red Poker Chips			7		
Blue Poker Chips			7		
S.B.			2		1,000 mls.
S.B.			2		400 mls.
S.B.			4		100 mls.
Cylinder			2		250 mls.
Cylinder			2		150 mls.
Sausepan			1	13 x 9 x 2 in.	
Unique shaped flask	3		1	12 x ½ in. (approx.)	
	S.B.		2		1,000 mls.
	S.B.		3		400 mls.
	S.B.		2		250 mls.
	S.B.		2		150 mls.
	E.B.		3		500 mls.
	E.B.		1		125 mls.
	F.B.F.		2		1,000 mls.
	F.B.F.		3		500 mls.
	3		2	5½ x 5½ x 2½	
	2.1		1	4 x 4 x 8½	
	2.2		1	4 x 4 x 7½	
	2.3		1	4 x 4 x 6½	
	2.4		1	4 x 4 x 5½	
	2.5		1	4 x 4 x 4½	
	2.6		1	4 x 4 x 3½	
	2.7		1	4 x 4 x 2½	
	1.1		1	3 x 3 x 8½	
	1.2		1	3 x 3 x 7½	

Table 2 (Continued)

Item				Dimensions (Where Applicable)	Volume (Where Applicable)
Pre-Posttest	Errorless	Conflict	No. Req'd.		
	1.3		1	3 x 3 x 6½	
	1.4		1	3 x 3 x 5½	
	1.5		1	3 x 3 x 4½	
	1.6		1	3 x 3 x 3½	
		TB	1		1,000 mls.
		TB	4		400 mls.
		TB	3		250 mls.
		TB	3		150 mls.
		SB	3		400 mls.
		SB	1		250 mls.
		SB	2		150 mls.
		EB	1		500 mls.
		EB	1		125 mls.
		FBF	1		1,000 mls.
		FBF	3		500 mls.
		FBF	1		250 mls.
		Retort Stand	1		
		Clamps	4		
		Board	1	15 x 8 in.	

[3]SB symbolizes standard beaker

TB symbolizes tapped beaker

EB symbolizes Erlenmeyer beaker

FBF symbolizes flat bottomed flask

3 symbolizes 3 quart milk carton

2 symbolizes 2 quart milk carton

1 symbolizes 1 quart milk carton

experimenters were used in such a way that all the subjects were exposed to each experimenter once on the pretests and 50% of the training in each experimental group was performed by each experimenter.

Baseline (Pretests)

All the subjects were given two sets of pretests on the conservation concepts. For the two experimental groups the second set was given in a staggered manner in order to provide a multiple baseline across subjects. Within each experimental group, subject 2's second pretest occurred two days after subject 1's, subject 3's occurred eleven days after subject 2's, and subject 4's occurred two days after subject 3's.

Baselines for the Conservation Concepts

All the subjects were given two sets of pretests for conservation of continuous quantity (CCQ), conservation of length (CL), and conservation of number (CN). These tests were taken from Inhelder, Sinclair, and Bovet (1974). On each pretest each concept was tested twice on different stimulus configurations. CCQ and CN judgements were countersuggested against four times when the answers were correct or wrong. CL judgements were countersuggested against only twice when right or wrong.

In order to be classified as a conserver, the subject had to give correct conservation judgements and explanations. Conservation explanations were considered adequate if they met one or more of the following criteria (taken from Forsberg, 1973):

1. Compensatory relations: the subject states that changes in certain dimensions are compensated for by changes in other dimensions. e.g., "This one is longer, but thinner."
2. Reversibility: the subject states that the transformation could be cancelled by an inverse transformation. e.g., "You could pour it back, and it would be the same."
3. Addition/Subtraction: the subject states that nothing has been added or taken away. e.g., "You didn't add any on or take any off."
4. Identical action: the subject states that the standard object could be transformed in a similar manner to the comparison object. e.g., "You could make that ball into a pancake like that."
5. Initial equality and/or irrelevant transformation: the subject states that the two objects were initially equal and/or that the transformation makes no difference to the property in question (these two explanations generally occurred together). e.g., "they were the same before, and you just poured them in here."
6. Logical necessity: the subject states a general rule. e.g., "No matter what shape it is, it will still weigh the same."
7. Quantitative equivalence based on another property: e.g., "It still has the same amount, so it must weigh the same."

In order to be classed as a nonconserver on any particular concept a subject could not have made any conservation judgements or explanations on the two pretests for that concept. If on all of the pretests all of a subject's judgements to the main questions following the transformations were nonconservation judgements but the subject changed his/her judgement under countersuggestion, these changed judgements were still rated as nonconservation judgements. Since the subject evidenced no understanding of conservation during the main portions of the pretests, these changed judgements were not taken as indicative of an understanding of conservation.

The twelve nonconservers to be assigned to the two experimental groups and the control group were given a developmental level score which was based upon: (a) percent judgements which were conservation judgements, (b) percent explanations which were conservation explanations, and (c) percent of nonconservation judgements which were changed to conservation judgements under countersuggestion, all taken from pretest one. These were used by the author as indications of developmental level. These percentages were converted to absolute figures and totalled to give the developmental level score. The subjects were then rank ordered and one member of each rank randomly assigned to one of the three groups. Thus, the groups were matched in terms of the rank ordered developmental level of their subjects.

The operational conservers were subjects who scored 100% correct on judgements and explanations which were generalizable

and resistant to countersuggestion.

Baseline for Behaviors Used as Indices of Cognitive Conflict

As indicated in the introduction one of the goals of this research was to directly measure behaviors that could be used as indicators of the presence of cognitive conflict in order to better judge the presence or absence of adaptational disequilibrium during the experimental procedures for inducing conservation behavior. The following behaviors were recorded as indicating cognitive conflict when they were emitted while the subject was attending to the possible conflict inducing stimuli. That is when the subject emitted these responses while not attending to the conflict producing stimuli these responses were not recorded as indicating conflict. This restricting condition on the definition was necessary because many of these responses were emitted in the errorless training when the subject was acquiring the echoic behavior and not attending to the conflict producing stimuli. In this situation they were considered to be not indicative of conflict but of difficulties in recall.

The occurrence of any one of the following five types of behavior were scored as indicating conflict:

1. Humming and ahing. Here each hum or ah was scored as an instance. In addition each repetition of words was also recorded as conflict. For example "I think--I think" would count as one instance.
2. Change of judgement. This was scored only if the change was spontaneous and unprompted by the

experimenter. For example, "There's more lemonade in N because it's thinner, and there (b) it's fatter," . . . then immediately afterward: "No, it's the same"--"How do you know?"--"Because I can see it"--"How can you see it?"--"I just know" (Inhelder, et. al., 1974, p. 55).

3. Facial expressions. Here frowns and puckering of the lips were scored if they were obvious enough to create no doubt in the observer as to their occurrence.
4. Pauses. Pauses, following a question by the experimenter, which were four seconds or longer and which were uninterrupted by the experimenter, were scored. A pause was considered terminated when either the experimenter or subject spoke.
5. Recognition of conflict producing stimuli. This occurred where the subject recognized problems with his judgements or pouring actions. For example, when beakers A and A' had the same amounts and the subject was asked to pour equal amounts into beakers B and B' where B' is narrower than B, and the subject makes the levels of B and B' equal. When in this situation the subject might have said, "Hey why is there still some up there (i.e., A')." This was scored as indicative of conflict (cf. Figure 4 on page 28.

On all pre and posttests and during training for both experimental groups all the sessions were tape recorded. In addition naive trained observers recorded the behavior indicators of cognitive conflict throughout all the pretests and the training of the conflict group. The observers were not informed about the purpose of the experiments, about the function of the two training methods, or about the author's predictions. In addition, they were asked not to discuss the experiment among themselves. After the experiment was over they were questioned as to whether they had figured out what was being tested. Although they knew at this time that the experiment was a study of the difficulties in learning conservation and about methods for such learning, none of them had figured out exactly what variables were being examined or what the author's predictions were. The behavior of the errorless group was recorded by the experimenter himself, since this program was much easier to manage. The posttest data on conflict was also recorded by the experimenter himself since these data were taken after the end of the university term and the student observers had left for summer employment. The posttest data on judgements and explanations was recorded only by the tape recorder.

Baseline for cognitive conflict in a non-conflict and non-training situation. A non-conflict situation was defined as one where the subject was being asked neutral questions during the pretests or being asked to echo the experimenter's prompts in the errorless training situation,

where there was no transformation of the test stimuli and where none of the conflict induction procedures were being used. The baseline for the non-conflict non-training situation was taken from the responses on the relational terms tests and from the neutral portions of each of the CCQ pre and posttests where the subjects were asked to make judgements about the test stimuli prior to their being transformed. This provided a total of twenty situations where the frequency of these behaviors could be measured in the absence of both conflict and training.

This baseline was necessary in order to determine the frequency of these behaviors when the child was not being exposed to the training and the stimuli that may have the potential to induce conflict.

Baseline for cognitive conflict in a conflict and non-training situation. For this baseline the indices of cognitive conflict were measured on the parts of the pretests where the subjects were exposed to the transformations, questioned, and had their answers countersuggested against.

Baseline for cognitive conflict in a non-conflict and errorless training situation. Training programs one, two, three, five, and six involved the errorless training of verbal rules in the absence of any transformations of the dimensions of the stimuli and in the absence of conflict induction procedures. Therefore, these programs were used as baseline measures of conflict behaviors in an echoic training but non-

conflict situation.

General Procedures

The eight subjects in the two experimental groups were given one half hour training each, Monday through Friday until they met criterion performance. The training took place in an elementary school.[4] Two rooms were used. The subject was seated at an apparatus stand which contained a token (poker chips) dispenser on his/her right, the training apparatus in the center, and a display of the backup reinforcers on the left. The experimenter sat at the subject's right and the observer sat behind and to the right of the experimenter. The training materials were outlined in Table 2.

Specific Training Procedures

The Errorless Program to Teach Conservation of Continuous Quantity

The purpose of this procedure was to develop appropriate CCQ judgements and explanations which would be generalizable and resistant to countersuggestion, without inducing cognitive conflict. In this way the hypothesized process of equilibration would be controlled. The method of experimental control of equilibration was an errorless discrimination procedure which utilized prompting, shaping, fading, and programing of generalization and resistance to countersuggestion. (For a description of these principles, see Martin and Pear,

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[4] Victor Mager School in the city of St. Vital.

1978).

The training program to teach conservation of continuous quantity consisted of variations of a basic three-step sequence. This sequence can be seen in Figure 1.

Insert Figure 1 about here

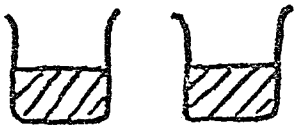
The major part of the training program consisted in teaching the subjects the appropriate answers to the questions and the appropriate verbal rules that go along with the correct answers, depending upon the verbal stimuli that were presented to the subject in Part B and C of Figure 1.

The answers to the questions (and the corresponding containers and their fluids) were taught using a positive reinforcement system and a prompting and questioning system, along with the behavioral principle of fading.

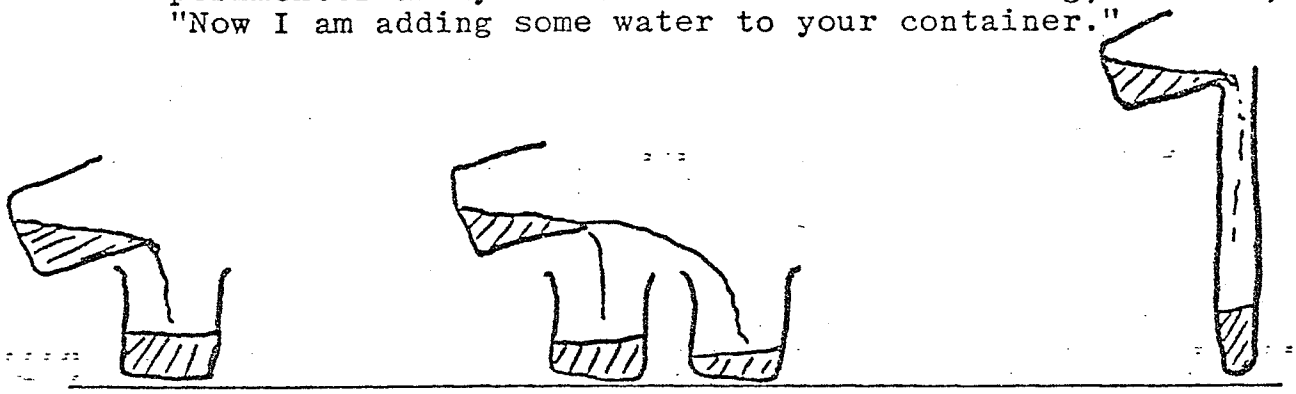
The reinforcement system and the experimental setting. A token reinforcer system (e.g., Kazdin, 1977) was used in which the immediate reinforcers were poker chips and the backup reinforcers ranged from toys valued at one cent to a hot wheels racing car. The one cent toys cost the subject one chip and the car cost 35 chips.

The child was token trained simultaneously with the conservation training. After every correct response the subject was told statements like, "good boy," "that's right," "boy are you ever smart," and given a chip. If he answered

(A) Two identical containers contained identical amounts of fluid. The subject is told, "Your container contains the same amount as mine."



(B) Something is then done to the fluid in the subject's container. Fluid is either added, or taken away, or poured into a completely new container, and the experimenter always described what he was doing, such as, "Now I am adding some water to your container."



(C) The subject is shown the final pair of containers of fluids and asked two questions:

	QUESTION	ANSWER
1.	"Do you have more than I have, or do you have the same amount as I have, or do you have less than I have?"	Subject has to give appropriate answer, which is either "the same," "more," or "less."
2.	"Why?"	Subject then has to give the appropriate verbal rule. The appropriate verbal rule consisted of such things as "Because they were the same to begin with and you just poured mine into this jar. Now it's higher but it's skinnier than yours, so they're the same" or "I have more, because they were the same to start with but you added some to mine," or "I have less, because they were the same to start with, but you poured some of mine away."

Figure 1: Basic 3-Step sequence for teaching conservation of continuous quantity.

wrong the experimenter said, "Oh, you just missed a chip but you will have lots more chances." This type of feedback was used in order to reduce to a minimum the probability of cognitive conflict occurring in error trials.

The prompting and questioning system. The sequence of prompt and question trials for each answer and verbal rule was similar to that used in other operant conditioning experiments (e.g., Cooley and Martin, 1972; Martin, 1975). The sequence used was as follows. The example used is taken from the teaching of the verbal rule for the concept of the conservation of unequal continuous quantity (see program 5 of Figure 2). The prompt trial on the new concept, i.e., Pn,

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Insert Figure 2 about here

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involved the following statement, "Iam pouring your water into this jar. Now do you have the same, more, or less than me? The experimenter immediately gave the answer, "more," then asked, "why?" He again provided the answer, "because mine had more to begin with and you just poured mine into this jar."

The question trail on the new concept, i.e., Qn, was identical except the experimenter did not provide the answer or the verbal rule. The Qn was repeated until the subject got three answers right, consecutively. Throughout all trials care was taken to insure that the subject was attending to the relevant stimuli.

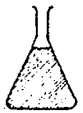
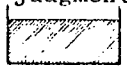
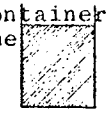
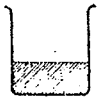
TRANSFORMATIONS	TYPE OF CONTAINERS	SCHEMATIC OF CONTAINERS AFTER THE TRANSFORMATION		ANSWER TO QUESTION 1 FROM FIGURE 1	VERBAL RULE (ANSWER TO QUESTION 2 FROM FIGURE 1)	KNOWN CONCEPT ALTERNATED WITH TEST CONCEPT i.e., THE QK.
		E's Container	S's Container			
1. S's fluid completely transferred to another container	Three 600 ml. beakers			Same	Because they were the same to begin with and you just poured mine into this jar.	--
2. S's fluid completely transferred to another container	Three 500 ml. Erlenmeyer beakers			Same	Same as above	--
3. S's fluid completely transferred to another container.	Three 500 ml. flat-bottomed flasks			Same	Same as above	--
4. S's fluid completely transferred to a container of different dimensions	2 3-quart milk cartons and 1 2-quart carton cut as indicated	Perceptual illusion created by partially filled container to aid judgment of same 		Same	Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they're the same.	1
5. Fluid added to S's container	Three 600 ml. beakers			More	Because mine had more to begin with and you just poured mine into this jar.	4
6. Some fluid poured out of S's container	Three 600 ml. beakers			Less	Because mine had less to begin with and you just poured mine into this jar.	5

Figure 2: The answers and verbal rules that were taught in the first five programs in the errorless training.

Next followed a prompt trial on a known concept, i.e., Pk, in this case the concept of conservation of equal continuous quantity based upon program 4 of Figure 2. The training of this concept was taught in the same manner. Then followed a question trial on the known concept, i.e., Qk. If the subject answered the Qk correctly, then one more Qn was given. If this was answered right then a new program was begun. If either this last Qn or the Qk were answered incorrectly then they were reviewed to a criteria of three times correct. This was followed by one trial on Qk or Qn, whichever was appropriate. Then one more trial was given for which ever question was being reviewed. If these were completed correctly a new program was begun. At the start of each session the concepts that involved either new rules or new types of containers which were previously learned were tested. When the subject responded correctly to a concept at the start of three sessions in a row, it was considered learned. If not the concept was reviewed and the three-test-correct criterion for learning was started again. All of the programs were designed in a similar manner.

The specific training program to teach appropriate judgements and verbal rules. The training strategy included 29 individual training programs. The answers and verbal rules that were taught in the first five programs are summarized in Figure 2.[5] The training strategy was designed to teach the

[5]See Appendix 3 for all the errorless programs.

concept of conservation of continuous quantity and to firmly establish in the subject's repertoire the compensation verbal rule that explains the judgement.

The principle of fading refers to the gradual change of stimuli that govern a response until that response eventually occurs to a completely or partially different set of stimuli (for a more detailed discussion of fading, see Martin and Pear, 1978). This was involved in programs 11 to 16, where the milk carton containers were cut down little by little until the subjects were making a clear cut continuous quantity conservation without the aid of the perceptual illusion. (When the subject looks down into a tall carton it is difficult to discriminate the actual height of the liquid). Fading was further involved in programs 17 to 22, where the conservation of continuous quantity was maintained, but made more difficult by using a skinnier carton, i.e., a 1 quart instead of a 2 quart carton. Programs 24 through 27 were designed to bring about generalization of conservation of continuous quantity, so that the conservation of continuous quantity would increase in probability when the subjects were exposed to different sized items with appearance much different from that of the milk cartons.

Programs 28 and 29 were designed to enable the subject to resist countersuggestion. They used the same apparatus as program 27. Concerning program 28, following the transformation the Pn was given. "Now would you say . . . etc? Why?" The subject's response was identical to program 27.

Then the Pn continued. "Now you know that the right answer is that they are the same because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same. However, look at how high it is here (the 500 ml. flask). Don't you think that actually makes it more? This is what I want you to tell me." The experimenter then prompts the answer, "No, because . . . etc." The Qn after the transformation was, "Look at how high it is. Don't you think that actually makes it more?" Program 29 followed the same format except it used the following countersuggestion, "Someone else told me that there's more in here because it's taller than there . . . Do you think he's right or wrong (Inhelder et. al. 1974, p. 278)?" Programs 28 and 29 were alternated.

Adaptational Disequilibrium Program to Teach Conservation of Continuous Quantity

The method used in this program was based upon Piaget's conclusion that the laws of learning are subordinate to the laws of development. This implies that the principles of operant conditioning will be effective in inducing CCQ only to the extent that they create disequilibrium within the optimal zone of interest, thereby activating the basic process of intellectual development--equilibration. The contingencies of reinforcement were integrated into two conflict induction methods: prediction-outcome, and dimensional discrimination training.

The program utilized an apparatus adopted from Inhelder et. al. (1974a, p. 42). The program consisted of six phases, each with several subcycles of pouring the liquid through the three levels of the apparatus.[6] For each subcycle different parts of the apparatus were changed in an attempt to systematically create conflict through prediction-outcome and dimensional discrimination. Some of these phases are outlined in Figure 3.

Insert Figure 3 about here

Figure 4 gives as an example the details of a part of phase 5

Insert Figure 4 about here

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cycle 4.

The conflict training program utilized a token reinforcement system similar to that used for the errorless training. The contingencies of reinforcement were used to accomplish three things. First, to provide an extrinsic source of motivation to keep the subject operating on the apparatus over the weeks that the training lasted. Second, they were used to facilitate conflict in prediction outcome and dimensional discrimination situations. The subject was told that when he answered like an older boy he would earn red chips, but when he answered like a younger boy he missed getting a chip.

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[6]See Appendix 4 for all the conflict phases and cycles.

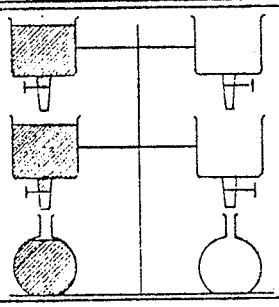
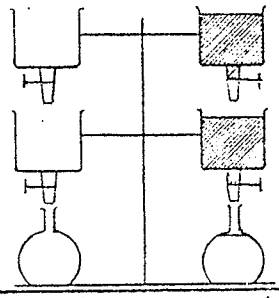
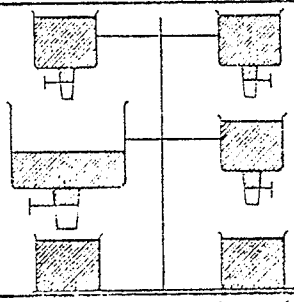
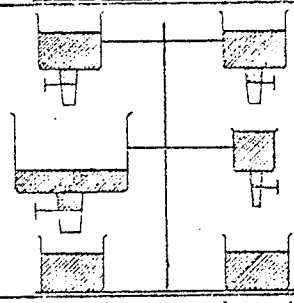
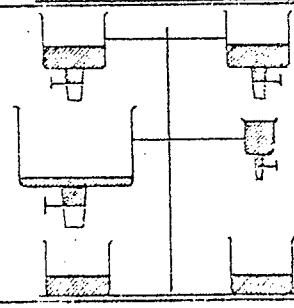
PHASE NO.	PHASE PURPOSE	CYCLE NO.	APPARATUS	TRANSFORMATION
1	1. Adaptation of S to equipment. 2. Focus S's attention on the closed cycle of the liquid flow. 3. Teach active search for contradictory judgements.	1	A_3 A'_3 B_3 B'_3 C_6 C'_6 F_6 @ 400 ml.	
1	Same as phase 1, cycle 1.	2	A_3 A'_3 B_3 B'_3 C_6 C'_6 F_6 @ 400 ml.	
2	1. Focus S attention on the fact that equal amts. rise to same level in A and A' and in C and C' but to different levels in B and B'. 2. To facilitate CCQ by: (a) approximating Piaget's 4 stages of the equilibration process and (b) prediction outcome conflict.	1	A_3 A'_3 B_4 B'_3 C_{12} C'_{12} F_{12} @ 400 ml.	
2	Same as phase 2, cycle 1.	2	A_3 A'_3 B_4 B'_2 C_{12} C'_{12} F_{12} @ 250 ml.	
2	Same as phase 2, cycle 1.	3	A_3 A'_3 B_4 B'_1 C_{12} C'_{12} F_{12} @ 150 ml.	

Figure 3: Some phases and cycles of the conflict training program.

Glass Beaker Sessions

Phase 5 Cycle 4 Sheet 1 Of 4
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_2 B'_1 F_{10} @125
C_9 C'_8

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Con-flict	Chips W, R WW, RR
1	1	Pour F in A_3 and A'_3					
2	1	Do A_3 and A'_3 have same amount?					
3	1	If $A_3 \rightarrow B_2$ and $A'_3 \rightarrow B'_1$ will B_2 and B'_1 have same amount? (R)					
	2	Why? (RR)					
4	1	Pour $A_3 \rightarrow B_2$					
	2	Pour $A'_3 \rightarrow B'_1$, just so - - Same to drink					
5a	1	That's right (R)					
If right	2	How can - be same when $B'_1 \uparrow$ than B_2? (R)					
	3	Does $B'_1 = B_2$ because $\uparrow$ and $\leftrightarrow$ (R)					
Go to 5b 14	4	Can - tell me why $B'_1 = B_2$ when $B'_1 \uparrow B_2$ (RR)					
5b	1	You did it like a young child					
If wrong	2	What about the juice up here? You left some of the juice for B'_1 up here. Does B'_1 really $= B_2$ or is it less? [(W) if S says no]					
	3	Can you tell me what the problem is? Why did you miss a chip when you were deciding about how much would be in B_2 and B'_1? (W)					
	4	When in A_3 and A'_3 how - did - have drink? (W)					
	5	How much did you -- re $A_3 \rightarrow B_2$ (W)					
	6	How much did you -- re $A'_3 \rightarrow B'_1$? (W)					
	7	If $A_3 = A'_3$ and all $A_3 \rightarrow B_2$ and only some $A'_3 \rightarrow B'_1$ how can $B_2 = B'_1$?					

Figure 4: An example of some of the details of phase 5 cycle 4.

However, if he was able to figure out why he lost the chip and then how the older boy would have done it, he would receive white chips. This presumably facilitated the discrimination between the right answer situation and the problem solving situation. Responses that moved in the direction of solving the problem were reinforced with one white chip and responses which solved it received two white chips. Correct judgements were reinforced with one red chip and correct explanations with two.

Prompting, where the experimenter specified the correct answer was not used in this program. However, a great deal of probing was used, where the experimenter asked Socratic type questions to facilitate the recognition of incompatible judgements and dimensional discrimination inconsistencies.

The third function of the reinforcement contingency was to provide an external source of confirmation which would reinforce any movement in the direction of internal equilibrium.

The contingencies were explicitly designed to facilitate the development of the compensation explanation. However, when other valid explanations occurred they were also reinforced.

All the subjects in the conflict group were taken through all the phases of the program. The only requirement for moving to a new phase was completion of the last, irregardless of whether it was done right or wrong. With the exception of subject 4 all the subjects were alternated on phase 6 cycle 1 and phase 5 cycle 7 until they completed both correctly three

consecutive times. These two cycles were designed to facilitate the discrimination between conservation of equal and unequal continuous quantity. At this point subject 4 lost interest in the training and it had to be discontinued. He said he was tired of the game and didn't want to play it any more. However, he did complete these two cycles several times, though not without a few errors, prior to the termination of his training.

Posttests

All the subjects with the exception of one from the control group who moved away and received only one posttest, received two sets of posttests. The first set was given one week after training was completed, and the second was given approximately five to six weeks after training. All the posttests followed the same format as the pretests. The tests for CL and CN were identical to the pretests. Seven tests for CCQ were given on each posttest. The transformations involved were: (a) from a 1,000 ml. standard beaker to 250 ml. cylinder, (b) the reverse of (a), (c) from a 250 ml. cylinder to four 100 ml. standard beakers, (d) from a 250 ml. cylinder to a 13 x 9 x 2 in. saucepan, (e) from a 1,000 ml. standard beaker to a 15 x 1 in. squiggley shaped glass tube made by the university glass blower, (f) a preference test where the subject's favourite soft drink was poured from a 1,000 ml. standard beaker into a 150 ml. cylinder and he/she was then told he/she could have his/her

pick to drink, and (g) a compensation judgement probe where the subject was presented with a 400 ml. standard beaker containing 250 mls. of liquid and an empty 250 ml. cylinder and told to pour the same amount into the cylinder.

Interobserver Reliability

Pretraining Reliability

Each of the four observers were given approximately fifteen hours pretraining. Each of them was rated with each of the other three observers on their observations of the practice subject's judgements and explanations on the tests for CCQ, CL, CN. They were rated in the same way on their observations of conflict responses across CCQ, CL, CN tests. Also their observations of judgements, explanations and conflict responses on programs and cycles from the errorless and conflict training were rated. Agreements and disagreements were based upon both the presence and absence of whichever of the above behaviors was being rated. The formula used was

$$\frac{\text{agreements}}{\text{agreements + disagreements}} \times 100$$

Interobserver reliability checks were taken on both experimenters once a week through the pretesting and training conditions. The same methods of calculation were used except that during training, reliability was calculated for two observers for the conflict group and for the experimenter and one observer for the errorless group. Scores were calculated on the basis of all the measures combined (judgements, explanations, and conflict) and on conflict only for both

errorless and conflict training groups. Agreements and disagreements were calculated on the basis of both the presence and absence of the behavior being recorded.

Interrater Reliability

Interrater reliability checks were taken by a naive rater on this taped data. Random samplings were taken of the pretests, posttests and training for both experimental groups. For the pretests and posttests all of the data on one subject randomly chosen from each experimental group was rated. For the training two of the errorless programs and two of the cycles for each subject in each group were randomly selected and rated. This constituted a rating of approximately five per cent of all the training programs and cycles.

The reliability checks were taken from the pretests, posttests, and training data for the two experimental groups on hmms, changes of judgements, pauses, and conservation judgements and explanations. It was necessary to break the rating down in this way because important theoretical conclusions were drawn from each of these categories, the data for which, was taken off of the tapes.

The method of calculation was the same as that described for the inter observer reliabilities.

CHAPTER III

RESULTS

Interobserver Reliability

Pretraining Reliability

The calculations of the reliabilities on the various pretraining observations resulted in 35 reliability scores. The range of these scores was 83% - 100% and the mean was 96%. The scores for the errorless and conflict procedures were 100%. The scores for total conflict were: 6 at 100% and 1 at 98%.

Pretest and Training Reliability

Scores were calculated on the basis of all the measures combined (judgements, explanations, and conflict) and on conflict only for both errorless and conflict training groups. As can be seen from Table 3 all the scores remained above 81% agreement.

Insert Table 3 about here

Interrater Reliabilities

As can be seen from Table 4 all of the ratings, except the hmms for the errorless group, are satisfactory.

Insert Table 4 about here

Table 3

Interobserver Reliability Ratings for Pretest and Training Conditions

	Type of Measure and Training Condition			
	All Measures[a]		Conflict Measure Only	
Pretest On C.C.Q., C.L., C.N.	Errorless 98%	Conflict	Errorless 99%	Conflict
Training Check #1	94%	90%	94%	85.4%
Training Check #2	84%	91%	81%	99.4%
Training Check #3	95%	84%	95%	94.1%
Training Check #4	90%	93%	86.2%	100%
Training Check #5	100%	88%	100%	94%

[a]All measures include judgments, explanations, and conflict behaviors.

Table 4

Interrater Reliability Ratings for Pretests, Posttests, Conflict, and Errorless Training

Condition	Type of Measures				
	Hmms	Changes of Judgments	Pauses	Judgments	Explanations
Pretests 1 & 2	86.7%	100%	100%	100%	100%
Posttests 1 & 2	81.5%	98.1%	96.3%	90.6%	83.7%
Conflict Training	92.6%	97.5%	98.8%	95.7%	99.4%
Errorless Training	79%	90.9%	96.4%		100%[a]

[a]Percentage based upon combined judgments and explanations.

The rating for the hmms for the errorless group is a little low in comparison to the convention of 80% (cf. Kazdin, 1975) as a minimal acceptable reliability score. However, given the complexity of the data here, this rating might be considered quite high. On all measures agreements were calculated on the basis of an agreement on the total number of hmms and repetitions for a training trial. These behaviors were often very difficult to discriminate. Thus, if one rater scored five hmms and the other four it would count as a disagreement for that trial. As can be seen all of the reliabilities which were below 100% would have been higher if agreement had been based upon individual responses. In the above example four agreements and one disagreement would have been recorded.

Subject Data

The summary of the developmental data on the subjects can be seen in Table 5. As can be seen the experimental and

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Insert Table 5 about here

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control groups were closely matched in their developmental level scores.

Table 5

Age and Developmental Level Scores of Subjects

Group	Age	Developmental Score
Errorless training		
Subject 1	5(6)	96.3
Subject 2	6(0)	54.1
Subject 3	5(3)	37.3
Subject 4	5(11)	30.0
Conflict training		
Subject 1	5(4)	82.8
Subject 2	5(7)	53.1
Subject 3	5(3)	41.5
Subject 4	6(0)	31.4
Control		
Subject 1	5(7)	86.5
Subject 2	5(6)	72.3
Subject 3	5(3)	42.7
Subject 4	5(5)	24.5
Comparison		
Subject 1	7(11)	N/A
Subject 2	7(6)	N/A
Subject 3	8(1)	N/A
Subject 4	8(2)	N/A

Pre and Posttest Conservation Abilities

CCQ on the pretests, last training program for the experimental groups, and posttests. Figure 5 shows the per cent of the correct judgements and explanations of the subjects at five points in the experiment. All the subjects

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Insert Figure 5 about here

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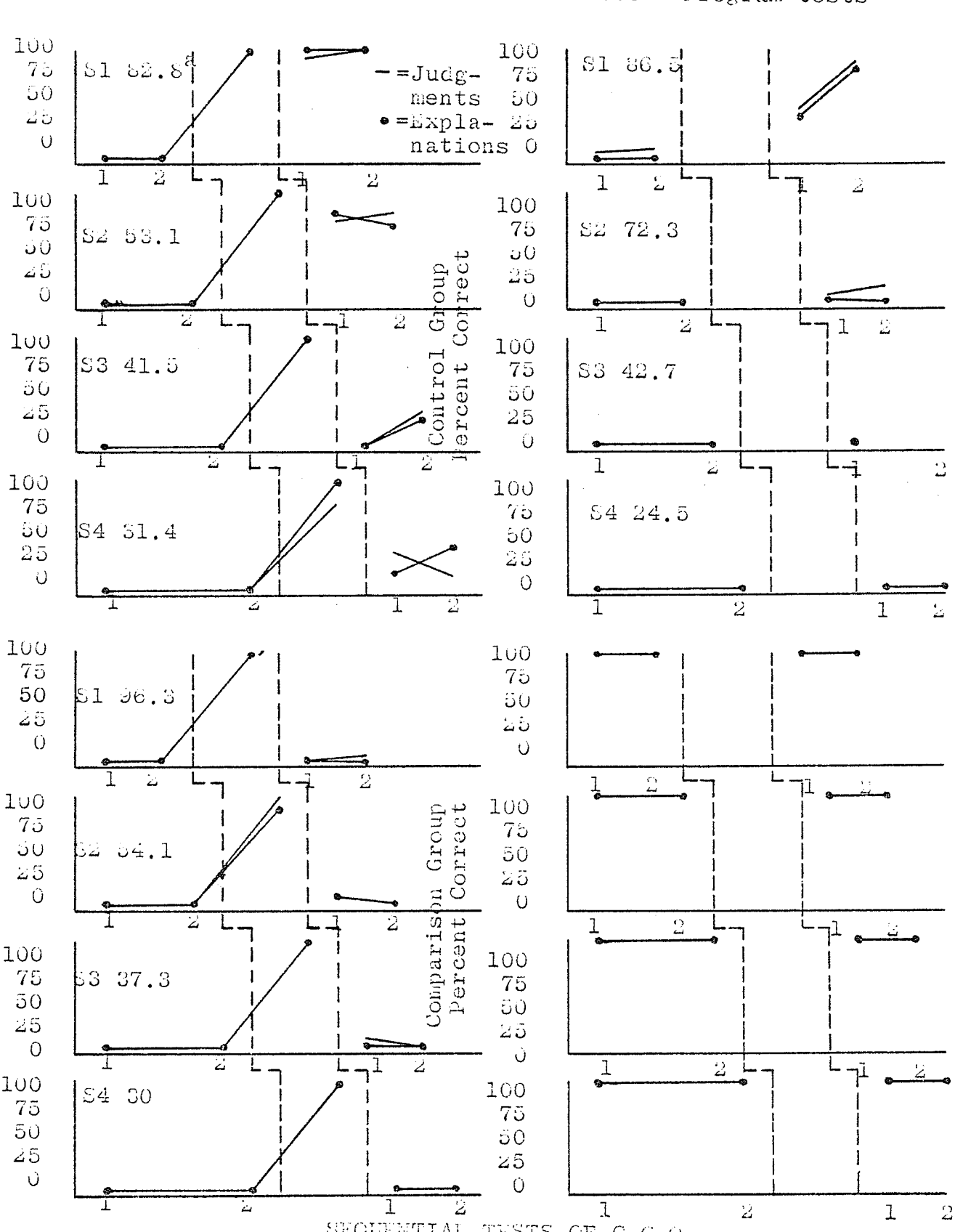
in the errorless and conflict groups and three of the subjects in the nonconserving control group scored zero on both pretests. The fourth subject in the control group scored 8.3% and 14.3% of his judgements correct on the first and second pretests, respectively.

In the conflict and errorless groups three of the subjects scored 100% on the last training program. In the conflict group one subject had two judgements wrong and in the errorless group one subject had one explanation wrong. In general then, three of the subjects in each experimental group were trained to criterion and one subject in each group was very near to criterion performance.

In the conflict group on the last posttest subject 1 had 100% correct judgements and explanations, subject 2 scored 82.1% and 72.4% respectively, subject 3, 33.3% and 30.4%, and subject 4, 22% and 44%. Using Flavell and Wohlwill's (1969) classification, subject 1 would be an operational conserver, subject 2 a consolidator, and subject 3



SEQUENTIAL TESTS OF C.C.Q.

Figure 5. Percent of C.C.Q. judgments and explanations correct on pretests, last training program and posttests, for the four groups.

[a] Subjects developmental level on pretests.

[b] One line means identical judgment and explanations

and subject 4 would be borderline transitional conservers. In the errorless group on the same test, subject 1 scored 3.3% and 0%, and subject 2, subject 3, and subject 5 scored 0% on judgements and explanations. In the control group subject 1, who was misdiagnosed[7] on the pretests, scored 84.2% and 80%, subject 2, 23% and 0%, subject 3 was unavailable, and subject 4 scored 0% on both judgements and explanations. In the comparison group all subjects scored 100% in their judgements and explanations.

CL, CN on the pre and posttests. Figure 6 shows the per cent correct of the combined judgements and explanations on CCQ, CL, and CN, on the pre and posttests for the experimental and control groups. As can be seen there was no consistent generalization between the trained and untrained

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Insert Figure 6 about here

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concepts. The only fairly consistant trend is for those concepts that were increasing on the pretests to continue to increase on the posttests. All the comparison group scored 100% on the pre and posttests for CL and CN.

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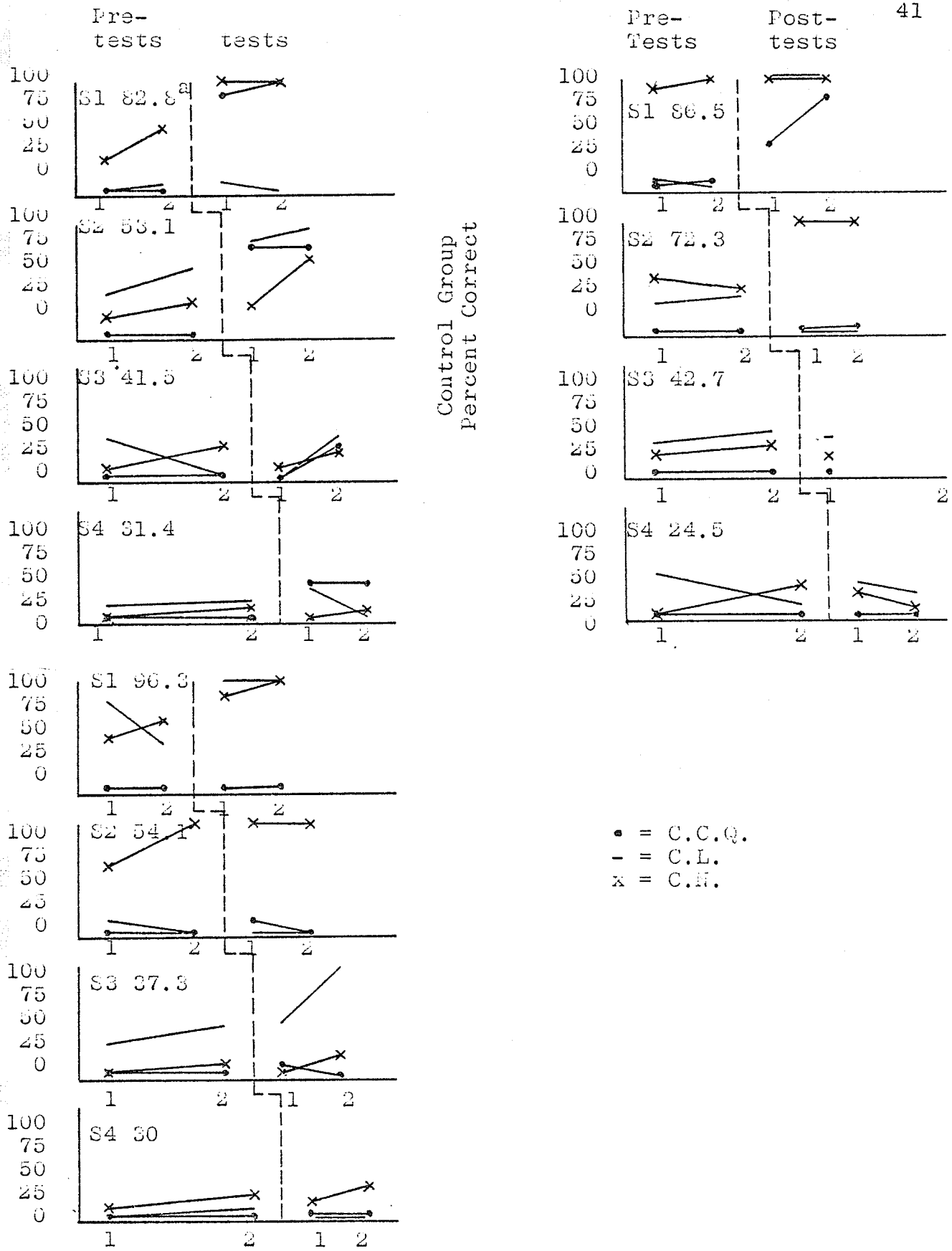
[7]As mentioned, an error was made on the data analysis of this subject, on the first pretest, which was not picked up until the tapes were reanalyzed.



SEQUENTIAL TESTS OF C.C.Q.

Figure 6. Percent of combined judgments and explanations correct for C.C.Q., C.L., and C.N. on the pretests and post-tests for the conflict, errorless, and control groups.

[a]Subjects developmental level on pretests.

Resistance to countersuggestion of the CCQ ability. On the two posttests for CCQ the errorless group resisted 4% of the total countersuggestions and these all occurred on the first posttest. The conflict group resisted 49% of the total countersuggestions. For this group on the last posttest subject 1 resisted 100%, subject 2 resisted 88.2%, subject 3 resisted 37.5%, and subject 4 resisted 22.2%. On the combined posttests the nonconserving control group resisted 12% of the total number of countersuggestions. Subject 1 accounted for 8.3% of these.

The comparison group resisted 100% of the countersuggestions on both the pre and posttests.

Also of interest, because of its relevance for the issue as to whether natural conservers can resist countersuggestion, is the fact that on the first pretest eight subjects, including the four in the comparison group, were tested who had all their judgements and explanations correct. All of these resisted all of the countersuggestions. Since these were conserving subjects only 4 of them could be used in the experiment.

Types of explanations used on the pre and posttests. Table 6 shows the total number and the percentage of each type of explanation, on the CCQ tests, used by each group.

Insert Table 6 about here

Table 6

Total Number of CCQ Explanations and Percent of Each Type of Explanation for Each Group on the Pretests and Posttests

	Number of Explanations and Percent of Each Type[7]				
	N	%E1	%E2	%E3	%E4	%E5
Comparison	306	32	8	13	4	43
Control	25	60	0	0	0	40
Conflict	117	37	3	0	0	60
Errorless	5	0	0	0	0	100

[7]The definition of each of these types of explanations was given in the methods chapter p. 12. The only group to emit correct explanations on the pretest was the comparison group. For the remaining three groups all these explanations were emitted on the posttests.

The figures for the experimental and control groups are all derived from the posttests. As can be seen the profile of the conflict group comes the closest to that of the natural conservers.

Conflict Data

Frequency of behavior used to indicate conflict as recorded directly by the observers. Figure 7 shows the frequency of these behaviors for each group across conditions as recorded by the observers. Minimal amounts of these behaviors were recorded for the control and comparison

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Insert Figure 7 about here

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groups across conditions. Concerning the errorless and conflict groups, only the training in the presence of the transformations produced significant amounts of these behaviors. Over 400% more of these behaviors were recorded for the conflict group than the errorless group.

The data show ABA design experimental control of these behaviors. Further, even though some conflict did occur for the errorless group, the procedures have clearly maintained control over these behaviors keeping them low in the errorless group and maximizing them in the conflict group.

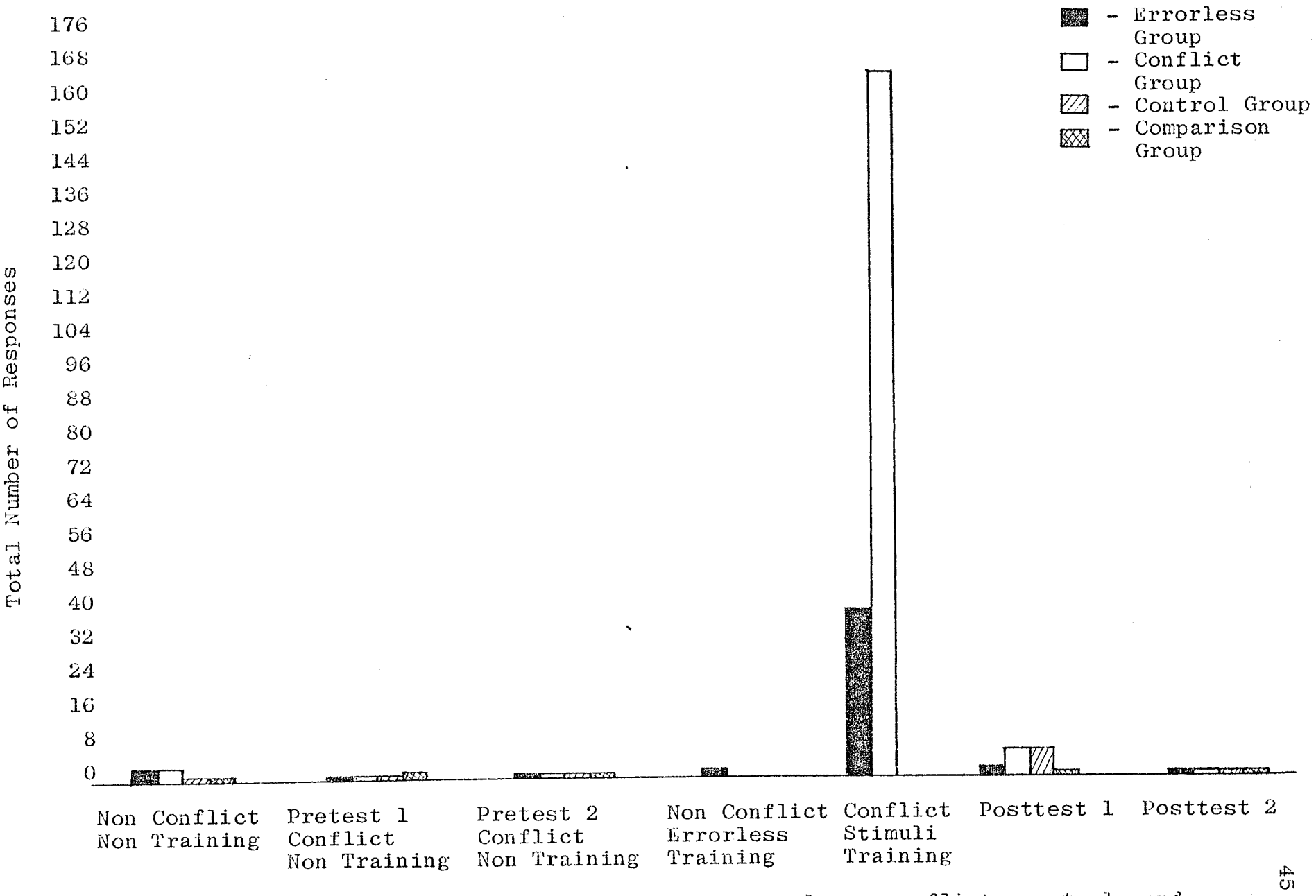

Figure 7. Total frequency of conflict for the errorless, conflict, control, and comparison groups across conditions as recorded by observers.

Frequency of behavior used to indicate conflict as recorded by the tape recorder. Table 7 gives the mean number of these responses per test and training program across conditions as taken from the tape recordings. Concerning the

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Insert Table 7 about here

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errorless group these data on Table 5 indicate that these subjects experienced some conflict on the conflict inducing part of the pretests. All the subjects increased their frequencies in the errorless training condition without transformation of the liquid, relative to the non-conflict non-training condition. In the training condition, where they were exposed to the transformation stimuli which were gradually faded in, only subject 1 and subject 3 show a noticeable increase over the errorless training without the transformation, and this increase is only about an average of one response per program. This indicates that the transformation variable which might have induced conflict appears not to have done so to any significant extent. This complements the data recorded by the observers which indicated that conflict for this group was low. Therefore, these responses under the control of the errorless training variables appear to be indicative of difficulties in acquiring the echoic behavior and not of conflict since there was not a significant increase in their frequency between the training without and with the transformation of the liquid. It is this transformation that

Table 7

Mean Number of Behaviors Indicative of Conflict Per Test or Training Program Across Conditions for the Experimental Groups Based on Tape Recordings

Non Conflict Non Training Condition		Conflict Non Training Pretests	Errorless Training Without Transformation	Errorless Training With Transformation	Conflict Training	Conflict Non Training Posttests
Errorless Group						
Sub. 1	0.35	1.25	0.91	1.97		1.21
Sub. 2	0.33	1.00	4.20	3.42		1.50
Sub. 3	0.19	2.00	1.25	2.25		1.86
Sub. 4	1.00	2.75	6.56	6.89		7.64
Conflict Group						
Sub. 1	0.10	1.25			7.00	1.60
Sub. 2	0.85	0.75			9.00	1.10
Sub. 3	0.00	0.50			5.14	1.60
Sub. 4	0.67	0.25			3.30	0.29

might have induced the conflict. With the exception of subject 4 the posttest response rate is about the same as the conflict nontraining pretest rate.

Concerning subject 1 and subject 3 of the conflict group, the pretests were conflict inducing. All the subjects showed a pronounced increase in these responses when they were exposed to the conflict induction treatment. This complements the data obtained by the observers. Once again these subjects, with perhaps the exception of subject 3, do not find the posttests to induce more conflict than the pretests.

Correlation between percentages of types of conflict behaviors and developmental level scores. An examination of Table 8 reveals an interesting fact. If all of the percentages of each type of behavior used to indicate conflict

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Insert Table 8 about here

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are rank ordered only pauses rank order in a manner which comes close to the rank order of the developmental scores, and also to the results of the training on conservation ability. In general within each group the percentages of pauses correlate well with the rank of the developmental score. Also there is a significant decrease, in the percentage of subject 1 of the errorless group, from that of the lowest percent in the conflict group, i.e., there is a

Table 8

Percentage of Conflict Constituted by Each Type of Conflict Related to the S's Developmental Level Score

	Developmental Score	Change of Judgments	Hums	Facial Expressions	Recognition of Conflict Stimuli	Pauses	Conserver Status on Last Posttest
Conflict Group							
Sub. 1	82.8	5.08	66.5	2.50	0.00	25.9	Operational
Sub. 2	53.1	6.17	46.8	13.31	3.30	30.5	Consolidator
Sub. 3	41.5	12.43	68.0	7.69	0.00	11.83	Transitional
Sub. 4	31.4	14.30	73.2	2.70	0.00	9.83	Transitional
Errorless Group							
Sub. 1	96.3	29.9	66.0	1.02	0.00	3.03	Nonconserver
Sub. 2	54.1	7.28	87.8	1.45	0.00	3.49	Nonconserver
Sub. 3	37.3	30.1	68.8	0.90	0.00	2.00	Nonconserver
Sub. 4	30.0	4.91	94.2	0.12	0.00	0.74	Nonconserver

significant difference between the percentages of pauses of a transitional conserver and a non-conserver. Furthermore, the percentages of pauses of the operational conserver and consolidater are significantly higher than those of the two transitional conservers.

Data on the Acquisition of Judgements and Explanations During Training

Number of each type of reinforced explanations. Table 9 shows the number of each type of explanation that was emitted

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Insert Table 9 about here

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by each subject and reinforced during training. It also shows the percentage of the total number of explanations, emitted by each group, made up of each type. As can be seen for the errorless group 100% were E1s. However, for the conflict group only 56% were E1s, while 4% were E3s and 40% were E5s. Also a total of 561 explanations were reinforced in the conflict group as compared to 1,068 in the errorless group. Nevertheless, on the two posttests the errorless group emitted only 5 correct explanations and the conflict group emitted 117 correct explanations. Furthermore, on these two posttests the errorless group only resisted 4% of the countersuggestions while the conflict group resisted 49%.

Table 9

Number of Reinforced Explanations of Each Type

Group	E1 Compensation	E3 Addition/Subtraction	E5 Initial Equality	Total
Conflict Group				
Subject 1	73	5	63	141
Subject 2	79	4	66	149
Subject 3	69	12	60	141
Subject 4	91	2	37	130
Total	312	23	226	561
	% of Total = 56	% of Total = 4	% of Total = 40	
Errorless				
Subject 1	344	0	0	344
Subject 2	265	0	0	265
Subject 3	255	0	0	255
Subject 4	204	0	0	204
Total	1,068			1,068
	% of Total = 100			

Order of emergence of the types of explanations in the conflict group. Although the conflict training was explicitly designed to facilitate the emergence of the compensation explanation, a glance at Figure 8 reveals that the addition/subtraction and initial equality explanations emerged spontaneously and prior to the first compensation explanation.

Insert Figure 8 about here

Relation between the emergence of conflict and explanations in the conflict group. No correct explanations occurred prior to conflict. In each case conflict emerged first. For subject 1 eleven conflicts occurred prior to or simultaneously with the reasoning out of the first correct explanation. For subject 2, subject 3, and subject 4, twenty-seven, ten, and nine conflicts respectively occurred prior to or simultaneously with the first correct explanation.

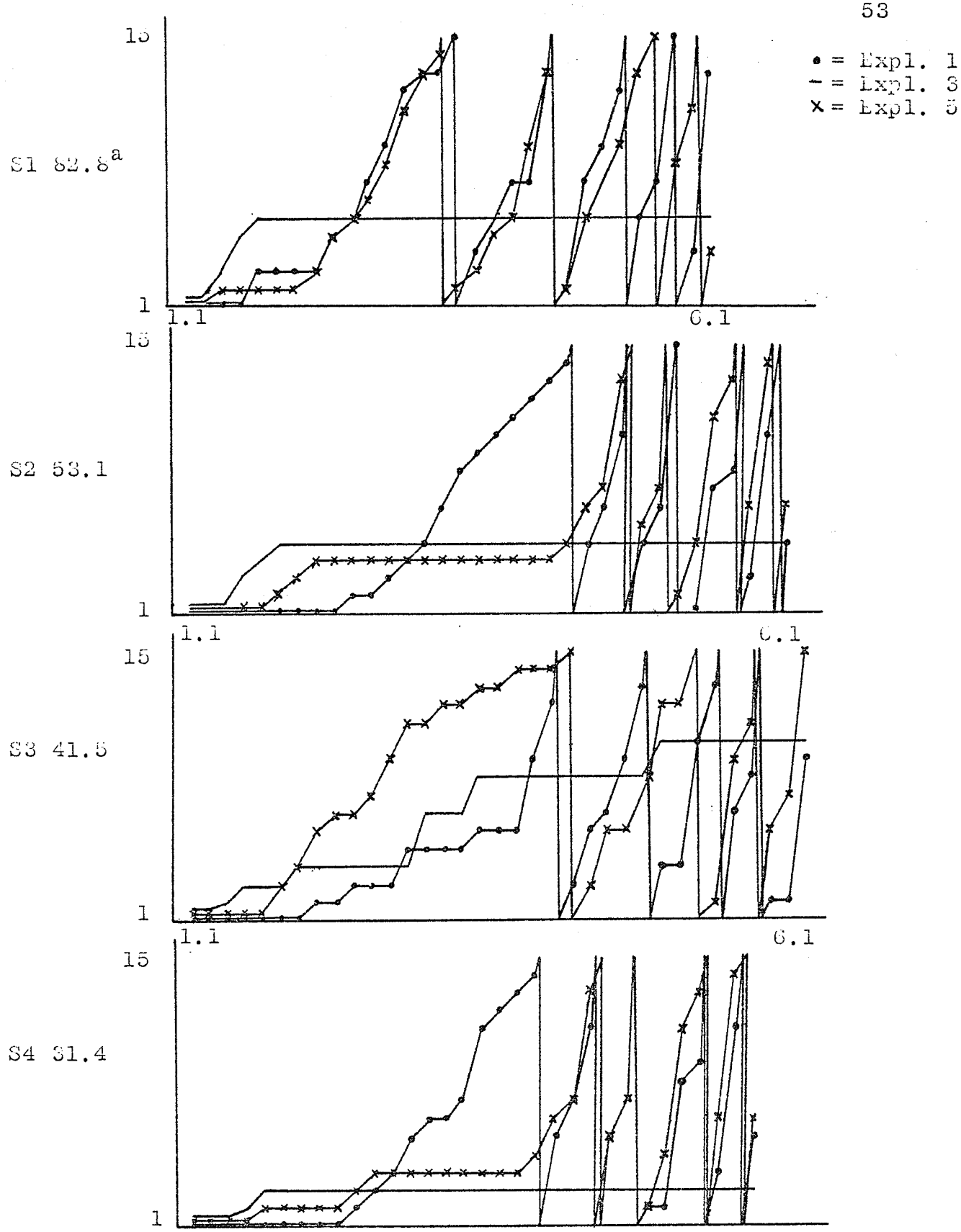

Figure 8. Order of emergence of the types of Explanations in the conflict group.

[a]Subjects developmental level score.

CHAPTER IV

DISCUSSION AND CONCLUSIONS

Evidence of the Equilibration Process

In Piaget's theory equilibration is an inferred explanatory concept. Several different types of data have been described which when taken together are convergent in their support of this inference.

The reason that these data are supportive is that they are confirming of several hypotheses that follow from Piaget's conceptualization of equilibration. These hypotheses are: First, that development should only occur when appropriate disequilibrium is created in the child's cognitive structures. Second, this disequilibrium should occur prior to or simultaneous with the change in understanding. Third, the change in understanding will only be indirectly controlled by the external contingencies of reinforcement. Their control will be limited by the child's pretraining level of cognitive development and the extent to which equilibration takes place.

The Success of the Conflict Induction Method

This method was successful in two relevant ways. First, it effectively induced adaptational disequilibrium, as measured on the behaviors taken to be indicative of this state. Second, only this method had a significant effect in develop-

ing the conservation of continuous quantity ability.

The errorless method was able to hold conflict at a minimum and also to gain control over the relevant conservation verbal behavior. Yet it did not induce an understanding of conservation of continuous quantity ability.

The errorless method was able to hold conflict at a minimum and also to gain control over the relevant conservation verbal behavior. Yet it did not induce an understanding of conservation of continuous quantity as evaluated by the posttests. Therefore, one of the necessary conditions for development in this area may be disequilibrium.

Conflict Always Occurred Prior to a Correct Judgement

The fact that in all 4 subjects of the conflict group, conflict behaviors occurred prior to the emergence of the first correct judgement, places conflict in the right temperal relation to these judgements to enable it to be causally related to them.

Relation Between Reinforcement and Development of Conservation Behaviors.

Several of the results need to be discussed here.

Order of emergence of types of explanations not directly determined by reinforcement contingencies. The reinforcement contingencies for the conflict group were deliberately designed to facilitate the development of the compensation explanation. In spite of this the addition/subtraction and

initial equality explanations emerged first for all 4 subjects. In the context of Piaget's theory one would expect the initial equality explanation to develop first because it is less difficult to reason with than the multiplication of asymmetrical relations. This is substantiated by the fact that even with the natural conservers compensation explanations constituted only 32% of the total while initial equality constituted 43%. The addition-subtraction explanation appears to be the most difficult since the natural conservers used it only 13% of the time. The fact that this explanation emerged first in the conflict group could be evidence against this. However, the type of addition/subtraction explanations that were used by these subjects was much more elementary than that used by natural conservers. In each case these early explanations used by the subjects occurred after a wrong prediction. When they were asked to explain why they were wrong, they would correctly explain that the error was in leaving some liquid in one of the beakers at the top, i.e., they recognized that some was taken away.

This result can be interpreted as supporting Piaget's postulate that an interior process of self-regulation determines the developmental sequences and that external reinforcement procedures do not control these processes but only facilitate them.

Posttest frequencies of each type of explanation not directly proportional to their frequency during training. Table 9 shows that for the conflict group 56% of the explanations were of the compensation type and 40% were of the initial equality type. Yet on the posttests the frequencies were reversed with the compensation type constituting only 37% and the initial equality type constituting 60%. In the errorless group a similar phenomenon occurred with the compensation type constituting 100% during training and 0% on the posttest, while the initial equality type constituted 100% on the posttest. These reversals represent the prevalence of responses with substantially lower reinforcement during training over those with higher frequencies of reinforcement. This would not be expected if reinforcement is the primary variable that determined the probability of these responses. Thus, while the prevailing reinforcement contingencies during training determined the relative frequencies of these explanations during training, once these were removed a different natural ordering occurred. This is once again supportive of the postulate of a natural sequence which is organismically regulated.

Errorless group reinforced 100% more than conflict group but showed no significant development on posttests. The errorless group was reinforced 1,068 times for correct explanations whereas the conflict group was reinforced only 561 times for the correct explanations. Yet on the posttests the errorless group showed no significant development.

This again throws doubt on the position that reinforcement is the primary variable controlling these developmental sequences.

The above three results may be interpreted as supporting Piaget's position that organismic processes of self-regulation determine developmental sequences and the environmental processes serve to facilitate development by activating these processes (cf. Halford, 1970; Overton & Reese 1973).

Developmental Score Predicts Development Through Training

Figure 5 indicates that the subject's pretest developmental score may be a good predicter of the subject's capacity to respond to training. This supports Piaget's position that external events will only effect the development of these behaviors when the subject's cognitive system possesses competence for these events.

This general section can be closed with the conclusion that this research has given some support to Piaget's postulate of an intrinsic process of self-regulation which he calls equilibration.

Evaluation of Behavioral Indices of Adaptational Disequilibrium

Table 8 indicates that only pauses are rank ordered in a manner that corresponds approximately to the rank ordering of both the developmental scores and the actual developments that occurred. This could indicate that pauses are better indices of disequilibrium than the other behaviors.

Logical Necessity and the Closure of Cognitive Structures

Piaget (1970b, 1971b) has theorized that logical necessity is the result of the closure of a cognitive structure and that these structures once formed should be resistant to counter-suggestion. The data presented above on the resistance of the natural conservers and the conflict trained conservers is supportive of this position.

Evidence of the Contingencies of Reinforcement

The discussion thus far indicates that relative to the development of C.C.Q. the contingencies of reinforcement may function as subordinate causes which when applied appropriately, as in the conflict group, activate the equilibration process by creating cognitive disequilibrium in the child's cognitive system. However, a further question needs to be asked. Are the contingencies necessary to the initiation of this development? The evidence presented here supports the conclusion that the contingencies are necessary and effective when their use is guided by an understanding of the organismic processes of development. That they are the necessary initiators of development is shown by the fact that the three nonconservers in the control group did not develop in their absence. That their effectiveness may be determined by organismic processes is shown by the differences between the two experimental groups.

Critique

One of the central shortcomings of this research was the fact that all of the behavioral indices of disequilibrium could also be taken as indices of difficulties in recall, as occurred in the errorless training without transformation portion of the experiment. Thus, even though these behaviors did not significantly increase in frequency in the errorless training with transformation portion, there is the possibility that some of these behaviors might have been indicative of genuine conflict. Fortunately the data recorded by the experimenter's themselves (which was reliable by inter-observer checks) complements the data off the tapes in indicating that only a minimal amount of conflict occurred in the errorless group.

Conclusion

It is the writer's opinion that the reported research supports Overton's (1973) thesis that all development involves an indissolvable strong interaction between organismic and environmental processes. In closing, it may be appropriate to quote the philosopher of science Bunge: "Efficient causes are effective solely to the extent to which they trigger, enhance, or damp inner processes . . . An adequate picture is provided by a synthesis of self-determination (organismic activity) and extrinsic determination (environmental activity) . . . The two exaggerations of environmentalism and innatism . . . are thereby avoided (quoted in Overton & Reese, 1973, p. 79)."

APPENDIX I

Piaget's Concepts of Equilibration and Disequilibrium

For Piaget the concept of equilibration is a theoretical construct which is used to explain the fact that the development of human intelligence is directed toward an end which, as cross cultural research indicates, may be species-specific (given of course the appropriate intellectual environment). This end is the logical-mathematical formal operations (c.f. Goldschmidt, Piaget, 1964, 1976). The central question is, how are we to explain the fact that the logical-mathematical operations follow the definite developmental path that is constituted by the invariant sequence of the four periods: the sensory-motor, preoperational, concrete, and formal operational periods.

For Piaget maturation, experience, and social transmission are the necessary, but not sufficient, conditions of this development. Maturation alone cannot explain it because the average ages at which the stages appear varies too greatly from culture to culture for this development to be genetically preprogrammed. Physical experience is inadequate because the properties, such as species, genus, seriatedness, numerosity, on which these operations are based, are not the properties of objects. Therefore, these operations cannot be the

products of abstractions from objects. Neither can linguistic transmission of knowledge totally explain these acquisitions and their directedness because in order to understand these transmissions the child must have the prerequisite structures to assimilate them.[8]

In order to explain this orientation of development towards a species-specific end state Piaget posits the process of equilibration. The idea of equilibration has its basis in Piaget's conception of the organism as an organization. This organization gives rise to emergent properties that cannot be explained by summing the properties of the elements out of which the organism is made.[9] One of these properties is that

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[8]The whole peripheralist theory of thought, which would identify thought with behavior, is called into question by the research of Smith, Brown, Loman, and Goodman (1947), in which an anesthesiologist had his total peripheral musculature paralyzed by curarine and yet was capable of lucid thought.

[9]Examples of these emergent properties, which cannot be explained by the properties of the elements are: (a) The different melting points and boiling points of the two alkanes n-butane and isobutane. These are structural isomers. Structural isomers have the same molecular formulas i.e., are made out of identical elements in identical numbers, but different structural formulas, i.e., their only difference is their organization. Because the only difference between these alkanes is their organization, only it can explain their different properties. (b) The biological functions of proteins are also emergent properties. Proteins have several levels of organization referred to as the primary, secondary, tertiary etc. levels. At the higher levels no new elements are added. Rather, only new forms of organization occur. However, the biological functions of the protein are determined by the higher levels of organization. This is proven by the fact that the denaturation of the protein, which breaks up only its higher levels of organization, destroys its biological function.

of self regulation. There are two generic types of self regulation. The first is based upon the operation of sub-structures e.g., genetic regulation, and constitutes the influence of the parts of the organism on the whole. Piaget calls these regulations the specialized functions (1971a). The second is based upon the dynamic interaction of all the parts in the whole. This constitutes the influence of the whole on the part and represents a much more general form of self regulation which Piaget (ibid.,) refers to as the organization function or equilibration and von Bertalanffy (1951, 1952, 1967, 1968, 1975) refers to as primary regulations. Bertalanffy posits that these regulations are at the basis of equifinal development where an organism can reach a species-specific end state from different initial conditions and in different ways, e.g., the development of a normal see urchin from only one quarter of a fertilized egg. If we place Piaget's concept of equilibration in this context we can begin to understand why he states, "Equilibration, as I understand it, is thus an active process. It is a process of self-regulation. I think that this self-regulation is a fundamental factor in development" (1964, p. 181).

Equilibration can be examined both as a process (the diachronic perspective) and as a state (the synchronic perspective).

Looked at as a process equilibration can be defined as the central principle of self-regulation of systematically organized wholes. By this process these wholes direct their

own development towards a state which is species-specific by relevantly varying the activities of their parts. This enables them to (a) control the form of new structures that are being constructed, e.g., cellular induction in physiological developments and the construction of the operations in intellectual development and (b) to compensate, within limits, for disturbances to the developmental processes, e.g., equifinal phenomena such as the development of the formal operations in different cultural environments.

Looked at as a state equilibration can be defined as the central principle of self-regulation of systematically organized wholes. In this state, these wholes by which these wholes maintain a relative equilibrium by relevantly varying the activities of their parts which enables them to compensate for disturbances to their equilibrium. An example at the physiological level is observed in the coordination of all the homeostatic mechanisms in the maintenance of the complex but highly specific interior milieu which characterizes the steady state of the organism. An example at the intellectual level would be the coordination of scientific reasoning by the formal operations (c.f. Furth, 1969; Harris, 1959; von Bertalanffy, 1968).

It might now be asked, what is it that activates this process of equilibration? For Piaget, intellectual equilibration is activated whenever disequilibrium is created in the cognitive system. As he states, "All development is composed of momentary conflicts and incompatibilities which must be overcome to reach a higher level of equilibrium" (1964, p. 185).

When this disequilibrium is introduced externally it is called adaptational disequilibrium. When it is introduced internally it is called organizational disequilibrium.

Brainerd (1973) has analyzed several methods for experimentally creating adaptational disequilibrium. The first is called dimensional discrimination training. This procedure creates disequilibrium by creating conflict between perceptual and quantitative cues. The second method is called prediction-outcome training. Here the child is asked to make a prediction about the result of an action which is contradicted by the outcome of that action. The third method is called conformity training. This can be accomplished by having the child model a conserver, or by placing conservers and nonconservers together and asking them to reach an agreement about the conservation judgement. The final method for creating adaptational disequilibrium is called direct feedback training where the experimenter tells the child that he/she is right or wrong after they have made their judgement.

It is because disequilibrium is essential to the posited process of equilibration and because there are experimental methods for manipulating it and also because behavior indices of it can be defined, that it was one of the central variables chosen for study in the research reported in this dissertation. This research had as its goal the test of the equilibration hypothesis.

APPENDIX 2

Summary of Conservation Research

Table 1

Analysis of the Conservation Induction Experiments

Properties of the Experiments															
Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria[a]
Bearison 1969 [1]	Yes	Measurement operations	Dimensional-discrimination -neg., comp., counting feedback, indirect verbal feedback	C.C.Q.	N.C.	Yes	Yes (weak) successful	Yes successful	No	No	Yes 1 mo. 7 mos. successful	No	1 25-45'	?	Yes
Beilin 1965 [2]	Yes	Gp1 Verbal rule instruction and reinforcement	Dimensional-discrimination -comp., neg., direct verbal feedback and physical r'fmt.	C.N. C.L.	Mixed NCs-TCs	Yes	Yes successful	Yes unsuccessful	No	No	Yes $\bar{X}$ of 3 weeks successful	No	2	35 ea. concept	Yes
Ibid.	No	Gp2 Non-verbal reinforcement	Dimensional-discrimination -comp., direct physical r'fmt.	C.N. C.L.	Mixed NCs-TCs	Yes	Yes unsuccessful	Yes unsuccessful	No	No	Yes $\bar{X}$ of 3 weeks unsuccessful	No	2	36 ea. concept	Yes
Ibid.	No	Gp3 Verbal orientation reinforcement	Ibid.	C.N. C.L.	Mixed NCs-TCs	Yes	Yes unsuccessful	Yes unsuccessful	No	No	Yes $\bar{X}$ of 3 weeks unsuccessful	No	2	36 ea. concept	Yes
Ibid.	No	Gp4 Equilibration	Dimensional-discrimination -neg.	C.N. C.L.	Mixed NCs-TCs	Yes	Yes unsuccessful	Yes unsuccessful	No	No	Yes $\bar{X}$ of 3 weeks unsuccessful	No	2	36 ea. concept	Yes

[a]Refers to the use of methods which will enable the diagnosis of the genuineness of the understanding of conservation.

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Boesma & Wilton 1974 3	Yes	Discrimination learning sets	Dimensional discrimination -comp., direct verbal feedback & physical r'fmt.	C.N. C.L.	NCs	Yes	Yes successful	Yes successful	No	No	Yes 3 wks. successful	No	2	192 ea. concept	Yes
Brainerd 1972a 4	Yes	Direct feedback	Dimensional discrimination -comp., direct verbal feedback	C.C.Q.	NCs	Yes	Yes successful	No	Yes successful	No	No	No	1	12	Yes
Brainerd 1972b 5	Yes	Direct feedback	Ibid.	C.N.	Mixed NCs-TCs	Yes	Yes successful	No	No	No	Yes 1 wk. successful	No	1	18	Yes
Brainerd 1974 6	Yes	Direct feedback	Ibid.	C.L.	Mixed NCs-TCs	Yes	Yes (weak) successful	Yes successful	No	No	Yes 1 wk. successful	No	1	12	Yes
Brainerd 1976 7	Yes	Direct feedback	Ibid.	C.D.Q.	Mixed	No	Yes successful	No	No	No	Yes immediate 1 wk. successful	No	1	8	No
Brison 1966 8	Yes	Conformity training-conserving peer	Dimensional discrimination - eg., comp. direct verbal feedback, physical r'fmt.	C.C.Q.	NCs	Yes	Yes successful	No	Yes 4 out of 5 trained Ss successful	No	No	No	2	5	Yes

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Bucher & Schneider 1973 9	Yes	Operant conditioning	Dimensional discrimination -A-S, comp., direct verbal feedback, & physical r'fmt.	C.N. C.S. C.C.Q.	? Conservation not pretested	No	Yes (weak) successful	Yes unsuccessful	No	No	No	No	App. 48	Min. of 236	No
Charbonneau, Robert Boorassa & Gladu-Bissonnette 1976 10	Yes	Conformity training adult model	Dimensional discrimination -comp., direct verbal feedback from model's judgment	C.C.Q.	NCs	Yes	Yes uccessful	No	No	No	Yes immediate 1 wk. 3 mo. successful	No	1	4	Yes
Christie & Smothergill 1970 11	No	Gp.1 Discrimination learning set Gp.2 Ss uninformed of results	Dimensional discrimination -comp. direct feedback None	C.L.	N.C.	Yes unsuccessful	Yes	No	No	No	No	No	?	96	No
Cooley & Martin 1972 12	Yes	Operant conditioning programmed learning	Dimensional discrimination A-S, direct verbal feedback, physical r'fmt.	C.C.Q.	NCs	Yes	Yes successful	Yes successful RE.C.W.	No	No	Yes immediate 1 mo. 5 mos. successful	No	$\bar{X}$. 13	$\bar{X}$. 329	Yes

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Cooley, Braun, & Kerger 1977 13	No	Operant conditioning: programmed learning	Ibid.	C.W.	NCs	Yes	Yes unsuccessful	Yes unsuccessful	No	Yes unsuccessful	Yes immediate 1 mo. 6 mos. unsuccessful	No	$\bar{X}$. 16	$\bar{X}$. 266	Yes
Curcio, Kattef, Levine & Robbins 1972 14	Yes	1. Dimensional discrimination 2. Addition-subtraction 3. Reversibility	Dimensional discrimination -neg., comp., A-S, indirect verbal feedback, verbal feedback	C.D.Q.	Mixed NCs-TCs	Yes	Yes successful Recompensator Ss	No	No	No	Yes immediate 1 wk. successful recompensator Ss	No	2	8	Yes
Figurelli & Keller 1972 15	Yes	Verbal rule instruction	Dimensional discrimination -comp., direct verbal & visual feedback, physical r'fmt.	C.C.Q. C.D.Q. C.N. C.S. C.2. dim. space	Mixed NCs-TCs	Yes	Yes successful re middle class Ss	No	No	No	No	No	1	?	No
Fleishman, Gilmore Ginsburg 1966, Exp. I.	Yes Re Gp. 3	Gp.1 Continuity training	None	C.C.Q.	NCs	No	Yes successful	No	No	Yes unsuccessful	No	No	1	3	No
		Gp.2 Continuity - visual training (language activation)	None												
		Gp.3 Feedback	Dimensional discrimination -comp. direct verbal feedback												
16															

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Ibid. Ext. II 17	No	One to one correspondence	None	C.D.Q.	? Not pretested	No	No	No	No	No	No	No	1	?	No
Ibid. Exp. III 18	No	One to one correspondence	None	C.D.Q.	? Not pretested	No	No	No	No	No	No	No	1	?	No
Frank 1966 19	Yes Gp. 2	Gp.1 Perceptual screening, -4-5 yr. olds	1. Prediction -outcome 2. Dimensional discrimination -comp. direct visual feedback	C.C.Q.	Mixed	Yes	Yes successful	No	No	No	No	No	?	?	No
		Gp.2 Perceptual screening 5-7 yr. olds	Ibid.												
Gelman 1969 20	Yes	Discrimination learning sets	Dimensional discrimination -comp., direct verbal feedback & physical r'fmt.	C.N. C.L.	NCs	Yes	Yes successful	Yes successful Re C.C.Q., C.M.	No	No	Yes immediate 2-3 wks. successful	No	2	192 ea. concept	Yes

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Greitzer & Jeffrey 1973 21	Yes Gps. 1, 2, 4	Gps. 1 & 2, discrimination learning set pretest-to pretest Gps. 3 & 4, operant conditioning fading (pretest-no pretest)	Dimensional discrimination -comp., direct feedback	C.L.	N.C.	Yes	?	No	No	No	No	No	?	?	No
Gruen 1965 22	Yes Re Gp. 2	Gp. 1 pretraining + direct training Gp. 2 pretraining + conflict training	Dimensional discrimination -comp., feedback from counting Dimensional discrimination -A-S	C.N.	NCs	Yes	Yes Gp. 2	Yes Gp. 2 successful re C.M., C.L.	No	No	No	No	2	32	Yes
Halford 1970 23	Yes	Classification learning set training	1. Dimensional discrimination 2. Prediction outcome 3. Direct feedback	C.D.Q.	NCs	No	Yes successful	No	No	No	No	No	7	?	No

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Halford & Fullerton 1970	Yes	One-to-one correspondence discrimination learning & equilibration	1. Prediction-outcome 2. Dimensional discrimination-comp., indirect verbal feedback, visual feedback	C.N.	NCs	Yes	Yes successful	No	No	No	Yes immediate 3 wks. successful	No	5	?	Yes
24															
Hamel 1971	No	Identity training (language improvement)	None	C.C.Q.	NCs	?	Yes	No	No	No	No	No	?	?	No
25															
Hamel & Riksen 1973	Yes	Gp. 1 Identity V.R.I. training	Dimensional discrimination -comp., direct verbal feedback	C.C.Q.	Mixed NCs-TCs	Yes	Yes Gp. 1 + 2 successful	Yes Gp. 1 + 2 successful Re C.S., C.N., C.W. C.A.			Yes immediate 1 wk. Gp. 1 & 2 successful	No	1	5	Yes
		Gp. 2 reversibility V.R.I. Training	1. Dimensional discrimination -neg., comp. direct verbal & visual feedback 3. Prediction outcome												
26															
Hamel, Van Der Veer, & Westerhof 1972	Yes Gp. 2	Gp. 2 + 3 Language activation verbal rule instruction	Dimensional discrimination -comp. indirect & direct verbal feedback	C.C.Q.	Gp. 2-TCs Gp. 3-NCs	Yes	Yes Gp. 2 successful	No	No	No	No	No	1	?	No
27															

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Hatano & Soga 1969 Expt. 1	Yes Gps. 1, 3, 4	Gp. 1 Conflict negation & external reinforcement	Dimensional discrimination -comp., A-S, physical r'fmt.	C.N.	NCs	No	Yes Gps. 1, 3, 4 successful Re posttest 2	No	No	Yes unsuccessful	Yes	No	2	48	No
		Gp. 2 Conflict, negation no ext. reinforcement	Dimensional discrimination A-S.												
		Gp. 3 Ext. reinforcement re conservation	Dimensional discrimination -comp., physical r'fmt.												
		Gp. 4 Conservation conflict, ext. reinforcement	Dimensional discrimination -comp., A-S, physical r'fmt.												
		Grp. 5 Conflict negation no ext. reinforcement, counting, verbal suggestion	Dimensional discrimination comp. A-S, indirect verbal feedback												

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Ibid. Expt. 2	Yes Gp. 1	Gp. 1 Verbal suggestion, inter numerical relations, ext. reinforcement	Dimensional discrimination -comp., A-S, indirect verbal feedback, physical reinforcement	C.N.	NCs	No	Yes Gp. 1 successful	No	No	No	No	No	2	48	No
		Gp. 2 Same as 1 but no reinforcement	Dimensional discrimination -comp., A-S, indirect verbal feedback												
29															
Inhelder Sinclair Bovat 1974a	Yes TCs	1. Dimensional discrimination -comp., indirect verbal feedback, visual feedback 2. Prediction-outcome	None	C.C.Q.	NCs TCs	Yes	Yes TCs successful	No	No	Yes TCs successful	Yes immediate 1-3 wks. TCs successful	Qualitative present in some Ss	2	?	Yes
30															

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Ibid. 1974b 31	Yes TCs	1. Dimensional discrimination -comp., indirect, verbal feedback & feedback from counting	None	C.D.Q.	NCs TCs	Yes	Yes TCs successful	No	No	Yes TCs successful	Yes 4-6 wks. TCs successful	Qualitative present in some Ss	3	?	Yes
Ibid. 1974c 32	Yes TCs	1. Dimensional discrimination -comp., indirect verbal feedback	None	C.M. C.N.	NCs TCs	Yes	Yes TCs successful	No	No	Yes TCs successful	Yes 6-8 wks.	No	3	?	Yes
Ibid. 1974d 33	No	Verbal training	None	C.M. C.N.	Mixed	Yes	Yes unsuccessful	No	No	Yes successful	Yes 2 wks. unsuccessful	No	3	?	Yes
Ibid. 1974e 34	Yes NCs & TCs	1. Dimensional discrimination -comp., indirect verbal feedback	None	C.L.	NCs TCs	Yes	Yes NCs & TCs successful	No	No	Yes successful	Yes 4-6 wks. NCs & TCs successful	Qualitative present in some Ss	3-4		Yes

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Ibid. 1974f	Yes NCs & TCs	1. Dimensional discrimination -comp., neg., indirect verbal-visual feedback, feedback from counting	None	C.D.Q. C.C.Q.	NCs TCs	Yes	Yes NCs & TCs successful	Yes C.W. successful	No	Yes successful	Yes time? successful	Qualitative present in some Ss	6	?	Yes
35															
Kingsley & Hall 1967	Yes	Learning sets	Dimensional discrimination -comp., direct verbal-visual feedback A-S re C.L.	C.W. C.L.	Mixed	Yes	Yes successful	No	Yes unsuccessful	No	Yes 4 mos.	No	9		Yes
36															
Lefebre & Pinard 1972[b]	Yes	1. Dimensional discrimination -comp., indirect verbal feedback	None	C.C.Q.	N.C.	Yes	Yes successful	?	?	?	Yes 2 mos. successful	?	?	?	Yes
37															
LeFrancois 1968	Yes	Learning sets	1. Dimensional discrimination -comp., indirect verbal feedback	C.M.	NCs	No	Yes successful	No	No	No	No	No	?	?	No
38															

[b]Analysis is based upon Charbonneau et. al.'s (1976) description.

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Mermelstein, Carr, Mills, & Schwartz 1967 39	No	Gp. 1 Cognitive conflict	None	C.N.	Mixed	Yes	Yes unsuccessful-all groups	No	Yes unsuccessful	No	Yes 1 wk. 2 mos. 3 mos. unsuccessful	No	8	?	Yes
		Gp. 2 Multiple classification	Dimensional discrimination -comp., direct verbal feedback												
		Gp. 3 Verbal rule instruction	Dimensional discrimination -comp., neg. direct verbal feedback												
		Gp. 4 Language activation	Prediction outcome												
Mermelstein & Meyer 1969 40	No	Gp. 1 Cognitive conflict	None	C.N.	Mixed	Yes	Yes unsuccessful - all groups	Yes, unsuccessful	Yes unsuccessful	No	Yes 3 wks. 2½ mos. 5 mos. unsuccessful	No	8	?	Yes
		Gp. 2 Multiple classification	Dimensional discrimination -comp., direct verbal feedback												
		Gp. 3 Verbal rule instruction	Dimensional discrimination -comp., neg. direct verbal feedback												
		Gp. 4 language activation	Prediction outcome												
Miller & Brownwell 1975 41	Yes	Conformity conserving peer	Dimensional discrimination -comp., direct verbal feedback	C.L. C.W.	NCs	Yes	Yes successful	No	No	Not on post-test	No	No	1	?	No

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Murray 1972 42	Yes	Conformity conserving peer	Dimensional discrimination comp., direct feedback	C.S. CN CM C.C.Q. C.D.Q. C.W.	Mixed but significant effect with 11 NCs	Yes	Yes successful	Yes successful	?	?	Yes 1 wk. successful	No	1	3	Yes
Murray 1974 43	Yes	Conformity-conserving peer	Dimensional discrimination	C.W.	NCs TCs	Yes	Yes successful	Yes successful re NCs & TCs to C.M. & not to C.C.Q.	No	No	No	No	1	4	Yes
Overbeck & Schwartz 1970 44	Yes Re Gps. 1 & 2	Gp. 1 Reinforced active training	Dimensional discrimination -comp., direct verbal & visual feedback	C.W.	Mixed	Yes	Yes successful re Gp. 1 & 2	No	No	No	No	No	1	12	No
		Gp. 2 Reinforced passive training	Ibid.												
		Gp. 3 Non reinforced active training	None												
		Gp. 4 Non reinforced passive training	None												

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Peters 1970	Yes Re Gp. 1, 2, 3	Gp. 1 Non cued discovery	Dimensional discrimination neg.	C.N.	Mixed	Yes	Yes successful Gps. 1, 2, 3 on posttest 1. Gps. 2, 3 on posttest 2.	Yes unsuccessful re C.A.	No	No	Yes 2 wks. successful Gps. 2 & 3	No	2	3	Yes
		Gp. 2 Perceptual cue guided discovery	Dimensional discrimination -counting, cue discrepancy, neg.												
		Gp. 3 verbal didactic instruction	Dimensional discrimination -neg., direct feedback												
45															
Rosenthal & Zimmerman 1972 Expt. 1	Yes	Gp. 1 Model, rule & feedback to model	Dimensional discrimination -comp. direct feedback	C. Space C.M. C.W. C.N. C.C.Q. C.D.Q.	Mixed NCs	Yes	Yes successful all gps.	No	No	No	No	No	?	?	No
		Gp. 2 Model, o rule, feedback to model	Ibid.												
		Gp. 3 Model, rule, no feedback to model	Ibid.												
		Gp. 4 Model, no rule, no feedback to model	Ibid.												
46															

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Rosenthal & Zimmerman 1972 Expt. 3	Yes Gp.1	Gp. 1 Model rule no feedback to model Gp. 2 V.R.1 - no modeling, no exposure to transformation	Dimensional discrimination -comp., direct feedback	C.Space C.M. C.W. C.N. C.C.Q. C.D.Q.	?	Yes	Yes successful re Gp. 1	No	No	No	No	No	?	?	No
47															
Ibid. Expt. 4	Yes	Model, no rule no feedback to model	Dimensional discrimination -comp., direct feedback	Ibid.	?	Yes sign. effect for judgements only	Yes successful re judgements	No	No	No	No	No	?	?	No
46															
Rothenberg & Orost 1969 Expt. 1	Yes	Learning sets conformity-conserving peer	Dimensional discrimination -neg., A-S, direct feedback	C.N.	Mixed	Yes	Yes successful	No	No	No	No	No	?	?	No
49															
Ibid. Expt. 2	Yes	Ibid.	Ibid.	C.N.	Mixed	Yes	Yes successful	No	No	No	Yes immediate 2 mos.	No	3	?	Yes
50															
Ibid. Expt. 3	Yes	Ibid.	Ibid.	C.N.	Mixed	Yes	Yes successful	Yes successful to C.D.Q.	No	No	Yes immediate 2 mos. 3 mos. successful	No	4	?	Yes
51															

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Sheppard 1974	Yes Gps. 1 & 2	Gp. 1 Compensation and combinatorial training Gp. 2 Ibid.	(1) Dimensional discrimination-comp., indirect feedback (2) Prediction-outcome Dimensional discrimination-comp., neg., indirect feedback tion-outcome	C.C.Q. C.M.	NCs	Yes	Yes successful both groups	Yes Gp. 1 successful to C.N. Gp. 2 successful to C.N., C.W., C.V.	No	No	Yes 4 days 2 wks. 2 mos. both groups successful	No	4	?	Yes
52															
Siegler & Liebert 1973	Yes Gps. 1, 2 & 3	Gp. 1 Verbal rule instruction Gp. 2 feedback Gp. 3 V.R.I + feedback	Dimensional discrimination -comp., A-S, direct feedback (rule) Dimensional discrimination -comp., A-S, direct feedback (right or wrong) Ibid.	C.C.Q.	NCs	Yes	Yes successful - three groups	Yes unsuccessful re C.L.	No	No	Yes 1 wk. successful - three groups	No	1	18	Yes
53															
Sigel Roeper & Hooper 1966	Yes	Multiple classification & reversibility	Dimensional discrimination comp., neg., indirect feedback	Not trained directly on conservation	NCs	Yes	No	Yes successful to C.M., C.C.Q., C.W., not to C.V.	No	No	Yes 2 wks. successful	No	?	?	Yes
54															

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Silverman & Geiringer 1973	Yes	Conformity-conserving peer	Dimensional discrimination -comp. direct feedback	C.L.	NCs	Yes	Yes successful	Yes successful to C.	No	Yes during expt. successful	Yes 1 mo. successful	No	1	?	Yes
55															
Silverman & Stone 1972	Yes	Conformity-conserving peer	Dimensional discrimination -comp. direct feedback	C.A.	NCs	Yes	Yes successful	No	No	Yes during expt. successful	Yes 1 mo. successful	No	1	?	Yes
56															
Sjöberg, Hoijer & Olsson 1970	Yes Re Gp.3	Gp. 1 Reversibility verbal rule instruction	Dimensional discrimination -comp., direct feedback	C.W.	NCs OCs	Yes	Yes successful re VRI Gps.	Yes successful re A-S, VRI Gp.	Yes successful re A-S, VRI & OCs	No	No	No	1	?	Yes
		Gp. 2 Decentering VRI	Ibid.												
		Gp. 3 Addition-subtraction VRI	Ibid.												
		Gp. 4 External visual reinforcement, reweighing	Dimensional discrimination -comp., direct visual feedback												
57															

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Smedslund 1961a [58]	No	Gp. 1 External visual r'fmt.	Dimensional discrimination -comp., direct visual feedback	C.W.	Mixed	Yes	Yes unsuccessful	No	No	No	Yes immediately 1 mo. unsuccessful	No	2	32	Yes
		Gp. 2 External r'fmt of addition subtraction	Dimensional discrimination -comp., A-S, direct visual feedback												
Smedslund 1961b [59]	No	Extinc- of visual cues	Dimensional discrimination -comp., direct verbal & visual feedback	C.W.	Mixed	Yes	Yes unsuccessful	Yes unsuccessful re C.S.	No	No	No	No	3	36	Yes
Smedslund 1961c [60]	No	Conflict without external r'fmt.	Dimensional discrimination -comp., A-S, neg.	C.M.	N.C.	Yes	?	No	No	No	No	No	3	36	No
Smedslund 1961d [61]	Yes Re Gp. 2	Gp. 1 C.C.Q. training	Dimensional discrimination -comp., A-S.	C.C.Q. C.D.Q.	NCs	Yes	Yes successful re Gp. 2	No	No	No	No	No	3	15	No
		Gp. 2 C.D.Q.	Ibid.												

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Smedslund 1963	Yes Gp. 4	Gp. 1 Stepwise addition subtraction-Müller-Lyer	Dimensional discrimination A-S	C.L.	NCs	No	Yes successful Gp. 4	No	Yes successful Gp.4	No	No	Yes Quantitative re Gp. 1 some evidence of its involvement	3	?	No
		Gp. 2 Compound addition subtraction-Muller Lyer	Ibid.												
		Gp. 3 Strengthening Müller Lyer	None												
		Gp. 4 Prediction outcome	Prediction outcome - neg., visual feedback												
		Gp. 5 Combination of above	Ibid.												

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Smith 1968	Yes Gps. 4, 5 & 6	Gps. 1 & 2 Addition-subtraction	Dimensional discrimination -A-S.	C.W.	NCs TCs	Yes	Yes V.R.I. successful for NCs & TCs . R.P. successful for TCs	No	Yes unsuccessful	No	Yes 1 wk. unsuccessful	No	1	12	Yes
		Gps. 3 & 4 Reinforcement practices	Dimensional discrimination comp., visual feedback												
		Gps. 5 & 6 Verbal rule instruction	Dimensional discrimination -comp., direct feedback, neg.												
Strauss & Langer 1970	No	Gp. 1 Conflict & screening	Prediction outcome-visual feedback	C.C.Q.	Mixed	Yes	Yes unsuccessful	No	No	No	Yes 10 days to 2 wks. unsuccessful	No	2	8	Yes
		Gp. 2 Conflict & no screening	1. Prediction outcome 2. Dimensional discrimination -comp., visual feedback												
		Gp. 3 To conflict & screening	None												
		Gp. 4 To conflict & no screening	None												

Table 1 (Continued)

Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Wallach & Sprott 1964 [65]	Yes	Reversibility training	1. Prediction outcome 2. Dimensional discrimination -neg., A-S, comp. visual feedback	C.N.	N.C.	Yes	Yes successful	No	No	Yes successful	Yes 2-3 wks. successful	No	1	8	Yes
Wallach, Wall & Anderson 1967 [66]	Yes Gp. 1	Gp. 1 Reversibility training Gp. 2 Addition-subtraction	1. Prediction outcome 2. Dimensional discrimination -comp., neg., visual feedback None re conservation: arrays not transformed	C.N.	N.C.	Yes	Yes successful re Gp. 1	Yes unsuccessful to C.C.Q.	No	Yes successful re Gp. 1	Yes 2-6 wks. successful re Gp. 1	No	1	4-6	Yes
Winer 1968 expt. 1 [67]	Yes Gp. 1	Gp. 1 Addition-subtraction set training & conflict Gp. 2 Addition subtraction set training no conflict	Dimensional discrimination -A-S, None	C.N.	NCs	Yes	Yes successful re Gp. 1	Yes unsuccessful to C.C.Q.	No	No	No	Yes quantitative Gp. 1 showed none	2	26	Yes

Table 1 (Continued)

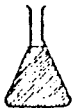
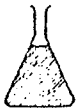
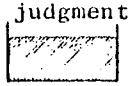
Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Wohlwill & Lowe 1962	No	Gp. 1 Reinforced practise	1. prediction outcome 2. Dimensional discrimination -comp., feedback from counting	C.N.	Mixed	Yes reversal tests	Yes unsuccessful all gps. not sign. different from control	No	No	No	No	No	2	18	No
		Gp. 2 Addition subtraction	1. Prediction outcome 2. Dimensional discrimination -comp., A-S, feedback from counting												
		Gp. 3 Dissociation	1. Prediction outcome 2. Dimensional discrimination -comp., feedback from counting												
69															
Zimmerman & Lanaro 1974	Yes Gps. 1 & 2	Gp. 1 Modeling, judgement & explanation	1. prediction-outcome 2. Dimensional discrimination -comp., direct feedback	C.L.	N.C.	Yes	Yes successful	Yes successful to 2 dim. space re judgements only	No	No	Yes 9 days successful	No	2	24	Yes
		Gp. 2 Modeling judgement, explanation & neg.	As above, plus neg.												
70															

Table 1 (Continued)

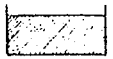
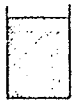
Experiment	Successful	Training Method	Confounded with Disequilibrium Methods	Concept Trained	Developmental Level of Ss	Required an Explanation	Tested For Specific Generalization	Tested For Non Specific Generalization	Tested For RTE	Tested For RTCS	Tested For Durability	Assessment of Conflict	Sessions	Trials	Meets Methodological Criteria
Zimmerman & Rosenthal 1974	Yes Gps. 1, 2, 3	Gp. 1 Modeling & explanation	1. Prediction outcome 2. Dimensional discrimination -comp., direct feedback	C.L.	N.C.	Yes	Yes successful all gps.	Yes successful to C.N., C.S., all gps.	No	No	Yes 7-10 days successful	No	1	12	Yes
		Gp. 2 Verbal rule instruction	Dimensional discrimination -comp., direct feedback												
		Gp. 3 Modeling & V.R.I.	Same as Gp. 1												

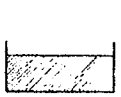
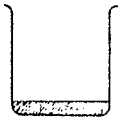
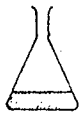
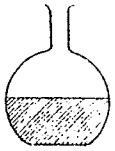
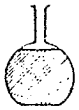
APPENDIX 3

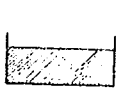
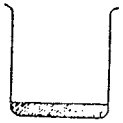
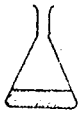
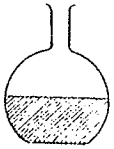
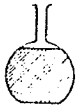
Programs for the Errorless Training

TRANSFORMATIONS	TYPE OF CONTAINERS	SCHEMATIC OF CONTAINERS AFTER THE TRANSFORMATION		ANSWER TO QUESTION 1 FROM FIGURE 1	VERBAL RULE (ANSWER TO QUESTION 2 FROM FIGURE 1)	KNOWN CONCEPT ALTERNATED WITH TEST CONCEPT i.e., THE QK.
		E's Container	S's Container			
1. S's fluid completely transferred to another container	Three 600 ml. beakers			Same	Because they were the same to begin with and you just poured mine into this jar.	--
2. S's fluid completely transferred to another container	Three 500 ml. Erlenmeyer beakers			Same	Same as above	--
3. S's fluid completely transferred to another container.	Three 500 ml. flat-bottomed flasks			Same	Same as above	--
4. S's fluid completely transferred to a container of different dimensions	2 3-quart milk cartons and 1 2-quart carton cut as indicated	Perceptual illusion created by partially filled container to aid judgment of same 		Same	Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they're the same.	1
5. Fluid added to S's container	Three 600 ml. beakers			More	Because mine had more to begin with and you just poured mine into this jar.	4
6. Some fluid poured out of S's container	Three 600 ml. beakers			Less	Because mine had less to begin with and you just poured mine into this jar.	5

The answers and verbal rules that were taught in the first five programs in the errorless training.

TRANSFORMATIONS	TYPE OF CONTAINERS	SCHEMATIC OF CONTAINERS AFTER THE TRANSFORMATION		ANSWER TO QUESTION 1 FROM FIGURE	VERBAL RULE (ANSWER TO QUESTION 2 FROM FIGURE)	KNOWN CONCEPT ALTERNATED WITH TEST CONCEPT AS PER THE DATA SHEET (FIGURE)
		E's Container	S's Container			
7. Fluid is added to the S's container and It is then transferred to a larger container	2 - 150 ml. beakers 1 - 250 ml. beakers E's beaker @ 80 E's beaker @ 150			More	Because mine had more to begin with and you just poured it into this jar.	4
8. S's fluid transferred to a larger container so that the levels of E's and S's fluid become the same height.	2 - 150 ml. beakers 1 - 250 ml. beaker E's beaker @ 80 S's beaker @ 120			More	Because mine had more to begin with and you just poured it into this jar. Now it's lower than it was but it's wider than yours. So it's still more.	4
9. Fluid is taken from the S's container and it is then transferred into a smaller container	2 - 250 ml. beakers 1 - 150 ml. beaker E's beaker @ 120 ml. S's beaker @50			Less	Because mine had more to begin with and you just poured it into this jar.	8
10. S's fluid is transferred to a smaller container so that the levels of E's and S's fluid become the same height.	2 - 250 ml. beakers 1 - 150 ml. beaker E's beaker @ 120 ml. S's beaker @80			Less	Because mine had less to begin with and you just poured into this jar. Now it's higher than it was but it's skinnier than yours. So it's still less.	8
11,12,13,14,15,16. the same as #4, except that the 2 qt. container was cut little by little, so that the perceptual illusion was faded out, and by the end of program 16, the subject was appropriately conserving continuous quantity (at least with the milk cartons used) without the perceptual illusion.	These were	Final comparison of Program 16. 		Same	Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they're the same.	8 and 10

TRANSFORMATIONS	TYPE OF CONTAINERS	SCHEMATIC OF CONTAINERS AFTER THE TRANSFORMATION		ANSWER TO QUESTION 1 FROM FIGURE	VERBAL RULE (ANSWER TO QUESTION 2 FROM FIGURE)	KNOWN CONCEPT ALTERNATED WITH TEST CONCEPT AS PER THE DATA SHEET (FIGURE)
		E's Container	S's Container			
17,18,19,20,21,22 & 23. Using skinnier cartons, the perceptual was again faded out so that by the end of program 23 the subject was appropriately conserving continuous quantity.	1 qt. milk illusion	Final comparison of Program 23 		Same	Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they're the same.	8 and 10
24. Fluid from S's container poured into completely new container.	Two 600 ml. beakers and one 150 ml. beaker (this is the first transformation with the beaker).			Same	Same as above.	8
25. Same as above.	Two 1000 ml. beakers and one 150 ml. beaker			Same	Same as above	10
26. Same as above.	Two 500 ml. Erlenmeyer beakers and one 125 ml. Erlenmeyer beaker			Same	Same as above	8
27. Same as above.	Two 1000 ml. flat-bottomed beakers and one 500 ml. flat-bottomed beaker.			Same	Same as above	10

TRANSFORMATIONS	TYPE OF CONTAINERS	SCHEMATIC OF CONTAINERS AFTER THE TRANSFORMATION		ANSWER TO QUESTION 1 FROM FIGURE	VERBAL RULE (ANSWER TO QUESTION 2 FROM FIGURE)	KNOWN CONCEPT ALTERNATED WITH TEST CONCEPT AS PER THE DATA SHEET (FIGURE)
		E's Container	S's Container			
17,18,19,20,21,22 & 23. Using skinnier cartons, the perceptual illusion was again faded out so that by the end of program 23 the subject was appropriately conserving continuous quantity.	1 qt. milk	Final comparison of Program 23 		Same	Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they're the same.	8 and 10
24. Fluid from S's container poured into completely new container.	Two 600 ml. beakers and one 150 ml. beaker (this is the first transformation with the beaker).			Same	Same as above.	8
25. Same as above.	Two 1000 ml. beakers and one 150 ml. beaker			Same	Same as above	10
26. Same as above.	Two 500 ml. Erlenmeyer beakers and one 125 ml. Erlenmeyer beaker			Same	Same as above	8
27. Same as above.	Two 1000 ml. flat-bottomed beakers and one 500 ml. flat-bottomed beaker.			Same	Same as above	

PROGRAM 1 APPARATUS Three 600 ml beakers TRANSFORMATION: S's juice completely transferred

CONCEPT Same 2 @ 300 ml to another beaker.

	E	Ss Answers	S
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with & you just poured mine into this jar.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	none	_____	_____
Qk	none	_____	_____

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 2 APPARATUS three 500 ml Erlenmeyer beakers TRANSFORMATION S's juice completely transfered to another beaker.

CONCEPT Same 2 @ 500 ml

	E	Ss Answers	E
Pa	(Assign beakers & get agreement of same amount before transformation, then give prompt). I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule).	The same. Because they were the same to begin with and you just poured mine into this jar.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qa	Lets do it again. (perform task again task) Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pb	none	_____	_____
Qb	none	_____	_____

Qa	As above	Qa	As above	Qa	As above
Qb	_____	Qb	_____	Qb	_____
Qa	As above	Qa	As above	Qa	As above
Qb	_____	Qb	_____	Qb	_____
Qa	As above	Qa	As above	Qa	As above
Qb	_____	Qb	_____	Qb	_____
Qa	As above	Qa	As above	Qa	As above

PROGRAM 3 APPARATUS three 500 ml flat-bottomed flasks TRANSFORMATION S's juice completely transferred to another container.

CONCEPT Same 2 @ 500 ml

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation and then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer). Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task) Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pn	none	_____	_____
Qn	none	_____	_____

Qn	As above	Qn	As above	Qn	As above
Qn	_____	Qn	_____	Qn	_____
Qn	As above	Qn	As above	Qn	As above
Qn	_____	Qn	_____	Qn	_____
Qn	As above	Qn	As above	Qn	As above
Qn	_____	Qn	_____	Qn	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 4

CONCEPT C.C.O. alternate with prog. 1

APPARATUS two 3-quart milk cartons @ 250 ml. each and one 2-quart milk carton (2,1)

TRANSFORMATION S's juice completely transfered to a container of different dimensions (ie./ to the 2-quart carton)

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign Jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me. or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar.	Ditto
Qk	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 5

CONCEPT Cons. of inequalities. Altern. with prog. 4.

APPARATUS three 600 ml. beakers

F @ 100 ml

S's @ 500 ml

TRANSFORMATION Juice added to S's container before transformation

	E	Ss Answers	E
Pn	(Assign jars & get agreement of S having more before transformation and then give prompt). I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Ps	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	ditto
Qs	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qs	_____	Qs	_____	Qs	_____
Qn	As above	Qn	As above	Qn	As above
Qs	_____	Qs	_____	Qs	_____
Qn	As above	Qn	As above	Qn	As above
Qs	_____	Qs	_____	Qs	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 6 APPARATUS three 500 ml. beakers.

TRANSFORMATION Some juice Poured out of S's jar before transformation

CONCEPT Cons. of inequalities. Altern. with prog. 5

E's @ 500 ml.

S's @ 100 ml.

	E	Ss Answers	E
Pn	(Assign jars & get agreement of S having less before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	Less. Because mine had less to begin with and you just poured mine into this jar.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pm	(Assign jars & get agreement of S having more before transformation and then give prompt). I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me, (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar.	ditto
Qm	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qm	_____	Qm	_____	Qm	_____
Qn	As above	Qn	As above	Qn	As above
Qm	_____	Qm	_____	Qm	_____
Qn	As above	Qn	As above	Qn	As above
Qm	_____	Qm	_____	Qm	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 7 APPARATUS two 150 ml beakers one 250 ml beaker E's @ 80 ml S's @ 150 ml TRANSFORMATION Juice is added to S's jar & it is then transfered to a larger jar.

CONCEPT Cons. of inequalities. Altern. with prog. 4

	E	Ss Answers	E
Pn	(Assign jars & get agreement of S having more before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..._... (Get S to echo the rule)	More. Because mine had more to being with and you just poured mine into this jar.	If Correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign Jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	ditto
Qk	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 8 APPARATUS two 150 ml beakers & one 250 ml beaker TRANSFORMATION S's juice transfered to larger jar so that the levels of E's & S's juice become the same height.

CONCEPT Cons. of inequalities. Altern. with prog. 4. E's @ 80 ml S's @ 120 ml

	E	Ss Answers	E
Pn	(Assign jars & get agreement of S having more before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me..... (Get S echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar. Now, it's lower than it was, but it's wider than yours. So it's still more.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip, but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	ditto
Qk	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 9 APPARATUS two 250 ml beakers & one 150 ml. beaker E's @ 120 ml. S's @ 30 ml TRANSFORMATION Juice is taken from S's jar & it is then transfered into a smaller jar.

CONCEPT Cons. of inequalities. Altern. with Prog. 8

	E	Ss Answers	E
Pn	(Assign jars & get agreement of S having less before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me .....- (Get S to echo the rule)	Less. Because mine had less to begin with and you just poured mine into this jar.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign jars & get agreement of S having more before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar. Now, its lower than it was, but it's wider than yours. So it's still more.	ditto
Qk	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 10 APPARATUS Two 250 ml. beakers and one 150 ml. beaker. E's @ 120 ml. S's @ 80 ml. TRANSFORMATION: S's juice is transfered to a smaller jar so that the levels of E's & S's juice become the same height.

CONCEPT Cons. of inequalities altern. with Prog. 8

	E	Ss Answers	E
Fn	(Assign jars & get agreement of S having less before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	Less. Because mine had less to begin with & you just poured mine into this jar. Now it's higher than it was, but its skinnier than yours. So it's still less.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Fk	(Assign jars & get agreement of S having more before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar. Now, it's lower than it was, but it's wider than yours. So it's still more.	ditto
Qk	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 11 APPARATUS Two 2-quart milk cartons & one 2 quart carton cut one inch (2.2) @ 250 ml ea. TRANSFORMATION S's juice completely transfered to a container of different dimensions (i.e.) to 2-quart cartons.

CONCEPT C.C.Q. altern. with Prog. 8

	E	S's Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign jars & get agreement of S having more before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar. Now, it's lower than it was, but it's wider than yours. So it's still more.	ditto
Qk	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me or more than me, or less than me? Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 12 APPARATUS 2 - 3 & 1 - 2,3 type cartons @ 250 mls. TRANSFORMATION S's juice transferred from 3 to 2,3

CONCEPT C.C.Q.
Altern. with prog. 10

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign jars & get agreement of S having less before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	Less. Because mine had less to begin with & you just poured mine into this jar. Now it's higher than it was, but its skinnier than yours. So it's still less.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qk	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 13 APPARATUS 2 - 3 & 1 - 2.4 type cartons TRANSFORMATION S's juice transferred from 3 to 2.4

CONCEPT C.C.Q. @ 250 mls.

Altern. with prog. 8

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If Correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign jars & get agreement of S having more before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More Because mine had more to begin with and you just poured mine into this jar. Now, it's lower than it was, but it's wider than yours. So it's still more.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip, but you will have lots more chances.
Qk	Lets do it again. (Perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 14 APPARATUS 2 - 3 & 1 - 2.5 type cartons TRANSFORMATION ½ juice transferred from 3 to 2.5

CONCEPT C.C.Q. @ 250 mls.

altern. with prog. 10

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign jars & get agreement of S having less before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	Less. Because mine had less to begin with & you just poured mine into this jar. Now it's higher than it was, but its skinnier than yours. So it's still less.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qk	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 15 APPARATUS 2 - 3 & 1 - 2.6 type cartons @ 250 mls. TRANSFORMATION S's juice transferred from 3 to 2.6

CONCEPT C.C.Q. altern. with prog. 8

	E	Ss Answers	E
P_n	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Q_n	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
P_k	(Assign jars & get agreement of S having more before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar Now, it's lower than it was, but it's wider than yours. So it's still more.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Q_k	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Q_n	As above	Q_n	As above	Q_n	As above
Q_k	_____	Q_k	_____	Q_k	_____
Q_n	As above	Q_n	As above	Q_n	As above
Q_k	_____	Q_k	_____	Q_k	_____
Q_n	As above	Q_n	As above	Q_n	As above
Q_k	_____	Q_k	_____	Q_k	_____
Q_n	As above	Q_n	As above	Q_n	As above

PROGRAM 16 APPARATUS 2 - 3 & 1 - 2.7 TRANSFORMATION 3's juice

type cartons transferred from

CONCEPT C.C.Q. @ 250 mls. 3 to 2.7

altern. with prog. 10

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? -Why?	ditto	ditto
P%	(Assign jars & get agreement of S having less before transformation the give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	Less. Because mine had less to begin with & you just poured mine into this jar. Now it's higher than it was, but its skinnier than yours. So it's still less.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Q%	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Q%	_____	Q%	_____	Q%	_____
Qn	As above	Qn	As above	Qn	As above
Q%	_____	Q%	_____	Q%	_____
Qn	As above	Qn	As above	Qn	As above
Q%	_____	Q%	_____	Q%	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 17 APPARATUS two 3-quart cartons & one 1-quart carton TRANSFORMATION S's juice transfered to 1-quart carton

CONCEPT C.C.Q. (cut one inch) (1.1)

altern. with Prog. 8 2 @ 250 ml

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pm	(Assign jars & get agreement of S having more before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want youtto tell me..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar. Now, it's lower than it was, but it's wider than yours. So it's still more	ditto
Qm	Lets do it again. (perform task again task) Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qm	_____	Qm	_____	Qm	_____
Qn	As above	Qn	As above	Qn	As above
Qm	_____	Qm	_____	Qm	_____
Qn	As above	Qn	As above	Qn	As above
Qm	_____	Qm	_____	Qm	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 18 APPARATUS 2 -3 & 1 - 1.2 type cartons @ 250 mls. TRANSFORMATION S's juice transferred from 3 to 1.2

CONCEPT C.C.Q.
Altern. with prog. 10

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pn	(Assign jars & get agreement of S having less before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	Less. Because mine had less to begin with & you just poured mine into this jar. Now it's higher than it was, but it's skinnier than yours. So it's still less.	ditto
Qn	none	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qn	_____	Qn	_____	Qn	_____
Qn	As above	Qn	As above	Qn	As above
Qn	_____	Qn	_____	Qn	_____
Qn	As above	Qn	As above	Qn	As above
Qn	_____	Qn	_____	Qn	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 19 APPARATUS 2 - 3 & 1 - 1.3 type cartons @ 250 mls. TRANSFORMATION S's juice transferred from 3 to 1.3

CONCEPT C.C.Q. altern. with prog. 8

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pm	(Assign jars & get agreement of S having more before transformation & then give prompt) I am pouring your juice into this jar. How, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar. Now, it's lower than it was, but it's wider than yours. So it's still more.	ditto
Qm	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qm	_____	Qm	_____	Qm	_____
Qn	As above	Qn	As above	Qn	As above
Qm	_____	Qm	_____	Qm	_____
Qn	As above	Qn	As above	Qn	As above
Qm	_____	Qm	_____	Qm	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 20 APPARATUS 2 - 3 & 1 - 1.4 type cartons @ 250 mls. TRANSFORMATION S's juice transferred from 3 to 1.4

CONCEPT C.C.Q. altern. with prog. 10

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign jars & get agreement of S having less before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	Less. Because mine had less to begin with & you just poured mine into this jar. Now it's higher than it was, but it's skinnier than yours. So it's still less.	ditto
Qk	none	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 21 APPARATUS 2 - 3 & 1 - 1.5 type cartons TRANSFORMATION S's juice transformed from

CONCEPT C.C.Q. @ 250 mls. 3 to 1.5

altern. with prog. 8

	E	Sn Answers	E
P$_n$	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Q$_n$	Lets do it again. (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
P$_k$	(Assign jars & get agreement of S having more before transformation & then give prompt) I am pouring your juice into this jar. How, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar. Now, it's lower than it was, but it's wider than yours. So it's still more.	ditto
Q$_k$	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Q$_n$	As above	Q$_n$	As above	Q$_n$	As above
Q$_k$	_____	Q$_k$	_____	Q$_k$	_____
Q$_n$	As above	Q$_n$	As above	Q$_n$	As above
Q$_k$	_____	Q$_k$	_____	Q$_k$	_____
Q$_n$	As above	Q$_n$	As above	Q$_n$	As above
Q$_k$	_____	Q$_k$	_____	Q$_k$	_____
Q$_n$	As above	Q$_n$	As above	Q$_n$	As above

PROGRAM 22 APPARATUS 2 - 3 & 1 - 1.6 type cartons TRANSFORMATION 6'n juice transferred from 3 to 1.6

CONCEPT C.C.Q @ 250 mls.

altern. prog. 10

	E	Es Answers	I
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign jars & get agreement of S having less before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	Less. Because mine had less to begin with & you just poured mine into this jar. Now it's higher than it was, but its skinnier than yours. So it's still less.	ditto
Qk	none	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 23 APPARATUS 2 - 3 & 1 - 1.7 type cartons TRANSFORMATION S's juice transferred from 3 to 1.7

CONCEPT C.C.Q. @ 250 mls.

altern. with prog. 8

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign jars & get agreement of S having more before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me, (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar. Now, it's lower than it was, but it's wider than yours. So it's still more.	ditto
Qk	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 24 APPARATUS two 600 ml. beakers and one 150 ml. TRANSFORMATION juice from S's jar into 150 ml. jar.

CONCEPT C.C.Q. alternate with Prog. 8 beaker 2 @ 150 ml.

	E	S Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pm	(Assign jars & get agreement of S having more before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar. Now, it's lower than it was, but it's wider than yours. So it's still more.	ditto
Qk	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 25 APPARATUS two 1000 ml. beakers and one 150 ml. beaker. TRANSFORMATION juice from Ss jar into 150 ml. jar.

CONCEPT C.C.Q. alterm. with prog. 10 2 @ 150 ml.

	E	Ss Answers	E
Pn	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same, Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy, Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pl	(Assign jars & get agreement of S having less before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	Less. Because mine had less to begin with & you just poured mine into this jar. Now it's higher than it was, but its skinnier than yours. So it's still less.	ditto
Ql	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above.
Ql	_____	Ql	_____	Ql	_____
Qn	As above	Qn	As above	Qn	As above
Ql	_____	Ql	_____	Ql	_____
Qn	As above	Qn	As above	Qn	As above
Ql	_____	Ql	_____	Ql	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 26 APPARATUS two 300 ml. & one 125 ml. Erlenmeyer beaker. TRANSFORMATION juice from S's jar into 125 ml. jar.

CONCEPT C.C.Q. altern. with Prog. 8 2 @ 125 ml.

	E	Ss Answers	E
Pm	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If Correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qm	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pk	(Assign jars & get agreement of S having more before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	More. Because mine had more to begin with and you just poured mine into this jar. Now, it's lower than it was, but it's wider than yours. So it's still more.	ditto
Qk	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qm	As above	Qm	As above	Qm	As above
Qk	_____	Qk	_____	Qk	_____
Qm	As above	Qm	As above	Qm	As above
Qk	_____	Qk	_____	Qk	_____
Qm	As above	Qm	As above	Qm	As above
Qk	_____	Qk	_____	Qk	_____
Qm	As above	Qm	As above	Qm	As above

PROGRAM 27 APPARATUS two 1000 ml. flat-bottomed beakers & one 500 ml. flat-bottomed beaker. 2 @ 500 ml. TRANSFORMATION juice from S's jar into 500 ml. jar.

CONCEPT C.C.Q. altern. with Prog. 10

	E	Ss Answers	E
Pa	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qn	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pa	(Assign jars & get agreement of S having less before transformation then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	Less. Because mine had less to begin with & you just poured mine into this jar. Now it's higher than it was, but its skinnier than yours. So it's still less.	ditto
Qk	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 28 APPARATUS two - 1000 ml. flat-bottomed beakers & one 500 ml. flat-bottomed beaker @ 500 ml. TRANSFORMATION juice from S's jar into 500 ml. jar.

CONCEPT C.S. on C.C.Q.

	E	Ss Answers	E
Qk	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip but you will have lots more chances.
Qk	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Qn	Now you know that the right answer is that they're the same because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same. However, look at how high it is here. Don't you think that actually makes it more? This is what I want you to tell me	No. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	ditto
Qn	Look at how high it is. Don't you think that actually makes it more.	ditto	ditto

Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

PROGRAM 29 APPARATUS two-1000 ml. flat-bottomed beakers & one 500 ml. flat-bottomed beaker. @ 500 mls. TRANSFORMATION Juice from Ss jar into 500 ml. jar.

CONCEPT C.S. on C.C.Q.

	E	Ss Answers	E
Pk	(Assign jars & get agreement of same amount before transformation & then give prompt) I am pouring your juice into this jar. Now, would you say that you have the same amount to drink as me, or more than me, or less than me (Give answer) Why? This is what I want you to tell me ..... (Get S to echo the rule)	The same. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	If correct response: Good boy. Here's your chip. If incorrect response: Oh, you just missed a chip, but you will have lots more chances.
Qk	Lets do it again (perform task again task). Now would you say that you have the same amount to drink as me, or more than me, or less than me? - Why?	ditto	ditto
Pn	Now you know that the right answer is that they're the same because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same. However, someone else said that because this one is higher it contains more. Where they right or wrong? This is what I want you to tell me	They were wrong. Because they were the same to begin with and you just poured mine into this jar. Now it's high but it's skinnier than yours. So they are the same.	ditto
Qn	Someone else said taht because this one is higher it contains more. Where they right or wrong?	ditto	ditto

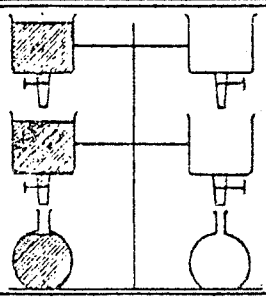
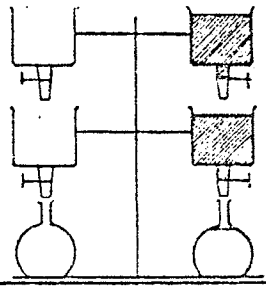
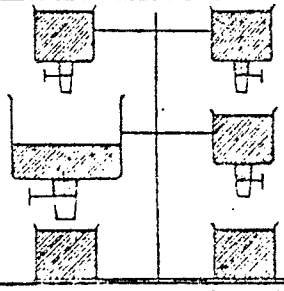
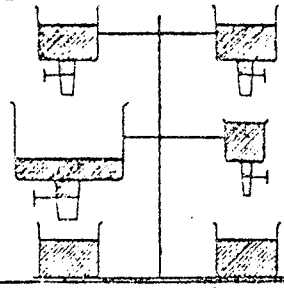
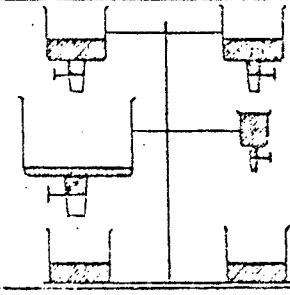
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above
Qk	_____	Qk	_____	Qk	_____
Qn	As above	Qn	As above	Qn	As above

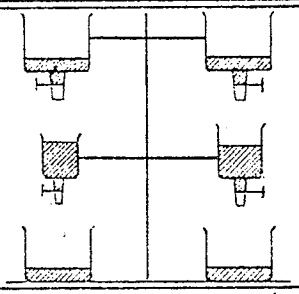
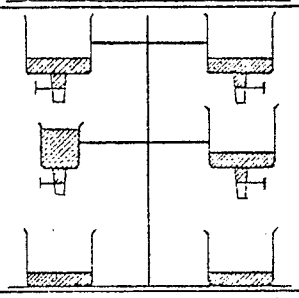
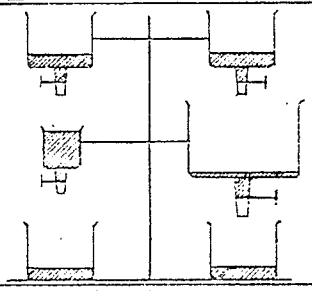
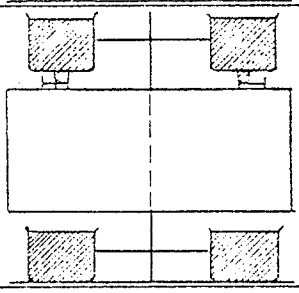
APPENDIX 4

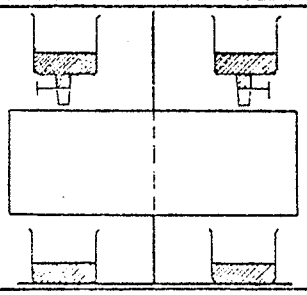
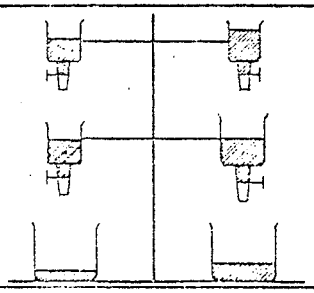
Phases and Cycles for the Conflict Training

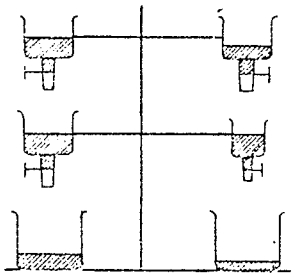
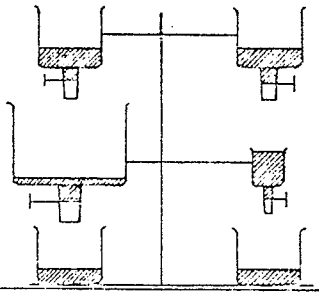
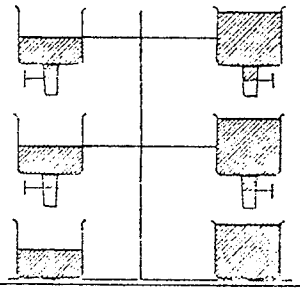
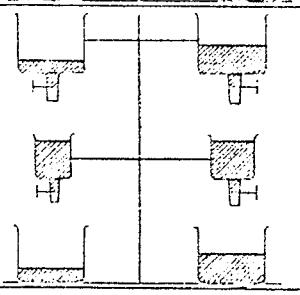
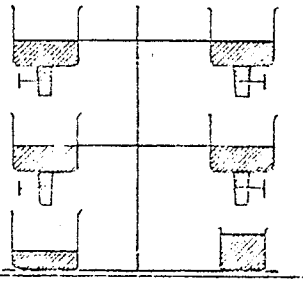
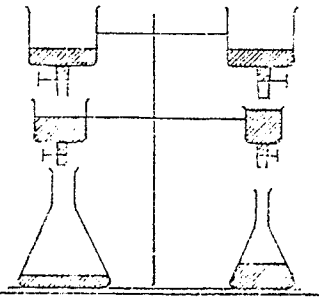
Sign	Significate
A	Top left beaker
B	Middle left beaker
C	Bottom left beaker
A'	Top right beaker
B'	Middle right beaker
C'	Bottom right beaker
F	Beaker or flask used for filling A and A'
1	150 ml. tapped beaker
2	250 ml. tapped beaker
3	400 ml. tapped beaker
4	1000 ml. tapped beaker
5	250 ml. flat bottomed flask
6	500 ml. flat bottomed flask
7	1000 ml. flat bottomed flask
8	125 ml. Erlenmyer beaker
9	500 ml. Erlenmyer beaker
10	150 ml. standard beaker
11	250 ml. standard beaker
12	400 ml. standard beaker

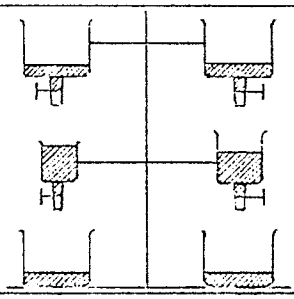
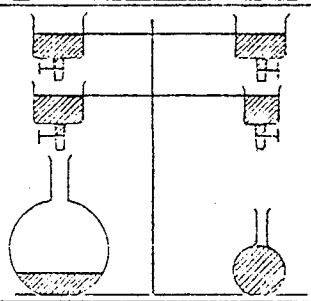
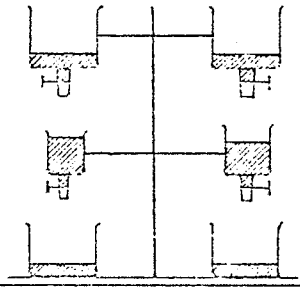
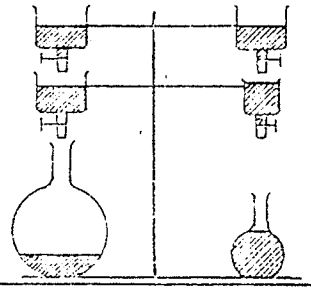
Figure 9: Signification of the symbols for the conflict training program.

PHASE NO.	PHASE PURPOSE	CYCLE NO.	APPARATUS	TRANSFORMATION
1	1. Adaptation of S to equipment. 2. Focus S's attention on the closed cycle of the liquid flow. 3. Teach active search for contradictory judgements.	1	A_3 A'_3 B_3 B'_3 C_6 C'_6 F_6 @ 400 ml.	
1	Same as phase 1, cycle 1.	2	A_3 A'_3 B_3 B'_3 C_6 C'_6 F_6 @ 400 ml.	
2	1. Focus S attention on the fact that equal amts. rise to same level in A and A' and in C and C' but to different levels in B and B'. 2. To facilitate CCQ by: (a) approximating Piaget's 4 stages of the equilibration process and (b) prediction outcome conflict.	1	A_3 A'_3 B_4 B'_3 C_{12} C'_{12} F_{12} @ 400 ml.	
2	Same as phase 2, cycle 1.	2	A_3 A'_3 B_4 B'_2 C_{12} C'_{12} F_{12} @ 250 ml.	
2	Same as phase 2, cycle 1.	3	A_3 A'_3 B_4 B'_1 C_{12} C'_{12} F_{12} @ 150 ml.	

PHASE NO.	PHASE PURPOSE	CYCLE NO.	APPARATUS	TRANSFORMATION
2	Same as phase 2, cycle 1.	4	A_3 A'_3 B_1 B'_2 C_{12} C'_{12} F_{12} @ 150	
2	Same as phase 2, cycle 1.	5	A_3 A'_3 B_1 B'_3 C_{12} C'_{12} F_{12} @ 150	
2	Same as phase 2, cycle 1.	6	A_3 A'_3 B_1 B'_4 C_{12} C'_{12} F_{12} @ 150	
3	1. Same as phase 2 except the saliency of the unequal levels at B & B' is increased due to the surprise effect when the screen is removed. 2. Create conflict re judgments higher = more and skinnier = less.	1	A_3 A'_3 B_4 B'_4 C_{12} C_{12} F_{12} @ 400	
3	Same as phase 3 cycle 1.	2	A_3 A'_3 B_4 B'_2 C_{12} C'_{12} F_{12} @ 250	Same as phase 3, cycle 1, but with B_4 & B'_2

PHASE NO.	PHASE PURPOSE	CYCLE NO.	APPARATUS	TRANSFORMATION
3	Same as phase 3, cycle 1	3	A_3 A'_3 B_4 B'_1 C_{12} C'_{12} F_{12} @ 150	
3	Same as phase 3, cycle 1	4	A_3 A'_3 B_1 B'_2 C_{12} C'_{12} F_{12} @ 150	Same as phase 3, cycle 1, but with B_1 & B'_2
3	Same as phase 3, cycle 1.	5	A_3 A'_3 B_1 B'_3 C_{12} C'_{12} F_{12} @ 150	Same as phase 3, cycle 1, but with B_1 & B'_3
3	Same as phase 3, cycle 1.	6	A_3 A'_3 B_1 B'_4 C_{12} C'_{12} F_{12} @ 150	Same as phase 3, cycle 1, but with B_1 & B'_4
4	To develop conservation of inequalities by having unequal amounts in A & A' which rise to the same level in B & B'.	1	A_3 A'_3 B_1 B'_2 F_{10} @ 80 ml. for A_3 C_{12} C'_{12} F_{10} @ 120 ml. for A'_3	

PHASE NO.	PHASE PURPOSE	CYCLE NO.	APPARATUS	TRANSFORMATION
4	Same as phase 4, cycle 1	2	A_3 A'_3 B_2 B'_1 F_{12} @ 120 ml. for A_3 C_{12} C'_{12} F_{12} @ 80 ml. for A'_3	
4	Same as phase 2. This cycle constitutes a review of CCQ.	3	A_3 A'_3 B_4 B'_1 C_{12} C'_{12} F_{12} @ 150 ml.	
5	To facilitate the development of the generalization of unequal CCQ	1	A_3 A'_3 F_{12} @ 100 ml. for A B_3 B'_3 C_{12} C'_{12} F_{12} @ 200 ml. for A'	
5	Same as phase 5 cycle 1	2	A_3 A'_3 B_1 B'_2 F_{10} @ 80 ml. for A_3 C_{12} C'_{12} F_{10} @ 120 ml. for A'_3	
5	To facilitate the development of the generalization of equal CCQ.	3	A_3 A'_3 B_3 B'_3 F_{12} @ 250 ml. C_{12} C_{11}	
5	Same as phase 5, cycle 3.	4	A_3 A'_3 B_2 B'_1 C_9 C'_8 F_{10} @ 125	

PHASE NO.	PHASE PURPOSE	CYCLE NO.	APPARATUS	TRANSFORMATION
5	Same as phase 5, cycle 1	5	A_3 A_3' B_1 B_2' F_{10} @ 80 ml. for A_3 C_{12} C'_{12} F_{10} @ 120 ml. for A'_3	
5	Same as phase 5, cycle 3.	6	A_3 A'_3 B_3 B'_2 C_7 C'_5 F_{10} @ 250 ml.	
5	Same as phase 5, cycle 1	7	A_3 A_3' B_1 B_2 F_{10} @ 80 ml. for A_3 C_{12} C'_{12} F_{10} @ 120 ml. for A'_3	
6	To facilitate the development of generalization and resistance to countersuggestion of equal CCQ	1	A_3 A'_3 B_3 B'_2 C_7 C'_5 F_{10} @ 250 ml.	

Glass Beaker Sessions

Phase 1 Cycle 1 Sheet 1 Of 1
Subject _____
Experimenter _____
Observer _____

Apparatus
A_3 A'_3
B_3 B'_3
C_6 C'_6 F_6 @500 ml.

Tape Footage _____
Date _____
Start Time _____
Stop Time _____
Reel #_____ Side #_____

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of Judgement or explanation
H = Humming, Pausing
F = Facial Expression (frown, looking away)

Step	#	E's Request or Question	S's Responses: Answer (NQ, NA, or verbatim report)	✓ X J	✓ X E	CHF Conflict	Chips W, R WW, RR
1	1	Put juice in F_6 filling to tape					
2	1	Pour juice from $F_6 \rightarrow A_3$					
3	1	Pour juice from $A_3 \rightarrow B_3$					
4	1	What happened when $A_3 \rightarrow B_3$					
	2	When we $B_3 \rightarrow C_6$ will juice come up to, over top, or below tape?					
5	1	Let $B_3 \rightarrow C_6$					
6	1	Where you right when you said _____?					
	2	You answered like a young child didn't you (W)					
	3	Let's find _____older child _____answer.					
	4	How high did you think - juice _____come? (W)					
	5	But what happened --- $B_3 \rightarrow C_6$ (W)					
	6	Can --show me on C_6 how high you thought--- and how high actually came? (W)					
	7	Can---- tell me what -- older child would think when $B_3 \rightarrow C_6$? (W,W)					

Glass Beaker Sessions

Phase 1 Cycle 2 Sheet 1 Of 1
Subject_____
Experimenter_____
Observer_____

Apparatus
A_3 A'_3
B_3 B'_3
C_6 C'_6 F_6 @500 ml.

Tape Footage_____
Date_____
Start Time_____
Stop Time_____
Reel #_____ Side#_____

Legend
NQ = No Question
NA = No Answer
j = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of Judgement or explanation
H = Humming, pausing
F = Facial Expression, (frown, looking away)

Step	#	E's Request or Question	S's Responses Answer (NQ, NA, or Verbatim report)	✓ X J	✓ X E	CHF Con-flict	Chips W, R WW, RR
1	1	Put juice in F_6 filling to tape					
2	1	Pour juice from $F_6 \rightarrow A'_3$					
3	1	Pour juice from $A'_3 \rightarrow B'_3$					
4	1	What happened when $A'_3 \rightarrow B'_3$					
	2	When we $B'_3 \rightarrow C'_6$ will juice come up to, over top, or below tape?					
5	1	Let $B'_3 \rightarrow C'_6$					
6	1	Were you right when you said _____?					
	2	You answered like a young child didn't you (W)					
	3	Let's find_____older child _____answer.					
	4	How high did you think - juice _____ come? (W)					
	5	But what happened _____ $B'_3 \rightarrow C'_6$ (W)					
	6	Can___show me on C'_6 how high you thought___ and how high actually came? (W)					
	7	Can___ tell me what ___ older child would think when $B'_3 \rightarrow C'_6$? (W,W)					

Glass Beaker Sessions

Phase 2 Cycle 1 Sheet 1 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B'_3 Flat
C_{12} C'_{12} 400 ml.

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict symbols
C = Change of judgement or explanation
H = Humming, pausing
F = Facial Expressions (frown, looking away)

Page	#	E's Request or Question	S's Responses Answer (NO, NA or Verbatim	✓ X J	✓ X E	C.H.F. Conflict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 and A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_4$					
	2	Pour $A'_3 \rightarrow B'_3$, just as -- Some to drink					
3a	1	You did it like a young child					
	2	When in A_3 & A'_3 how -did- have- drink? (W)					
	3	How much did you--re $A_3 \rightarrow B_4$? (W)					
	4	How much did you -- re $A'_3 \rightarrow B'_3$? (W)					
	5	If $A_3 = A'_3$ and all $A_3 \rightarrow B_4$ and only some $A'_3 \rightarrow B'_3$ how can $B_4 = B'_3$?					
	6	You left some for B'_3 in A'_3					
	7	How much would an older child pour from A'_3 to B'_3? (W,W)					
3b	1	That's right (R)					
	2	How can - be same when B'_3 ↑ than B_4? (R)					
	3	Does $B'_3 = B_4$ because ↑ and ↔ (R)					
	4	Can - tell me why $B'_3 = B_4$ when B'_3 ↑ B_4 (R,R)					
4	1	Elastic on levels of B_4 and B'_3					
5	1	If $B_4 \rightarrow C_{12}$ and $B'_3 \rightarrow C'_{12}$ will C_{12} and C'_{12} have same or more in one					

Glass Beaker Sessions

Phase 2 Cycle 1 heet 2 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B'_3 F_{-}
C_{12} C'_{12} @400 ml.

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming, Pausing
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Responses Answer (NQ,NA Or Verbatim	✓ J	X E	C.H.F. Conflict	Chips W, R WW,RR
6	1	Let $B_4 \Rightarrow C_{12}$ and $B'_3 \Rightarrow C'_{12}$					
7a	1	Do we have same, more, less? (R). Why? (R,R)					
7b	1	Do we have same, more, etc?					
	2	You answered like a young child (W)					
	3	Did juice in $B_4 = B'_3$? (W)					
	4	When $B_4 \Rightarrow C_{12}$ and $B'_3 \Rightarrow C_{12}$ what happened?					
	5	Does $C'_{12} = C_{12}$?					
	6	Could $B_4 = B'_3$ then? (W)					
	7	What about juice here A'_3					
	8	If $A'_3 \Rightarrow B'_3$ & $B'_3 \Rightarrow C_{12}$ would $C'_{12} = C_{12}$? (W)					
8	1	Let $A'_3 \Rightarrow B'_3 \Rightarrow C'_{12}$					
9	1	Do we both have same? (R)					
	2	Why? (R)					
	3	What is the difference between the younger & older girls' way of pouring $A_3 \Rightarrow B_4$ & $A'_3 \Rightarrow B'_3$? (W,W)					

Glass Beaker Sessions

Phase 2 Cycle 2 Sheet 1 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B'_2
C_{12} C'_{12} F_{12} 250 ml.

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = change of judgement or explanation
H = Humming, Pausing
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Responses Answer (NQ, NA or Verbati...)	✓ X J	✓ X E	C.H.F. Con- flict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 & A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_4$					
	2	Pour $A'_3 \rightarrow B'_2$, just so -- Same to drink					
3a	1	You did it like a young child					
	2	When in A_3&A'_3 how - did - have - drink? (W)					
	3	How much did-- re $A_3 \rightarrow B_4$? (W)					
	4	How much did you -- re $A'_3 \rightarrow B'_2$? (W)					
	5	If $A_3 = A'_3$ and all $A_3 \rightarrow B_4$ and only some $A'_3 \rightarrow B'_2$ how can $B_4 = B'_2$?					
	6	You left some for B'_2 in A'_3					
	7	How much would an older child pour from A'_3 to B'_2? (W,W)					
3b	1	That's right (R)					
	2	How can - be same when B'_2 < than B_4? (R)					
	3	Does $B'_2 = B_4$ because > and < (R)					
	4	Can - tell me why $B'_2 = B_4$ when $B'_2 \uparrow B_4$ (R,R)					
4	1	Elastic on levels of B_4 & B'_2					
5	1	If $B_4 \rightarrow C_{12}$ & $B'_2 \rightarrow C'_{12}$ will C_{12} and C'_{12} have same or more in one					

Glass Beaker Sessions

Phase 2 Cycle 2 Sheet 2 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B'_2
C_{12} C'_{12} F_{12} @250 ml.

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = change of judgement or explanation
H = Humming, Pausing
F = Facial expressions, (frown, looking away)

Stage #		E's Request or Question	S's Responses Answer (NO, NA or Verbatim	✓ X J	✓ X E	C.H.F. Con-flict	Chips W,R WW,RR
6	1	Let $B_4 \rightarrow C_{12}$ and $B'_2 \rightarrow C'_{12}$					
7a	1	Do we have same, more, less? (R). Why? (R,R)					
7b	1	Do we have same, more, etc?					
	2	You answered like a young child (W)					
	3	Did juice in $B_4 = B'_2$? (W)					
	4	When $B_4 \rightarrow C_{12}$ and $B'_2 \rightarrow C_{12}$ what happened?					
	5	Does $C'_{12} = C_{12}$?					
	6	Could $B_4 = B'_2$ then? (W)					
	7	What about juice here A'_3					
	8	If $A'_3 \rightarrow B'_2$ & $B'_2 \rightarrow C_{12}$ would $C'_{12} = C_{12}$? (W)					
8	1	Let $A'_3 \rightarrow B'_2 \rightarrow C'_{12}$					
9	1	Do we both have same? (R)					
	2	Why? (R)					
	3	What is the difference between the younger & older girls' way of pouring $A_3 \rightarrow B_4$ and $A'_3 \rightarrow B'_2$? (W,W)					

Glass Beaker Sessions

Phase 2 Cycle 3 Sheet 1 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B'_1
C_{12} C'_{12} F_{12} @150 ml

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming, Pausing
F = Facial expressions (Frown, looking away)

Step	#	E's Request or Question	S's Responses Answer (NQ,NA or Verbatim	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW,RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 and A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_4$					
	2	Pour $A'_3 \rightarrow B'_1$ just so -- same to drink					
3a	1	You did it like a young child					
	2	When in A_3 and A'_3 how - did have - drink? (W)					
	3	How much did you --re $A_3 \rightarrow B_4$? (W)					
	4	How much did you -- re $A'_3 \rightarrow B'_1$? (W)					
	5	If $A_3 = A'_3$ and all $A_3 \rightarrow B_4$ and only some $A'_3 \rightarrow B'_1$ how can $B_4 = B'_1$?					
	6	You left some for B'_1 in A'_3					
	7	How much would an older child pour from A'_3 to B'_1 (W,W)					
3b	1	That's right (R)					
	2	How can - be same when $B'_1 \uparrow$ than B_4? (R)					
	3	Does $B'_1 = B_4$ because $\uparrow$ and $\Leftrightarrow$ (R)					
	4	Can - tell me why $B'_1 = B_4$ when $B'_1 \uparrow B_4$ (R,R)					
4	1	Elastic on levels of B_4 and B'_1					
5	1	If $B_4 \rightarrow C_{12}$ and $B'_1 \rightarrow C'_{12}$ will C_{12} and C'_{12} have same or more in one					

Glass Beaker Sessions

Phase 2 Cycle 3 Sheet 2 Of 2
Subject _____
Experimenter _____
Observer _____

Apparatus
A_3 A'_3
B_4 B'_1
C_{12} C'_{12} F_{12}@150 ml.

Tape Footage _____
Date _____
Start Time _____
Stop Time _____
Reel _____ Side _____

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming, Pausing
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Responses Answer (NQ, NA, or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
6	1	Let $B_4 \rightarrow C_{12}$ and $B'_1 \rightarrow C'_{12}$					
7a	1	Do we have same, more, less? (R). Why? (R,R)					
7b	1	Do we have same, more, etc?					
	2	You answered like a young child (w)					
	3	Did juice in $B_4 = B'_1$? (W)					
	4	When $B_4 \rightarrow C_{12}$ and $B'_1 \rightarrow C_{12}$ what happened?					
	5	Does $C'_{12} = C_{12}$?					
	6	Could $B_4 = B'_1$ then? (W)					
	7	What about juice here A'_3					
	8	If $A'_3 \rightarrow B'_1$ and $B'_1 \rightarrow C_{12}$ would $C'_{12} = C_{12}$? (W)					
8	1	Let $A'_3 \rightarrow B'_1 \rightarrow C'_{12}$					
9	1	Do we both have same? (R)					
	2	Why? (R)					
	3	What is the difference between the younger & older girls' way of pouring $A_3 \rightarrow B_4$ and $A'_3 \rightarrow B'_1$? (W,W)					

Glass Beaker Sessions

Phase 2 Cycle 4 Sheet 1 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_1 B'_2
C_{12} C'_{12} F_{12}@150

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C= Change of judgement or explanation
H= Humming or Pausing
F = Facial Expressions (frown, looking away)

STEP	#	E's Request or Question	S's Responses Answer (NO, NA or Verbatim)	✓ J	✓ E	X C.H.F. Con-flict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 & A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_1$					
	2	Pour $A'_3 \rightarrow B'_2$, so some to drink					
3	1	Do we have same, more, less?					
	2	You answered like a young child (W)					
	3	Why is B'_2 less than B_1?					
	4	No -- part of mistake. You only looked at how ↓ B'_2 is					
	5	Look how fat B'_2 is					
	6	Is it $>$ or $<$ than B_1? (W)					
	7	You should look at how fat & how ↓ juice is before answering					
	8	Do you think because $B'_2 < B_1$ but ↓ B_1 that $B'_2 = B_1$? (R)					
	9	How much would older child say is in B'_2? (W)					
	10	How much would younger child say is in B'_2 (W)					
	11	Who would be right? (W)					
	12	Why (W,W)					
4	1	Elastic on levels B_1 & B'_2					
5	1	If $B_1 \rightarrow C_{12}$ and $B'_2 \rightarrow C'_{12}$ will C'_{12} and C_{12} have same or less in one					

Glass Beaker Sessions

Phase 2 Cycle 4 Sheet 2 Of 2
Subject _____
Experimenter _____
Observer _____

Apparatus
A_3 A'_3
B_1 B'_2
C_{12} C'_{12} F_{12} @150

Tape Footage _____
Date _____
Start Time _____
Stop Time _____
Reel _____ Side _____

Legend

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming, pausing
F = Facial expressions (frown looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Con-flict	Chips W, R WW, RR
6	1	Let $B_1 \rightarrow C_{12}$ & $B'_2 \Rightarrow C'_{12}$					
7a	1	Do we both have same etc? (R)					
	2	Do you agree we have a problem? (W)					
	3	Did $B_1 = B'_2$? (W)					
	4	Did you think that $C_{12} = C'_{12}$ after $B_1 \Rightarrow C_{12}$ & $B'_2 \rightarrow C_{12}$? (W)					
	5	Can you tell me what the problem is? (W,W)					
	6	Would an older child have looked at how ↓ B'_2 and how fat B'_2 is? (R)					
	7	Why should you look at how ↓ and fat B'_2 is? (R,R)					
7b	1	Do we have same, more, less? (R) Why? (R,R)					

Glass Beaker Sessions

Phase 2 Cycle 5 Sheet 1 Of 2
Subject_____
Experimenter_____
Observer_____

Apparatus
A_3 A'_3
B_1 B'_3
C_{12} C'_{12} F_{12}@ 150

Tape Footage_____
Date_____
Start Time_____
Stop Time_____
Reel_____Side_____

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming, pausing
F = Facial Expressions (frown, looking away)

Step	#	E's Request or Question	S's Responses Answer (NO, NA, or Verbatim)	✓ J	X E	C.H.F. Conflict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 and A'_3 have same amount?					
2	1	Pour $A_3 \Rightarrow B_1$					
	2	Pour $A'_3 \Rightarrow B'_3$, so some to drink					
3	1	Do we have same, more, less?					
	2	You answered like a young child (W)					
	3	Why is B'_3 less than B_1?					
	4	No -- part of mistake. You only looked at how ↓ B'_3 is					
	5	Look at how fat B'_3 is					
	6	Is it >< than B_1? (W)					
	7	You should look at how fat & how ↓ juice is before answering					
	8	Do you think because B'_3 >< B_1 but ↓ B_1 that $B'_3 = B_1$? (R)					
	9	How much would older child say is in B'_3? (W)					
	10	How much would younger child say is in B'_3? (W)					
	11	Who would be right? (W)					
	12	Why? (W,W)					
4	1	Elastic on levels B_1 & B'_3					
5	1	If $B_1 \Rightarrow C_{12}$ and $B'_3 \Rightarrow C'_{12}$ will C'_{12} and C_{12} have same or less in one					

Glass Beaker Sessions

Phase 2 Cycle 5 Sheet 2 Of 2
Subject _____
Experimenter _____
Observer _____

Apparatus
A_3 A'_3
B_1 B'_3
C_{12} C'_{12} F_{12}@150

Tape Footage _____
Date _____
Start Time _____
Stop Time _____
Reel _____ Side _____

Legend

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming, pausing
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Responses Answer (NQ,NA, Verbatim)	✓ J	✓ E	X C.H.F. Conflict	Chips W, R WW, RR
6	1	Let $B_1 \rightarrow C_{12}$ & $B'_3 \rightarrow C'_{12}$					
7a	1	Do we both have same etc? (R)					
	2	Do you agree we have a problem? (W)					
	3	Did $B_1 = B'_3$? (W)					
	4	Did you think that $C_{12} = C'_{12}$ after $B_1 \rightarrow C_{12}$ & $B'_3 \rightarrow C_{12}$? (W)					
	5	Can you tell me what the problem is? (W,W)					
	6	Would an older child have looked at how B'_3 and how fat B'_3 is? (R)					
	7	Why should you look at how B'_3 and fat B'_3 is? (R,R)					
7b	1	Do we have same, more, less? (R) Why? (R,R)					

Glass Beaker Sessions

Phase 2 Cycle 6 Sheet 1 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_1 B'_4
C_{12} C'_{12} F_{12} @150

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming, pausing
F = Facial Expressions (frown, looking away)

SIT	#	E's Request or Question	S's Responses Answer (NQ,NA, or Verbatim)	✓ J	X J	X E	C.H.F. Conflict	Chips W, R WW,RR
1	1	Pour F into A_3 and A'_3						
	2	Do A_3 & A'_3 have same amount?						
2	1	Pour $A_3 \Rightarrow B_1$						
	2	Pour $A'_3 \Rightarrow B'_4$, so some to drink						
3	1	Do we have same, more, less?						
	2	You answered like a young child (W)						
	3	Why is B'_4 less than B_1?						
	4	No -- part of mistake. You only looked at how ↓ B'_4 is.						
	5	Look at how fat B'_4 is						
	6	Is it) (than B_1? (W)						
	7	You should look at how fat & how ↓ juice is before answering						
	8	Do you think because $B'_4 \rightarrow B_1$ but ↓ B_1 that $B'_4 = B_1$? (R)						
	9	How much would older child say is in B'_4? (W)						
	10	How much would younger child say is in B'_4? (W)						
	11	Would he be right? (W)						
	12	Why? (W,W)						
4	1	Elastic on levels B_1 & B'_4						
5	1	If $B_1 \Rightarrow C_{12}$ and $B'_4 \Rightarrow C'_{12}$ will C'_{12} and C_{12} have same or less in one?						

Glass Beaker Sessions

Phase 2 Cycle 6 Sheet 2 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_1 B'_4
C_{12} C'_{12} F_{12}@150

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming, pausing
F = Facial Expressions (frown looking away)

Step	#	E's Request or Question	S's Responses Answer (NQ, NA, Verbatim)	✓ J	✓ X E	C.H.F. Con-flict	Chips W, R WW, RR
6	1	Let $B_1 \rightarrow C_{12}$ & $B'_4 \rightarrow C'_{12}$					
7a	1	Do we both have same etc? (R)					
	2	Do you agree we have a problem? (W)					
	3	Did $B_1 = B'_4$? (W)					
	4	Did you think that $C_{12} = C'_{12}$ after $B_1 \rightarrow C_{12}$ & $B'_4 \rightarrow C_{12}$? (W)					
	5	Can you tell me what the problem is? (W,W)					
	6	Would an older child have looked at how ↓ B'_4 and how fat B'_4 is? (R)					
	7	Why should you look at how ↓ and fat B'_4 is? (R,R)					
7b	1	Do we have same, more, less? (R) Why? (R,R)					

Glass beaker Sessions

Phase 3 Cycle 1 Sheet 1 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B'_3 F_{12} @400
C_{12} C'_{12}
Legend

Tape Footage
Date
Start Time
Stop Time
Reel Side

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ X J	✓ X E	C.H.F. Con-flict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 and A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_4$					
	2	Pour $A'_3 \rightarrow B'_3$, just so -- Same to drink					
3	1	E removes shield					
	2	When S does it wrong. Do we both have the same to drink?					
	3	You did it like a young child didn't you? (W)					
	4	Can you tell me what the problem is? (W,W)					
	5	When juice in A_3 & A'_3 how much did we both have to drink? (W)					
	6	How much did you think we would both have in B_4 & B'_3 (W)					
	7	But now you think there is more in B'_3 (W)					
	8	Your problem seems to be that you thought B_4 would = B'_3 but now you think B'_3 has more					
	9	Now can you tell me what the problem is? (W,W)					
	10	Let's see if we can find out more about this problem					
	11	Is the juice in B_4 and B'_3 different in any way? (W)					
	12	Is there another way the juice is different in B_4 & B'_3? (W)					
	13	Do you think that B'_3 has more because it is ↑ (W)					
	14	If it has more because it is ↑ won't it have less because it is skinnier? (W)					

Glass Beaker Sessions

Phase 3 Cycle 1 Sheet 2 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B'_3 F_{12} @ 400
C_{12} C'_{12}

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
3	15	So its more because its ↑ & less because its skinnier? (W)					
	16	But how can it be more & less at the same time?					
	17	Maybe the problem is that you only thought about how high it is and you should have thought about both how high and how skinny it is. Maybe because it is higher and skinnier at the same time B_4 and B'_3 have the same amount. [(W) if he answers yes]					
	18	Now, for two chips can you tell me what the problem is? (W,W)					
4	1	Elastic on levels of B_4 & B'_3					
5	1	If $B_4 \rightarrow C_{12}$ and $B'_3 \rightarrow C'_{12}$ will C_{12} & C'_{12} have same or more in one?					
6	1	Let $B_4 \rightarrow C_{12}$ and $B'_3 \rightarrow C'_{12}$					
7a	1	S answers right Do we have same, or one a lot and one a little (R)					
	2	Why? [(R,R) if S refers to both dimensions of the beakers]					

Glass Beaker Sessions

Phase 3 Cycle 2 Sheet 1 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B'_2 F_{12}@250
C_{12} C'_{12}

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ X E	C.H.F. Conflict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 and A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_4$					
	2	Pour $A'_3 \rightarrow B'_2$, just so -- Same to drink					
3	1	E removes shield					
	2	When S does it wrong. Do we both have the same to drink?					
	3	You did it like a young child didn't you? (W)					
	4	Can you tell me what the problem is? (W,W)					
	5	When juice in A_3 and A'_3 how much did we both have to drink? (W)					
	6	How much did you think we would both have in B_4 & B'_2 (W)					
	7	But now you think there is more in B'_2 (W)					
	8	Your problem seems to be that you thought B_4 would = B'_2 but now you think B'_2 has more					
	9	Now can you tell me what the problem is? (W,W)					
	10	Let's see if we can find out more about this problem					
	11	Is the juice in B_4 and B'_2 different in any way? (W)					
	12	Is there another way the juice is different in B_4 & B'_2? (W)					
	13	Do you think that B'_2 has more because it is ↑ (W)					
	14	If it has more because it is ↑ won't it have less because it is skinnier? (W)					

Phase 3 Cycle 2 Sheet 1 Of 1

Subject

Experimenter

Observer

Apparatus

A_3 A'_3

B_4 B'_2 F_{12}@250

C_{12} C'_{12}

Tape Footage

Date

Start Time

Stop Time

Reel Side

Legend

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols

C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Con-flict	Chips W, R WW, RR
3	15	So its more because its ↑ & less because its skinnier? (W)					
	16	But how can it be more & less at the same time?					
	17	Maybe the problem is that you only thought about how high it is and you should have thought about both how high and how skinny it is. Maybe because it is higher and skinnier at the same time B_4 and B'_2 have the same amount. [(W) is he answers yes]					
	18	Now for two chips can you tell me what the problem is? (W,W)					
4	1	Elastic on levels of B_4 and B'_2					
5	1	If $B_4 \Rightarrow C_{12}$ and $B'_2 \Rightarrow C'_{12}$ will C_{12} and C'_{12} have same or more in one?					
6	1	Let $B_4 \Rightarrow C_{12}$ & $B'_2 \Rightarrow C'_{12}$					
7a	1	S answers right Do we have same, or one a lot and one a little (R)					
	2	Why? [(R,R) if S refers to both dimensions of the beakers]					

Phase 3 Cycle 3 Sheet 1 Of 1

Subject

Experimenter

Observer

Apparatus

A_3 A'_3

B_4 B'_1 F_{12}@150

C_{12} C'_{12}

Tape Footage

Date

Start Time

Stop Time

Reel Side

Legend

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols

C = Change of judgement or explanation
H = humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Con-flict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 and A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_4$					
	2	Pour $A'_3 \rightarrow B'_1$, just so -- same to drink					
3	1	E removes shield					
	2	When S- does it wrong. Do we both have the same to drink?					
	3	You did it like a young child didn't you? (W)					
	4	Can you tell me what the problem is? (W,W)					
	5	When juice in A_3 & A'_3 how much did we both have to drink? (W)					
	6	How much did you think we would both have in B_4 & B'_1 (W)					
	7	But now you think there is more in B'_1 (W)					
	8	Your problem seems to be that you thought B_4 would = B'_1 but now you think B'_1 has more					
	9	Now can you tell me what the problem is? (W,W)					
	10	Let's see if we can find out more about this problem					
	11	Is the juice in B_4 and B'_1 different in any way? (W)					
	12	Is there another way the juice is different in B_4 and B'_1? (W)					
	13	Do you think that B'_1 has more because it is ↑ (W)					
	14	If it has more because it is ↑ won't it have less because it is skinnier? (W)					

Clinical Interview Sessions

Phase 3 Cycle 2 Grade 2 of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B_1 F_{12} @150
C_{12} C'_{12} Legend

Tape Footage
Date
Start Time
Stop Time
Reel Side

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ X J	✓ X E	C.H.F. Conflict	Chips W, R WW, RR
3	15	So its more because its ↑ & less because its skinnier? (W)					
	16	But how can it be more and less at the same time?					
	17	Maybe the problem is that you only thought about how high it is and you should have thought about both how high and how skinny it is. Maybe because it is higher and skinnier at the same time B_4 and B'_1 have the same amount. [(W) if he answers yes]					
	18	Now for two chips can you tell me what the problem is? (W,W)					
4	1	Elastic on levels of B_4 & B'_1					
5	1	If $B_4 \rightarrow C_{12}$ and $B'_1 \rightarrow C'_{12}$ will C_{12} and C'_{12} have same or more in one?					
6	1	Let $B_4 \rightarrow C_{12}$ & $B'_1 \rightarrow C'_{12}$					
7a	1	S answers right Do we have same, or one a lot and one a little (R)					
	2	Why? [(R,R) if S refers to both dimensions of the beakers]					

Class Beaker Sessions

Phase 3 Cycle 4 Sheet 1 of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_1 B'_2
C_{12} C'_{12} F_{12} @150

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 and A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_1$					
	2	Pour $A'_3 \rightarrow B'_2$					
3	1	E removes the shield					
	2	Do we both have the same amount to drink?					
	3	You did it like a young child didn't you? (W)					
	4	Can you tell me what the problem is? (W,W)					
	5	When juice in A_3 & A'_3 how much did we both have to drink? (W)					
	6	How much did you think we would both have in B_1 & B'_2? (W)					
	7	But now you think there is more in B_1 (W)					
	8	Your problem seems to be that you thought B_1 would = B'_2 but now you think B'_2 has less					
	9	Now can you tell me what the problem is? (W,W)					
	10	Let's see if we can find out more about this problem.					
	11	Is the juice in B_1 & B'_2 different in any way? (W)					
	12	Is there another way the juice is different in B_1 & B'_2? (W)					
	13	Do you think that B'_2 has less because it is ↓? (W)					
	14	If it has less because it is ↓ won't it have more because it is fatter? (W)					

Glass beaker Sessions

Phase 3 Cycle 4 Sheet 2 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_1 B'_2 F_{12} @150
C_{12} C'_{12}

Leg md

Tape Footage
Date
Start Time
Stop Time
Reel Side

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
3	15	So its less because its ↓ and its more because it is fatter? (W)					
	16	But can it be less and more at the same time?					
	17	Maybe the problem is that you only thought about how low it is when you should have thought about both how low it is and how fat it is. Maybe because its lower and fatter at the same time B'_2 and B_1 have the same amount. [(W) if answer is yes]					
	18	Now for 2 chips can you tell me what the problem is? (W,W)					
4	1	Elastic on levels of B_1 & B'_2					
5	1	If $B_1 \rightarrow C_{12}$ and $B'_2 \rightarrow C'_{12}$ will C_{12} & C'_{12} have same or more in one?					
6	1	Let $B_1 \rightarrow C_{12}$ and $B'_2 \rightarrow C'_{12}$					
7a	1	S answers right Do we have same, or one a lot and one a little (R)					
	2	Why? [(R,R) if S refers to both dimensions of the beakers.]					

Glass Beaker Sessions

Phase 3 Cycle 5 Sheet 1 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_1 B'_3 F_{12} @150
C_{12} C'_{12}

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ X J	✓ X E	C.H.F. Con- flict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 and A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_1$					
	2	Pour $A'_3 \rightarrow B'_3$					
3	1	E removes shield					
	2	Do we both have the same amount to drink?					
	3	You did it like a young child didn't you? (W)					
	4	Can you tell me what the problem is? (W,W)					
	5	When juice in A_3 & A'_3 how much did we both have to drink? (W)					
	6	How much did you think we would both have in B_1 & B'_3? (W)					
	7	But now you think there is more in B_1 (W)					
	8	Your problem seems to be that you thought B_1 would = B'_3 but now you think B'_3 has less.					
	9	Now can you tell me what the problem is? (W,W)					
	10	Let's see if we can find out more about this problem					
	11	Is the juice in B_1 & B'_3 different in any way? (W)					
	12	Is there another way the juice is different in B_1 & B'_3? (W)					
	13	Do you think that B'_3 has less less because it is ↓ ? (W)					
	14	If it has less because it is ↓ won't it have more because it is fatter? (W)					

Glass Beaker Sessions

Phase 3 Cycle 5 Sheet 2 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_1 B'_3 F_{12} @150
$C_{12}C'_{12}$

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step #		E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ X E	C.H.F. Con-flict	Chips W, R WW, RR
3	15	So its less because its ↓ and its more because it is fatter? (W)					
	16	But can it be less and more at the same time?					
	17	Maybe the problem is that you only thought about how low it is when you should have thought about both how low it is and how fat it is. Maybe because its lower and fatter at the same time B'_3 and B_1 have the same amount. [(W) if answer yes					
	18	Now for 2 chips can you tell me what the problem is? (W,W)					
4	1	Elastic on levels of B_1 & B'_3					
5	1	If $B_1 \rightarrow C_{12}$ and $B'_3 \rightarrow C'_{12}$ will C_{12} & C'_{12} have same or more in one?					
6	1	Let $B_1 \rightarrow C_{12}$ and $B'_3 \rightarrow C'_{12}$					
7a	1	S answers right Do we have same, or one a lot and one a little (R)					
	2	Why? [(R,R) if S refers to both dimensions of the beakers]					

Phase 3 Cycle 6 Sheet 1 Of 2 — Press Beaker Sessions

Subject_____
Experimenter_____
Observer_____

Apparatus
A_3 A'_3
B_1 B'_4 F_{12} @150
C_{12} C'_{12}

Tape Footage_____
Date_____
Start Time_____
Stop Time_____
Reel_____ Side_____

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 and A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_1$					
	2	Pour $A'_3 \rightarrow B'_4$					
3	1	E removes shield					
	2	Do we both have the same amount to drink?					
	3	You did it like a young child didn't you? (W)					
	4	Can you tell me what the problem is? (W,W)					
	5	When juice in A_3 & A'_3 how much did we both have to drink? (W)					
	6	How much did you think we would both have in B_1 & B'_4? (W)					
	7	But now you think there is more in B_1 (W)					
	8	Your problem seems to be that you thought B_1 would = B'_4 but now you think B'_4 has less.					
	9	Now can you tell me what the problem is? (W,W)					
	10	Let's see if we can find out more about this problem					
	11	Is the juice in B_1 & B'_4 different in any way? (W)					
	12	Is there another way the juice is different in B_1 & B'_4 ?(W)					
	13	Do you think that B'_4 has less because it is ↓ ? (W)					
	14	If it has less because it is ↓ won't it have more because it is fatter? (W)					

Glass beaker Sessions

Phase 3 Cycle 6 Sheet 2 of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_1 B'_4 F_{12}@150
C_{12} C'_{12}
Leg nd

Tape footage
Date
Start Time
Stop Time
Reel Side

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Con-flict	Chips W, R WW, RR
3	15	So its less because its ✓ and its more because it is fatter (W)					
	16	But can it be less and more at the same time?					
	17	Maybe the problem is that you only thought about how low it is when you should have thought about both how low it is and how fat it is. Maybe because its lower and fatter at the same time B'_4 and B_1 have the same amount. [(W) if answer yes]					
	18	Now for 2 chips can you tell me what the problem is? (W,W)					
4	1	Elastic on levels of B_1 & B'_4					
5	1	If $B_1 \rightarrow C_{12}$ and $B'_4 \rightarrow C'_{12}$ will C_{12} & C'_{12} have same or more in one?					
6	1	Let $B_1 \rightarrow C_{12}$ and $B'_4 \rightarrow C'_{12}$					
7a	1	S answers right. Do we have same, or one a lot and one a little? (R)					
	2	Why? [(R,R) if S refers to both dimensions of the beakers]					

Phase 4 Cycle 1 Sheet 1 of 2 — r Sessic.

Subject_____
Experimenter_____
Observer_____

Apparatus
A_3 A'_3 F_{10}@80
B_1 B'_2 F_{10}@120 for A'_1
C_{12} C'_{12}

Tape Footage_____
Date_____
Start Time_____
Stop Time_____
Reel_____ Side_____

Legend

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ X J	✓ X E	C.H.F. Conflict	Chips W, R WW, RR
1	1	E pours 80 mls into A_1 and 120 mls into A'_1					
	2	Do these both contain the same amount or one more?					
2	1	Let A_1 flow into B_1					
	2	When we let A'_1 flow into B'_2 will we both have the same amount or will one have more?					
3	1	Let A'_1 flow into B'_2					
4a when S right	1	Were you right when you said _____? [If S says yes (R)]					
	2	Why? [If S says because he had more to begin with (R,R)]					
4b when S wrong	1	Were you right when you said _____? Now you've answered like a young child. Let's see if we can find out more about the problem.					
	2	When juice was in A_1 & A'_1 did we both have the same amount? (W)					
	3	Why do you think they both look the same now?					
	4	Is the juice in B'_2 different in any way from B_1? [i.e., width (W)]					
	5	Is the juice in B'_2 the same in any way to B_1? [i.e. in height (W)]					
	6	Do you think that because B'_2 is wider it makes B_1 and B'_2 look the same amount when actually B'_2 has more? (W)					

Glass Beaker Sessions

Phase 4 Cycle 1 Sheet 2 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_1 B'_2 F_{10}@80
C_{12} C'_{12} F_{10}@120 for A'_1

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ X J	✓ X E	C.H.F. Conflict	Chips W, R
	7	Now for 2 chips can you tell me what the problem is? (W,W)					
5	1	E marks levels B_1 & B'_2 with elastic bands					
6	1	When we let $B_1 \rightarrow C_{12}$ and $B'_2 \rightarrow C'_{12}$ will we both have the same amount to drink?					
7a when S right	1	Were you right when you said _____? (R) Good, you answered like an older child.					
	2	now for 2 chips can you tell me why you have more? [If S says because he had more in A'_1 or B'_2 (R,R)]					
7b when S wrong	1	Were you right when you said _____?					
	2	you answered like a younger child, didn't you? [If S agrees (W)]					
	3	Let's see if we can find out more about this problem					
	4	Were A_1 & A'_2 the same amount to drink? That's right (W)					
	5	Were B_1 & B'_2 the same amount or did one have more to drink? [If S says more (W)]					
	6	Now does C'_{12} have the same or more than C_{12} (W)					
	7	Now for 2 chips can you tell me what an older child would have said about how much would be in C_{12} & C'_{12} when he passed the juice from B_1 & B'_2					

Glass Beaker Sessions

Phase 4 Cycle 2 Sheet 1 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_2 B'_1 F_{12} @120 for A_3
C_{12} C'_{12} F_{12} @80 for A'_3

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ X E	C.H.F. Con-flict	Chips W, R WW, RR
1	1	E pours 120 ml into A_2 and 30 ml into A'_2					
	2	Do these both contain the same amount or one more?					
2	1	Let A_2 flow into B_2					
	2	When we let A'_2 flow into B'_1 will we both have the same amount or will one have more?					
3	1	Let A'_2 flow into B'_1					
4a when S right	1	Were you right when you said _____? [If S says yes (R)]					
	2	Why? [If S says because he had more to begin with (R,R)]					
4b when S wrong	1	Were you right when you said _____? Now you've answered like a young child. Let's see if we can find out more about the problem.					
	2	When juice was in A_2 & A'_2 did we both have the same amount? (W)					
	3	Why do you think they both look the same now?					
	4	Is the juice in B'_1 different in any way from B_2? [i.e., skinnier (W)]					
	5	Is the juice in B'_1 the same in any way to B_2? [i.e., in height (W)]					
	6	Do you think that because B'_1 is skinnier it makes B_2 & B'_1 look like the same amount when actually B_2 has more? (W)					

Phase 4 Cycle 2 Sheet 2 of 4
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_2 B'_1 F_{12} @120 for A_3
C_{12} C'_{12} F_{12}@80 for A'_3

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Con-flict	Chips W, R WW, RR
	7	Now for 2 chips can you tell me what the problem is (W,W)					
5	1	E marks levels of B_2 & B'_1 with elastic bands					
6	1	When we let $B_2 \rightarrow C_{12}$ and $B'_1 \rightarrow C'_{12}$ will we both have the same amount to drink?					
7a when S right	1	Were you right when you said _____? (R) Good, you answered like an older child.					
	2	Now for 2 chips can you tell me why you have more? [If S says because he had more in A'_2 or B'_1 (R,R)]					
7b when S wrong	1	Were you right when you said _____?					
	2	You answered like a younger child, didn't you? [If S agrees (W)]					
	3	Let's see if we can find out more about this problem					
	4	Were A_2 & A'_2 the same amount to drink? That's right (W)					
	5	Were B_2 & B'_1 the same amount or did one have more to drink? [If S says more (W)]					
	6	Now does C'_{12} have the same or more than C_{12} (W)					
	7	Now for 2 chips can you tell me what an older child would have said about how much would be in C_{12} & C'_{12} when he passed the juice from B_2 & B'_1					

Glass Dealer Sessions

Phase 4 Cycle 3 Sheet 1 OF 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B'_1 F_{12} @150 ml.
C_{12} C'_{12}

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ X E	C.H.F. Con-flict	Chips W, R WW, RR
1	1	Pour F into A_3 and A'_3					
	2	Do A_3 and A'_3 have same amount?					
2	1	Pour $A_3 \rightarrow B_4$					
	2	Pour $A'_3 \rightarrow B'_1$, just so— Same to drink					
3a	1	You did it like a young child					
	2	When in A_3 & A'_3 how - did - have - drink? (W)					
	3	How much did you -- re $A_3 \rightarrow B_4$? (W)					
	4	How much did you -- re $A'_3 \rightarrow B'_1$? (W)					
	5	If $A_3 = A'_3$ and all $A_3 \rightarrow B_4$ and only some $A'_3 \rightarrow B'_1$ how can $B_4 = B'_1$?					
	6	You left some for B'_1 in A'_3					
	7	How much would an older child pour from A'_3 to B'_1? (W,W)					
3b	1	That's right (R)					
	2	How can - be same when $B'_1 \uparrow$ than B_4? (R)					
	3	Does $B'_1 = B_4$ because $\uparrow$ and $\longleftrightarrow$ (R)					
	4	Can - tell me why $B'_1 = B_4$ when $B'_1 \uparrow B_4$ (R,R)					
4	1	Elastic on levels of B_4 and B'_1					
5	1	If $B_4 \rightarrow C_{12}$ and $B'_1 \rightarrow C'_{12}$ will C_{12} and C'_{12} have same or more in one					

Glass beaker Sessions

Phase 4 Cycle 3 Sheet 2 of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_4 B'_1 F_{12} @150 ml.
C_{12} C'_{12}

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

		S's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ X J	✓ X E	C.H.F. Con-flict	Chips W, R WW, RR
6	1	Let $B_4 \rightarrow C_{12}$ and $B'_1 \rightarrow C'_{12}$					
7	1	Do we have same, more, less? (R) Why? (R,R)					
7a	1	Do we have same, more, etc?					
	2	You answered like a young child (W)					
	3	Did juice in $B_4 = B'_1$? (W)					
	4	When $B_4 \rightarrow C_{12}$ & $B'_1 \rightarrow C'_{12}$ what happened?					
	5	Does $C'_{12} = C_{12}$?					
	6	Could $B_4 = B'_1$ then? (W)					
	7	What about juice here A'_3					
	8	If $A'_3 \rightarrow B'_1$ and $B'_1 \rightarrow C'_{12}$ would $C'_{12} = C_{12}$? (W)					
3	1	Let $A'_3 \rightarrow B'_1 \rightarrow C'_{12}$					
9	1	Do we both have same? (R)					
	2	Why? (R)					
	3	What is the difference between the younger & older girls' way of pouring $A_3 \rightarrow B_4$ & $A'_3 \rightarrow B'_1$? (W,W)					

Glass Beaker Sessions

Phase 5 Cycle 1 Sheet 1 of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_3 B'_3 F@ 100 for A
C_{12} C'_{12} F@ 200 for A'

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
1	1	E pours 100 ml into A_3 and 400 ml into A'_3					
	2	Do these both contain the same amount or does one have more?					
2	1	Let $A_3 \rightarrow B_3$					
	2	When we let $A'_3 \rightarrow B'_3$ will we both have the same amount or will one have more? [(R)when right]					
	3	Which one?					
3	1	Let $A'_3 \rightarrow B'_3$					
4	1	Were you right when you said ——? [(R)when right]					
	2	Why? [(R) if S says "Because they were more up above"and (RR) if he says B'_3 is higher than B_3]					
5	1	Is the juice in B'_3 different in any way from the juice in B_3? Is it higher? [(R) if right on 1. If not (W)]					
	2	Is juice in B'_3 the same in any way as B_3? Is it just as fat? [(R) or (W)]					
	3	Do you think that because the juice is higher in B'_3 than in B_3 but just as fat as B_3 that this is why B'_3 has more? [(R) or (W)]					
	4	Now can you tell me why B'_3 has more than B_3? [(RR) or (WW)]					

Glass Beaker Sessions

Phase 5 Cycle 1 Sheet 2 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_3 B'_3 F@ 100 for A
C_{12} C'_{12} F@ 200 for A'

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ X E	C.H.F. Con-flict	Chips W, R WW, RR
6	1	If we let $B_3 \rightarrow C_{12}$ and $B'_3 \rightarrow C'_{12}$ will we both have the same or will one have more? (R)					
	2	Let $B_3 \rightarrow C_{12}$ and $B'_3 \rightarrow C'_{12}$					
7	1	Were you right when you said ——? (R)					
	2	Why? [(R) if he says "Because there was more in B'_3"(RR) if he says "Because C'_{12} is higher than C_{12} but just as fat]					
8	1	Is the juice in C'_{12} different in any way from C_{12}? Is it higher? [(R) if right on 7.1 If not (W)]					
	2	Is the juice in C'_{12} the same in any way as C_{12}? Is it just as fat? [(R) or (W)]					
	3	Do you think that because the juice is higher in C'_{12} than in C_{12} but just as fat as C_{12} that this is why C'_{12} has more? [(R) or (W)]					
	4	Now can you tell me why C'_{12} has more than C_{12}? [(RR) or (WW)]					

Glass Beaker Sessions

Phase 5 Cycle 2 Sheet 1 Of 2
Subject _____
Experimenter _____
Observer _____

Apparatus
A_3 A'_3 F_{10}@80
B_1 B'_2 F_{10}@120 for A'_1
C_{12} C'_{12}

Tape Footage _____
Date _____
Start Time _____
Stop Time _____
Reel _____ Side _____

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ X J	✓ X E	C.H.F. Con-flict	Chips W, R WW, RR
1	1	E pours 80 mls into A_1 and 120 mls into A'_1					
	2	Do these both contain the same amount or one more?					
2	1	Let A_1 flow into B_1					
	2	When we let A'_1 flow into B'_2 will we both have the same amount or will one have more?					
3	1	Let A'_1 flow into B'_2					
4a when S right	1	Were you right when you said _____? [If S says yes (R)]					
	2	Why? [If S says because he had more to begin with (R,R)]					
4b when S wrong	1	Were you right when you said _____? Now you've answered like a young child. Let's see if we can find out more about the problem.					
	2	When juice was in A_1 & A'_1 did we both have the same amount? (W)					
	3	Why do you think they both look the same now?					
	4	Is the juice in B'_2 different in any way from B_1? [i.e., width (W)]					
	5	Is the juice in B'_2 the same in any way to B_1? [i.e. in height (W)]					
	6	Do you think that because B'_2 is wider it makes B_1 and B'_2 look the same amount when actually B'_2 has more? (W)					

Glass Beaker Sessions

Phase 5 Cycle 2 Sheet 2 Of 2
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_1 B'_2 F_{10}@80
C_{12} C'_{12} F_{10}@120 for A'_1

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ X E	C.H.F. Conflict	Chips W, R WW, RR
	7	Now for 2 chips can you tell me what the problem is? (W,W)					
5	1	E marks levels B_1 & B'_2 with elastic bands					
6	1	When we let $B_1 \rightarrow C_{12}$ and $B'_2 \rightarrow C'_{12}$ will we both have the same amount to drink?					
7a when S right	1	Were you right when you said _____? (R) Good, you answered like an older child.					
	2	now for 2 chips can you tell me why you have more? [If S says because he had more in A'_1 or B'_2 (R,R)]					
7b when S wrong	1	Were you right when you said _____?					
	2	you answered like a younger child, didn't you? [If S agrees (W)]					
	3	Let's see if we can find out more about this problem					
	4	Were A_1 & A'_2 the same amount to drink? That's right (W)					
	5	Were B_1 & B'_2 the same amount or did one have more to drink? [If S says more (W)]					
	6	Now does C'_{12} have the same or more than C_{12} (W)					
	7	Now for 2 chips can you tell me what an older child would have said about how much would be in C_{12} & C'_{12} when he passed the juice from B_1 & B'_2					

Glass beaker sessions

Phase 5 Cycle 3 Sheet 1 Of 1
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_3 B'_3 F_{12}@250
C_{12} C'_{11}

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
1	1	Pour F in A_3 and A'_3					
2	1	Do A_3 & A'_3 have the same amount?					
3	1	If $A_3 \rightarrow B_3$ and $A'_3 \rightarrow B'_3$ will B_3 & B'_3 have same amount? (R)					
	2	Why? (R,R)					
4	1	S lets $A_3 \rightarrow B'_3$ and $A'_3 \rightarrow B'_3$					
5	1	Does $B_3 = B'_3$ or does one have more? (R)					
	2	Why? (R,R)					
6	1	If $B_3 \rightarrow C_{12}$ and $B'_3 \rightarrow C'_{11}$ will C_{12} and C'_{11} have same amount? (R)					
	2	Why? (R,R)					
7	1	S lets $B_3 \rightarrow C_{12}$ and $B'_3 \rightarrow C'_{11}$					
8a	1	Does $C_{12} = C'_{11}$ or does one have more and one less? (R)					
	2	Why? (R,R)					
8b If answer wrong	1	You answered like a young child didn't you? (W)					
	2	Can you tell me what the problem is? (W,W)					
	3	When juice was in B_3 and B'_3 did we both have the same? That's right (W)					
	4	Did we let all the juice out of B_3 and B'_3? That's right (W)					
	5	Now if $B_3 = B'_3$ and we let all the juice out of B_3 and B'_3 won't C_{12} and C'_{11} have the same amount?					
	6	Now for two chips, can you tell me what the problem is? (W,W)					

Glass Beaker Sessions

Phase 5 Cycle 4 Sheet 1 Of 4
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_2 B'_1 F_{10} @125
C_9 C'_8

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	J	E	C.H.F. Conflict	Chips W, R WW, RR
1	1	Pour F in A_3 and A'_3					
2	1	Do A_3 and A'_3 have same amount?					
3	1	If $A_3 \rightarrow B_2$ and $A'_3 \rightarrow B'_1$ will B_2 and B'_1 have same amount? (R)					
	2	Why? (RR)					
4	1	Pour $A_3 \rightarrow B_2$					
	2	Pour $A'_3 \rightarrow B'_1$, just so - - Same to drink					
5a	1	That's right (R)					
If right	2	How can - be same when $B'_1 \uparrow$ than B_2? (R)					
	3	Does $B'_1 = B_2$ because $\uparrow$ and $\leftrightarrow$ (R)					
~~Go~~ to 5b 14	4	Can - tell me why $B'_1 = B_2$ when $B'_1 \uparrow B_2$ (RR)					
5b	1	You did it like a young child					
If wrong	2	What about the juice up here? You left some of the juice for B'_1 up here. Does B'_1 really $= B_2$ or is it less? [(W) if S says no]					
	3	Can you tell me what the problem is? Why did you miss a chip when you were deciding about how much would be in B_2 and B'_1? (W)					
	4	When in A_3 and A'_3 how - did - have drink? (W)					
	5	How much did you -- re $A_3 \rightarrow B_2$ (W)					
	6	How much did you -- re $A'_3 \rightarrow B'_1$? (W)					
	7	If $A_3 = A'_3$ and all $A_3 \rightarrow B_2$ and only some $A'_3 \rightarrow B'_1$ how can $B_2 = B'_1$?					

Glass Beaker Sessions

Phase 5 Cycle 4 Sheet 2 Of 4
Subject
Experimenter
Observer

Apparatus
A_3 A'_1
B_2 B'_1 F_{10} @125
C_9 C'_8

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step #		E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
	8	You left some for B'_1 in A'_3					
	9	How much would an older child pour from A'_3 to B'_1? (WW)					
	10	Would older child be right? (W)					
	11	~~Should~~ we let all $A'_3 \rightarrow B'_1$? (W)					
	12	Now do B_2 and B'_1 have the same to drink or does one have more? [(W) if right. If wrong, "you answered like a younger child and missed a chip"]					
	13	Let's see if we can find out more about this problem.					
	14	Is the juice in B_2 and B'_1 different in any way? [(W) or (R)]					
	15	Is there another way the juice is different in B_2 and B'_1? [(W) or (R)]					
	16	Do you think that B_2 and B'_1 have the same because A_3 and A'_3 had the same and B'_1 is taller and skinnier than B_2? [(W)or(R)]					
	17	Now can you tell me why we know that B_2 and B'_1 have the same to drink? [(R) if he says same above and (RR) if he gives compensation rule.]					
6	1	If $B_2 \rightarrow C_9$ and $B'_1 \rightarrow C'_8$ will C_9 and C'_8 have same amount?(R)					
	2	Why? (RR)					
	3	S lets $B_2 \rightarrow C_9$ and $B'_1 \rightarrow C'_8$					
7a If right	1	That's right (R)					
	2	How can - be same when C'_8 ↑ than C_9? (R)					
	3	Does $C'_8 = C_9$ because ↑ and ↔(R)					

Glass Beaker Sessions

Phase 5 Cycle 4 Sheet 3 Of 4
Subject
Experimenter
Observer

Apparatus
A_3 A'_1
B_2 B'_1 F_{10} @125
C_9 C'_8

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
Go to 7b 14	4	Can - tell me why $C'_8 = C_9$ when $C'_8 \uparrow C_9$ (RR)					
7b f wrong	1	You did it like a young child					
	2	What about the juice up here? You left some of the juice for C'_8 up here. Does C'_8 really $= C_9$ or is it less? [(W) if S says no]					
	3	Can you tell me what the problem is? Why did you miss a chip when you were deciding about how much would be in C_9 and C'_8? (W)					
	4	When in A_3 and A'_3 how - did - have drink? (W)					
	5	How much did you -- re $A_3 \rightarrow C_9$ (W)					
	6	How much did you -- re $A'_3 \rightarrow C'_8$? (W)					
	7	If $A_3 = A'_3$ and all $A_3 \rightarrow C_9$ and only some $A'_3 \rightarrow C'_8$ how can $C_9 = C'_8$?					
	8	You left some for C'_8 in A'_3					
	9	How much would an older child pour from A'_3 to C'_8? (WW)					
	10	Would older child be right? (W)					
	11	Should we let all $A'_3 \rightarrow C'_8$? (W)					
	12	Now do C_9 and C'_8 have the same to drink or does one have more? [(W) if right. If wrong, "you answered like a younger child and missed a chip"]					
	13	Let's see if we can find out more about this problem.					

Glass Beaker Sessions

Phase 5 Cycle 4 Sheet 4 of 4
Subject
Experimenter
Observer

Apparatus
A_3 A'_1
B_2 B'_1 F_{10} @125
C_9 C'_8

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend

NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step #	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ X J	✓ X E	C.H.F. Con-flict	Chips W, R WW, RR
14	Is the juice in C_9 and C'_8 different in any way? [(W) or (R)]					
15	Is there another way the juice is different in C_9 and C'_8? [(W) or (R)]					
16	Do you think that C_9 and C'_8 have the same because A_3 and A'_3 had the same and C'_8 is taller and skinnier than C_9? [(W)or(R)]					
17	Now can you tell me why we know that C_9 and C'_8 have the same to drink? [(R) if he says same above and (RR) if he gives compensation rule.]					

Phase 5 Cycle 5 repeats Phase 5 Cycle 2.

Phase 5 Cycle 6 repeats Phase 5 Cycle 4 with different apparatus.

Phase 5 Cycle 7 repeats Phase 5 Cycle 2.

Glass Beaker Sessions

Phase 6 Cycle 1 Sheet 1 Of 3
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_3 B'_2 F_{10} @250 ml.
C_7 C'_5

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Con-flict	Chips W, R WW, RR
1	1	Pour F in A_3 and A'_3					
2	1	Do A_3 and A'_3 have same amount?					
3	1	If $A_3 \Rightarrow B_3$ and $A'_3 \rightarrow B'_2$ will B_3 and A'_2 have same amount? (R)					
	2	Why? (R,R,)					
4	1	Pour $A_3 \rightarrow B_3$					
	2	Pour $A'_3 \rightarrow B'_2$, just so -- Same to drink					
5a	1	You did it like a young child					
	2	When in A_3 and A'_3 how - did - have drink? (W)					
	3	How much did you -- re $A_3 \rightarrow B_3$? (W)					
	4	How much did you -- re $A'_3 \rightarrow B'_2$? (W)					
	5	If $A_3 = A'_3$ and all $A_3 \rightarrow B_3$ and only some $A'_3 \rightarrow B'_2$ how can $B_3 = B'_2$?					
	6	You left some for B'_2 in A'_3					
	7	How much would an older child pour from A'_3 to B'_2? (W,W)					
5b	1	That's right. (R)					
	2	How can - be same when $B'_2 \uparrow$ than B_3? (R)					
	3	Does $B'_2 = B_3$ because $\uparrow$ and $\leftrightarrow$ (R)					
	4	Can - tell me why $B'_2 = B_3$ when $B'_2 \uparrow B_3$? (R,R)					
6	1	If $B_3 \rightarrow C_7$ and $B'_2 \rightarrow C'_5$ will C_7 and C'_5 have same amount? (R)					
	2	Why? (R,R)					
7	1	S lets $B_3 \Rightarrow C_7$ and $B'_2 \Rightarrow C'_5$					

Glass Beaker Sessions

Phase 6 Cycle 1 Sheet 2 Of 3
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_3 B'_2 F_{10}@250 ml
C_7 C'_5

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

STEP	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
8a	1	Does C_7 = C'_5 or does one have more and one less? (R)					
	2	Why? (R,R)					
8b If answer wrong	1	You answered like a young child didn't you? (W)					
	2	Can you tell me what the problem is? (W,W)					
	3	When juice was in B_3 and B'_2 did we both have the same? That's right. (W)					
	4	Did we let all the juice out of B_3 and B'_2? That's right. (W)					
	5	Now if B_3= B'_2 and we let all the juice out of B_3 and B'_2 won't C_7 and C'_5 have the same amount?					
	6	Now for two chips, can you tell me what the problem is? (W,W)					
9	1	Can you tell me once again, do C_7 and C'_5 have the same amount to drink? (W)					
	2	Why? (W,W)					
C.S.10	1	But look at how high the juice is in C'_5. Doesn't that make it more? [(R) if S says no] Why? (R,R)					
	2	If S says yes. You answered like a young child. Can you tell me what an older child would have said? [(R,R) if S can answer correctly.]					

Class Beaker Sessions

Phase 6 Cycle 1 Sheet 3 Of 3
Subject
Experimenter
Observer

Apparatus
A_3 A'_3
B_3 B'_2 F_{10} @250 ml.
C_7 C'_5

Tape Footage
Date
Start Time
Stop Time
Reel Side

Legend
NQ = No Question
NA = No Answer
J = Judgement (✓ or X)
E = Explanation (✓ or X)
R = Red Chip
W = White Chip

Conflict Symbols
C = Change of judgement or explanation
H = Humming
F = Facial expressions (frown, looking away)

Step	#	E's Request or Question	S's Response Answer (NQ, NA or Verbatim)	✓ J	✓ E	C.H.F. Conflict	Chips W, R WW, RR
10	3	If not Let's see if we can find out what the problem is.					
	4	Did A_3 and A'_3 have the same amount? (W)					
	5	When $A_3 \rightarrow B_3$ and $A'_3 \rightarrow B'_2$ did B_3 and B'_2 have the same amount? (W)					
	6	If $B_3 = B'_2$ then when $B_3 \rightarrow C_7$ and $B'_2 \rightarrow C'_5$ would C_7 and C'_5 have the same amount? (W)					
	7	Does the fact that C'_5 is higher really make it more than C_7? (W) Why not? (W,W)					
	8	But someone else told me that C'_5 had more than C_7 because it was higher. Were they right or wrong? [(R) if S says wrong] Why? (R,R)					
	9	If S says yes. You answered like a young child. Can you tell me what an older child would have said? (R,R) if S can answer correctly.					
	10	If not Let's see if we can find out what the problem is.					
	11	Did A_3 and A'_3 have the same amount? (W)					
	12	When A_3 B_3 and A'_3 B'_2 did B_3 and B'_2 have the same amount? (W)					
	13	If $B_3 = B'_2$ then when B_3 C_7 and B'_2 C'_5 would C_7 and C'_5 have the same amount? (W)					
	14	Does the fact that C'_5 is higher really make it more than C_7? (W) Why not? (W,W)					

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