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**LA THÈSE A ÉTÉ
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COGNITIVE ADVANCEMENT IN
MENTALLY RETARDED ADOLESCENTS AND ADULTS

by Fay C. F. Tang

Thesis presented to the School of
Graduate Studies of the University
of Ottawa in Partial fulfillment
of the requirements for the degree
of Doctor of Philosophy

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INTRODUCTION

It is generally held that Piaget's major contribution in the field of psychology and education is his theory of intellectual development. An individual's intellectual growth is the result of his interaction with the environment involving the processes of adaptation and organization. Intellectual development follows an invariant order of stages: namely, sensori-motor, pre-operational, concrete operational and formal operational. At the final stage of formal operations an individual is said to have achieved logical thought. Preceding this in the developmental sequence certain logical properties of thinking appear in the stage of concrete operations when children are able to demonstrate the capacity of making certain conservations. Conservation is defined as the ability to recognize constant quantitative relationships in spite of changing information produced by perceptual variations (Piaget, 1964/1967).

The concept of conservation has stimulated the imagination of many researchers and it has been the most frequently investigated feature of Piaget's theory (Flavell, 1963). Of the many researchers who have studied various aspects of conservation, the majority have investigated the conservation operations and their acquisition. Most of these studies have been carried out with normal or average children and only a few have investigated the conservation abilities of mental retardates.

A normal child masters the operation of conservation at approximately seven years of age in the concrete stage of intellectual development. With mentally retarded children the cognitive development progresses at a slower rate. In fact Inhelder (1943/1968) maintains that the full cognitive development of mentally retarded adolescents and adults is at best problematical. Stephens (1968) working with mentally retarded individuals also concludes that "the development of reasoning appears to proceed at a slower tempo in retardates than in normals, and this development tends to become arrested as the retardates reach early adolescence". The literature reveals some areas of uncertainty regarding the cognitive development of mentally retarded adolescents and adults (Inhelder and Sinclair, 1969; Pinard and Laurendeau, 1969). Accordingly, there appears to be a need for the present study which is designed to investigate the effects of training to advance cognitive operation in mentally retarded adolescents and adults.

The thesis is organized into three chapters. In the first chapter, a review of the literature is presented, which includes Piaget's theory of intelligence, his concept of conservation, related research, and finally the research problem and the experimental hypotheses.

In the second chapter, the training methodology and procedures used in the study, the description of the samples, and the

analysis techniques of the data are described.

In the last chapter, the results are presented, followed by a discussion, summary and conclusions.

At the end of the thesis, a bibliography and appendices are presented. The appendices contain the testing and training manuals, and an abstract of the dissertation.

CHAPTER I

REVIEW OF THE LITERATURE

One of Piaget's most important contributions to child psychology is his discovery of the profoundly complex problem of conservation and his methods of exploring it (Ginsburg and Oppen, 1969). Conservation is defined as the ability to recognize constant quantitative relationships in spite of changing information produced by perceptual variations (Piaget, 1964/1967).

In the first section of this chapter, Piaget's theory of intelligence is outlined. This is followed by a discussion of the concept of conservation. A presentation of previous research on conservation with mentally retarded individuals is in the third part. The research question is specified in the final portion of this chapter.

Piaget's Theory of Intelligence

Piaget (1947/1967) has outlined a theory of intellectual development which is basically a qualitative description of the development of intelligence. According to Piaget, intellectual growth involves the processes of adaptation and organization. Adaptation is the process of interacting with the environment by (1) assimilating or incorporating it into an already existing cognitive structure, and (2) accommodating

or modifying the existing structure to suit it. The organism is said to be in a state of cognitive equilibrium when there is a balance between assimilation and accommodation. Organization involves a structured concept called "schemas".

Piaget (1964/1967) defines the latter as repeatable psychological units of intelligent action which enable one to adapt more efficiently to the demands of his environment. Adaptation deals with things in the environment while organization deals with cognitive structure itself.

Piaget (1964) states that the development of intelligence is affected by maturation, experience, social interaction and most importantly by equilibration. The latter refers to self-regulatory processes of the organism. According to Piaget (1947/1967) equilibration is the progression of internal organization of knowledge and it integrates the effects of the other three factors. Its process is the backbone of cognitive development.

Development progresses through a series of qualitatively different stages of perceptions and adaptations. The stages are designated as the sensori-motor, the preoperational, the concrete operational and the formal operational (Piaget, 1947/1967). Piaget (1935/1966) asserts that cognitive development is a coherent process of successive qualitative changes of cognitive structures or schemas. Each stage is the product of the previous one and a preparation for the

stage that follows (Piaget, 1954/1976). The entire process of development flows along in cumulative fashion. The growth of logic is a function of the developmental process.

However, the child is not always in the same stage of development. He may display different levels of achievement relative to the solving of problems requiring the use of similar mental operations. This phenomenon of performance vacillation is labelled by Piaget as horizontal decalage (Piaget, 1954/1976).

The major characteristics of cognitive development in the different stages encompass all aspects of the child's intelligence - his notion of space, time, number, reality, causality.

Piaget (1935/1966) stresses that every child must pass through the stages of cognitive development in the same order. The rates at which children progress may not be the same due to hereditary as well as experiential factors. For instance: "bright" children go through the stages rapidly; and "dull" children slowly; and still others never reach or complete the last stages (concrete and formal operations) of development (Wadsworth, 1971).

Many researchers have trained normal and mentally retarded children for a particular mental operation in an attempt to accelerate development. Conservation is both a mental operation and one aspect of the development of intelligence that has been frequently investigated and explored (Flavell, 1963). This is probably due to the claim that conservation

is the primary element for the growth of logic. The concept of conservation is explained in the following section.

Conservation

Flavell (1963) remarks that the richest part of Piaget's theory is the formation of concrete operations and "the main code is the concept of conservation". Piaget (1967/1968) suggests that the operational concepts of conservation are acquired by the child through interaction with his total environment. Piaget (1964/1967) considers conservation as an index of operational development which marks the transition from preoperational thought to operational thought. Piaget (1941/1965) also reports that conservation is a necessary condition for all rational activity and behavior. He asserts that those who possess conservation operations more readily adapt to the exigencies in their environment than those who do not.

Flavell (1963) outlines four steps in the acquisition of conservation; namely,

(1) The child concentrates on only one of the stimulus dimensions involved in the situation. For example, in a substance conservation task, he concentrates either on the height or width of the beaker and fails to demonstrate the conservation concept.

(2) The child vacillates between the two stimulus

dimensions involved. After centering on one of the dimensions, the child shifts to the other. He still fails to demonstrate the conservation concept.

(3) The child centers on one stimulus dimension and then on the other, and subsequently is more inclined to assert the conservation concept.

(4) The child is capable of conserving and giving at least one logical reason to support his judgment.

Logical reasons offered in support of conservation responses must bear upon the logical notions of identity, negation, reversibility, and compensation.

When a child uses the logical notion of identity to support his position, he will refer to the observable fact that nothing has been added or taken away - it is the same clay, water, etc.

When he uses the logical notion of negation, he refers to the possibility that if any operation can be literally and completely annulled that is, the original status of an element can be regained by undoing those operations which have changed the element.

When he uses the logical notion of reversibility, he refers to the observable fact that an object can be reversed back to the original form - a ball which was flattened into a pancake can be restored to the same plasticine ball.

When he uses the logical notion of compensation, he

refers to the observable fact that two stimulus dimensions compensate each other - what is lost in height is gained by the increase of width.

According to Piaget and Inhelder (1942/1974), operations involved in different types of conservations are the same. Piaget and Inhelder (1942/1974, pp. 4-5, 14-16) claim that conservation of substance represents the simplest possible quantification of qualities. The reason that substance is quantified before weight and volume is that it provides the children with an undifferentiated quality. Children subsequently develop this quality into differentiated ones, such as weight and volume.

Researchers working with Piaget's theory have usually described the conservations of substance, weight and volume as being on an ordinal scale of intellectual development (Wilton, 1974). This scale suggests that the ability to conserve weight always implies the ability to conserve substance. Similarly the ability to conserve volume always implies the ability to conserve weight and substance (Wadsworth, 1971).

There is some evidence to support the inclusion of conservation of number, length and area into an ordinal sequence (Piaget, 1941/1965; Piaget, Inhelder and Szemienka, 1948/1970). However, this notion does not seem to have been clearly incorporated into Piaget's theoretical scheme

(Wohlwill, 1966).

Sullivan (1967) points out that all conservations follow a similar course of development. Though striking irregularity exists, this is what Piaget (1954/1976) has labelled 'horizontal decalage' as mentioned earlier in this paper.

Conservation is also manifested at different times (Sullivan, 1967). As indicated by Piaget (1947/1967) conservation of substance is developed at about seven years of age in normal children. It is followed by conservation of weight at approximately eight years of age and conservation of volume is then obtained at eleven years of age. Piaget's criterion for age placement of conservation is that seventy-five percent of the children at a given age succeed on the conservation tasks (Piaget, 1930/1969).

Due to the importance given to this concept by Piaget, authors have attempted to induce the early acquisition of an operational concept of conservation. The purpose for doing so is to study the necessary and sufficient conditions of this developmental gain. Piaget (1941/1965) has maintained that specific direct training or teaching has little or no effect on the acquisition of conservation. However, results from studies conducted with normal children and mentally retarded children indicate that training for a particular mental operation can accelerate development (Brison and Bereiter, 1967; Field, 1974, 1977; Hunter and Lister, 1970; Lister, 1969, 1970, 1972;

Lancaster and McManis, 1973; O'Hare, 1976; Richards and Stone, 1970; Vandenheuvel, 1974). It is not unreasonable to expect that if provided with proper training, mentally retarded adolescents and adults might be able to acquire conservation operations which they do not currently manifest. Conservation training might enhance their cognitive development and place them in a better position to engage in other mental processes of adaptation and hence more intelligent behavior.

The following section is a review of related studies. The review is limited to those including at least one sample of mentally retarded subjects, and in which concrete operational functioning was the main concern.

Related Research

The literature reveals an abundance of research reporting the results of conservation studies. However there are only a few studies of the performance of mentally retarded children in conservation tasks and there are even fewer conservation studies conducted with mentally retarded adolescent and adult samples. It seems likely that given the proper approach conservation acceleration should be possible for mentally retarded adolescents and adults.

The limited scope of research in this area stimulated interest in the present study whose purpose is to investigate the possibility of accelerating substance conservation in

mentally retarded adolescents and adults.

The following presents those studies of conservation operation in mentally retarded individuals. However, before presenting these related studies, a brief definition of mental retardation is discussed.

Operational definition of mental retardation

Mental retardation has been exclusively determined by intellectual functioning (measured intelligence) or intelligence quotient (IQ) scores derived from performance on a standardized intelligence test (Heber, 1957; Herbert, 1977; Robinson and Robinson, 1970).

According to the American Association on Mental Deficiency, "Mental retardation refers to significantly sub-average general intellectual functioning existing concurrently with deficits in adaptive behavior, and manifested during the developmental period" (Herbert, 1977). In this definition, general intellectual functioning is defined as the results obtained by assessment with one or more of the individually administered general intelligence tests. Significantly subaverage is defined as an IQ more than two standard deviations below the mean for the test. Adaptive behavior refers to the effectiveness or degree with which an individual meets the standards of personal independence and social responsibility expected for age and cultural groups.

The developmental period refers to the period between birth and the eighteenth birthday (Herbert, 1977).

According to this definition, mental retardation is an essentially two-dimensional problem. For a person to be diagnosed as being mentally retarded, impairments in intellectual functioning must coexist with deficits in adaptive behavior.

Despite the limitations of intelligence tests, such as testing conditions and errors in measurement, intelligence test scores are viewed as more valid and reliable measures of an individual's ability than the measures of adaptive behavior or clinical judgment (Herbert, 1977). In practice, subaverage general intelligence refers to an IQ of 67 or below on the Stanford-Binet Scale and Cattell Scale and an IQ of 69 or below on the Wechsler scales. Borderline defective intelligence refers to an IQ of between 70 and the level of subaverage intelligence. These guidelines are used extensively and universally in diagnosing mental retardation (Baroff, 1974; Brainerd, 1971; Elkind, 1970; Herbert, 1977; Kauffman and Payne, 1975; Terman and Merrill, 1962; Wechsler, 1955). These authors agree that mental retardation is descriptive of current behavior and does not necessarily limit the prediction of a person's future diagnostic status in different situations.

Conservation research in mental retardation

Observations about Piaget's theory of mental development and mental retardation were first made in 1943 by Inhelder. In the first part of this section, conservation acquisition in mental retardation is discussed. This is followed by a discussion of conservation acquisition in mental retardates in relation to normal children. Finally, conservation acceleration is discussed in the last part of this section.

Conservation acquisition in mental retardation

Inhelder (1966, 1943/1968) first applied Piaget's stage development of intelligence in diagnosing reasoning and classification in mental retardation. She examined 157 mentally retarded subjects between the ages of 7½ and 52 years. The great majority of these subjects were school-age retardates; only a few were adults. Substance, weight and volume conservation tasks were administered to all the subjects as a means of studying the level of reasoning attained in their cognitive development.

Inhelder (1943/1968) reported that the mentally retarded subjects passed through the same stages of cognitive development as normals, but at a slower rate and with a more limited upper range of cognitive development. Mental retardates stayed longer at any given stage. The majority of subjects

Inhelder examined gave no evidence of concrete operational reasoning (conservation). Those who had arrived at conservation of substance or even that of weight, did so without achieving that of volume. Inhelder also observed that none of her subjects gave any evidence of formal operational reasoning. The operation of these subjects is predominantly perceptual over intellectual. This is similar to young children of average or normal intelligence at the preoperational stage or below the age of 7 years.

However, Inhelder's (1943/1968) research was designed in such a way that she saw the subjects individually in one session only. She did not present statistical comparisons for the differences she reported in cognitive development between those of normal intelligence and the mental retardates.

Inhelder's work was the first recorded study of conservation acquisition with mentally retarded subjects. Her observations were well supported in the literature (Woodward, 1959, 1961; Woodward and Stern, 1963).

Person (quoted in Stearn and Borkowski, 1969) concluded in his study that "the pattern of intellectual growth is not necessarily different for retarded children, simply slower and more vulnerable to distortion".

Stearns and Borkowski (1969), Hunter and Lister (1970) and Lister (1972), also discovered that the cognitive development and the acquisition of conservation of their mentally

retarded subjects followed Piaget's (1947/1967, 1942/1974) stated sequence of cognitive development. However such development was again seen to be much slower than the development observable in normal children.

Feigenbaum (1963), Goldschmid (1967), Stearns and Borkowski (1969), and Klauss and Green (1972) reported that the degree of conservation acquisition is a function of mental age in mentally retarded children.

Whether or not the mentally retarded individual is institutionalized seems to have little effect on his ability to conserve. Brekke and Williams (1974) found that institutionalized mental retardates and noninstitutionalized mental retardates of matched mental ages performed no differently on the conservation of weight tasks.

Conservation acquisition in mental retardates in
relation to normal children

Current researchers have investigated differences between mental retardates and normal children with respect to certain Piagetian conservation problems. They focused on both chronological and mental age factors in relation to the acquisition of conservation by their subjects.

It is reported that mentally retarded children acquired conservation operation at a later chronological age than normal children (Brown, 1973; Gruen and Vore, 1972; Lovell,

Healey and Rowland, 1962; Mitchell, Lovell and Everett, 1962), and that mental retardates (including institutionalized children and adults) demonstrated concrete operational reasoning (conservation) at later mental age levels than normal children (Hood, 1962; Langley, Drew and Watson, 1972; Stephens, Manhaney and McLaughlin, 1972).

Clearly, conservation performance of both mental retardates and normal children corresponds more closely to their mental ages than to their chronological ages (McManis, 1969). Both groups also had least difficulties in conservation of mass (substance) and most difficulties in conservation of volume. This result supports Piaget's (1942/1974) sequential arrangement of the various types of conservation.

The results of studies in which the mental ages of subjects were matched reveal that conservation acquisition is an invariant sequence which is also related to mental age development in both mentally retarded children and normal children (Brown, 1973; Keasey and Charles, 1967). The results also pointed out that mental retardates and normal children of similar mental ages were equivalent in their performance on the following conservation tasks, namely: (1) number conservation (Brown, 1973; Gruen and Vore, 1972); (2) substance conservation (Brison and Bereiter, 1967; Brown, 1973; Gruen and Vore, 1972; McManis, 1969); (3) weight conservation (Brown, 1973; Gruen and Vore, 1972; McManis, 1969); and (4) volume

conservation (McManis, 1969; Stevenson, Hale, Klein and Miller, 1968).

A few others (Achenbach, 1969; McManis, 1969) compared conservation performance of institutionalized mental retardates (children and adults) with normal children with matched mental ages. The results were not significantly different, though McManis (1969) stated that normal children obtained slightly higher scores than mentally retarded subjects.

The results of the above studies revealed no significant differences between the performance of male and female subjects. However, results contrary to those just cited which show the relationship of mental age to conservation performance have been found by some investigators. Brogle (1970) examined conservation of substance, weight and volume in institutionalized mental retardates (children and adults) and normal children of matched mental ages. He concluded that normal children showed higher conservation scores than mental retardates. Brekke and Williams (1974) indicated that normal children and adolescents had significantly higher conservation levels than non-institutionalized mentally retarded children and institutionalized mental retardates (children and adults).

In this study (Brekke and Williams, 1974) analysis of covariance was used to compare the performances on the conservation tasks covarying with mental age.

In summary, studies focusing on comparing conservation performances between mental retardates and normal children have indicated that:

(1) Some proportions of the samples of mental retardates were as capable of performing on conservation tasks as normal children of similar mental age.

(2) Mental retardates demonstrated the accepted invariant sequence of the acquisition of conservation of substance, weight and volume.

(3) Institutionalized mentally retarded children and adults, noninstitutionalized mentally retarded children and normal children of equivalent mental ages tended to show comparable levels of conservation performance and conservation acquisition.

(4) Mental age could be viewed as the most reliable predictor of conservation performance and acquisition.

Now some attempts have been made to accelerate conservation acquisition in mental retardates. These studies are set in the following context which develops the major thrusts in conservation acceleration studies:

Conservation acceleration in mental retardation

A number of investigators have been successful in accelerating conservation in some preoperational children after extensive, systematic and theoretically based training

(Bearison, 1975; Biskin and Rice, 1975; Botvin and Murray, 1975; Brainerd, 1972, 1974, 1977; Brainerd and Allen, 1971; Brison, 1966; Bucher and Schneider, 1973; Côté, 1968; Denney, Zeytinoglu and Selzer, 1977; Halford and Fullerton, 1970; Inhelder and Sinclair, 1969; Kahn and Garrison, 1973; Larson, 1975; Lefrançois, 1968; Lopata and Pasnak, 1976; May and Tisshaw, 1977; Mermelstein, 1967, 1969; Murray, 1968, 1972; Rattan, 1974; Reich, 1976; Richardson and Biskin, 1974; Sheppard, 1973; Siegel, Raeper and Hooper, 1966; Siegler, 1973; Silver, 1976; Silverman, Vanderhorst and Eull, 1976; Smith, 1968; Towler, 1967; Travis, 1969; White, Yussen and Docherty, 1976; Winer, 1968; Wohlwell and Lorne, 1962; Zilkha, 1977; Zimmerman and Lanaro, 1974; Zimmerman and Rosenthal, 1974).

The literature reveals very few studies on conservation acceleration in mental retardates. The following section may well be taken as a comprehensive survey of the area. Since most of the studies suffer similar shortcomings, critical comments will be made only after all the studies have been described.

Richards and Stone (1970) assessed the effects of training in conservation attainment and subsequent transfer and generalization of conservation ability to other areas of performance. Subjects were 17 educable mentally retarded children with chronological ages ranging from 7 years and

9 months to 12 years and 7 months, mental ages ranging from 3 years and 11 months to 9 years, and IQs ranging from 44 to 77 points. Seven subjects were nonconservers while 10 were partial conservers on a pretest of conservation. Subjects were also pretested on the Picture Arrangement and Information subtests on the Wechsler Intelligence Scale for Children. They were also given the Number Concept Test, and a Conservation Test with Motivational Involvement.

Subjects were divided into four groups of three to five subjects per group. Each group received five, 50 minute periods of group training. The training focused on conservation of continuous and discontinuous quantities, and equivalence and cardinal value of sets in number concept. Each period of training was started with a review of what was taught in the preceding period. The last period of training was devoted to a review of all materials covered.

During the training periods concrete materials were manipulated and careful explanations were given in front of the group. The experimenter asked an individual child conservation questions after each transformation. The experimenter repeated the same process with another child in the group. The process of transformation, question and explanation was followed until every child in the group gave correct responses indicating conservation ability. Subjects were rewarded with a penny immediately after delivering a correct

response.

Subjects were posttested with the pretest instruments after an unspecified interval. Posttest results showed that mean posttest scores were significantly higher than mean pretest scores. (Conservation, $F = 79.98$, $p < .01$; WISC Information, $F = 14.56$, $p < .01$; WISC Picture Arrangement, $F = 6.62$, $p < .05$; Number Test, $F = 6.99$, $p < .05$; Conservation with Motivational Involvement, $F = 15.97$, $p < .01$).

Richards and Stone (1970) concluded that conservation could be taught successfully to nonconserving mentally retarded children. They also stated tentatively that there was transfer effect from learned conservation.

Field (1977) trained a group of 48 nonconserving ESN children (32 boys and 16 girls) to acquire conservation, applying verbal-rule explanations.

The subjects were pretested on the conservation of number, mass, length, liquid, and weight tasks. They were also pretested on the Peabody Picture Vocabulary Test. The chronological ages ranged from 8 years to 12 years and 2 months. The mental ages ranged from 4 years and 7 months to 8 years and 5 months. The subjects were assigned to eight groups, seven experimental groups and one control group. Each group consisted of six subjects matched on CA, MA, sex and school.

The experimental group subjects had three individual training sessions on conservation of number and conservation of length problems with increasing difficulty from one session to the next. During the training period, each experimental group was provided with a specific explanation of either identity, or reversibility, or compensation, alone or in every combination. A correct response was immediately reinforced with a token, a verbal comment, "Good!" from the experimenter, together with an appropriate explanation assigned to the group. An incorrect response elicited a comment, "No, ... you see ..." and an appropriate explanation.

The control group subjects received no training. However they were seen individually in three sessions for games and received arbitrarily the same number of reinforcement given to the experimental subjects.

The subjects were posttested 3 and 12 days after training. Both posttests included the same items used in the pretest. During the posttesting, the subject was asked for an explanation to support his judgment.

Results indicated that the conservation of number and length were attained by most experimental subjects.

Field (1977) found that the training effects of identity and reversibility were highly and equally significant ($F = 12.84, p < .0009$). The training of compensation had little impact on posttest scores.

Field also reported that those experimental subjects who were assigned to the identity group gave a high percentage of identity explanation for their conservation judgments. This was similar to other groups. All subjects with identity training learned to conserve.

Subjects in the following studies were mental retardates. In each children and adolescents were treated as one group. They attended special educational classes and were labelled as educably subnormal (ESN) retardates.

Lister (1969, 1970, 1972) did three studies with this group of ESN children and adolescents in an attempt to:

- (a) accelerate weight conservation in her first study,
- (b) accelerate volume conservation in her second study, and
- (c) examine the possibility that training on a particular conservation would generalize to others.

Lister used identical training techniques for these three studies. The method of training was flexibly adapted to the need of the individual child, though it was kept within standard guidelines and limits. The subjects were given varieties of experiences involving manipulation of concrete materials in different situations and explanations of transformations and conservation judgments.

Subjects in all three studies were of approximately the same age range, from 9 to 16 years. Subjects in the first study ($N = 6$) were nonconservers, while subjects in the

second study (N = 15) and third study (N = 17) were mainly partial conservers at the beginning of the experiment. Subjects in the experimental and control groups were matched for mental ages in the first study, and they were matched for chronological ages, IQs and conservation ability in the second and third study.

All experimental subjects were given one, and only one, individual training session.

In the first study (weight conservation) Lister gave subjects 15 to 30 minutes' training on a variety of weight conservation tasks.

In the second study (volume conservation) Lister administered 30 minutes' training to subjects on volume conservation. Each training session was begun with a repetition of the pretest situations.

In the third study (generalization of conservation training) Lister had two experimental groups. One group received a variety of conservation training on conservation of number, substance, length, weight, area, and volume. One group received area conservation training only. Each training session was of approximately 20 minutes duration. Some pretest items were integrated into the training.

None of the control group subjects in these three studies received conservation training.

Subjects were posttested individually 2 and 4 weeks

after training in the first study, 1 and 2 weeks after training in the second study, and 1 week and 2 months after training in the third. Posttest items in all these studies were similar to those of the pretest, but included some new materials and situations.

Criteria used by Lister (1969, 1970, 1972) in her studies for a successful conservation response were conservation judgment plus adequate explanations for the judgment.

Results of the posttests for all the experimental subjects were positive. Subjects in the first and second study gave correct judgments and adequate explanations to all posttest items. Twelve percent of the subjects in the third study failed to give correct judgments to any posttest items. These subjects were nonconservers at pretest while others who succeeded on the posttest were partial conservers.

A retention test was administered 8 months after training in the first study, and 5 months after training in the second study. All trained subjects responded correctly with adequate explanations.

Lister (1969, 1970, 1972) claimed that attempts to induce conservation operations in her studies were successful. Some subjects even attained conservation of volume. Lister stated that the subjects trained to conserve volume were able to conserve weight and substance on posttest.

Field (1974) also conducted a study with ESN children

and adolescents. The study attempted to discover the variables which were critical to the development of conservation. Field compared two training methods: (a) the learning set method, and (b) the verbal rule method. There were 22 subjects who were all nonconservers as indicated on pretest on conservation of number, mass, length, liquid, and weight tasks. Criteria for a successful response to test items were correct conservation judgment and adequate explanations for that judgment. Subjects were also matched on mental age (Peabody Picture Vocabulary Scale - PPVT); the minimum mental age for the group was 5 years. Subjects were randomly assigned into three groups: (a) learning set group, (b) verbal rule instruction group, and (c) control group. Each subject was given three individual training sessions at 2 to 4 day intervals. Each training session was from 12 to 15 minutes' duration.

In the learning set group, each training session included the same 10 problems, five dealing with number conservation, and five with length. Each problem used a different test material; each material had three sets, and there were three, five or seven in each set. Each problem was presented to an individual subject in three transformations. For each transformation the experimenter focused only on two sets of material which had equal numbers. The third set had unequal numbers from the two identical sets. The

transformation itself required the experimenter to manipulate one of two identical sets by expanding or contracting the material.

Correct responses were reinforced immediately with a counter which was exchanged for candies at the end of each training session.

The training given to the verbal rule instruction group was identical to that given to the learning set group. However, in the verbal rule group the experimenter made a statement immediately after the subject had made a judgment of the transformation. The statement emphasized either identity, or reversibility or compensation. While making such a statement the experimenter returned the material to its original position.

There was no concrete object reinforcement given subjects in the verbal rule instruction group.

Control group subjects had three individual nontraining sessions of the same duration as the training sessions. Subjects were also arbitrarily given the same number of reinforcements as the subjects in the treatment groups.

There were four posttests. Posttest I was given 4 or 5 days after the completion of training. Posttest II was given 16 months after the training. Posttest III was given 5 to 10 days after a retraining session for all subjects. The type of retraining was the same as the original training

for each subject. The purpose of retraining was to ensure further benefit of the training. Two months after the retraining session Posttest IV was given to those who were still nonconservers and who had received a second retraining on the verbal rule method. All the posttests were the same as the pretest with the addition of four new items, two for number conservation task and two for conservation of length.

Results of all the posttests indicated that the performance of the verbal rule instruction group was significantly higher than all others. However, all three groups improved their performance from Posttest I to Posttest III. Field (1974) considered that the improvement made by the control group subjects on the posttests was a general development of conservation skill in the period of test intervals. During Posttest III all subjects were also retested on the PPVT scale. All three groups increased their mean MA scores. The learning set group increased 11 months, the verbal rule group increased 16 months and the control group increased 13 months.

Field (1974) concluded that ESN retardates could be trained to obtain conservation. Training with number and length problems was generalized to conservation responses dealing with number, length, mass, liquid and weight conservation. Field stressed that verbal rule training was effective in training conservation skills in ESN subjects.

O'Hare (1976) investigated the efficacy of a token-reinforced instructional program designed to teach conservation of number and substance to a group of 70 mentally retarded children and adolescents.

The subjects were pretested on the conservation of number and substance tasks. They were either nonconservers or partial conservers and they were randomly divided into two equal groups.

The experimental subjects were trained in small groups consisting of four, five or six subjects respectively. The training period was 4 weeks with three 45 minute sessions each week. Each training session began with the examiner demonstrating the conservation of number and substance tasks together with the appropriate verbal explanations. The subjects were asked to repeat the verbal explanations and also to manipulate the materials. The subjects were reinforced for giving correct verbal responses and concrete demonstrations of the conservation concept by handling the materials.

The control subjects participated in motor skill activities for equivalent periods of time.

All the subjects were posttested on the conservation of number, substance, and weight tasks 2 days and 13 days after the training. An extinction test was given to those subjects who had acquired conservation on the 14th day. No

reinforcement was provided for the posttesting.

Results indicated that the experimental group improved significantly on both conservation of the number task ($D = .88$, $p < .01$) and conservation of the substance task ($D = .74$, $p < .01$). There was no significant change between the two posttests ($p < .05$). The control group subjects did not improve in their posttests' performance.

O'Hare (1976) concluded that conservation can be acquired by mental retardates who are exposed to a token-reinforced, Piagetian-based training program. The acquired ability is reported to be durable and resistant to change.

Hunter and Lister (1970) evaluated the effects of a multi-step schedule instruction on weight conservation acceleration. Twelve ESN subjects with ages ranging between 13 and 15 years were selected. They all had completed a multi-step schedule of instruction on the concept of weight. They were subsequently tested on a sample of weight conservation problems and were found to be nonconservers.

Subjects were divided equally into an experimental and a control group. The experimental group subjects had a training session. They were posttested 2 weeks and 4 weeks later on weight problems. All six experimental group subjects attained conservation, while the control group subjects did not. At this point the control group subjects were given a training session. Two and 4 weeks later these

control group subjects were conserving consistently on both posttests.

Eight months later the 11 available subjects were tested again and found to have retained the conservation of weight ability.

Hunter and Lister (1970) concluded that when the subjects had learned with understanding, the newly acquired weight conservation ability could become durable and applicable to other weight conservation problems.

Lancaster and McManis (1973) examined the effects of a number conservation training procedure which included cognitive-conflict training. Subjects were 18 noninstitutionalized, mentally retarded adolescents attending a pre-vocational training centre. Subjects understood the terms "more" and "less", and they were partial conservers on a number conservation pretest. They were also pretested on substance conservation tasks. Their MAs ranged from 5 years and 9 months, to 7 years and 9 months, and their IQs from 43 to 69. Subjects were divided into three groups matched on mental age, IQ, and performance on number conservation pretest. Three groups were to receive training on addition-subtraction and reversibility under the following three conditions:

(a) cognitive conflict - the training procedure required that one of the two sets of objects be transformed, while the other set remained unchanged. This produced a perceptual

discrepancy between the sets,

(b) nonconflict -- the training procedure required both sets of objects to be transformed simultaneously which produced no perceptual discrepancy between the sets, and

(c) no training.

Subjects in the two experimental groups--cognitive conflict condition and nonconflict condition--received two 30-minute training sessions per week for 5 consecutive weeks. Each training session included four transformations: two addition-subtraction operations, and two reversibility operations. Subjects in the control group--no training condition--received no training nor were they seen by the experimenter.

Subjects were posttested one week after training on the same number and substance conservation tasks used for the pretest. Posttest performance on number conservation was significantly higher than pretest performance ($F = 8.98$, $df = 1/15$, $p < .01$) in both treatment groups, but not in the control group. However, performance on number conservation in both treatment groups did not differ significantly. Posttest and pretest performances on substance conservation in both treatment groups produced no significant difference.

Lancaster and McManis (1973) advanced that the two training procedures of cognitive conflict and nonconflict had produced significant changes in each treatment group. However, half of the subjects in each treatment group were

still not completely trained; they were unable to give correct conservation judgment responses together with acceptable justifications in any of the posttest items. Effects of training on number conservation were shown on the posttest on number conservation tasks. Effects of training were not generalized to other types of conservation tasks.

The foregoing studies were concerned with conservation acceleration in different age groups of mentally retarded individuals. The following studies are concerned with conservation acceleration in mentally retarded individuals in relation to normal children and gifted children.

A thorough search of the literature reveals only one study (Vandenheuvel, 1974) of the effect of training in the acquisition of conservation operations in mentally retarded adults.

Vandenheuvel (1974) attempted to induce conservation operations in three groups of subjects, one group of 28 normal intelligence children, one group of 28 institutionalized mentally retarded children and adolescents, and one group of 28 institutionalized mentally retarded adults. All subjects were pretested and were found to understand the terms "same", "more" and "less". They were also nonconservers on pretest conservation tasks of substance, number and weight. They also failed on a test of transitivity. The criteria for successful performance on a task were a correct

answer together with a consistent and appropriate explanation.

Subjects in the three age groups were divided equally into an experimental group and a control group. Experimental group subjects were trained in one individual session on liquid substance conservation. Training was terminated when a subject made correct judgments on three consecutive trials or upon completion of a total of 12 trials. During training subjects received appropriate verbal feedback from the experimenter such as "yes (no), that's right (wrong)".

Subjects in the control group also received the same training procedure but with no feedback. The number of trials was matched with that of the experimental subjects.

A posttest was given immediately after training, and repeated 1 and 2 weeks later. Posttest items were identical to the pretest items.

Results on both posttests showed that subjects in the experimental groups gave significantly more correct responses than subjects in the control groups. The experimental subjects also increased correct judgments on number and substance conservation tasks but not on weight conservation tasks.

Brison and Bereiter (1967) reported the first study of conservation acceleration in mentally retarded individuals. Subjects were a group of normal children ($N = 37$), a group of retarded children ($N = 26$) and a group of gifted children ($N = 33$). The subjects' mental ages ranged between 64 months

and 87 months. The mean mental ages of the three groups were: gifted, 80 months; normals, 76 months; and retarded, 72 months. All the subjects were nonconservers on a pretest on substance conservation tasks. They were also pretested for their comprehension of the terms "more", "same", and "not as much". The criterion for a conservation response was correct judgment accompanied with adequate explanations.

Brison and Bereiter (1967) randomly assigned the subjects to two groups--experimental and control. The experimental group subjects were trained in groups of seven children. Each group included two children who were not subjects and who were able to conserve substance. Subjects were given training on liquid (juice) and solid (clay) conservation of substance. The training sequence involved five stages. Posttests to assess the effect of training were administered after each stage of training. There were four conservation posttests, each employing a different substance--juice, sand, clay and paper. There were two extinction conservation tests, one employing juice, and the other employing clay. The extinction tests followed posttests to assess the stability of the concept of conservation of substance.

All five training stages were conducted in separate single sessions. The interval between training sessions varied from 3 to 5 days. Each subject was given Stage I training followed by posttests. If the subject

succeeded on all the posttests, he proceeded to the extinction tests. However, after the completion of Stage I training, each subject's route through the program was determined by his success or failure on the conservation posttest items.

The posttest criterion for the acquisition of conservation was that a subject had to give correct responses to all the test items. For example, if a subject failed on Posttest I of the conservation of liquid substance test, he was to go to Stage II training. After this training he returned to Posttest I. He proceeded to Posttest II only after succeeding in Posttest I.

Brison and Bereiter (1967) reported in the results of their study that the difference among the three groups of normal, gifted and retarded children in the acquisition of substance conservation was not significant. Less than 50% of the subjects in each group showed conservation judgments. The three groups did not differ in the amounts of training required to acquire conservation. The groups also did not differ in ability to generalize the acquired conservation to other materials. There was a greater tendency for the subjects to conserve, following training, with liquid substance than with solid substance. However, Brison and Bereiter (1967) pointed out that the retarded subjects did make more errors in training than did normal and gifted children. There was also some evidence that retarded subjects were more

susceptible to extinction of conservation responses.

Having described studies which report attempts at fostering conservation acquisition in mentally retarded individuals, it now seems appropriate to offer some critical comments on those studies. Results from all of the previously cited training studies seem to indicate that mental retardates can benefit from training in conservation acquisition. However certain weaknesses present in those studies need to be considered before recommendation about the training of mental retardates are advanced. The following section consists of critical comments of the aforementioned studies and questions arising therefrom which state the purpose of the current study.

A close look at the training method employed by most of the authors shows that similar tasks were used both in the actual training and in the posttest. For example, in Lister's (1969, 1970, 1972) and Field's (1977) studies of ESN children and O'Hare's (1976) study of mentally retarded children and adolescents, the training procedures were very explicit and detailed; they seemed to be geared specifically to provide the subjects with a capacity to make correct answers and to give appropriate explanations. The training method used by Lister was "eclectic" and unspecific which varied from subject to subject. This was because Lister strongly emphasized that the training method should be adapted to the needs of the individual child. The training appears to be merely a rote learning, task training as subjects were trained to respond in certain ways to the questions and then re-tested

on the same questions.

For example, in Lister's (1970) study, the training of volume conservation began with a repetition of pretest items which were also used for the posttest. Results of the posttest were then used to claim success for the training. When pretest, training and posttest items are very similar, one might well ask if in fact any training effect can be observed.

Lister reported that some of her ESN subjects were successfully trained to attain volume conservation: a formal operation. According to Inhelder (1943/1968) mentally retarded individuals simply cannot reach this level of intellectual functioning.

It may be that, in Lister's studies, preoperational explanations were incorrectly accepted as proof of formal operational functioning. Since the volume conservation tasks employed by Lister on the posttest were similar in nature to those in the training procedures, subjects' judgments could simply be preservations of the initial judgments made by the experimenter in each training situation. Even though a subject said, "they were the same" as an explanation, he may not have understood the relationship between the quantitative elements involved. This kind of qualitative identity is present in the thought of the preoperational child (DeVries, 1969; Piaget, 1967/1968); it should not be taken as evidence of formal operational thought.

Furthermore, the great majority of her subjects were partial conservers of weight prior to training and her results are necessarily compromised by this fact.

The studies conducted by Lancaster and McManis (1973), O'Hare (1976), and Richards and Stone (1970) share this weakness in that the sample often included those subjects at the transitional stage of conservation. Inhelder and Sinclair (1969) stress that one of the essential aspects in an adequate training study is to differentiate transitional and non-conserving subjects at the beginning of an experiment. In other words, all subjects should be nonconservers before an experiment commences.

The results of some of the studies (Brison and Bereiter, 1967; Lister, 1969, 1970, 1972; Vandenheuvel, 1974) are suspect in that subjects did not always receive the same amount or even the same type of training. In spite of this the results of such training were held to affect all the subjects in an identical fashion.

In many studies (Brison and Bereiter, 1967; Hunter and Lister, 1970; Lancaster and McManis, 1973; Lister, 1969, 1970, 1972) stability and generalization of the acquired conservation abilities were not appropriately examined. According to Piaget (1964) a fully acquired operation is durable and generalizable, and evidence of its existence must include these criteria.

Richards and Stone (1970) reported that training on conservation of quantity and number concept had enabled subjects to generalize the newly acquired operations to performance on some WISC subtests. Richards and Stone also stated that WISC scores were found to be resistant to practice effect, even with a test interval of one to two weeks. However, since no control group was included in this study its results might well be questioned.

Many studies employed identical test items for both pretest and posttest (Brison and Bereiter, 1967; Field, 1974; Lancaster and McManis, 1973; Vandenheuvel, 1974). Others (Field, 1977; Hunter and Lister, 1970; Lister, 1969, 1970, 1972) used some pretest items for posttesting. Subjects' performance on the posttest then could be due to practice effects and recall. That this might be the case is supported by Field's (1974) study in which control group subjects also showed improvement on the posttests.

A general criticism of all the just previously cited studies might be that they do not provide any evidence that mentally retarded individuals acquire conservation schemas which allow them to transfer to utilize their newly acquired ability in other activities or tasks requiring conservation. That is, what has passed for conservation training may well be nothing more than task training, since individuals were not given an opportunity in the posttest to demonstrate

the breadth and scope of the newly acquired skill.

The objective for the training of mentally retarded individuals in conservation operations is to enable them to use the ability so acquired in their interaction with the environment. Evidence of this ability to transfer learning is what is lacking in previous studies.

There is therefore a need for precise experimental investigation of the following questions: (1) Can training in conservations enable mentally retarded adolescents and adults to acquire these operations? (2) Can the conservation ability thus acquired be generalized to other activities and tasks, thereby demonstrating conceptual advance? The present study is designed to answer these questions.

Research Problem and Hypotheses

Research Problem

In the present study an attempt is made to (1) advance the cognitive development (acquisition of substance conservation operation) in mentally retarded adolescents and adults who are nonconservers by employing a training method that will be argued to be more appropriate than those methods used previously, and (2) provide evidence that the conservation ability so acquired can be generalized to other activities requiring that ability, thus demonstrating conceptual advance.

Hypotheses

It is therefore hypothesized that:

(1) a greater proportion of mentally retarded adolescents and adults who receive conservation training will be conservers than those mentally retarded adolescents and adults who do not receive such training;

(2) mentally retarded adolescents and adults who receive conservation training will be able to give a greater proportion of conservation responses than mentally retarded adolescents and adults who do not receive such training.

CHAPTER II

EXPERIMENTAL DESIGN

The testing of the hypotheses required the study of a group of nonconserving mentally retarded adolescents and adults, the selection of a conservation training method for the subjects, and the training of research assistants. The discussion of these three components of the design is followed by the descriptions of the selection procedure and of the composition of the sample. This is followed by the presentation of the training and posttesting procedures, and the explanation of the scoring methods used. The chapter ends with a discussion of the statistical design and techniques used to analyze the data.

Training Method and Procedures

The training method used in the present study was a modified form of that developed by Travis (1969). It is based on behavioristic principles which hold that reinforcement can be used to shape behavior, and that new behavior can be acquired with reinforcement. Neisworth and Smith (1973) state that the behavioral sciences in the last two decades have made the greatest contribution to the training and management of mentally retarded individuals in noncognitive areas. The present study was designed to apply behavioristic principles

of learning to cognitive behaviors; specifically to the acquisition of conservation ability as postulated by Piaget.

This choice was made because behavioristic learning principles have been successfully used in the hastening of the development of conservation ability in normal children (Travis, 1969), and because of a basic assumption that behavioristic learning approaches are particularly appropriate for training mentally retarded individuals. This assumption has extensive support in the literature (Ausman and Gaddy, 1974; Baer, Perterson and Sherman, 1967; Birnbrauer, Wolfe, Kidder and Tague, 1965; Brickey, 1978; Gardner, 1972; Haskett and Hollar, 1978; Hobbs and Goswick, 1977; Karen, Eisner and Endres, 1974; Mulhern, 1969; Neisworth and Smith, 1973; O'Malley and Golden, 1978; Remington, Foxen and Hogg, 1977; Sanders, 1975).

Travis (1969) used a behavioristic approach of continuous reinforcement as the basis for a substance conservation training technique. He ensured the acquisition of a substance conservation response by presenting to each subject a systematic series of progressively greater deformations of an initial stimulus pattern. The series begins with an imperceptible deformation and terminates with a very gross deformation. After each deformation the subject indicates whether or not the stimulus objects still contain the same amount of substance as they did before the deformation. The correct response is always followed by a reinforcement.

There are four training phases in Travis' method with 26 items in Phase I and 24 items in Phases II, III and IV. The training is done on an individual basis. Each phase is presented to an individual subject in a single session. On the basis of one phase per day, it takes four days to complete the entire training procedure with a subject.

In Travis' training procedure two pretests and two posttests are administered. The purpose of the first pretest is to ensure that all subjects understand the terms "same amount", "more than", and "not as much". The purpose of the second pretest is to ensure that all subjects do not demonstrate the ability to conserve substance. Posttest I is designed to test the acquisition of a reliable, consistent and generalized response of substance conservation; it is administered one week after the training. Posttest II is designed to test resistance to extinction, durability, and generalizability of conservation; it is administered four weeks after the training. Both posttests have two parts; the first consisting of liquid substance conservation tasks similar to the items used in Pretest II and in the training sessions, the second part consists of plasticine substance conservation tasks to which the subjects are introduced for the first time.

However, in the present study Travis' Pretest II and the second part of his posttest served as the only posttest.

The reason for eliminating the first part of the posttest was that it was a repetition of Pretest II and of the training items. Thus, in the present study the same items used in the pretest selection of the subjects were also used as posttest, but in parallel forms. This step was taken in order to avoid the possibility that some subjects might recall previous test items. Posttest I is designed to test the acquisition of a reliable and consistent response of substance conservation. Posttest II, including two novelty items, is designed to test durability and generalizability of conservation.

In other respects the Travis methodology was closely followed with some minor modifications which are described below.

In the present study the reinforcers were mainly miniature marshmallows. One subject refused to accept these reinforcers, declaring that he was no longer a baby who yearned for candy. His teacher suggested money as a reinforcer. With his agreement and the approval of his ward staff, this subject was awarded ten cents at the end of each training and posttest session. A few subjects accepted cookies, and another accepted peanuts as an alternative.

Subjects in the control group were given freedom to choose their reinforcer on the basis of the alternatives given to the experimental group. The same number of reinforcers given to the first subject in the experimental group

was awarded randomly to the first subject in the control group. This was for the purpose of providing the same number of reinforcers to the experimental group and to the control group subjects.

Travis' methodology is employed on normal children. As pointed out by Inhelder (1943/1968) mentally retarded individuals learn at a slower rate than normal children. Therefore in the present study, to allow for the slowness of the subjects, training sessions were doubled. In other words, each phase in the present study comprised two sessions administered on the same day, with one session in the morning and another in the afternoon. The entire procedure for each subject was completed in four days (see Appendix 1 procedural chart).

Description of the Instruments

The conservation of substance test was designed by Piaget and Inhelder (1942/1974). It involves showing two equal amounts of substance in the same form (such as liquid in identical containers, and clay in balls), then changing one shape into another and asking the subjects if the new shape has the same amount of substance as the one that was not altered. The subjects' responses are recorded and classified as conservation or nonconservation responses. This method has been employed frequently in Piagetian

research as exemplified in the literature. The apparatus used in the present study was derived from Travis' training method, with some modification (see Appendix 2).

Training of the Research Assistants

The entire project was carried out by the investigator with the assistance of four teacher aides (two in each of the institutions where the project took place). The assistants were employed as teacher aides in these facilities. None of these assistants had ever been directly involved with the subjects in the classroom setting.

All testing and training of the subjects was carried out individually with the pretest being conducted by the investigator and a teacher aide. The experiment itself was carried out by two assistants, and the posttest was performed by the investigator. On one occasion only was the Posttest I of a group of seven subjects done by a psychometrist of the institution, trained by the investigator.

All teacher aides were trained by the investigator before performing their tasks. The pretest was first introduced to them by an itemized demonstration which was followed by their observing the investigator in an actual testing situation with the prospective subjects. A discussion which followed allowed the investigator to clarify any points which might have been unclear to the teacher aides.

The training of the teacher aides for the experiment took place after the completion of the pretest. The teacher aides who carried out the training program with the experimental group were the same persons who participated in the pretest selection of subjects.

Those teacher aides who worked with the control group subjects were introduced to the discrimination tasks which were in booklet form.

Two manuals with corresponding picture booklets were prepared for the study; namely, (1) the pretest and posttest manual and booklet, and (2) the substance conservation training manual and booklet (see Appendix 3, 4, 5, 6).

The Sample

Selection of the Sample

The sample was selected from a total school population of 357 students in two institutions for mentally retarded individuals in the province of Ontario. In one institution there were 218 residents of which 113 attended school. In the second institution there were 1192 residents of which 244 attended school. The schools are operated by the provincial Ministry of Education.

To participate in the educational program in these institutions the residents must meet the following criteria: be of legal age for compulsory education, and be capable

of benefitting from the program. The reason for choosing those residents who were enrolled in the educational program as subjects for the present study was that the possible cognitive advance obtained from the experiment might enhance their cognitive functioning in future academic learning.

The preliminary criteria for the selection of the sample were comprehensible speech, adequate vision, and freedom from severe perceptual and/or emotional problems. On the basis of these criteria 143 residents (41 from one institution and 102 from another) were selected. These 143 individuals were pre-tested for the selection of the sample.

Pretest I.- All subjects were shown four identical transparent cylindrical beakers. Two of the beakers contained the same amounts of water while one contained more, and the other less, than the pair with identical amounts. The subject was first asked to touch two glasses containing "the same amounts" of water. Then he was asked to touch two glasses containing different amounts of water and to indicate which beaker had "more than" the other, and which had "not as much" as the other. Subjects failing to respond correctly to any one of these tasks were eliminated from the experiment.

Pretest II.- All subjects were given eight conservation of substance tasks with the first three of different deformations of liquid and the remaining five of different deformations of solid substance (clay).

On the first task of Pretest II, subjects were shown two identical cylindrical beakers (G) approximately one inch apart which contained the same amounts of orange water. The experimenter said to the subjects, "There are two glasses; they are the same size and they both have the same amounts of water in them". After the subjects had acknowledged that the two identical beakers contained the same amounts of liquid, the experimenter introduced a third beaker (H) placed approximately two inches from the pair. The experimenter said, "There is another glass", then added, "Watch what I do", and poured the contents of one of these two beakers into the empty third beaker. After the deformation, the subjects were asked, "_____ (his name) do you think this glass (indicating the beaker into which liquid has been transferred) has the same amount of water, more water, or not as much water as this one?" (indicating the beaker whose contents had not been removed). After the subjects had given their answers, they were asked, "Why do you think so?" or "How do you know?" All explanations were recorded and later analyzed (see record form in Appendix 7).

On the second task of Pretest II, subjects were shown the same two cylindrical beakers (G) as in the first task. But this time the two beakers contained different amounts of liquid. After the subjects had acknowledged that the two identical beakers contained different amounts of liquid, the

contents of the teaker containg the larger amount were poured into the empty third beaker (H). The standard questions were asked and explanations were recorded.

On the third task of Pretest II, subjects were shown two identical cylindrical beakers (H) containing the same amounts of liquid. After the subjects had acknowledged that these two beakers contained the same amounts of liquid, the contents of one of these two beakers were poured into the empty third beaker (G). The standard questions were asked and explanations were recorded.

On the fourth task of Pretest II, subjects were shown two identical clay balls (25 g each). After the subjects had acknowledged that these two balls were identical (containing the same amounts of clay), one of the balls was flattened into a pancake. After the deformation, the subjects were asked, "_____ (his name) do you think this one (indicating the pancake) has the same amount of clay, more clay or not as much clay as this one?" (indicating the remaining ball). After the subjects had given their answers, they were asked, "Why do you think so?" or "How do you know?" All explanations were recorded.

On the fifth task of Pretest II, subjects were shown the same two identical clay balls. After the subjects' acknowledgment, one of the balls was transformed into a cross. The standard questions were asked and explanations

were recorded.

On the sixth task of Pretest II, again the same two identical clay balls were shown to the subjects. After the subjects' acknowledgment, one of the balls was transformed into a bowl. The standard questions were asked and explanations were recorded.

On the seventh task of Pretest II, the same two identical clay balls were presented to the subjects. After the subjects' acknowledgment that the two balls contained the same amounts of clay, one ball was transformed into a snake. The standard questions were asked, explanations were recorded.

The last task of Pretest II was to transform the snake into a necklace. This task was followed by the same standard questions and again the explanations were recorded.

All explanations were analyzed. According to Smedslund (1961) subjects possess a reliable and generalized conservation response if they give "symbolic" and/or "symbolic-logical" explanations to justify their answers. "Symbolic" explanations were those which "directly or indirectly refer to previous events in the same test item" (Smedslund, 1961, p. 74). "Symbolic-logical" explanations were those which "explicitly state that nothing has been added or taken away" (Smedslund, 1961, p. 74).

Only those subjects who failed on all of the conservation of substance tasks remained in the experiment, and were

assigned either to the experimental group or to the control group as previously reported. The experimental group was given Travis' substance conservation training program. The control group was provided with no conservation training, but was given instead a social interaction situation in which the experimenter and the subjects worked on some discrimination tasks. This was necessary in order to ensure that results on the posttests of the experimental subjects were due to conservation training rather than social interaction with the experimenter.

After the pretest selection, a printed list of the names of the subjects was given to the principals of both institutions, who were asked to group the subjects according to the availability of the subjects for the four consecutive days of the experiment. The subjects' activities had to be rearranged between the school and other departments within the institution in order to minimize conflict in scheduling and to ensure the subjects' availability for both other activities and for the present study. The principals also grouped the subjects according to geographic location; all subjects who attended classes in the same area were scheduled for the same experiment. This arrangement was meant to minimize the subjects' prolonged absence from the classroom. Such a procedure also facilitated the efforts of the teacher aides in transporting the subjects to and from the site of the experiment and the classrooms.

The data relative to age, sex, length of institutionalization and IQ of each subject were obtained from the medical file. Intelligence scores were derived from either the Stanford-Binet Scale or Wechsler Intelligence Scale (Children's and Adults') administered within the twenty-four months preceding the present study.

A Description of the Sample

The sample consisted of 48 mentally retarded adolescents and adults. Twenty-two of them were selected from one institution and the remaining 26 from the other. In the experimental group, there were 25 subjects (7 females and 18 males). Chronological ages ranged from 149 months to 256 months, IQs from 36 to 69 points and length of institutionalization from 11 months to 186 months.

The mean age was 212.80 months with a standard deviation of 26.35 months. The mean IQ was 49.24 with a standard deviation of 10.86. The mean length of institutionalization was 86.28 months with a standard deviation of 54.64 months.

In the control group there were 23 subjects (4 females and 19 males). Chronological ages ranged from 179 months to 257 months; IQs, from 30 to 67 points, length of institutionalization, from 25 months to 170 months.

The mean age was 220.26 months with a standard deviation of 23.95 months. The mean IQ was 43.96 with a standard

deviation of 9.34. The mean length of institutionalization was 85.43 months with a standard deviation of 36.56 months.

Table 1 summarizes the aforementioned data.

Training procedure

The training was carried out individually with the subjects in the experimental group by the teacher aides. The teacher and student were seated comfortably at a desk facing each other. The teacher had the beakers, four containers of coloured liquid and reinforcers on a low table or stool beside her. She also had the training booklet, record form and pencils on the desk. The teacher attempted to establish a good rapport with the student before the training procedure started. The teacher maintained a pleasant and purposive manner throughout the session.

Once rapport was established, the teacher said, "Now we are going to play with some of these things (pointing to the beakers and containers). I am going to ask you what you think about some of them. You will have to watch very carefully. When you answer some questions you will get some marshmallows (pointing to the reinforcers). Now don't forget that you must watch very carefully and remember what you begin with each time".

On the first training item (Phase I, Session A, No. 1), the student was shown two cylindrical beakers (F) approximately

Table 1
Means and Standard Deviations of the Ages, IQs and Length of Institutionalization of the Experimental and Control Group Subjects, Expressed in Months.

Variables	Experimental Group N:25 (F:7 M:18)		Control Group N:23 (F:4 M:19)		t	df
	Mean	σ	Mean	σ		
Age	212.80	26.35	220.26	23.95	-1.0021	46 NS*
IQ	49.24	10.86	43.96	9.34	1.7615	46 NS
Length of Institutionalization	86.28	54.64	85.43	36.56	.0611	46 .NS

* NS not significant at the .05 level.

one inch apart, which contained the same amounts of red liquid as indicated in the training booklet. The teacher said, "Here are two glasses; they are the same size and they both have the same amounts of water in them". After the student had acknowledged that the two identical beakers contained the same amounts of liquid, the teacher introduced the third beaker (F) placed approximately two inches from the pair. The teacher said, "There is another glass". Then he said, "Watch what I do", and poured the contents of one beaker (one in the pair that is close to the third beaker) into the empty third beaker (shown in training booklet). (The newly emptied beaker was placed at the far end of the table.) The teacher asked, "_____, (student's name) do you think this glass (indicating the beaker into which the liquid has been transferred) has the same amount of water, more water, or not as much as this one?" (indicating the beaker whose contents had not been removed).

After each answer, the teacher said, "That's right", or "That's wrong", according to whether the answer was correct or incorrect. According to Piaget (1960a, 1960b) telling the subject that he is wrong could lead to the cognitive disequilibrium which is essential for further cognitive growth.

The student's response was recorded on the record form (see Appendix 8). If the response was right, the teacher wrote "R"; if the response was wrong, "W". The reinforcer was

given to the student upon delivering a right response.

The teacher proceeded with the training items as listed in the training booklet. After each deformation, the standard question was again asked, a verbal comment was given, and the response was recorded and reinforced if correct. The training items in one phase were completed in a single session without interruption. The eight training sessions averaged 25 minutes each in duration.

While the experimental group was given the training, the control group was provided with discrimination task exercises, during which all control group subjects were reinforced randomly with approximately the same number of reinforcers as were provided for the experimental group subjects.

Posttest

All subjects were given two posttests using test items similar to those used in pretest II, but in parallel forms. That is, in the posttests, sand (orange liquid in pretest) was used for ~~items~~ one to three, while plasticine (clay in pretest) was used for items four to eight. Posttest I was administered 1 week after the training, and Posttest II, 3 weeks later.

There were two extra novelty items (Items 9 and 10) on Posttest II. This enabled the experimenter to verify the ability of the subjects to transfer learning.

Instructions for these two extra items were as follows: Item 9: The teacher presented the student with two piles of 10 red poker chips each, about an inch apart and said, "There are two piles of chips. They are the same size and have the same amounts of chips". After the students' acknowledgment that such was the case, the teacher said, "Watch what I do", and knocked down the pile on her right. The teacher asked, "_____ (student's name), do you think this pile (pointing to the pile which has just been knocked down) has the same amount of chips, more chips or not as many chips as this pile" (pointing to the pile remaining standing). After the student gave his response, the teacher asked, "Why do you think so?" or "How do you know?" The teacher recorded all responses. Item 10: The instruction was identical to item nine, but the material was different. For item 10, pennies were used instead of poker chips.

During the pretest, training (experimental groups only), and posttest, if a subject disagreed with the statement that the presented stimuli were the "same amount" or "different amount" the experimenter manoeuvred the stimuli to the subject's satisfaction, or arranged to arrive at a mutual agreement before proceeding to the transformation required.

An Explication of the Scoring Methodology

There has been disagreement as to who could be called a conserver, and authors have employed divergent criteria for classifying subjects as conservers. Some demanded total correct posttest responses (Lister, 1969). Others concentrated on the number of tasks a subject was able to do correctly (Vandenhoevel, 1974). Travis' criterion was that all the posttest responses be correct. The present study adopted this latter criterion. However, the number and type of tasks a subject was able to do was recorded for verification of the second hypothesis.

Subjects were said to possess a reliable, consistent conservation response if they gave correct answers to all eight tasks in Posttest I with "symbolic" and/or "symbolic-logical" explanations to justify their answers (Travis, 1969). Posttest I was designed to assess the acquisition of a reliable, consistent response after the cognitive training of conservation responses. The requirement that all responses be correct with "symbolic" and/or "symbolic-logical" explanations for these responses, was adopted to ensure the existence of a cognitive dimension of conservation behavior (Travis, 1969).

According to Piaget (1964) an operation is fully acquired if: (1) it is reliable, (2) it is durable, and (3) it is generalizable (transferable). Posttest II was therefore

designed to assess not only reliability, consistency and durability, but also generalizability. The criterion for scoring in Posttest II was that the answers of all 10 tasks must be correct with symbolic and/or symbolic-logical explanations. If subjects met this criterion, "they were deemed to possess the conservation of substance operation" (Travis, 1969, p. 31).

The Statistical Procedures for Analysis of Data

Hypothesis I

It was hypothesized that a greater proportion of subjects who received conservation training would become conservers than would those subjects who did not receive such training. Evidence for the presence of the conservation operation is a perfect score: all correct answers given by a subject on both posttests. On the basis of this criterion a subject is classified either as a conserver or a nonconserver.

The original plan was to test hypothesis I, using a normal approximation to the binomial test of the null hypothesis that there is no difference between the proportion of conservers in the training condition and in the control condition. Because none of the control subjects became conservers, however, the proportion is zero. With this extreme value the normal approximation becomes very poor (Glass and Stanley,

1970, p. 325). Thus, hypothesis I was tested by determining the 95% confidence interval for the proportion of experimental subjects who became conservers using the procedure discussed by Natrella (1963). Using this procedure the null hypothesis that the proportion of the training-group subjects who are conservers after training is zero, is rejected at the .05 level, if zero is not within the 95% confidence interval.

Hypothesis II

It was hypothesized that a greater proportion of subjects who received conservation training would be able to give conservation responses than those subjects who did not receive such training.

This hypothesis was tested by using a corrected χ^2 technique. All the subjects were classified into two groups according to whether they had zero conservation responses, or one or more such responses. A 2x2 contingency table was formed using this grouping as one dimension, and the experimental-control grouping as the other dimension. A corrected χ^2 (for continuity) was used in order to adjust for the discreteness of the dependent variable (Marascuilo and McSweeney, 1977).

In the next chapter, the actual analysis of the data, the results and a discussion of the findings are presented.

CHAPTER III

PRESENTATION, DISCUSSION, SUMMARY AND CONCLUSIONS

The object of this study was to investigate if the conservation of substance operation could be accelerated in a group of nonconserving mentally retarded adolescents and adults. The results of this study are presented in the first part of this chapter. This is followed by a discussion, summary and conclusions.

Presentation

The first hypothesis predicted that a greater proportion of subjects who received conservation training would become conservers (exhibiting the conservation of substance operation) than those subjects who received no such training.

The data presented in Table 2 indicate that seven (28%) subjects in the experimental group gave conservation responses to all 18 items on posttest I and posttest II; they were therefore acknowledged to be conservers. These subjects satisfied the criteria for acquiring the conservation of substance operation. There was no subject in the control group able to give conservation responses to all 18 items.

A confidence interval approach was used to test this hypothesis. Using the procedure of Natrella (1963, p. 7-2; and Table A22, p. T-39) the 95% confidence interval for the

Table 2

Number of Subjects Giving Conservation Responses to all Items
on Posttests I and II Combined (Number of Conservers)

Subjects	Number of Conservers	%
Experimental (N=25)	7	28
Control (N=23)	0	0

proportion of conservers in the training condition is from .118 to .475. Since zero is not in this interval the null hypothesis that the population proportion is zero is rejected at the .05 level.

The second hypothesis predicted that a greater proportion of the subjects who were trained would exhibit conservation responses than the subjects who received no such training. This hypothesis predicted that a greater proportion of those subjects who were reinforced for giving conservation responses to a series of progressively larger deformations of substance conservation tasks would give conservation responses than subjects receiving no such training, when tested on the posttests. This prediction was assessed by comparing the performance of the experimental group and the control group on the same posttests; posttest I given one week after training and posttest II given four weeks after training.

The test results on posttest I and posttest II are presented in Table 3 which indicates the frequency of conservation responses given by the subjects of the experimental group and of the control group. Table 3 also presents the number of subjects who gave conservation responses to all items on posttest I and posttest II in both the experimental group and the control group. The information in Table 3 demonstrates that on posttest I the subjects in the experimental group delivered 40% of the maximum conservation

Table 3

Number of Conservation Responses Given by Subjects and Number of Subjects Giving Conservation Responses to all Items on the Posttests in the Treatment Grouping.

Test Group	Conservation Responses		Subjects Giving Conservation Responses to all Items	
	Maximum	Observed %	Observed	%
Posttest I	Experimental (N=25)	200	80	40
	Control (N=23)	184	3	1.63
Posttest II	Experimental (N=25)	250	117	46.8
	Control (N=23)	230	15	6.52
			10*	40
			0	0

* Includes the seven subjects who gave conservation responses to all items on posttest I.

responses, whereas the subjects in the control group gave only 1.63%. The data also show that 28% (7 of 25) experimental group subjects gave conservation responses to all items on posttest I, while none of the 23 control group subjects were able to do so. The data in Table 3 also indicate that on posttest II the subjects in the experimental group gave 46.8% of the maximum conservation responses while the subjects in the control group emitted 6.52%, and that 40% (10 of 25) experimental group subjects gave conservation responses to all items on posttest II while none of the control group subjects did so.

As was explained in Chapter II, a χ^2 test was used to test hypothesis II. For posttest I, a χ^2 of 7.88 was obtained, which is significant at the .05 level. The data are presented in Table 4. For posttest II, a χ^2 of 4.84 was obtained, which is also significant at the .05 level. The data are presented in Table 5.

Discussion, Summary and Conclusions

In the present study an attempt was made to examine the following questions:

- (1) Can nonconserving mentally retarded adolescents and adults be trained to acquire conservation of substance? and
- (2) If acquired, is this behavior durable and generalizable?

Table 4

Relationship Between Conservation Responses and Treatment Grouping on Posttest I.

		<u>Subject</u>		Sum
		Control	Experimental	
Number of Conservation Responses	One or more	3	14	17
	Zero	20	11	31
	Sum	23	25	48

Corrected χ^2 value = 7.88

Table 5

Relationship Between Conservation Responses and Treatment Grouping on Posttest II

		Subject		Sum
		Control	Experimental	
Number of Conservation Responses	One or more	5	14	19
	Zero	18	11	29
	Sum	23	25	45

Corrected χ^2 value = 4.53

These questions were examined in a controlled experiment described in the foregoing pages. The results indicated that the training procedure was effective in bringing about the acquisition of conservation of substance. Twenty-eight percent of the 25 subjects who were trained became conservers, whereas no subjects from the control group became conservers by the end of the experiment.

It is evident that the treatment condition produced a reliable, durable and generalizable conservation behavior in more than one quarter of the experimental group subjects. This learned behavior was successfully maintained over a one month period following training. The subjects also succeeded in solving other problems requiring this ability.

In addition, this newly acquired conservation operation appeared strengthened with the passage of time. Three subjects in the experimental group were unable to succeed on all of the test items on posttest I, but did so on posttest II. Two of these subjects failed at the beginning of the test. They subsequently performed well after their "initial fright". According to the criteria used in the present study, these subjects were not classified as conservers. However, these subjects had definitely benefitted from the training, and were able to cope with many conservation tasks. The present criteria may be too severe in that a subject had to succeed on all of the posttests to be regarded as a conserver.

Two other subjects in the experimental group improved greatly in their performance from posttest I to posttest II. They succeeded on 80% of the tasks on posttest II, while they obtained only 12% and 37% respectively on posttest I.

In the control group, three subjects gave a correct response on one item together with appropriate explanations on posttest I. In addition, five subjects were successful with one to five items on posttest II. In the hospital medical records all of these subjects had been diagnosed as having emotional disturbance and/or organic problems besides mental retardation.

These subjects should probably have been excluded from the present study once they were found to have additional problems. However, due to the difficulties of finding individuals who suffered only from mental retardation, these subjects were included in the study. Nonetheless the improvement made by these subjects on the posttests was not statistically significant.

These findings were at best unclear since the five subjects in the experimental group who had been diagnosed as having emotional and/or organic problems did not attain conservation. In fact their performance was the poorest in the group.

Clearly there were some questions which arose from these findings. However, no further attempt was made to clarify

these issues in the absence of definitive data.

The results of the present experiment were as hypothesized. The implications arising therefrom are provocative, in that it appears that conceptual advance in mentally retarded adolescents and adults is a probable outcome of properly structured teaching.

Piaget (1967/1968) contends that the attainment of the conservation operation is the result of the child's interaction with his total environment. Inhelder (1943/1968) and Stephens (1968) state that a mental retardate's cognitive development stops at early adolescence. However, the present training experiment seemed to fulfill the requirements for producing the conservation operation in a significant proportion of mentally retarded adolescents and adults, thus demonstrating conceptual advance. In other words, training has successfully increased a mental retardate's repertoire of schemas, which are the repeatable psychological units of intelligent behavior, in his cognitive structure. These newly acquired schemas enable their possessor to adapt more efficiently to the experimental environment. This was demonstrated in the present study by the subjects' successful performance on the posttests.

It seems clear that cognitive development was demonstrated to be possible in mentally retarded adolescents and adults who were provided with precisely structured learning experiences

coupled with relevant reinforcement. In the present training program, the systematic presentations of the task sequence together with the instruments, reinforcers and social reinforcement were designed to provide the subjects with components similar to a good learning environment.

The procedures provided the subjects with a systematic opportunity to become aware of the need to adapt to their learning environment. In accordance with Piaget's theory, it might be expected that through the adaptation process, new schemas were created in the cognitive structure of the learners. The evidence shows that developmental change involving the attainment of conservation operations was observable in a significant proportion of those exposed to the experimental teaching strategies.

According to Piaget, the capacity to generalize learning, as demonstrated by the posttest performance of the conserving subjects, requires the presence of an elaborated adaptive mechanism. Consistent with his theory, this adaptive mechanism must of necessity be a cognitive one. If such is the case, it would seem to follow that the conceptual advance attained by the conserving subjects would necessarily involve the development of elaborated cognitive structures.

One might ask how the current procedures have effected such a change. Two major factors seem to be of prime importance. The first concerns the discrete structure of a

teaching strategy which permitted and encouraged the subjects to become aware that responding to the learning task required that they adapt to their environment. In Piaget's theory, adaptation necessarily involves the establishment of a state of cognitive equilibrium in response to a prior state of disequilibrium. In order for a subject to be put in a state of disequilibrium, he must have the capacity to be aware that a problem exists. It might be argued that mentally retarded adolescent and adult subjects were seldom able to discern that "problems" in fact did exist, unless the environment was structured to permit them to become aware of the problem, and, subsequently, to induce a state of cognitive disequilibrium. It is held that the discrete structure of the current experimental procedure in fact provided just the sort of environment which is conducive to bringing about an awareness, in mentally retarded adolescent and adult subjects, of the necessity to respond.

Subjects' responsiveness and involvement are held to be a function of reinforcement, the second major factor influencing the successful outcome of training procedures.

It is generally held that the behavioristic approaches are successful in helping mental retardates to acquire new skills. In the present study, a behavioristic approach characterized the training procedure which seemed to make the subjects more enthusiastic, willing and responsive learners.

It was found that the use of concrete rewards was valuable as a motivating factor. The results indicated that the greater the number of reinforcers earned by a subject during the training sessions, the better his performance was on the posttests.

It seems clear that with mentally retarded adolescent and adult subjects extrinsic reinforcement helps to ensure that they will attend to the structured learning situation. It might well be that in getting the subjects to pay attention to the learning task by reinforcing them for so doing, subjects are exposed to an opportunity of being placed in a state of cognitive disequilibrium. This would result in cognitive development if the state of cognitive disequilibrium is not beyond their capacity to restore a state of cognitive equilibrium given the adaptive schemas available to them.

Whether or not one accepts the foregoing theoretical speculations, the fact remains that the present study has demonstrated that cognitive change can be induced in a significant proportion of mentally retarded adolescent and adult subjects who have been exposed to a controlled experimental environment.

It is hoped that the present study will provide insights into better ways of helping mentally retarded individuals to attain conceptual advance which, in turn, should enable them to adapt and to interact more efficiently with their environment. There

is hope that training procedures which are based on the present model will help mental retardates to become more self-reliant and less dependent on others for their needs. Clearly the development of the potential abilities of mental retardates would be beneficial, first to them, and ultimately to society as a whole.

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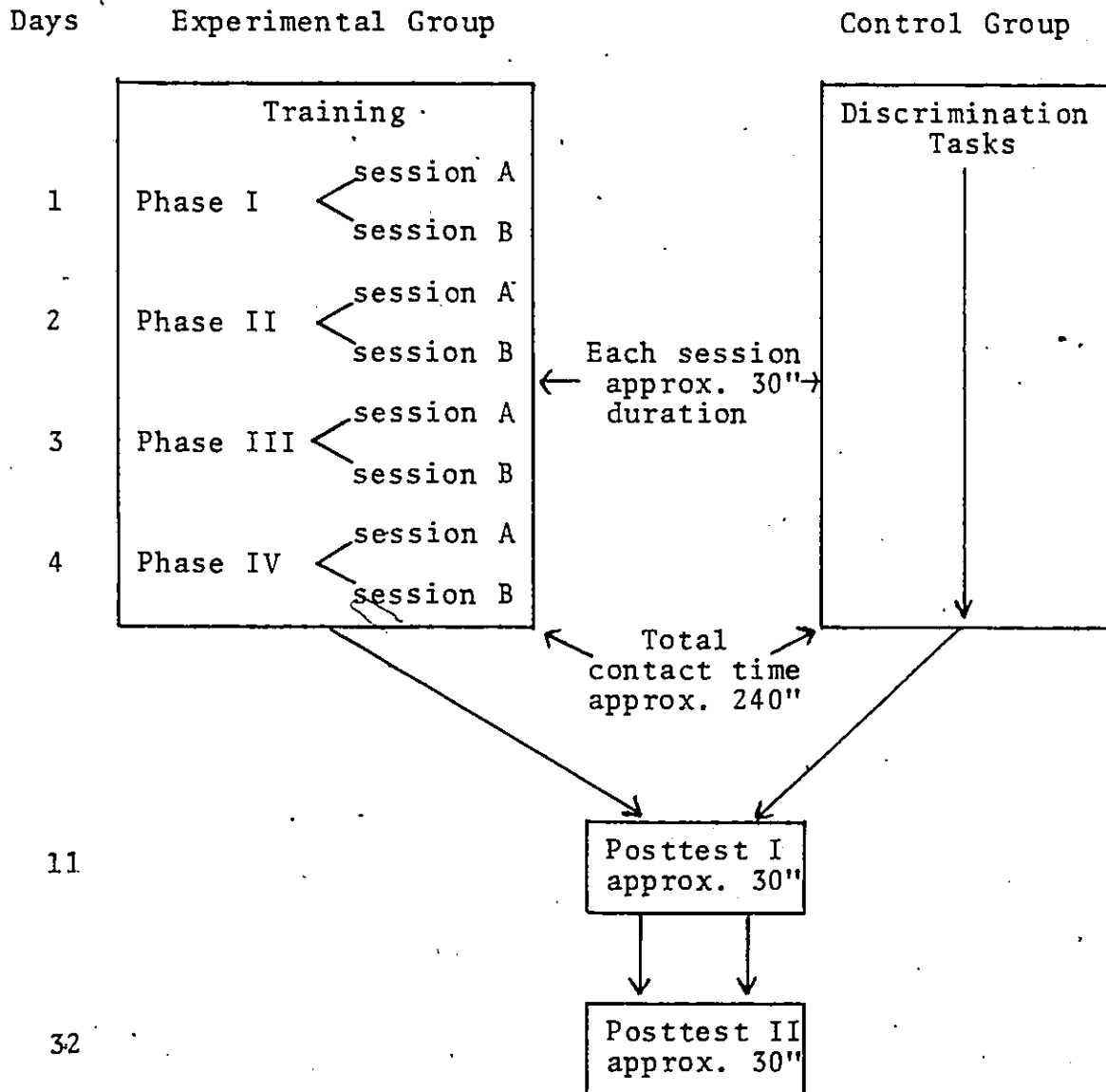
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APPENDIX 1

PROCEDURAL CHART

PROCEDURAL CHART

Pretests I and II (Approximately 20 minutes)



APPENDIX 2

APPARATUS

APPARATUS

1. Beakers:-	<u>Groups</u>	<u>Inner Diameter</u>	<u>Height</u>	<u>No. of Beakers</u>
	A	7/8"	3"	4
	B	1"	2-7/8"	3
	C	1-1/4"	2-11/16"	3
	D	1-1/2"	2-5/8"	3
	E	1-3/4"	2-1/2"	3
	F	2"	3-3/8"	3
	G	1"	2-1/2"	2
	H	2-1/4"	1-1/2"	2

2. Coloured liquid: 5 containers of coloured liquid of red, blue, green, yellow and orange.
3. Clay: 2 25g clay balls.
4. Plasticine: 2 30g plasticine balls.
5. Reinforcers: marshmallows, cookies, peanuts, and money.
6. Red poker chips: 20.
7. Pennies: 20.

APPENDIX 3

MANUAL FOR PRETEST AND POSTTEST

Manual
For Pretest and Posttest
For Substance Conservation Training Program
Fay C. F. Tang
University of Ottawa
1978

Manual For Pretest and Posttest

For Substance Conservation Training Program

The pretest consists of two parts. The first part--Pretest I, stipulates that the individual student understands the terminology of "same amount", "more than", and "not as much". The second pretest--Pretest II, is used to ensure that the student does not have any amount of substance conservation ability.

Pretest I consists of only one item which has three questions. Pretest II consists of eight items with the first three items of liquid substance conservation tasks and the remaining five of solid substance conservation tasks.

Students are tested individually and they have to answer all of the three questions correctly in Pretest I in order to proceed to Pretest II. Students who fail to answer any of these three questions correctly are eliminated from the program.

There are two posttests. Posttest I is administered one week after training, and Posttest II four weeks after training. Test items on Pretest II are used for both posttests, but with different materials--sand and plasticine. There are two new items in Posttest II.

Students are also tested individually for both the posttests.

MaterialsPretest

Glasses - Four identical glasses

Coloured Liquid - One container of orange (O) liquid

Clay - Two identical clay balls.

Posttest

Sand -

Plasticine - Two identical plasticine balls

Red poker chips - 20

Pennies - 20

Pretest and Posttest.

Beakers

<u>Groups</u>	<u>Inner diameter</u>	<u>Height</u>	<u>No. of beakers</u>
G	1"	2-1/2"	2
H	2-1/4"	1-1/2"	2

Record form.

Pretest Procedure

The teacher and student are seated comfortably at a desk facing each other. The teacher has the beakers, one container of orange liquid, and a quantity of clay, on a low table or stool beside him. He also has the pretest instruction, pretest booklet, record form and pencils on the desk. The teacher attempts to establish a good rapport with the student before the testing procedure starts. The teacher maintains a pleasant and

purposive manner throughout the session.

Once rapport is established, the teacher says, "Now we are going to play with some of these things (pointing to the glasses, beakers, container and clay). I am going to ask you what you think about some of them. You will have to watch very carefully".

On Pretest I, the student is shown four identical glasses approximately one inch apart. Two of the glasses contain the same amounts of orange liquid while one of the remaining contains more and the other less, than the pair with the same amounts (shown in pretest booklet).

The teacher says, "There are four glasses; they are the same size. Two of the glasses have the same amounts of water in them, one has more water in it and one has not as much water in it as the others. Now I want you to look at them very carefully and point to the two glasses which have the same amounts of water in them".

After the student has given his answer, the teacher says, "Fine".

The teacher proceeds to ask the second question, "Now _____ (student's name) point to the one which has more water in it".

After the student has given his answer, the teacher says, "Fine".

The teacher proceeds to ask the third question, "Now,

_____ (student's name) point to the one which has not as much water in it as the others". Again the teacher says, "Fine", in responding to the student's answer.

The water is returned to the container.

The test is terminated for those students who failed to answer correctly any of these questions. For those who answered all three questions correctly, the teacher is to proceed to introduce Pretest II by saying, "Now, _____ (student's name) we are going to play some more with these things (pointing to the beakers, container and clay). I am going to ask you what you think about some of them. You will have to watch very carefully and remember what you begin with each time".

On the first item of Pretest II, the student is shown two identical beakers (G) approximately one inch apart which contain the same amounts of orange liquid (shown in pretest booklet).

The teacher says, "There are two glasses; they are the same size and they both have the same amounts of water in them".

After the student acknowledges that the two identical beakers contain the same amounts of liquid, the teacher introduces the third beaker (H) placed approximately two inches from the pair. The teacher says, "There is another glass". Then he says, "Watch what I do", and pours the contents of one

beaker (the one that is closest to the third beaker) into the empty third beaker (shown in pretest booklet). (The newly emptied beaker is placed at the far end of the table.)

The teacher asks, "_____, (student's name) do you think this glass (indicating the beaker into which the liquid has been transferred) has the same amount of water, more water, or not as much water as this one?" (indicating the beaker whose contents have not been removed).

After the student has given his answer, the teacher says, "How do you know?" or "Why do you think so?" All explanations are recorded.

The water is returned to the container and the beakers are returned to the box.

On the second item of Pretest II, the student is shown the same two beakers (G) (as the first item) one inch apart. But this time the two beakers contain different amounts of liquid (shown in pretest booklet). The teacher says, "There are two glasses; they are the same size but they have different amounts of water in them".

After the student acknowledges that the two identical beakers contain different amounts of liquid, the teacher introduces the third beaker (H) placed two inches from the pair. The teacher says, "There is another glass". Then he says, "Watch what I do", and pours the contents of that beaker which contains more liquid (shown in pretest booklet)

into the empty third beaker. (The newly emptied beaker is placed at the far end of the table.)

The teacher asks the same standard question, "(student's name), do you think this glass (indicating the beaker into which liquid has been transferred) has the same amount of water, more water, or not as much water as this one?" (indicating the beaker whose contents have not been removed).

After the student has given his answer, the teacher says, "How do you know?" or "Why do you think so?" All explanations are recorded.

The water is returned to the container and the beakers are returned to the box.

On the third item of Pretest II, the student is shown two identical beakers (H) containing the same amounts of liquid (shown in pretest booklet).

The teacher says, "There are two glasses; they are the same size, and they both have the same amounts of water in them".

After the student acknowledges that the two identical beakers contain the same amounts of liquid, the teacher introduces the third beaker (G). The teacher says, "There is another glass". Then he says, "Watch what I do", and pours the contents of one beaker into the emptied third beaker (shown in pretest booklet). (The newly emptied beaker is placed at the far end of the table.)

The teacher asks, "____ (student's name), do you think this glass (indicating the beaker into which the liquid has been transferred) has the same amount of water, more water, or not as much water as this one?" (indicating the beaker whose contents have not been removed).

After the student has given his answer, the teacher says, "How do you know?" or "Why do you think so?" All explanations are recorded.

The water is returned to the container and the beakers to the box.

On the fourth item of Pretest II, the student is shown two identical clay balls. The teacher says, "There are two balls; they are the same size, and they both have the same amounts of clay in them".

After the student acknowledges that the two identical balls contain the same amounts of clay, the teacher flattens one of the balls into a pancake.

The teacher asks, "____ (student's name), do you think this one (indicating the pancake) has the same amount of clay, more clay, or not as much clay as this one?" (indicating the remaining ball).

After the student has given his answer, the teacher says, "How do you know?" or "Why do you think so?" All explanations are recorded.

On the fifth item of Pretest II, the student is shown

the same two identical clay balls. The teacher says, "There are two balls; they are the same size and they both have the same amounts of clay in them".

After the student acknowledges that the two identical balls contain the same amounts of clay, the teacher transforms one of the balls into a cross.

The teacher asks, "_____ (student's name), do you think this one (indicating the cross) has the same amount of clay, more clay, or not as much clay as this one?" (indicating the remaining ball).

After the student has given his answer, the teacher says, "How do you know?" or "Why do you think so?" All explanations are recorded.

On the sixth item of Pretest II, the student is shown the same two identical clay balls. After the student's acknowledgment, one of the balls is transformed into a bowl. The standard questions are asked and explanations are recorded.

On the seventh item of Pretest II, the student is shown the same two identical clay balls. After the student's acknowledgment, one of the balls is transformed into a snake. The standard questions are asked, the explanations are recorded.

The last item of Pretest II is to transform the snake into a necklace. The standard questions are asked and the explanations are recorded.

Posttest ProcedurePosttest I

Procedure is the same as in Pretest II but using different test materials. Sand is used for items one to three, and plasticine is used for items four to eight.

Posttest II

Procedure is the same as Posttest I, using identical materials for items one to eight.

On the ninth item, the student is shown two piles of 10 poker chips one inch apart. The teacher says, "There are two piles of chips. They are the same size and have the same amounts of chips".

After the student's acknowledgment that such is the case, the teacher says, "Watch what I do", and knocks down the pile of poker chips on his right. The teacher asks, "_____ (student's name), do you think this pile (pointing to the pile which has just been knocked down) has the same amount of chips, more chips or not as many chips as this pile" (pointing to the pile remaining standing).

After the student has given his answer, the teacher says, "How do you know?" or "Why do you think so?" All explanations are recorded.

On the tenth item, the student is shown two piles of 10

pennies one inch apart. The teacher says, "There are two piles of pennies. They are the same size and have the same amounts of pennies".

After the student's acknowledgment, the teacher says, "Watch what I do" and knocks down the pile of pennies on his right. The teacher asks, "____ (student's name), do you think this pile (pointing to the pile which has just been knocked down) has the same amount of pennies, more pennies or not as many pennies as this pile?" (pointing to the pile remaining standing).

After the student has given his answer, the teacher says, "How do you know?" or "Why do you think so?" All explanations are recorded.

PRETEST AND POSTTEST RECORD FORM

102

Name _____ Date of Birth _____

School _____ Age _____ Sex: M
F

Items	Rs	Explanations
Pretest II		Date _____
Liquid (orange colour) 1		
2		
3		
Clay 4		
5		
6		
7		
8		
Total correct Rs		
Posttest I		Date _____
Sand 1		
2		
3		
Plasticine 4		
5		
6		
7		
8		
Total correct Rs		
Posttest II		Date _____
Sand 1		
2		
3		
Plasticine 4		
5		
6		
7		
8		
Poker chips 9		
Pennies 10		
Total correct Rs		

APPENDIX 4

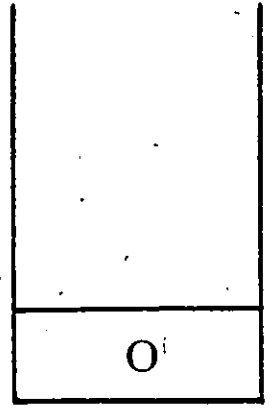
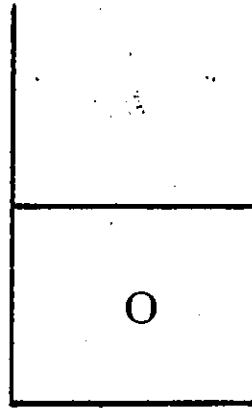
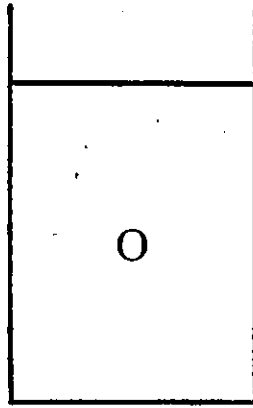
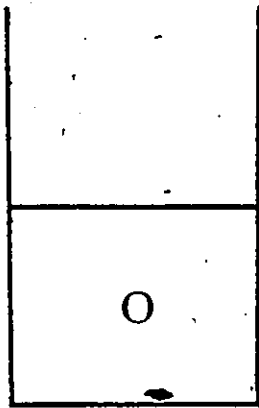
BOOKLET FOR PRETEST AND POSTTEST

7

Booklet For
Pretest and Posttest
For Substance Conservation Training Program
Fay C. F. Tang
University of Ottawa
1978

Pretest I
Terminology Test

105

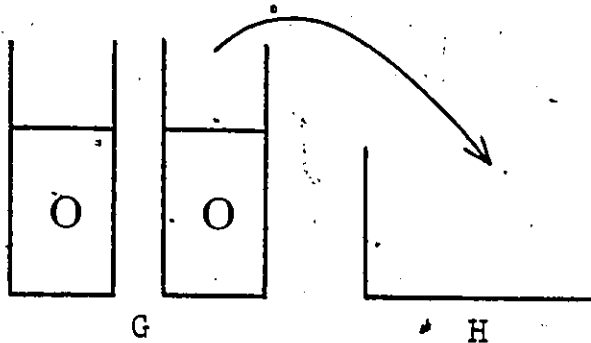


Pretest II

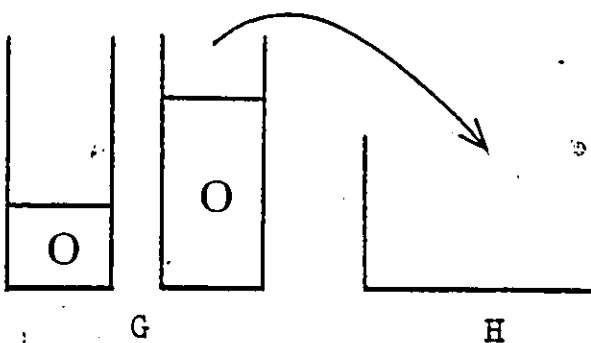
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Liquid Substance Tasks

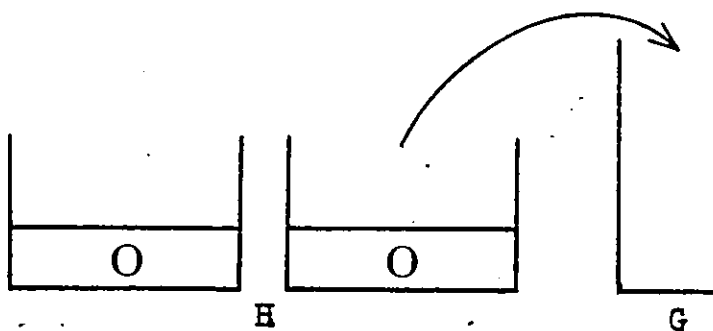
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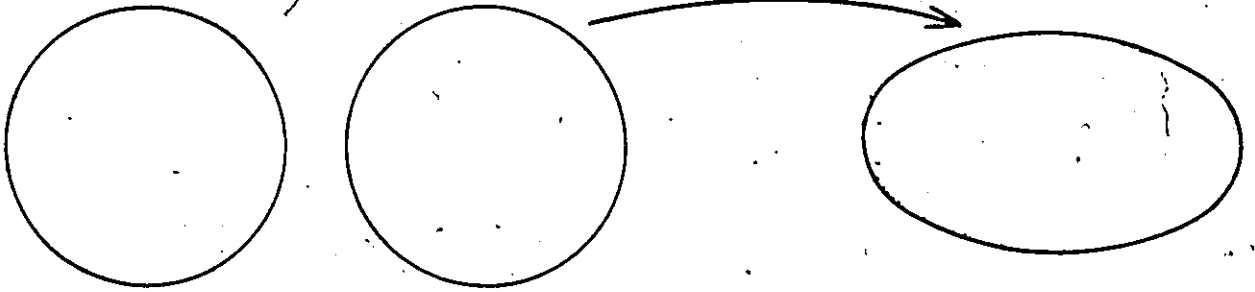
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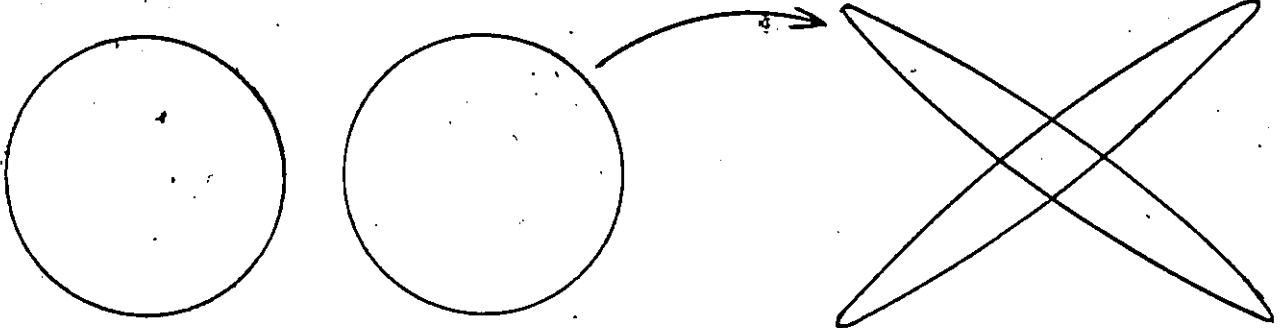
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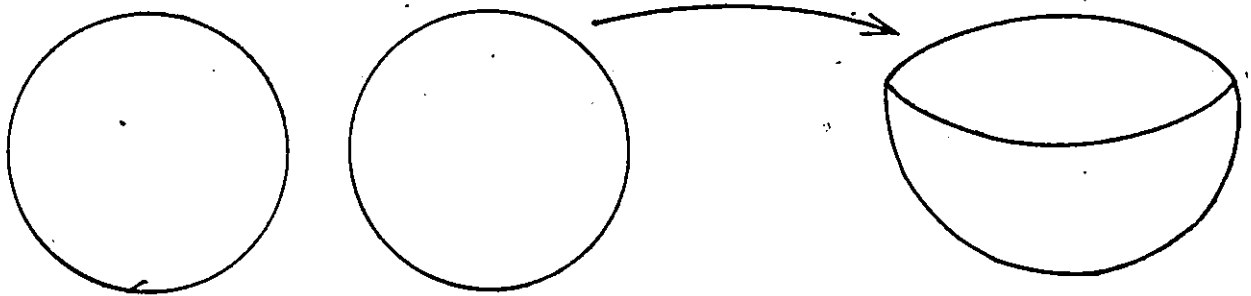
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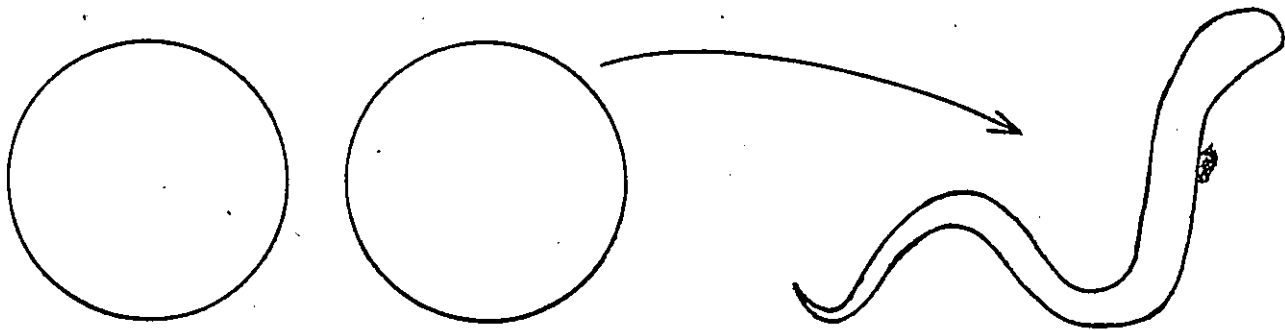
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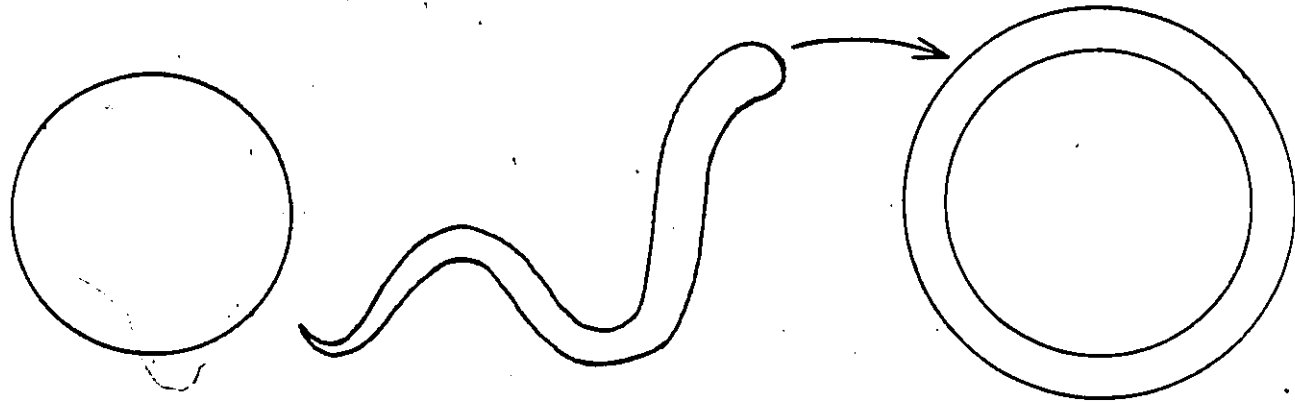
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8



APPENDIX 5

MANUAL FOR

SUBSTANCE CONSERVATION TRAINING

Manual
For
Substance Conservation Training
Fay C. F. Tang
University of Ottawa
1978

Manual For
Substance Conservation Training

This manual is designed for teachers to conduct substance conservation training through the application of continuous positive reinforcement to students for the advancement of cognitive operation. Cognitive operation here is limited to Piaget's conservation of substance. Conservation is defined as the ability to recognize constant quantitative relationships in spite of changing information produced by perceptual variations. According to Piaget, conservation is necessary for rational behavior and for adaptation in the environment.

Results from studies conducted with mentally retarded children indicate that training for a particular conservation operation accelerates cognitive development. It is therefore expected that if provided with proper training, mentally retarded adolescents and adults will be able to acquire conservation operations which they do not currently manifest. Conservation training should enhance both their cognitive development and intelligent behavior, which improvement will be reflected in their academic performance in curricular activities (i.e., arithmetics, fractions, etc.).

Selection Criteria

The students are selected according to two pretest criteria. The first stipulates that the individual student

understands the terminology of "same amount", "more than", and "not as much". Another criterion is that the student does not have any substance conservation ability.

The students selected are at a mental age of approximately six or six and a half years. They must be able to communicate verbally, possess adequate eyesight, and be without severe perceptual and/or emotional problems.

Training Program

The training program is a modified form of the method developed by Travis (1969) based on Piaget's substance conservation test, and behavioristic principles of positive reinforcement. It consists of four phases, with 26 items in phase I, and 24 items in phases II, III and IV. Training is done on an individual basis. Each phase is presented to a student in two sessions (A and B); one session in the morning, and another in the afternoon on the same day. Each session takes approximately one half hour. It takes four days to complete the entire training procedure with a student (see appendix A Procedural Chart).

Training MaterialsBeakers

<u>Groups</u>	<u>Inner diameter</u>	<u>Height</u>	<u>No. of beakers</u>
A	7/8"	3"	4
B	1"	2 7/8"	3
C	1 1/4"	2 11/16"	3
D	1 1/2"	2 5/8"	3
E	1 3/4"	2 1/2"	3
F	2"	2 3/8"	3

Coloured Liquid

Four containers of coloured liquid of red (R), blue (B), green (G) and yellow (Y).

Reinforcer

Marshmallows, cookies, peanuts, and money.

Training Booklet

(enclosed) (same booklet as appendix 6).

Record Form

(see appendix B).

Training Procedure

The teacher and student are seated comfortably at a desk facing each other. The teacher has the beakers, four containers of coloured liquid and reinforcers on a low table or stool beside him. He also has the training booklet, record

form and pencils on the desk. The teacher attempts to establish a good rapport with the student before the training procedure starts. The teacher maintains a pleasant and purposeful manner throughout the session.

Once rapport is established, the teacher says, "Now we are going to play with some of these things (pointing to the beakers and containers). I am going to ask you what you think about some of them. You will have to watch very carefully. When you answer some questions you will get some _____ (pointing to the reinforcers). Now don't forget that you must watch very carefully and remember what you begin with each time".

On the first training item (Phase I, Session A, No. 1), the student is shown two cylindrical beakers (F) approximately one inch apart, containing the same amounts of red liquid (shown in training booklet). The teacher says, "There are two glasses; they are the same size and they both have the same amounts of water in them".

After the student acknowledges that the two identical beakers contain the same amounts of liquid, the teacher introduces the third beaker (F) placed approximately two inches from the pair. The teacher says, "There is another glass". Then says, "Watch what I do", and pours the contents of one beaker (one in the pair that is close to the third beaker) into the empty third beaker (shown in training booklet).

(The newly emptied beaker is placed at the far end of the table.) The teacher asks, "_____ (student's name), do you think this glass (indicating the beaker into which liquid has been transferred) has the same amount of water, more water, or not as much water as this one?" (indicating the beaker whose contents have not been removed).

After each answer, the teacher says, "That's right", or "That's wrong", according to whether the answer is correct or incorrect. The student's response is to be recorded on the record form. If the response is right, the teacher writes "R"; if the response is wrong, writes "W". The reinforcer is to be given to the student upon delivering a right response. The water is returned to the container and the beakers are returned to the box.

On the second training item (Phase I, Session A, No. 2), the student is shown the same two cylindrical beakers (F) (as Phase I, Session A, No. 1) one inch apart. But this time the two beakers contain different amounts of red liquid (shown in training booklet). The teacher says, "There are two glasses; they are the same size but they have different amounts of water in them".

After the student acknowledges that the two identical beakers contain different amounts of liquid, the teacher introduces the third beaker (F) placed two inches from the pair. The teacher says, "There is another glass". Then says, "Watch

what I do", and pours the contents of that beaker which contains less liquid into the empty third beaker (shown in training booklet). (The newly emptied beaker is placed at the far end of the table.) The teacher asks the same standard question, "_____ (student's name), do you think this glass (indicating the beaker into which liquid has been transferred) has the same amount of water, more water, or not as much water as this one?" (indicating the beaker whose contents have not been removed). The teacher gives the appropriate verbal comment, "That's right", or "That's wrong", according to whether the answer is correct or incorrect. Response is to be recorded on the record form with "R" for right, and "W" for wrong. The right response is followed by the reinforcer. Water is returned to the container, and beakers to the box.

The teacher proceeds with the training items as listed in the training booklet. Again the standard question is asked, a verbal comment is given, and the response is recorded and reinforced if correct. The training items in each phase must be completed in a single session without interruption.

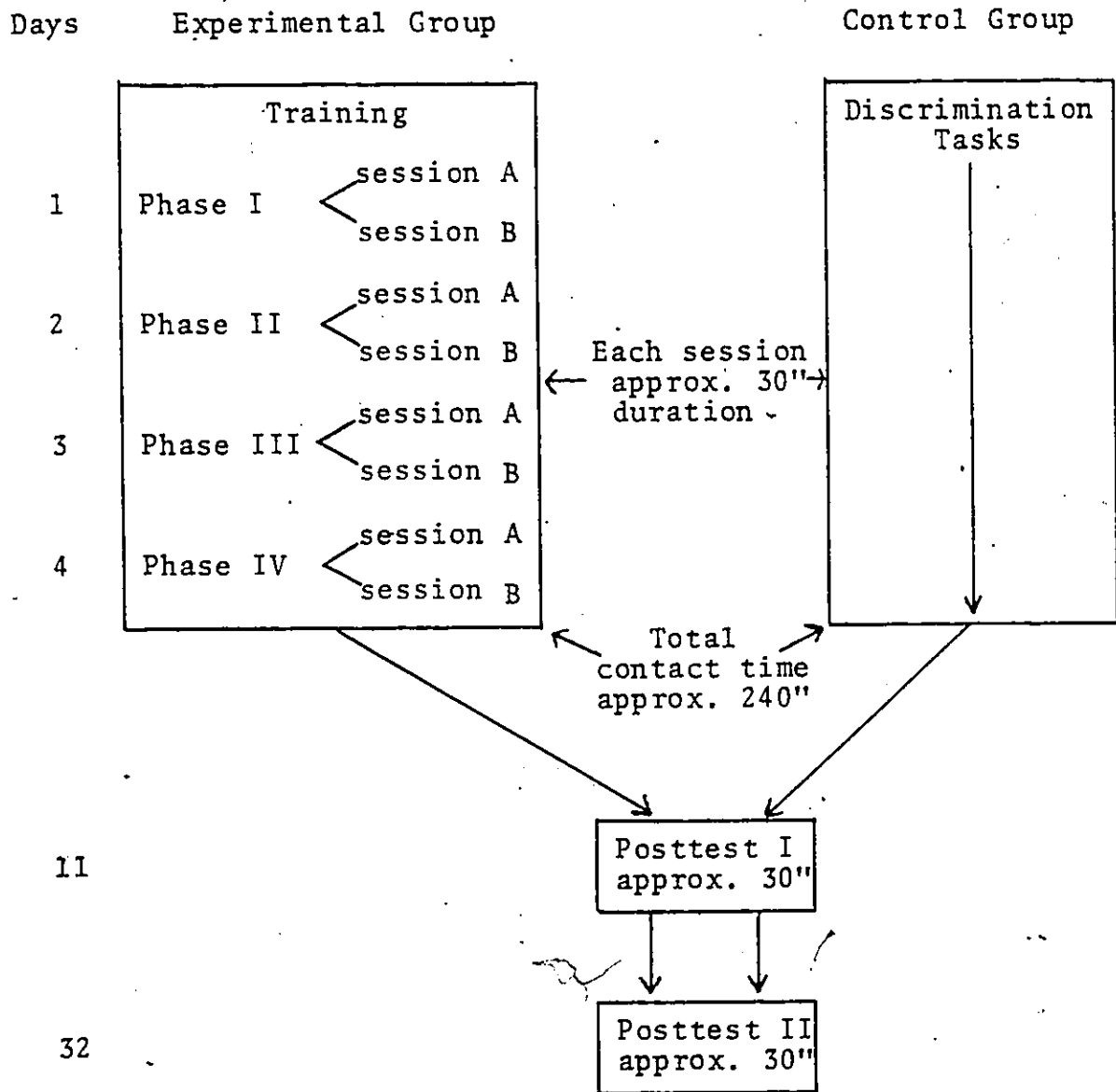
The teacher is provided with a card which restates the standard question, the appropriate verbal comment, and recording procedures (see appendix C).

The same format is repeated for each item.

APPENDIX A

PROCEDURAL CHART

Pretests I and II (Approximately 20 minutes)



SUBSTANCE CONSERVATION TRAINING RECORD FORM

Name _____ Date of Birth _____ Age _____

Date:

Phase I _____ Phase II _____ Phase III _____ Phase IV _____

School _____

Sex: M
FCode: R - right response - reinforce
W - wrong response

Phase I		Phase II		Phase III		Phase IV	
A	B	A	B	A	B	A	B
1.	_____	1.	_____	1.	_____	1.	_____
2.	_____	2.	_____	2.	_____	2.	_____
3.	_____	3.	_____	3.	_____	3.	_____
4.	_____	4.	_____	4.	_____	4.	_____
5.	_____	5.	_____	5.	_____	5.	_____
6.	_____	6.	_____	6.	_____	6.	_____
7.	_____	7.	_____	7.	_____	7.	_____
8.	_____	8.	_____	8.	_____	8.	_____
9.	_____	9.	_____	9.	_____	9.	_____
10.	_____	10.	_____	10.	_____	10.	_____
11.	_____	11.	_____	11.	_____	11.	_____
12.	_____	12.	_____	12.	_____	12.	_____
13.	_____	13.	_____	13.	_____	13.	_____
14.	_____	14.	_____	14.	_____	14.	_____
15.	_____	15.	_____	15.	_____	15.	_____
16.	_____	16.	_____	16.	_____	16.	_____
17.	_____	17.	_____	17.	_____	17.	_____
18.	_____	18.	_____	18.	_____	18.	_____
19.	_____	19.	_____	19.	_____	19.	_____
20.	_____	20.	_____	20.	_____	20.	_____
21.	_____	21.	_____	21.	_____	21.	_____
22.	_____	22.	_____	22.	_____	22.	_____
23.	_____	23.	_____	23.	_____	23.	_____
24.	_____	24.	_____	24.	_____	24.	_____
25.	_____	Total	_____	Total	_____	Total	_____
26.	_____	Time	_____	Time	_____	Time	_____
Total	_____						
Time	_____						

Appendix C

General Introduction

"Now we are going to play with some of these things (pointing to the beakers and containers). I am going to ask you what you think about some of them. You will have to watch very carefully. When you answer some questions you will get some _____ (pointing to the reinforcers). Now, don't forget that you must watch very carefully and remember what you begin with each time."

Item Introduction

"There are two glasses; they are the same (or different) size and they both have the same (or different) amounts of water in them."

"There is another glass."

"Watch what I do."

Standard Question

"_____ (student's name), do you think this glass has (or these glasses all together have) (indicating the beaker into which liquid has been transferred) the same amount of water, more water, or not as much water as this one?" (indicating the beaker whose contents have not been removed).

Appropriate Verbal Comment

"That's right", or "That's wrong", according to whether the answer is correct or incorrect.

Recording Procedures

Write "R", if the response is right--the reinforcer is to be given to the student.

Write "W", if the response is wrong.

The same format is repeated for each item.

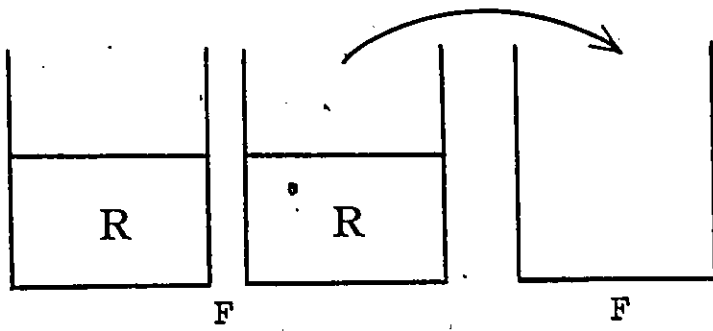
APPENDIX 6

BOOKLET FOR SUBSTANCE CONSERVATION TRAINING

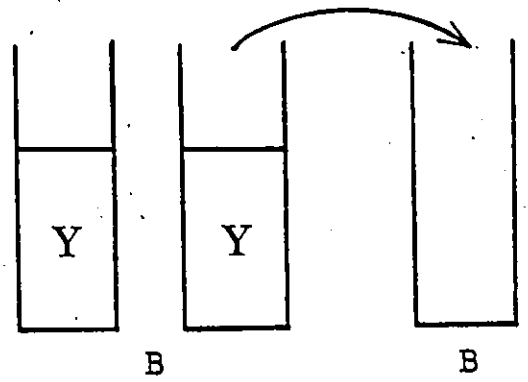
Booklet
For
Substance Conservation Training
Fay C. F. Tang
University of Ottawa
1978

Phase I - Training

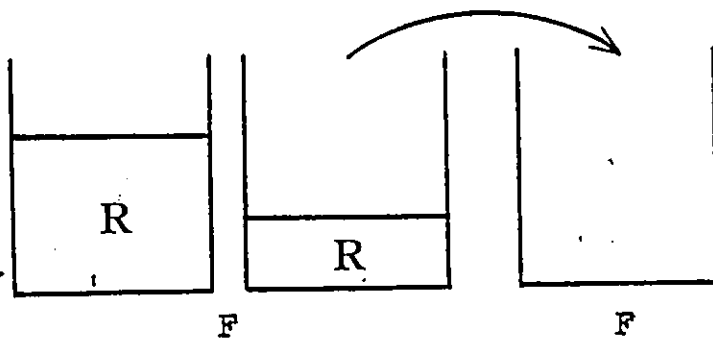
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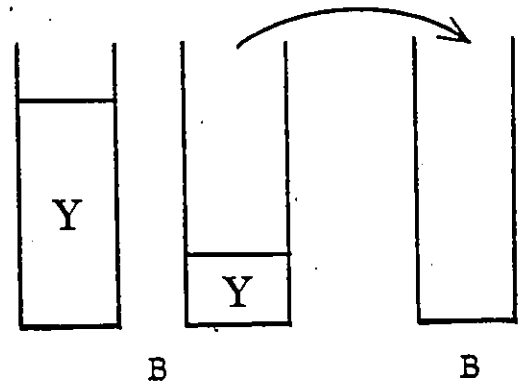
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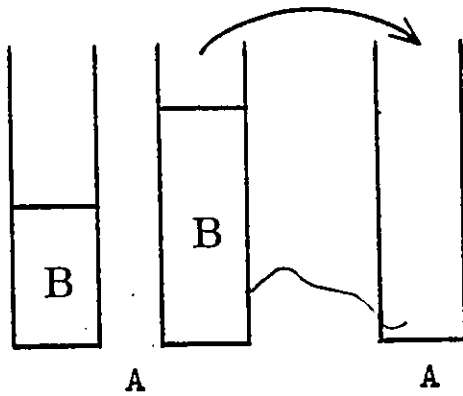
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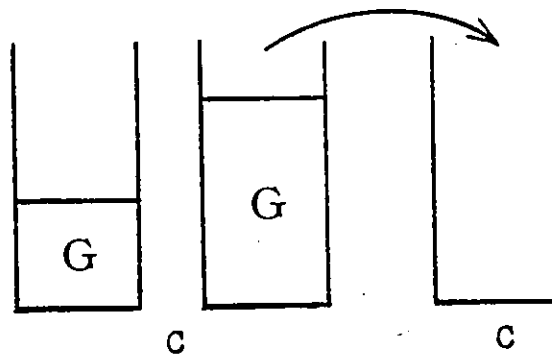
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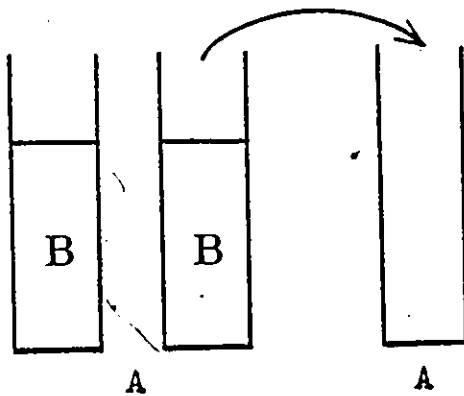
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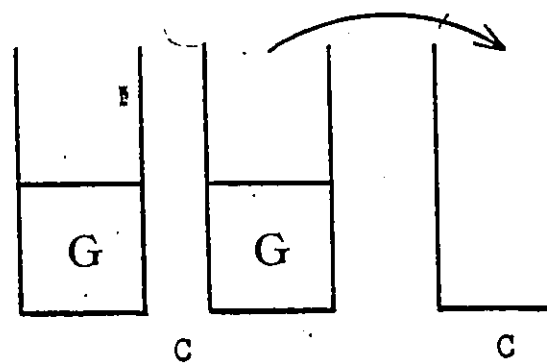
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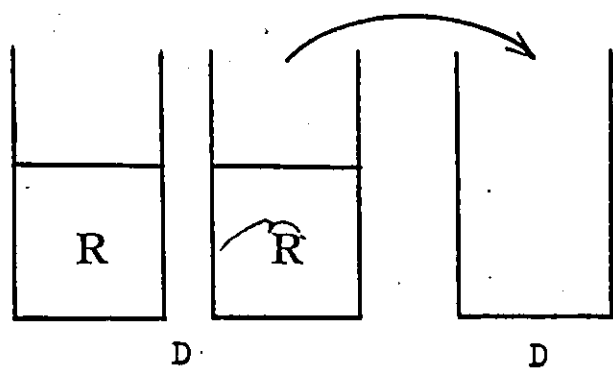
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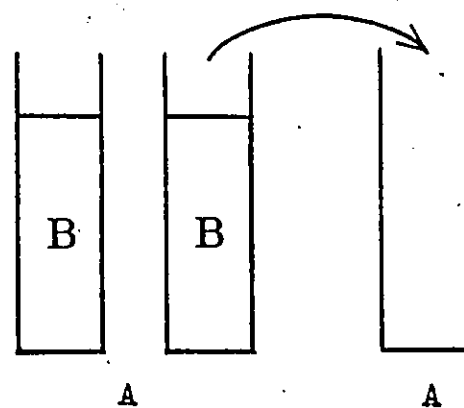
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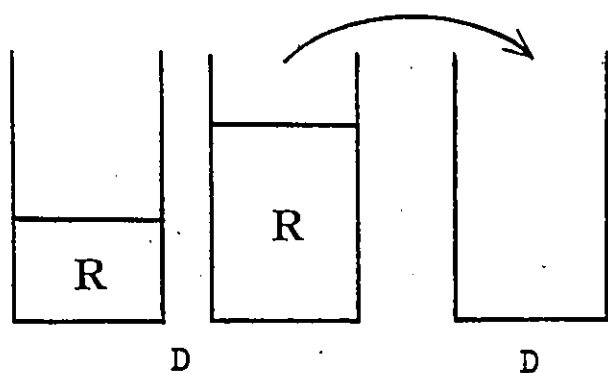
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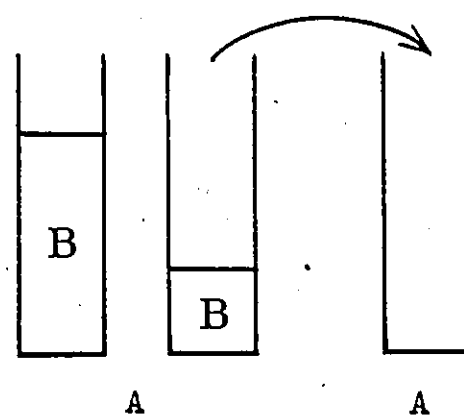
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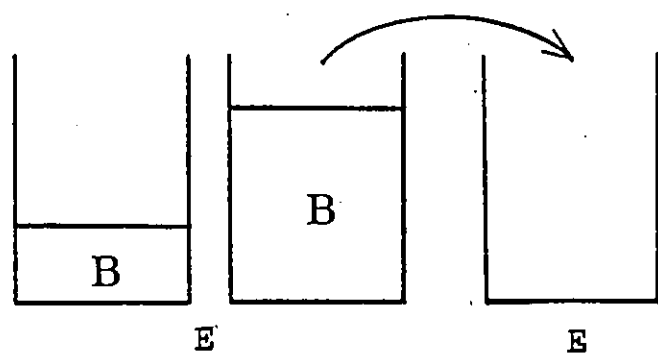
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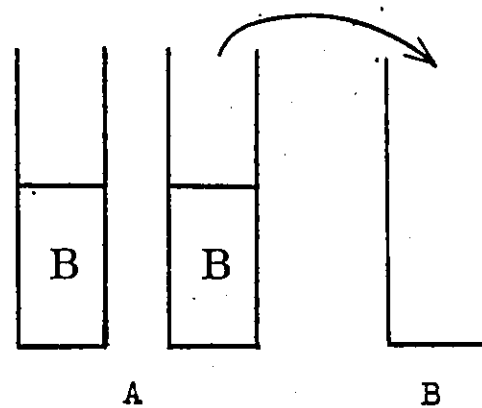
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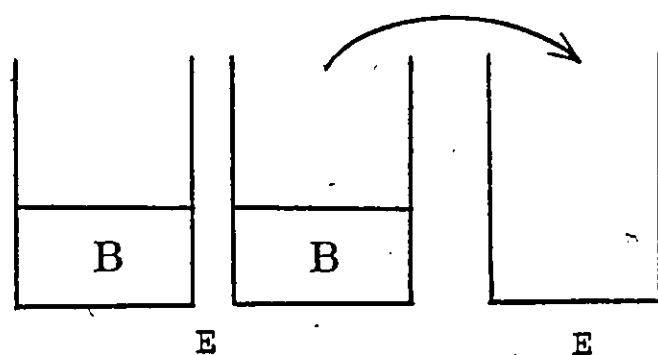
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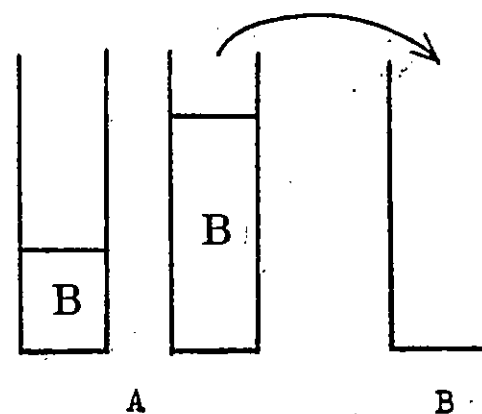
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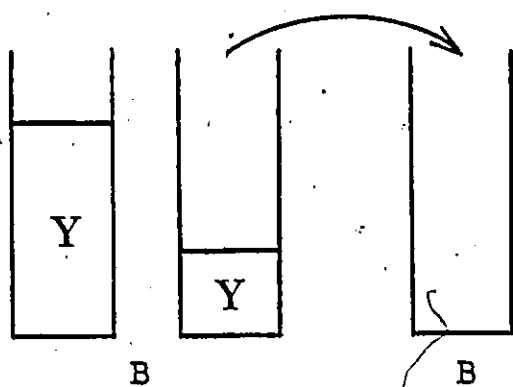
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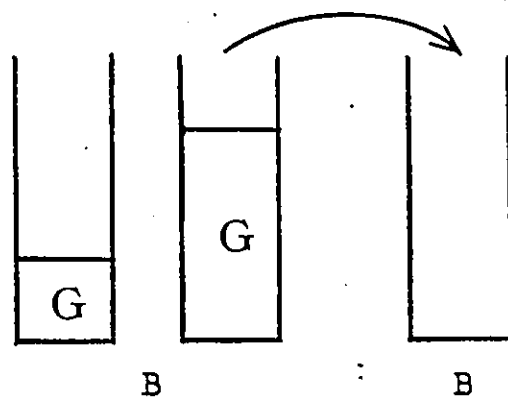
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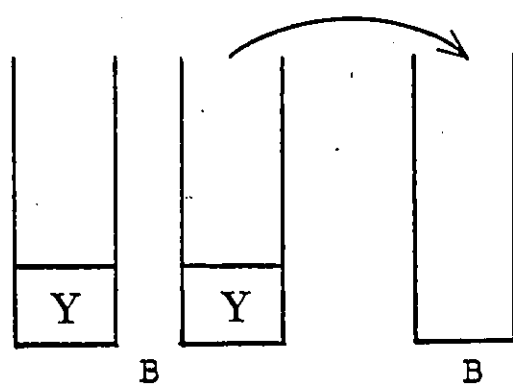
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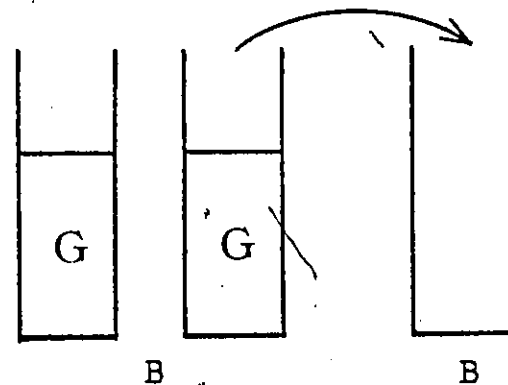
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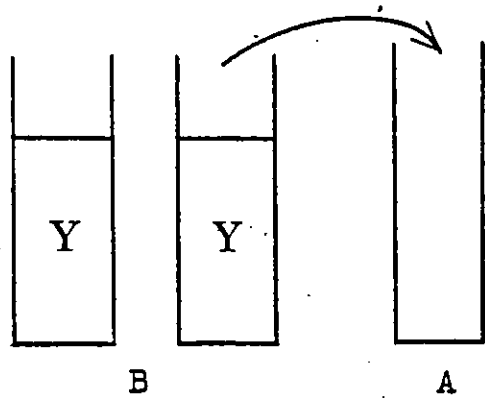
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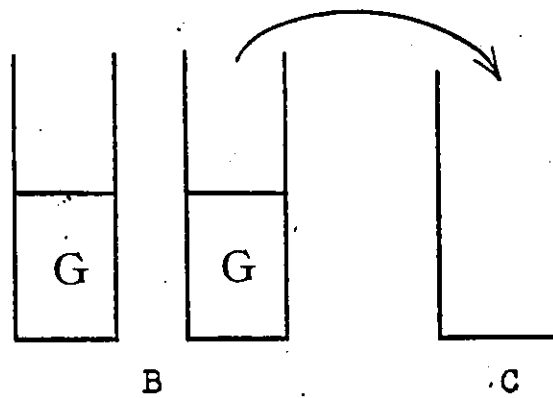
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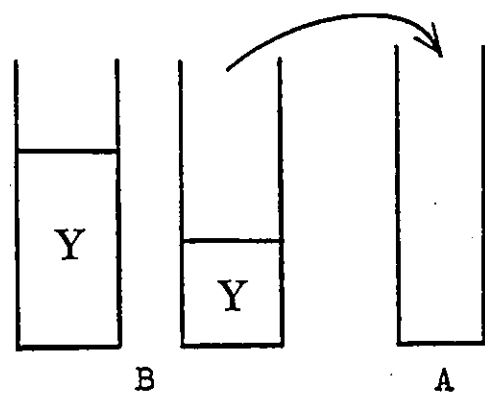
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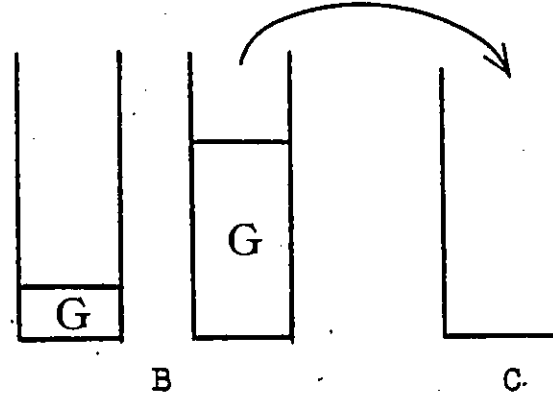
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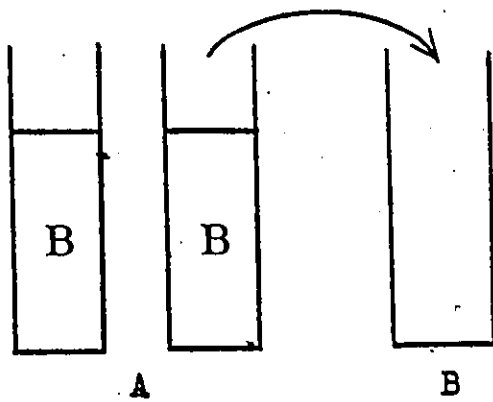
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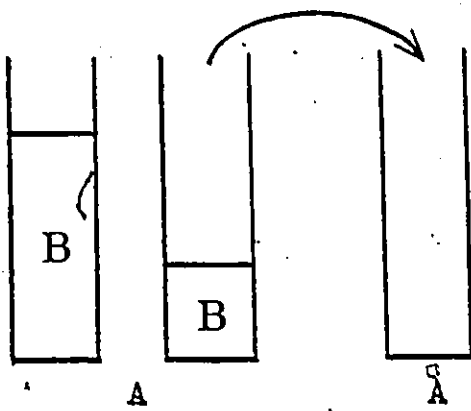
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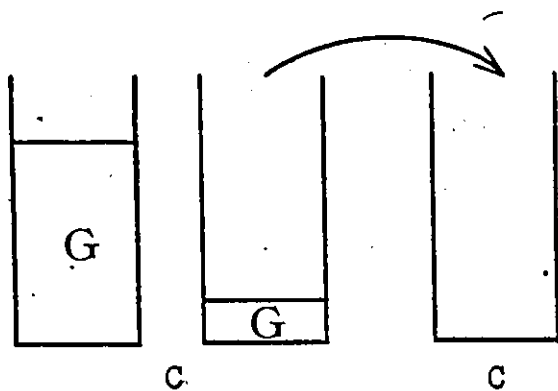


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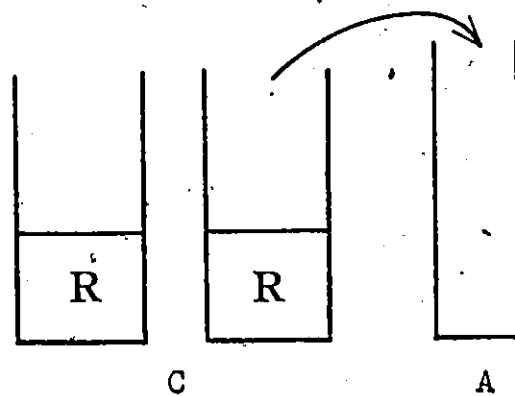


Phase II - Training

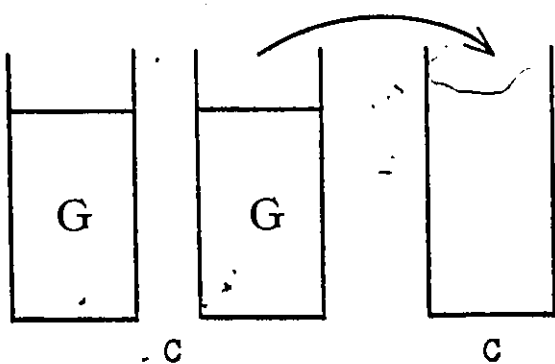
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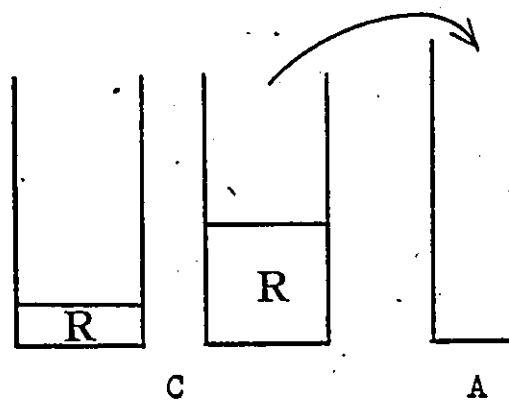
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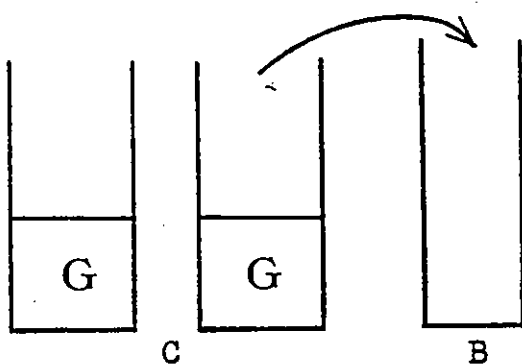
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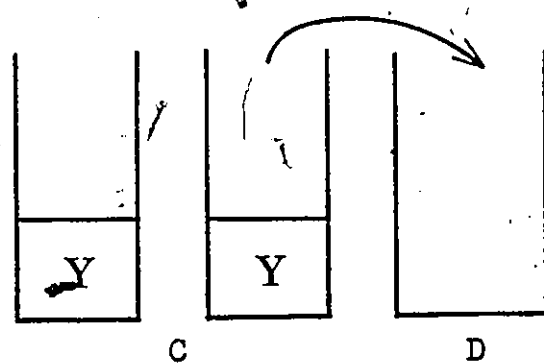
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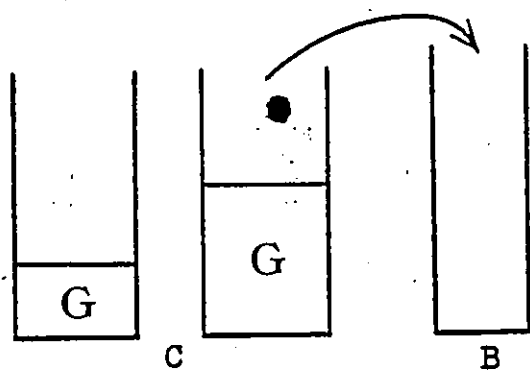
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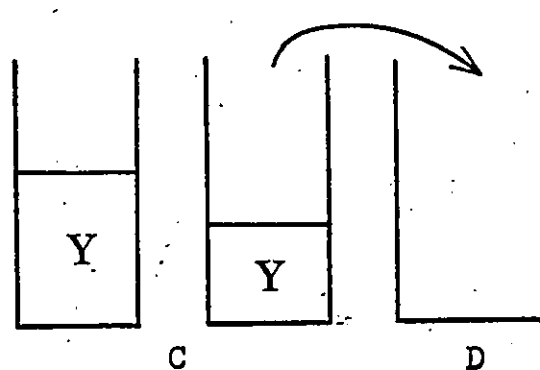
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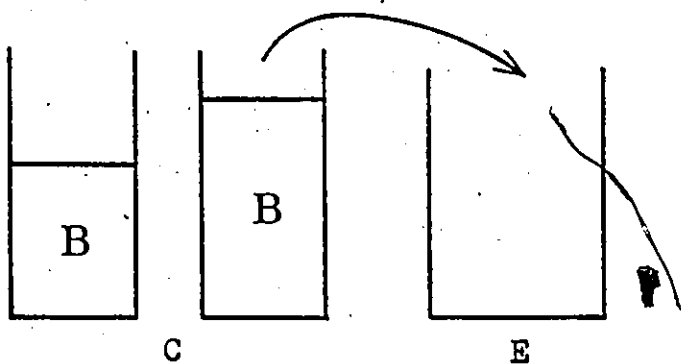
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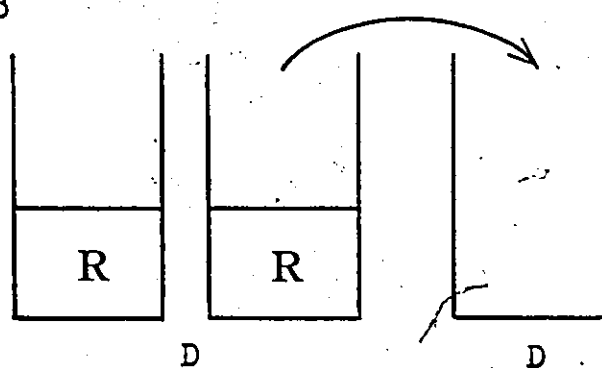
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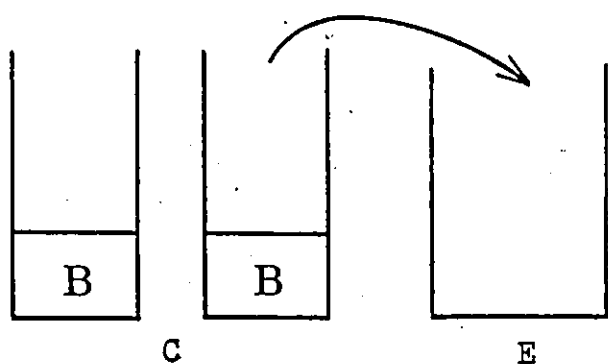
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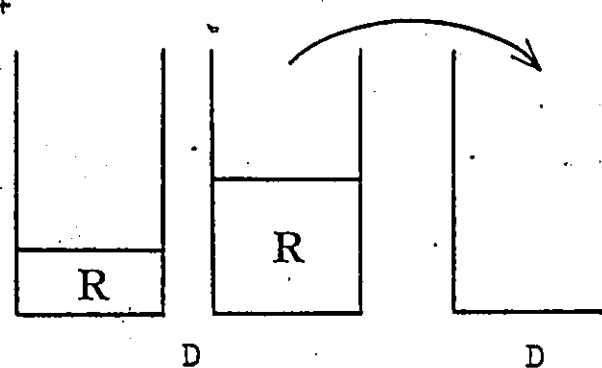
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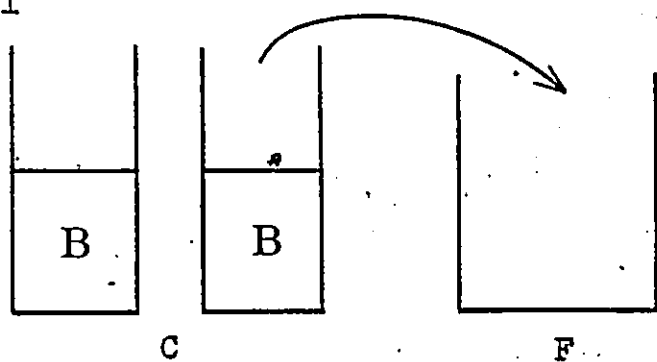
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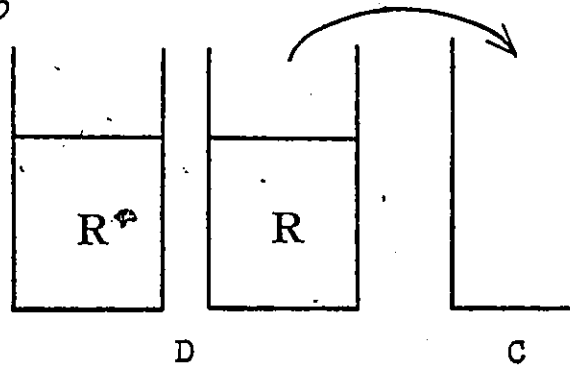
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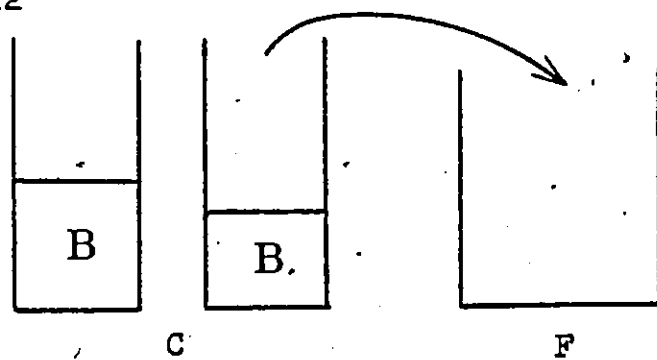
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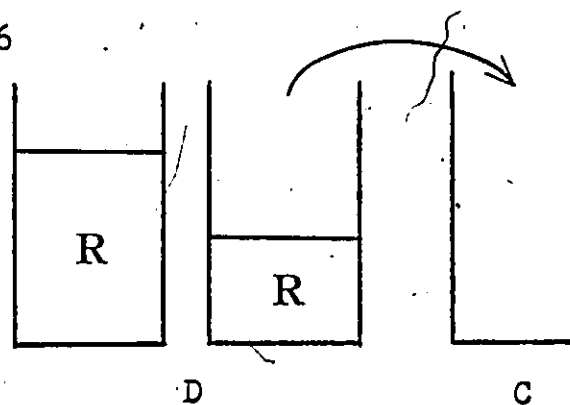
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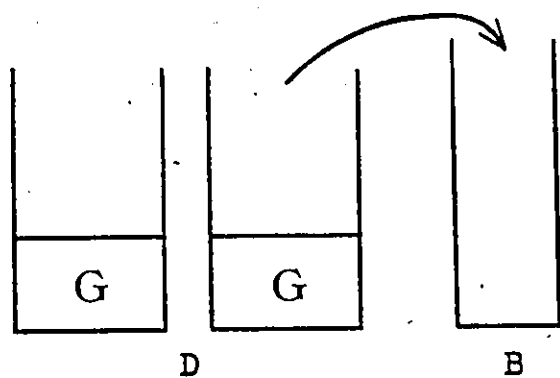
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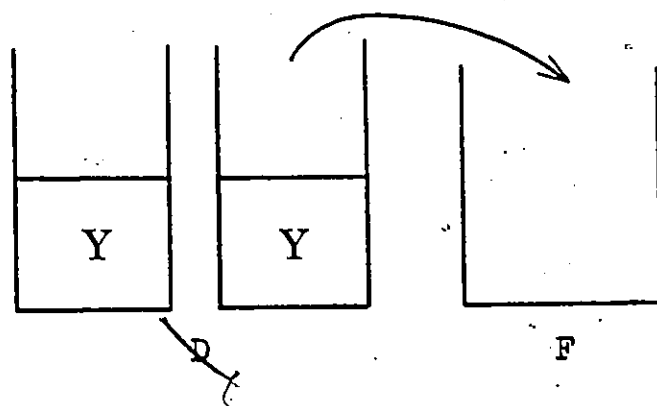
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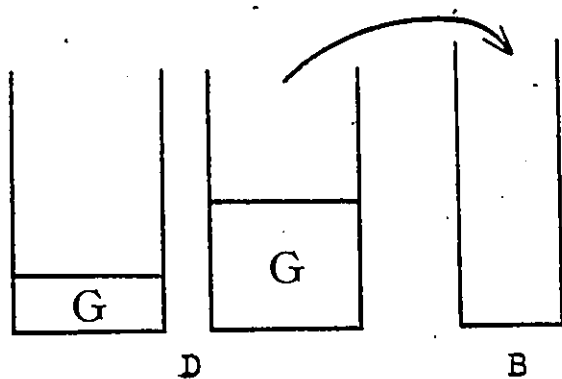
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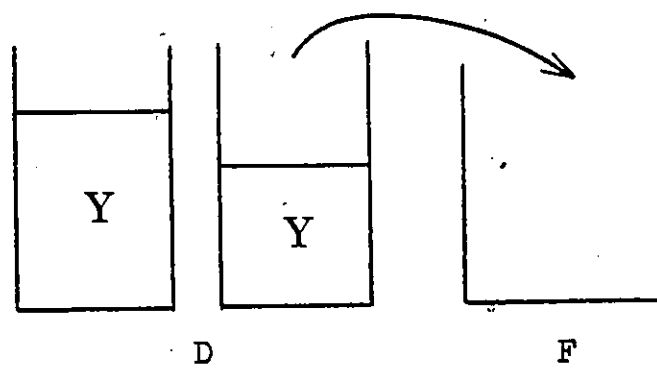
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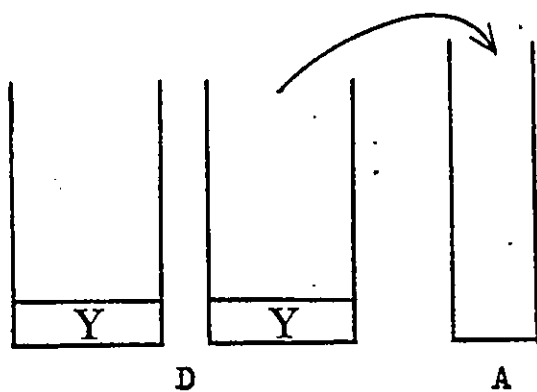
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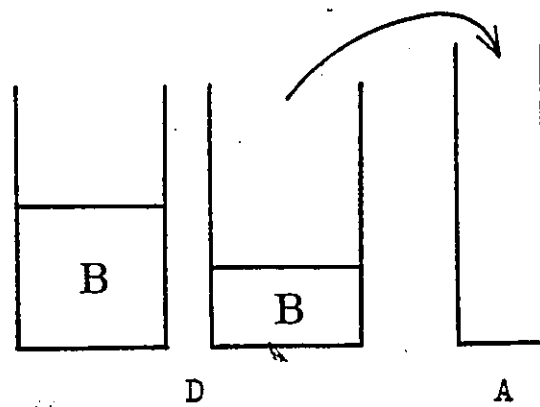
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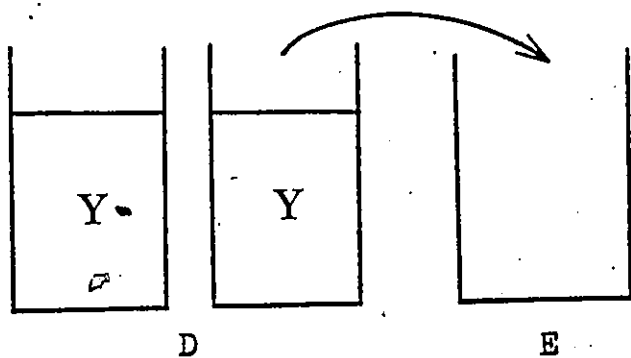
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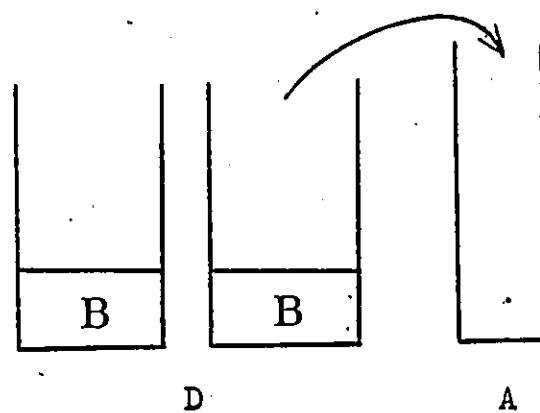
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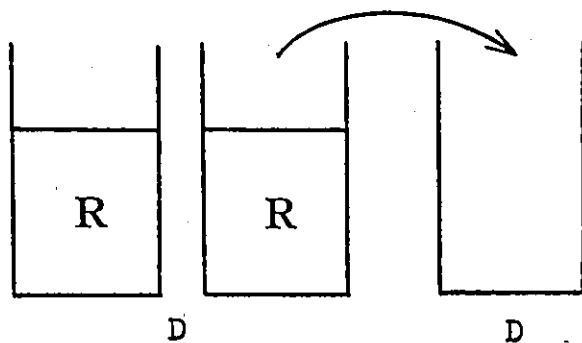


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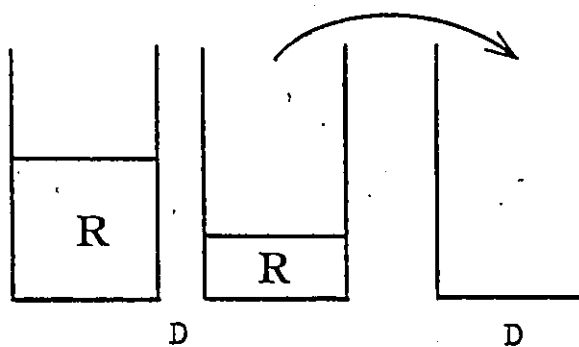


Phase III - Training

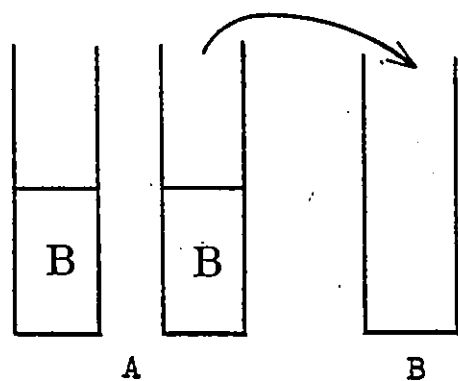
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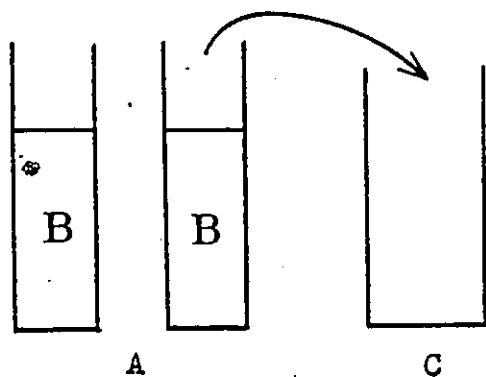
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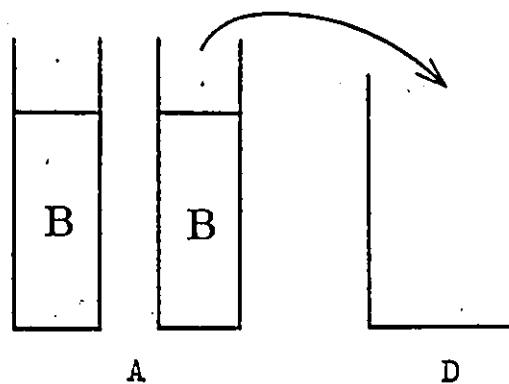
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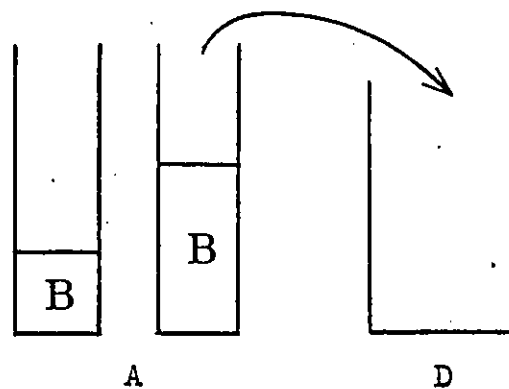
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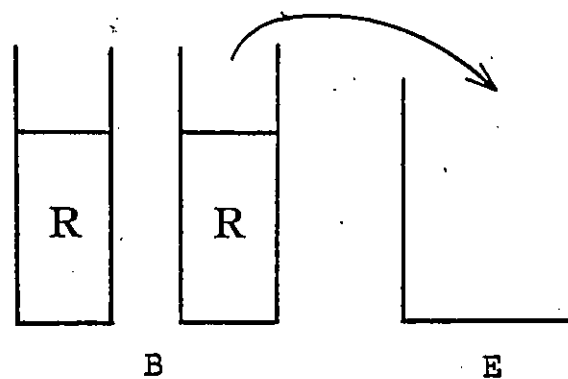
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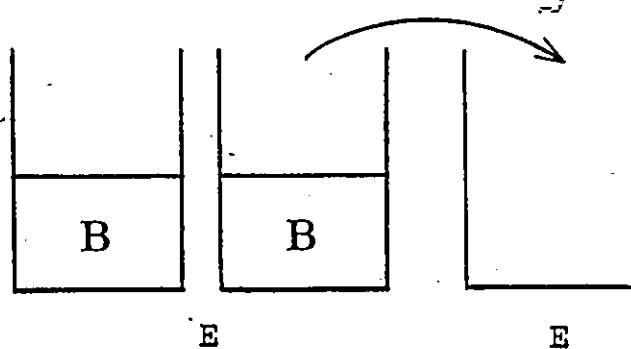
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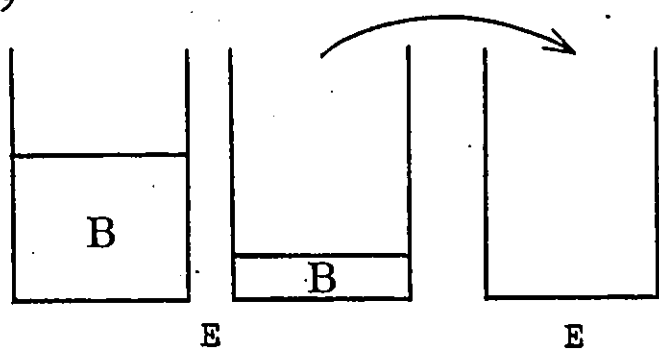
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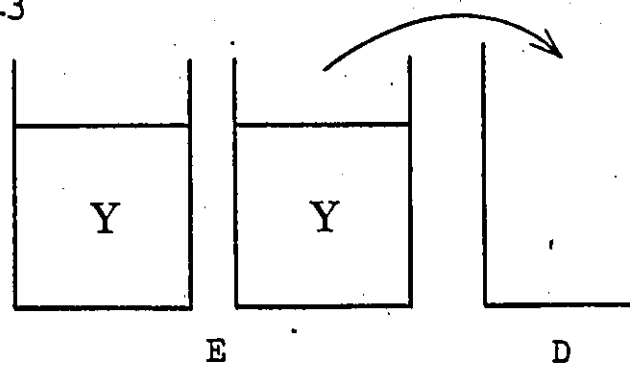
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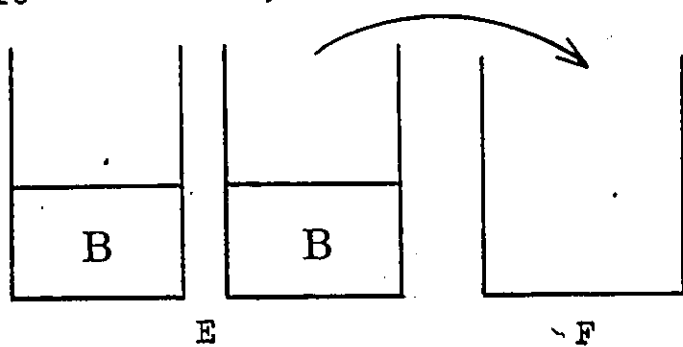
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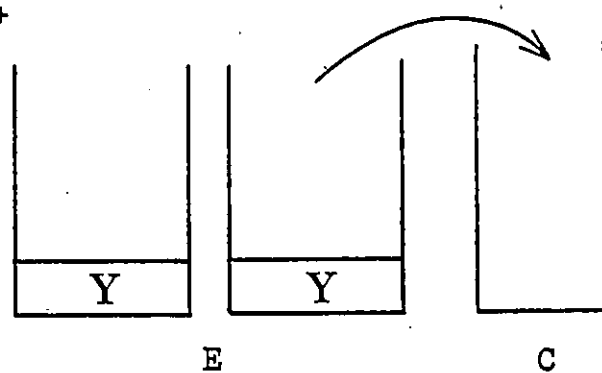
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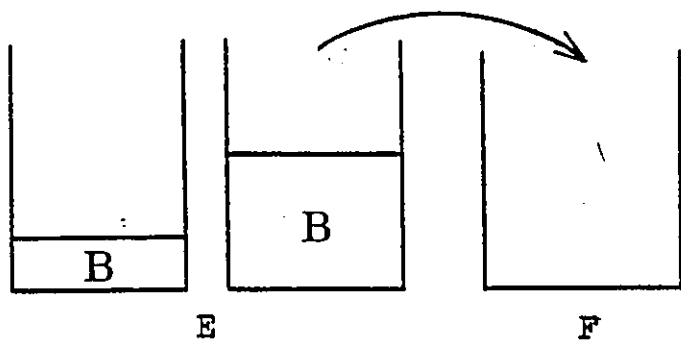
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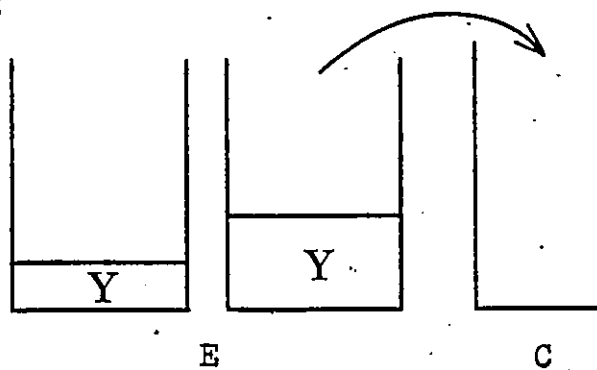
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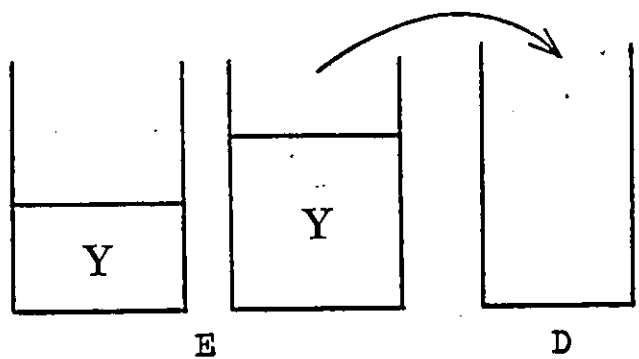
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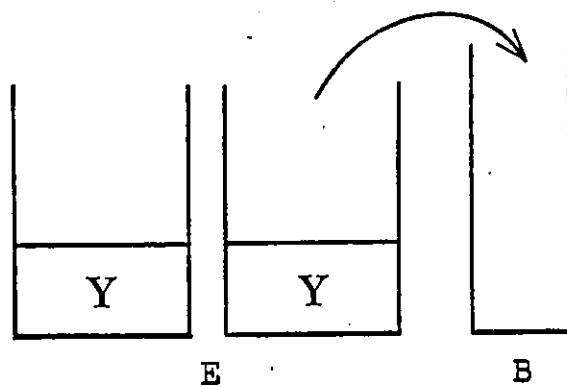
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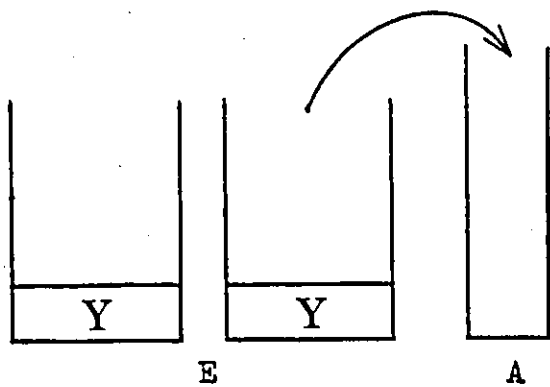
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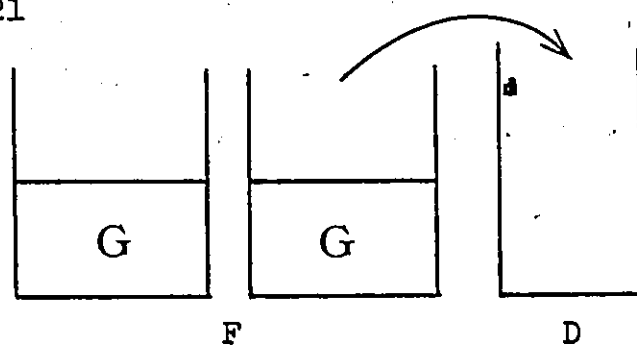
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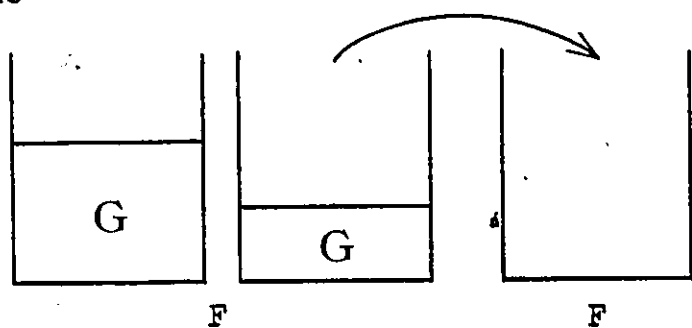
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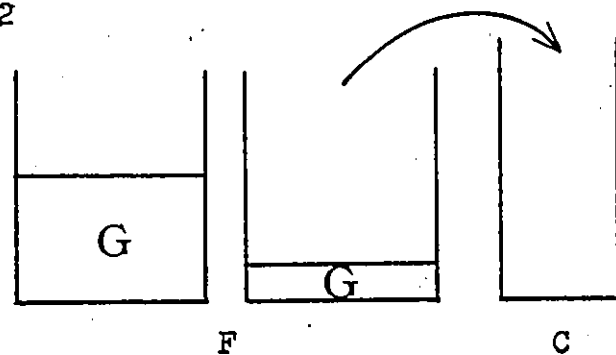
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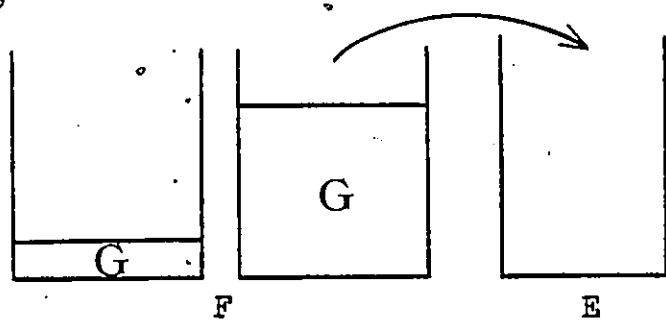
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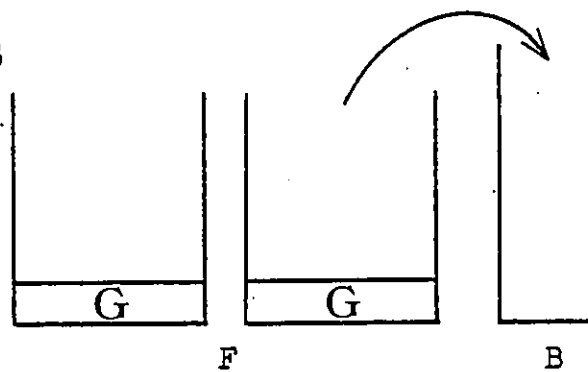
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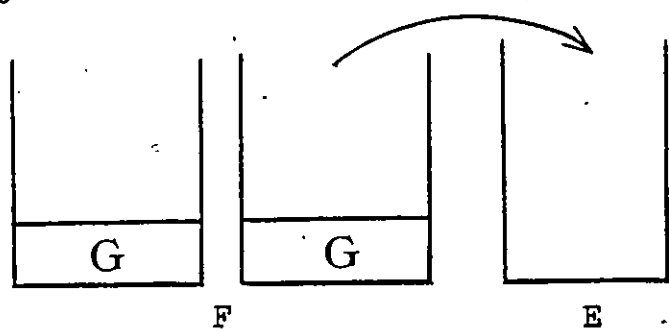
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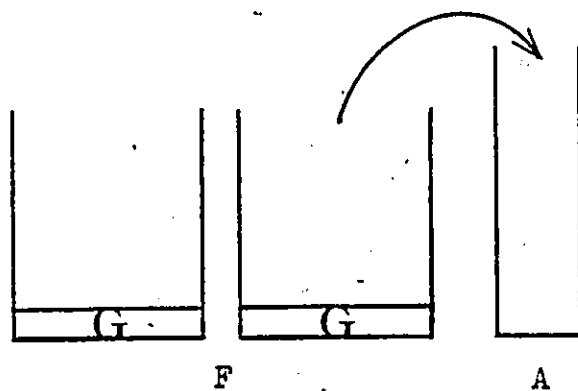
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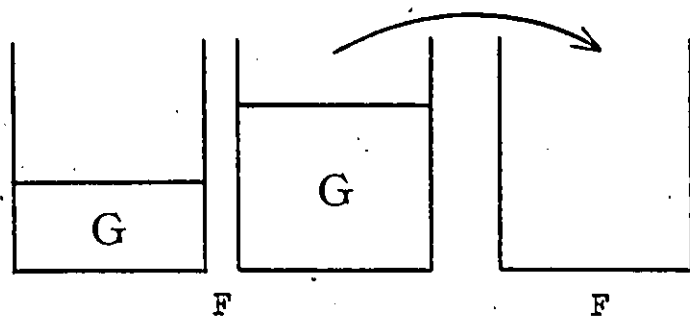


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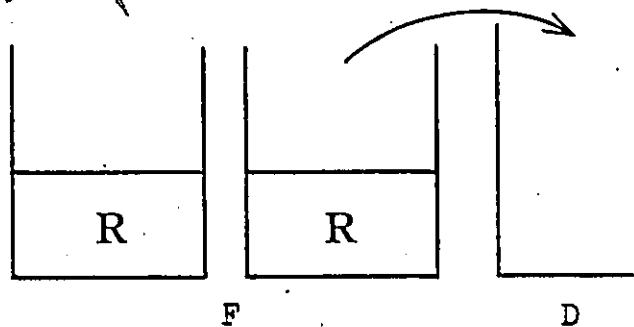


Phase IV - Training

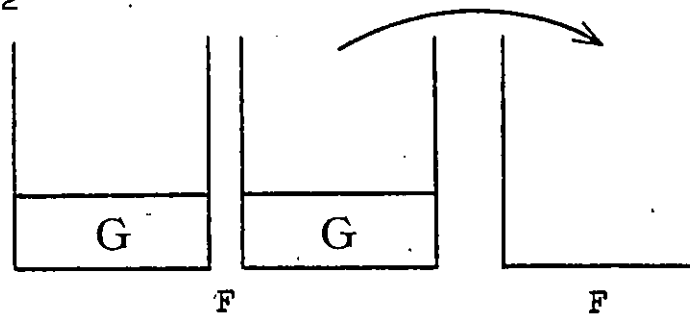
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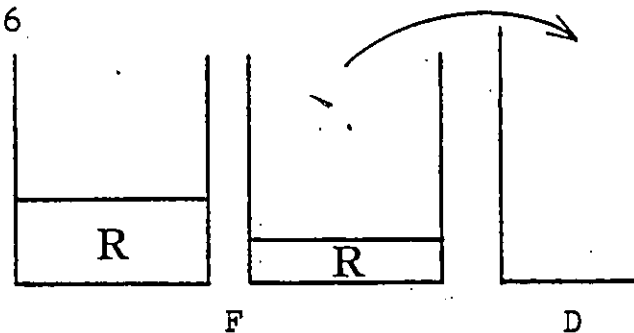
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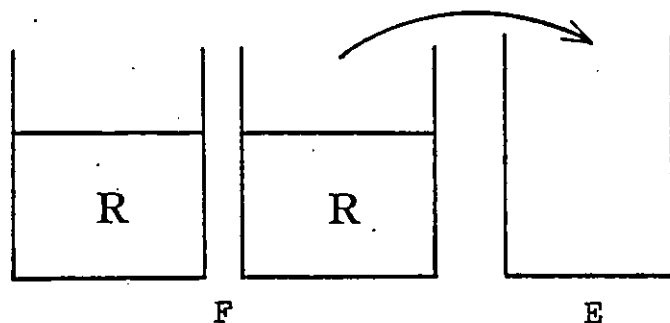
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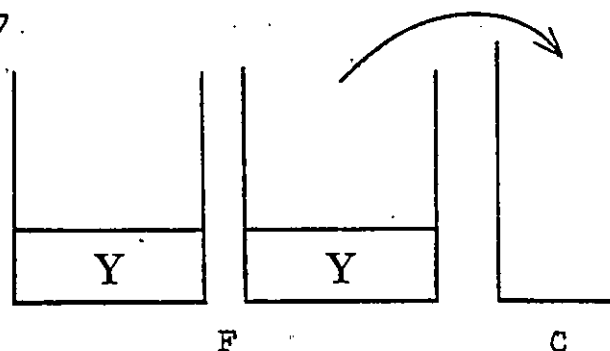
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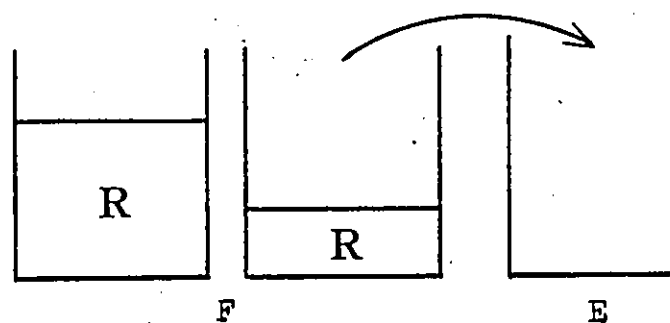
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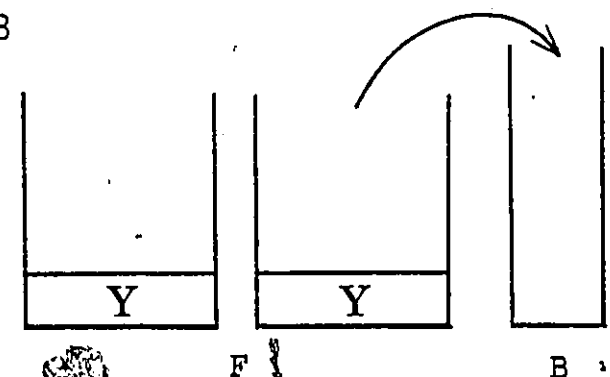
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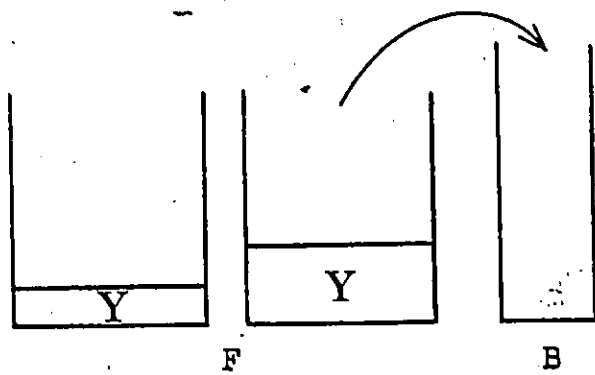
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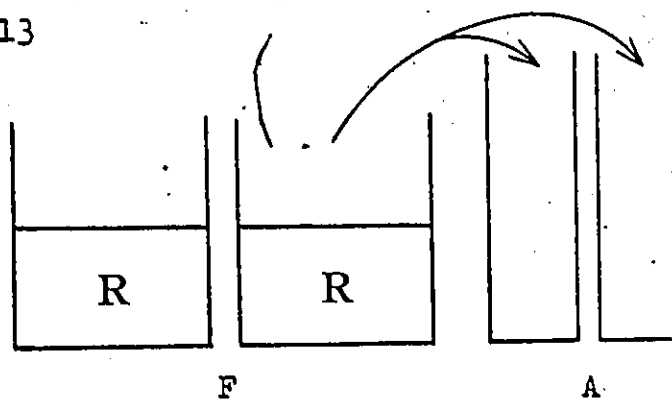
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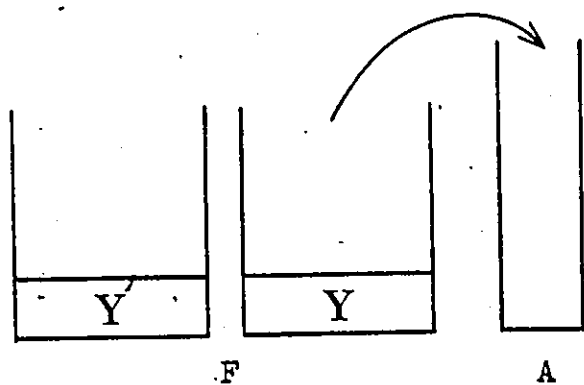
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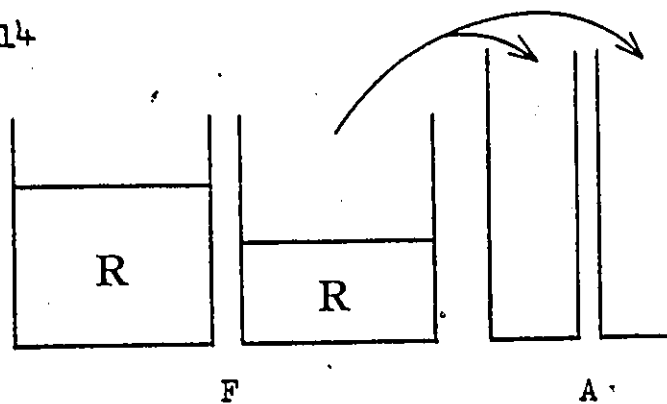
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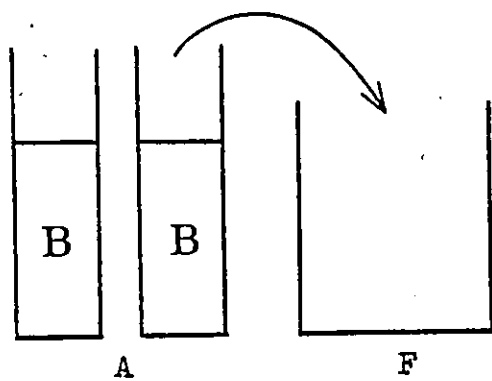
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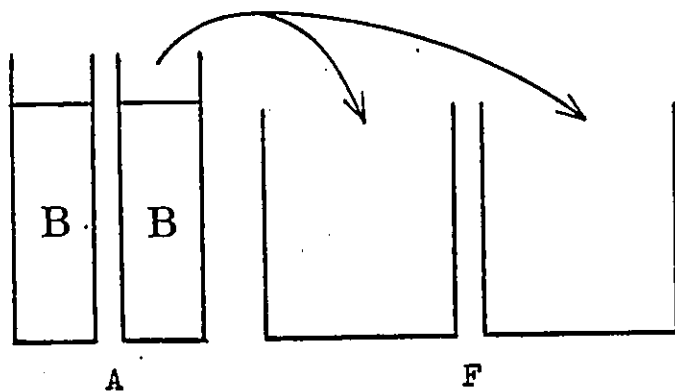
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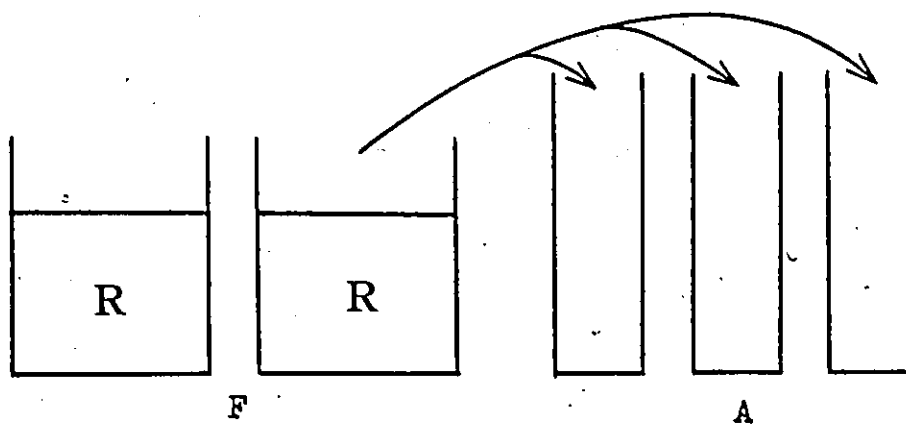
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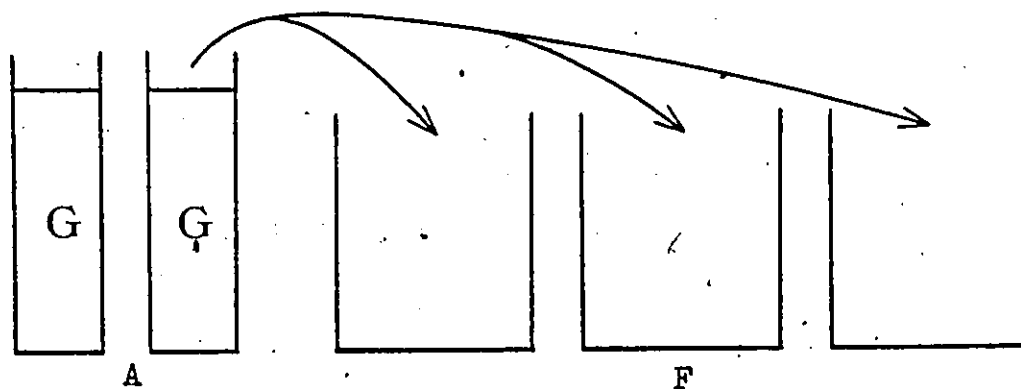
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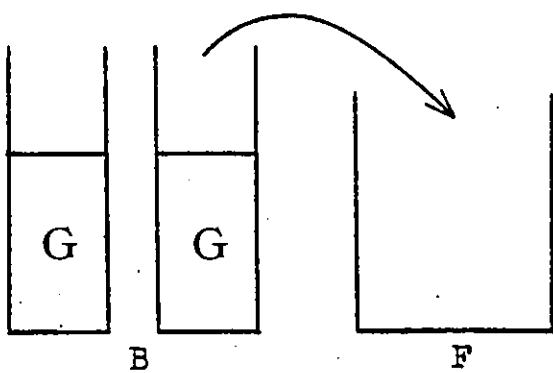
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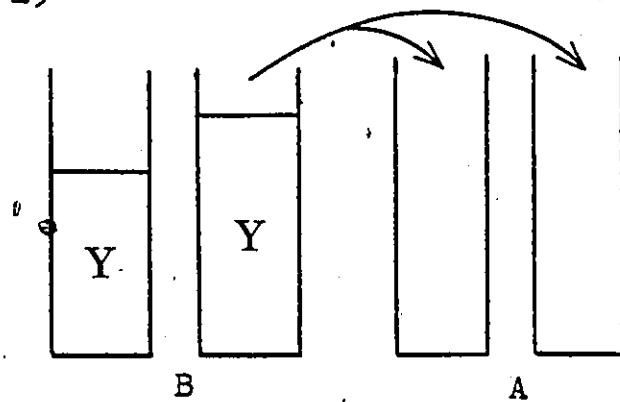
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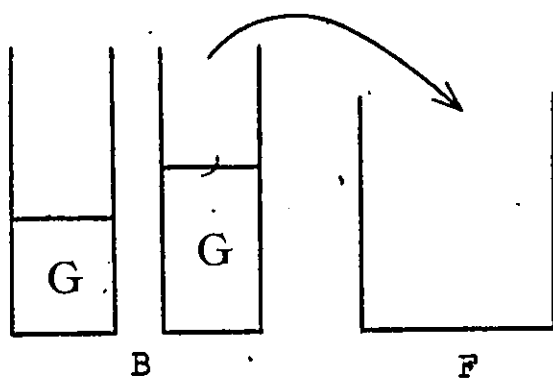
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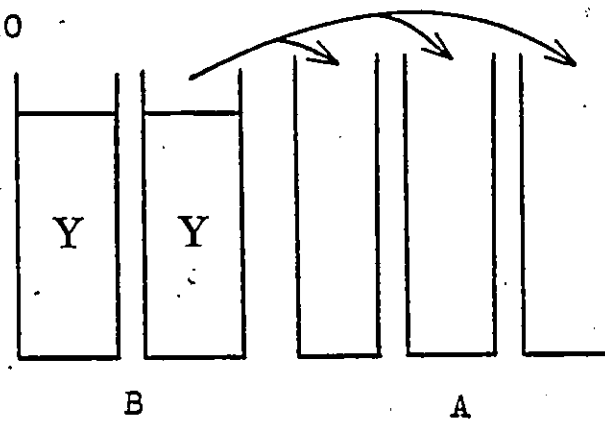
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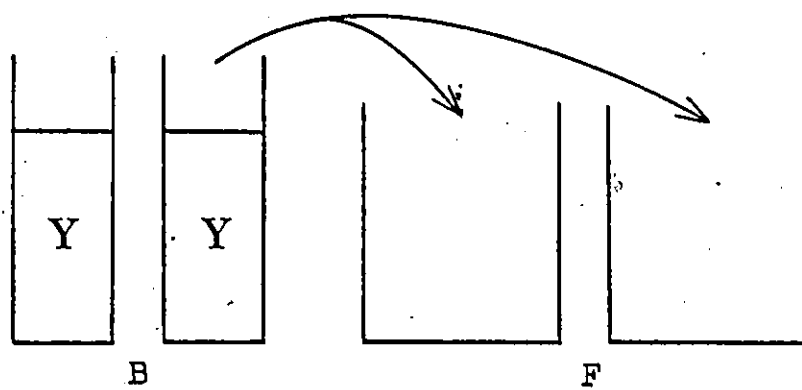
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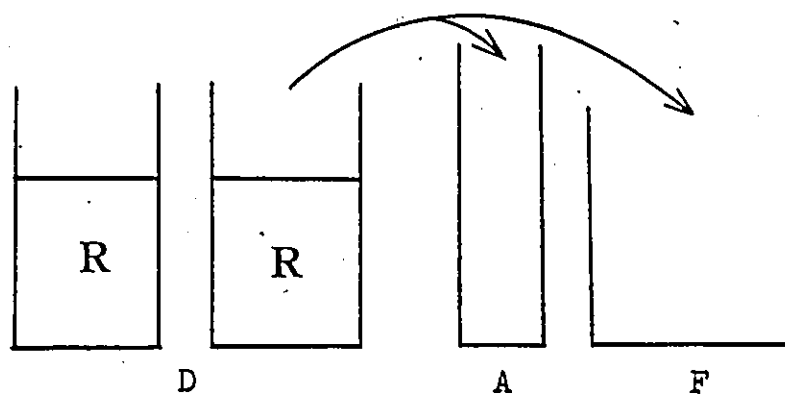
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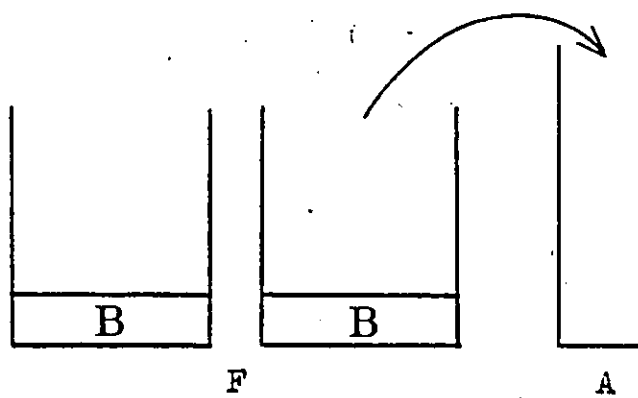
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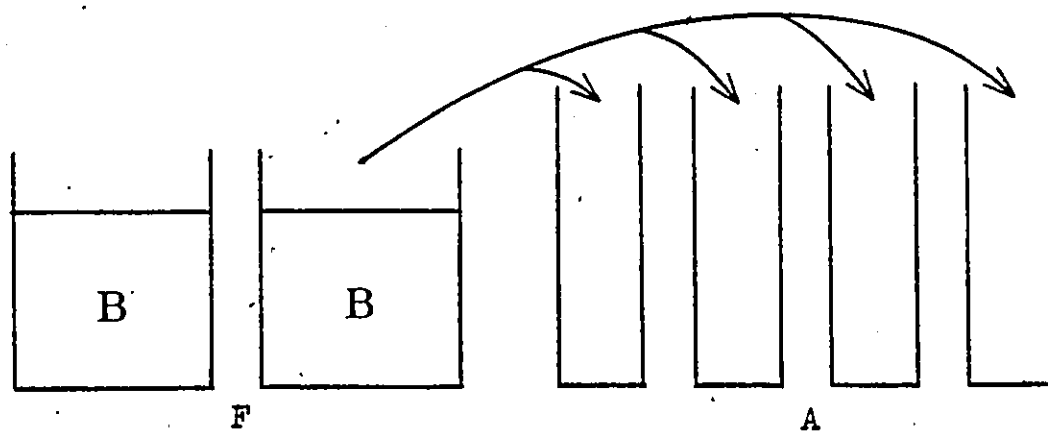
22



23



24



APPENDIX 7

PRETEST AND POSTTEST RECORD FORM

PRETEST AND POSTTEST RECORD FORM

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Name _____ Date of Birth _____

School _____ Age _____ Sex: M
F

Items	Rs	Explanations
Pretest II		Date _____
Liquid (orange colour) 1		
2		
3		
Clay 4		
5		
6		
7		
8		
Total correct Rs		
Posttest I		Date _____
Sand 1		
2		
3		
Plasticine 4		
5		
6		
7		
8		
Total correct Rs		
Posttest II		Date _____
Sand 1		
2		
3		
Plasticine 4		
5		
6		
7		
8		
Poker chips 9		
Pennies 10		
Total correct Rs		

APPENDIX 8

SUBSTANCE CONSERVATION TRAINING RECORD FORM

SUBSTANCE CONSERVATION TRAINING RECORD FORM

Name _____ Date of Birth _____ Age _____

Date:

Phase I _____ Phase II _____ Phase III _____ Phase IV _____

School _____

Sex: M
FCode: R - right response - reinforce
W - wrong response

Phase I		Phase II		Phase III		Phase IV	
A	B	A	B	A	B	A	B
1.	_____	1.	_____	1.	_____	1.	_____
2.	_____	2.	_____	2.	_____	2.	_____
3.	_____	3.	_____	3.	_____	3.	_____
4.	_____	4.	_____	4.	_____	4.	_____
5.	_____	5.	_____	5.	_____	5.	_____
6.	_____	6.	_____	6.	_____	6.	_____
7.	_____	7.	_____	7.	_____	7.	_____
8.	_____	8.	_____	8.	_____	8.	_____
9.	_____	9.	_____	9.	_____	9.	_____
10.	_____	10.	_____	10.	_____	10.	_____
11.	_____	11.	_____	11.	_____	11.	_____
12.	_____	12.	_____	12.	_____	12.	_____
13.	_____	13.	_____	13.	_____	13.	_____
14.	_____	14.	_____	14.	_____	14.	_____
15.	_____	15.	_____	15.	_____	15.	_____
16.	_____	16.	_____	16.	_____	16.	_____
17.	_____	17.	_____	17.	_____	17.	_____
18.	_____	18.	_____	18.	_____	18.	_____
19.	_____	19.	_____	19.	_____	19.	_____
20.	_____	20.	_____	20.	_____	20.	_____
21.	_____	21.	_____	21.	_____	21.	_____
22.	_____	22.	_____	22.	_____	22.	_____
23.	_____	23.	_____	23.	_____	23.	_____
24.	_____	24.	_____	24.	_____	24.	_____
25.	_____	Total	_____	Total	_____	Total	_____
26.	_____	Time	_____	Time	_____	Time	_____
Total	_____						
Time	_____						

APPENDIX 9

ABSTRACT OF

Cognitive Advancement in

Mentally Retarded Adolescents and Adults

ABSTRACT OF

Cognitive Advancement in
Mentally Retarded Adolescents and Adults¹

The purpose of the present study was to accelerate the conservation of substance (as described by Piaget) in mentally retarded adolescents and adults. It was hypothesized that a greater proportion of experimental group subjects would become conservers after training than the control group subjects. It was further hypothesized that the experimental group subjects would give a greater proportion of conservation responses after training than the control group subjects.

The subjects were 48 non-conserving mentally retarded adolescents and adults who were residents of two institutions in the province of Ontario. These subjects were divided into an experimental group (N = 25) and a control group (N = 23). The experimental group subjects were given eight half-hour individual training sessions of conservation of substance in four consecutive days with two sessions daily. Correct responses were reinforced immediately with edible goodies or money. The control group subjects received no training. However they were seen individually for an equal number of sessions for exercises of discrimination task. They were also

¹ Fay C. F. Tang, doctoral thesis presented to the School of Graduate Studies of the University of Ottawa, Ontario, 1979, ix-142 p.



reinforced in random fashion with the same number of reinforcers given to the experimental group subjects.

All of the subjects were posttested individually one week and four weeks after the training. They were reinforced after each posttest session.

Data were analysed by using a normal approximation to the binomial test and a corrected χ^2 technique.

The results support the hypotheses. Twenty-eight percent of the experimental group subjects attained the conservation operation; none of the control group subjects did so. The experimental group subjects gave 43.4% of the total posttests maximum conservation responses and the control group subjects gave only 4.2%.