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THE EFFECTS OF TRAINING DESIGNED TO  
ACCELERATE PIAGETIAN CONSERVATION  
IN CHILDREN ON WISC SUBTEST SCORES

by

Leland J. Winger, Jr.

A thesis submitted in partial fulfillment  
of the requirements for the degree

of

Master of Science

in

Psychology

Approved:

UTAH STATE UNIVERSITY  
Logan, Utah

1973

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Leland J. Winger, Jr.

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## ABSTRACT

The Effects of Training Designed to Accelerate Piagetian  
Conservation in Children on WISC Subtest Scores

by

Leland J. Winger, Jr., Master of Science

Utah State University, 1973

Major Professor: Dr. Elwin C. Neilsen  
Department: Psychology

The purpose of this study was to test experimentally for generalization effects to certain WISC subtests from training designed to accelerate Piagetian conservation in children.

Forty-five subjects were randomly selected for participation in this study, which involved a pretest-posttest control group design. All subjects were pretested on a Conservation Test and on the Information, Arithmetic, Picture Arrangement, and Object Assembly subtests from the WISC. Subjects found to be conservers on the Conservation pretest were excluded from the study. Subjects from the experimental group found to be non-conservers on the Conservation pretest were taught conservation principles using several different tasks adapted from Piaget's experiments. Following the instructional periods, all subjects were posttested using the same measures used for pretesting.

## ABSTRACT (Continued)

The results indicated that Piagetian conservation can be experimentally induced in previously non-conserving children, but there was no significant generalization from the induced conservation to the WISC subtests.

( 53 pages)

## INTRODUCTION

Piaget (1961), Piaget and Inhelder (1956), and Piaget, Inhelder and Szeminska (1960) have demonstrated that Piaget's theory of the developmental nature of conservation in children is supported by empirical data. That the principles of conservation can be learned through planned experience has also been demonstrated (Smedslund, 1961; Wallach & Sprott, 1964; Beilin, 1965; Bruner, 1966; Sigel, Roeper & Hooper, 1966; Kingsley & Hall, 1967; Mackay & Kilkenney, 1968; Richards, 1968; Smith, 1968; Bearison, 1969; Gelman, 1969; Minichiello & Goodnow, 1969; Rothenberg & Orost, 1969; Halford & Fullerton, 1970; Lister, 1970; Overbeck & Schwartz, 1970; Roll, 1970; Brainerd & Allen, 1971a, 1971b; Halford, 1971; Murray, 1972). Piaget, however, has maintained that at least two basic questions remain unanswered about teaching conservation principles. First, is the learning lasting; and second, is generalization or transfer to related behaviors possible with conservation thus learned? A great deal of research has resulted from the first question, and an attempt will be made in the review of literature section of this paper to answer that question on the basis of the studies that have been done. The second question is the basis for this study, and research relating to this question will also be presented in the review of literature section of this paper.

Research in the area of Piaget's concept of conservation has shown that ability to conserve, as measured by Piagetian type tests, is positively



correlated with I. Q. measures (Elkind, 1961; Figenbaum, 1963; Goldschmid, 1967; Richards, 1968; Bat-Haee, Mehryer, & Sabharwal, 1972; Gaudia, 1972). Significant correlations between level of conservation attainment and mental age have also been reported (Mannix, 1960; Goldschmid, 1967; Richards, 1968; Stearns & Borkowski, 1969; McManis, 1969). Elkind (1961), Goldschmid (1967), and Bat-Haee, Mehryer and Sabharwal (1972) have reported positive correlations between WISC subtests scores and conservation test scores. In Elkind's 1961 study, five WISC subtests were found to significantly correlate with conservation scores beyond the .01 level. Dudek, Lister, Goldberg and Dyer (1969) and Bat-Haee, Mehryer and Sabharwal (1972) have concluded that Piagetian tasks and WISC measures of intelligence both appear to be sampling cognitive processes which are highly related.

Since Piagetian tasks and WISC subtests both appear to be sampling highly related cognitive processes, and since conservation can be experimentally induced through training, then what effect will experimental induction of conservation have on the WISC subtest scores of the subjects involved? Would such a transfer, if it occurred, result in significantly different WISC subtest scores? Only one research report on this question could be found in the literature reviewed (Richards, 1968). The lack of a control group, however, raises questions about Richards's findings.

The problem of this study is, then, the lack of research concerning the effect of training designed to accelerate childrens' acquisition of Piagetian conservation on WISC subtest scores.

## REVIEW OF LITERATURE

### Theoretical Background

The present research focuses on Piaget's concept of conservation. For Piaget, the transition in a child from non-conservation to conservation involves a change from pre-operational to concrete operational thought (Flavell, 1963). In order to better understand what is meant by the above Piagetian terms and to establish a Piagetian perspective for this study, it is deemed pertinent to present a general, brief discussion of Piaget's theory of intellectual growth.

For Piaget, intellectual growth or activity cannot be separated from the "total" functioning of the organism. Thus, he considers intellectual functioning as a special form of biological activity (Piaget, 1952). This does not mean that mental behavior can be attributed to biological functioning, but rather that the concepts of biological developments are useful for looking at intellectual development. Biological acts are acts of adaptation to the physical environment and organizations of the environment whereas cognitive acts are acts of organization of and adaptation to the perceived environment. Intellectual and biological activity, then, are both part of the overall process by which an organism adapts to the environment and organizes experience (Wadsworth, 1971).

Piaget is a developmental psychologist and as such views intellectual growth as following a continuum from birth to adulthood. This continuum

he divides into four major periods which can further be broken down into subperiods, stages, and sub-stages. Operating across all four periods of cognitive development are three important functional processes. These processes are assimilation, accommodation, and equilibrium (Piaget, 1952; Flavell, 1963; Lavatelli, 1970; Wadsworth, 1971). Assimilation is the process of incorporating environmental events into the existing cognitive structure of the individual. Accommodation refers to adjusting the existing framework of thought so as to incorporate the data one has assimilated. The balance between assimilation and accommodation is referred to by Piaget as equilibrium.

An act of intelligence in which assimilation and accommodation are in balance or equilibrium constitutes an intellectual adaptation. Adaptation occurs whenever a given organism-environment interchange modifies the organism such that further interchanges, favorable to its preservation, are enhanced (Flavell, 1963).

Intellectual structures that organize events as they are perceived by the organism into groups according to common characteristics are called schema. Simplistically, schema can be thought of as concepts or categories (Wadsworth, 1971). It is these schema into which new data is absorbed by assimilation. New schema are created or old schema are modified by the process of accommodation.

The above processes apply to intellectual functioning at all levels of cognitive development. Now, considering the developmental nature of Piaget's theory, the periods of development will be discussed.

Various authors dealing with the periods of cognitive growth have given different presentations. Berlyne (1957) and Maier (1965) present five major stages representing Piaget's periods of cognitive growth. Hunt (1961) and Flavell (1963) discuss the same sequence under three main periods. Inhelder and Piaget (1958), Piaget (1967) and Wadsworth (1971) consider four main periods in the development of intelligence. For purposes of this study, the latter method will be adopted.

1) Period of Sensory-Motor Intelligence (0-2 years). During this period, behavior is primarily motor. The child does not yet "think" conceptually. Intellectual organization is a practical one; it involves simple perceptual and motor adjustments to things rather than symbolic manipulations of them. Piaget (1952) discriminates six major steps or stages in the overall developmental sequence of the sensory-motor period.

Stage 1 (0-1 month). Behavior of the infant at this stage is entirely reflexive (sucking, grasping, crying, etc.). He is unable to differentiate between self and environment and has no concept of objects in his environment. The infant is completely ego-centered.

Stage 2 (1-4 months). The infant begins to become aware of objects in his environment. Reflexes start to change and alter their form as a function of experience. Initial coordination of schema (i.e. eye-ear coordination) begins to take place.

Stage 3 (4-8 months). The infant becomes increasingly oriented toward objects and events beyond his body. He will become very interested in and will reproduce events that occur that are unusual to him (i.e. ring a bell repeatedly). He remains basically egocentric; he sees himself as the primary cause of all activity.

Stage 4 (8-12 months). The child's coordination of schema increases. Behavior patterns emerge that constitute the first clear acts of intelligence. The child begins to anticipate events and may "use means to attain ends," for example, he may anticipate his mother's leaving when she puts on her coat and then cry to prevent her from leaving.

Stage 5 (12-18 months). The infant begins to form new schema to solve new problems. He experiments; he devises and tests new response patterns or schema. According to Piaget (1950), the child is now exhibiting truly intelligent behavior.

Stage 6 (18-24 months). During this stage the child moves from the sensory-motor level of intelligence to representational intelligence. He is able to mentally represent objects and solve problems through representation cognitively.

2) Period of Preoperational Thought (2-7 years). This period is characterized by the development of language and rapid conceptual development. The child evolves from one who functions primarily in a sensory-motor mode to one who functions primarily in a conceptual-symbolic mode. Socialization of the child's behavior takes place with

the clear interchange of ideas between people brought about by the development of language.

The child's thinking is egocentric. He cannot see the viewpoint of another. He believes that everyone thinks the same way he does, and that everyone thinks the same things he does. As a result, the child never questions his own thoughts because they are, as far as he is concerned, the only thoughts possible and consequently must be correct. He concludes that evidence contradicting his thoughts must be wrong, since to him, his thought is correct.

During this period the child is perceptually oriented. Perceptual evaluation dominates cognitive evaluation. The child centers on one variable only (i.e. width) in dealing with environmental objects. He lacks the ability to coordinate variables (i.e. width and height). For example, the quantity of a given amount of clay will be perceived as changing when molded into a different shape. The child centers perceptually on either the height or width of the clay, ignoring the other dimension. Static situations are dominate over transformations.

Irreversibility is another characteristic of this stage, reversibility being defines as "the permanent possibility of returning to the starting point of the operation in question" (Inhelder and Piaget, 1958, p. 272). In the clay quantity example above, the child cannot comprehend the possibility of molding the clay back into the original shape to determine that it is still the same quantity.

Reversibility and the ability to attend to transformations are necessary operations for the child to develop in order to conserve. Conservation is defined as the understanding that certain empirical properties such as quantity or weight remain invariant, despite certain transformations such as displacing objects, sectioning an object into pieces, or changing its shape (Inhelder and Piaget, 1958). Obviously then, since the child is unable to attend to transformations and since his thought is irreversible at the period of preoperational thought he cannot conserve at this point. He is now beginning, however, to have intuitive notions about quantity and transformations. In the clay quantity problem (which represents a problem in conservation of mass) discussed earlier, the child might maintain two equal quantities of clay to remain equal if the shapes are not a great deal different. However, if one quantity of clay is shaped drastically different from the other, the child's tendency to center perceptually is evoked and he will not maintain the constancy of the quantities. The transition into the period of concrete operations marks the beginning of conservation in the child.

3) Period of Concrete Operations (7-11 years). During this period, a child's reasoning processes become logical. When faced with a discrepancy between thought and perception, as in conservation problems, the concrete operational child makes cognitive and logical decisions as



opposed to perceptual decisions. He is not perception bound. The child cannot, however, yet apply his logic to problems that are hypothetical or purely verbal.

Schema for the operations of seriation, classification, and reversibility appear. The child is free of thought characterized by egocentrism and inability to follow transformations. In those areas where a child has attained concrete thinking, static situations are subordinate to transformations. Now any static state is conceived as the outcome of transformations.

As mentioned earlier, the ability to solve conservation problems emerges during this period. However, despite the similarity among various conservation tasks (i.e. conservation of number, of area, of volume, etc.) they are not achieved at the same time (Flavell, 1963). For example, according to Wadsworth (1971) conservation of number occurs around ages 6 to 7, conservation of area around ages 7 to 8, and conservation of volume around ages 11 to 12. Each type of conservation concept, however, shows about the same developmental trend: 1. no conservation; 2. a state of transition in which the child tentatively hypothesizes conservation for some transformations but denies it for others; and 3. a logically certain assertion of conservation in the case of all transformations for the type of conservation concept in question (Copeland, 1970).

4) Period of Formal Operations (11-15 years). The child's cognitive structures reach their greatest level of development during this period, and the child becomes able to apply logic to all classes of problems. He can deal effectively not only with reality, but also with the world of pure possibility. He is able to solve verbal problems, hypothetical problems, and use scientific reasoning. He can formulate tests, reject or accept hypotheses through the process of deductive reasoning, all on the basis of his own logical operations.

#### Conservation Research Based on Piaget's Theory

Research concerning Piagetian conservation as relates to this study will now be reviewed in some detail.

#### Experimental induction of conservation

This study is based on the assumption that acquisition of conservation can be experimentally induced or accelerated in children. There is a vast amount of research that supports this assumption (Smedslund, 1961; Wallach & Sprott, 1964; Beilin, 1965; Bruner, 1966; Sigel, Roper, & Hooper, 1966; Kingsley & Hall, 1967; Mackay & Kilkeny, 1968; Richards, 1968; Smith, 1968; Bearison, 1969; Gelman, 1969; Minichiello & Goodnow, 1969; Rothenberg & Orost, 1969; Halford & Fullerton, 1970; Lister, 1970; Overbeck & Schwartz, 1970; Roll, 1970; Brainerd & Allen, 1971a, 1971b; Halford, 1971; Murray, 1972). Reviewing the literature, this writer found only three studies since 1965 that failed

to accelerate or induce the type of conservation with which they were concerned (Gruen, 1965; Smith, 1968; Christie & Smothergill, 1970).

The above cited studies represent examples of several types of conservation (i.e. conservation of number, of length, of area, etc.). Brainerd and Allen (1971a) reviewed the literature from 1962 to 1969 concerning conservation of number and concluded that that type of conservation can be experimentally induced. Experiments by Halford and Fullerton (1970) and Roll (1970) have given support to this conclusion. A review of research from 1965 to 1969 indicates that conservation of length can also be experimentally induced (Brainerd & Allen, 1971a). A similar finding was arrived at for the conservations of weight and mass by Brainerd and Allen (1971a) who reviewed the research done in these areas from 1961 to 1968. In a 1970 study, Overbeck and Schwartz also provided support for the experimental induction of the conservation of weight by successfully inducing weight conservation. The non-developmental attainment of conservation has also been reported for the conservation of quantity taken either as such or broken down into the sub-units of conservation of continuous quantities (Mackay & Kilkenny, 1968; Bearison, 1969; Minichiello & Goodnow, 1969; Halford, 1971). On the basis of the above, the experimental induction of conservation definitely seems attainable. Conservation tasks used in this research will be selected primarily from the above indicated areas.

Piaget (1967) has questioned the permanence of conservation attained through learning experiences. Research in this area, however, has tended to support the permanence of induced conservation. Mackay and Kilkenny (1968) and Gelman (1969) administered a second posttest two weeks after the first posttest had indicated that conservation had been induced in non-conserving children. Results of the second posttest showed the induced conservation to be stable. Further support for the durability of induced conservation was provided by Rothenberg and Orost (1969). Posttests administered two and three months after induction of conservation showed the conservation had been retained. Using a sample of educably sub-normal children, Lister (1970) reported the durability of induced conservation to extend to at least five months. Bearison (1969) has reported that the effects of training that induced conservation, in his study, were maintained over a seven month period. These studies do not prove the permanence of induced conservation. They do indicate a likelihood that induced conservation may be permanent. More research is needed in this area, possibly with a longer time lapse between induction of conservation and the delayed posttest. It is recognized, however, that with a longer delay it would be difficult to distinguish with a posttest whether the results after the time lapsed were due to the previous training or to the natural development of conservation as proposed by Piaget.

### Conservation as related to intelligence

Since this study is concerned with the effects of accelerated or induced conservation on certain WISC subtests, research relating conservation to intelligence measures will be reviewed here.

Figenbaum (1963) reported a positive relationship between I. Q. as measured by Stanford-Binet intelligence scores and conservation test scores. He concluded that age is not sufficient to account for differences in conservation, but rather, that there is an interaction between general intelligence and age in the attainment of conservation. Significant correlations between scores on Piagetian type conservation tests and WISC scores have been reported by Elkind (1961). The Information, Arithmetic, Picture Arrangement, Object Assembly, and Coding subtests scores and the verbal and full scale scores correlated with scores on Piagetian type conservation tests beyond the .01 level of significance. Goldschmid (1967) reported positive correlations between conservation test scores and various measures of intelligence. Intelligence test scores were based on Stanford-Binet, Otis (school P), or Pinter-Cunningham (school L) test scores, all correlations were significant beyond the .01 level. He also found a positive correlation between scores on the WISC vocabulary subtest and scores on the conservation test which was significant at the .001 level.

Using mentally retarded children as subjects, Richards (1968) reported conservation scores correlated with I. Q., WISC Information

Subtest scores, and WISC Picture Arrangement subtest scores. These correlations were all significant beyond the .01 level. Positive correlations between scores on three measures of intelligence and total conservation score was reported by Bat-Haee, Mehryer and Sabharwal (1972). Measures of intelligence used included the Ravens Colored Progressive Matrices, the WISC Vocabulary subtest, and the WISC Arithmetic subtest. The total conservation score included mass, weight, and volume conservation items. Correlations significant beyond the .01 level also have been reported between conservation test scores and I. Q. as measured by the Peobody Picture Vocabulary Test within all groups and at every level of age tested (Gaudia, 1972).

Less directly, Mannix (1960) reported a higher relation between level of conservation and mental age than between level of conservation and chronological age. He did not say which instrument he used to determine mental age, however, similar results were reported by Stearns and Borkowski (1969). They administered the Stanford-Binet to obtain mental age scores. Goldschmid (1967) derived mental age scores from either the Stanford-Binet, the Otis (school P), or the Pinter-Cunningham (school L) tests for his subjects, and found that mental age scores were positively correlated with conservation test scores significant at the .001 level. Lorge-Thorndike mental ages for normals and Stanford-Binet mental ages for retarded subjects have also been reported (McManis, 1969) to be significantly related to

conservation test scores. Richards (1968) reported the correlation between mental age and conservation scores to be significant beyond the .01 level.

It appears that measures of intelligence and conservation tasks are both sampling cognitive processes which are highly related. Similar conclusions have been reported by Dudek, Lester, Goldberg and Dyer (1969) and Bat-Haee, Mehryer and Sabharwal (1972) concerning Piagetian tasks and WISC measures of intelligence.

#### Generalization of induced conservation

This research is designed to test for a possible generalization effect from training designed to accelerate conservation to certain WISC subtests. In view of this, studies concerned with generalization of induced conservation will now be reviewed.

In a review of literature published from 1961 to 1969, Brainerd and Allen (1971a) concluded that those studies that have looked for specific transfer of induced conservation have, without exception, found it. By "specific transfer" is meant transfer to parallel problems of the same concept. This actually tells us little or nothing about generalization of the induced conservation if we consider that true attainment of a conservation concept (i.e. conservation of mass) implies that the child can then solve most, if not all, conservation problems in the area of that concept. A similar finding to Brainerd and Allen's was reported by Murray (1972). Along the same line, Overbeck & Schwartz (1970)

reported that conservation of weight induced using continuous material [i. e. clay] generalized to conservation of weight using discontinuous materials [plastic loops]. Again, this would be expected if conservation of weight had truly been induced. An actual grasp of the concept should not be affected by differences in materials.

Several examples of non-specific transfer of induced conservation have also been reported. Some tendency for those children who experimentally acquired conservation of number to also acquire conservation of length and/or substance has been noted (Gruen, 1965). Approximately 60% nonspecific transfer of training from induced conservation of length and number to conservation of mass and liquid amount (continuous quantities) was reported to Gelman (1969) using one of his training techniques. Rothenberg and Orost (1969) induced conservation of number in kindergarten children and found a generalization effect to conservation of discontinuous quantity. Also concerning generalization from conservation of number, Wallach, Wall and Anderson (1967) experimentally induced conservation of number and then found that the training effects generalized to only one of eight children on liquid conservation (continuous quantity). They concluded that there was no transfer effect. A significant transfer effect was noted by Bearison (1969). He induced conservation of continuous quantity in his subjects and then tested for transfer effect to the conservation of area, mass, discontinuous quantity, number, and length. The transfer effect was statistically significant beyond the .05 level for all types of conservation



tested. Lister (1970) using totally non-conserving educably sub-normal children as subjects, induced conservation of volume. He then tested for and found generalization to conservation of weight and substance. Kingsley and Hall (1967) reported that children trained to conserve length and weight improved significantly more at conserving substance than did control groups. Murray (1972) induced or accelerated conservation of number, substance, continuous quantities, weight, discontinuous quantities, and two-dimensional space in non-conserving subjects. He found a significant transfer effect among previous non-conservers to conservation of length and area. His results are somewhat clouded, however, by his failure to pretest for conservation of length and area.

In reviewing the literature, only one study was found that related non-specific transfer of induced conservation to WISC subtests. Richards (1968) induced conservation of number in mentally retarded children through teaching. As part of his study he tested for generalization effects to two WISC subtests, Information and Picture Arrangement. An increase in performance on both WISC subtests was noted after induction training was completed. But the absence of a control group raises questions about Richards's finding. He concluded, "Very tentatively, the data of this study supports the hypothesis that teaching children conservation can improve performance in other areas" (Richards, 1968, p. 50). This finding relates directly to the present study.

Summarizing this section, it appears that specific transfer of induced conservation is attainable. The data on non-specific transfer to dissimilar conservation concepts, however, is still inconclusive. It has been shown for some studies, but not for others. Expectation of non-specific transfer to WISC subtests is very tentative on the basis of the one study reported here.

## PURPOSE AND OBJECTIVES

The purpose of this study is to test experimentally for generalization effects to certain WISC subtests from training designed to accelerate Piagetian conservation in children. Piaget himself has indicated that the possibility of generalization to related behaviors should be considered when an attempt is made to induce learning experimentally (Piaget, 1967). In view of this, the preceding review of literature has demonstrated: a) The experimental acceleration or induction of conservation is attainable, and b) There is a relationship between Piagetian levels of conservation development and standard I. Q. measures, in particular WISC measures.

The preceding review of literature also included one study (Richards, 1968) that tentatively supported the hypothesis that teaching children conservation can improve performance in other areas. This conclusion was reached when an increase in performance on two WISC subtests was noted after conservation acceleration training was successful in accelerating or inducing conservation. Lack of a control group in Richards's study makes it difficult to account for the increase in performance on the two WISC subtests.

Based on findings from research discussed in the review of literature, the objective of this study is: To determine whether induced conservation, if learned, generalizes to performance on certain WISC subtests.

Hypotheses formulated on the basis of the preceding objective are:

(1) The mean posttest score for the Conservation Test will be significantly higher for the experimental group than for the control group.

(2) The mean posttest score for the Information subtest of the WISC will be significantly higher for the experimental group than for the control group.

(3) The mean posttest score for the Arithmetic subtest of the WISC will be significantly higher for the experimental group than for the control group.

(4) The mean posttest score for the Picture Arrangement subtest of the WISC will be significantly higher for the experimental group than for the control group.

(5) The mean posttest score for the Object Assembly subtest of the WISC will be significantly higher for the experimental group than for the control group.

## PROCEDURES

Population and Sample

Forty-five kindergarten children were used as subjects. They were randomly selected (by assigning the children numbers and then consulting a table of random numbers) from an elementary school in Logan, Utah, and twenty each were assigned randomly to the experimental and the control group by a method similar to that used in selection. The other five children were selected to be used as replacements. As it turned out all five of the replacements were needed. Three members of the initial group of forty children were unavailable for inclusion in the study due to illness. Another child's parents refused to allow their child to participate. A fifth child had recently moved to the United States from San Salvador, and he was excluded from the study due to his inadequate grasp of the English language.

Logan, Utah, is a university town in Northern Utah with a population of about 22,000. The elementary school which the subjects attended (Hillcrest Elementary) was located near the University and the subjects' parents were largely either employed by the University (professors, secretaries, etc.) or students. There was, then, a middle class background bias for the subjects of this study.

### Design

A pretest-posttest control group design was used (Campbell & Stanley, 1971). The following measures were administered as pretests and posttests to each subject during regular school hours:

- 1) Piagetian-type Conservation Test (Appendix A).
- 2) Arithmetic, Information, Picture Arrangement, and Object Assembly subtests from the Wechsler Intelligence Scale for Children.

In order to insure that only nonconservers were included in this study, any subject who scored more than seven points on the conservation pretest was classified as a conserver and excluded from the study. One child was excluded on this basis.

Subjects in the experimental group were given five 30-minute periods of instruction in conservation during which items similar to those used in the Conservation Test were presented and explained to them (Appendix B). One 30-minute period of instruction was given each day for five consecutive school days. After the final instruction period, posttesting was initiated for all subjects and continued on consecutive school days until all subjects had been tested.

### Materials

The Piagetian-type Conservation Test items and the Piagetian Tasks Used for Learning Experiences were adapted by the writer from those presented by Piaget (1961) and Piaget, Inhelder, and Szeminska (1960).

A variety of materials such as macaroni, beans, various shaped containers, sticks, paper clips, and poker chips were used in the presentation of the Piagetian items. On the Conservation Test, subjects were scored one point for each conserving response that they were able to justify by explaining it. Each time a subject gave a correct conserving response, he was asked to explain why he gave that answer. If he was able to do so using the concepts of reversibility, compensation, or invariant quantity, he was scored one point for that item. If the subject was unable to justify his conserving response, or if he gave an incorrect response to the conservation question, a "0" was scored for that item. A complete description of the Conservation Test is presented in Appendix A. A description of the Piagetian Tasks Used for Learning Experiences is presented in Appendix B.

The WISC subtests of Arithmetic, Information, Picture Arrangement, and Object Assembly from a standard WISC test kit were used. These particular subtests were selected on the basis of the finding that they all correlated with Piagetian conservation measures beyond the .01 level of significance (Elkind, 1961).

#### Method

After completion of pretesting, subjects in the experimental group were given five 30-minute periods of instruction in conservation as follows:

Period 1-Conservation of Length.

Period 2-Review, and Conservation of Area.

Period 3-Review, and Conservation of Number.

Period 4-Review, and Conservation of Discontinuous Quantities.

Period 5-Review of all materials covered in periods 1 through 4.

In order to facilitate and expediate instruction during the teaching sessions, subjects in the experimental group were given the instruction periods in groups of five.

Teaching tasks and materials used during the instruction periods are described in Appendix B. Each of the tasks used for instructional purposes was carefully explained to the subjects and reasons were given to the subjects for the equality of the quantities after the transformations. The reasons include reversibility, compensation, or invariant quantity. The subjects were then questioned and re-questioned, as the materials were manipulated, until each subject in the group gave, and was able to justify, conserving answers. To hold the attention of the children and provide motivation, an M&M was given for each correct answer during the learning sessions.

Posttesting began at the completion of the last instructional period and continued on consecutive school days until all subjects were post-tested. Of the remaining 39 subjects, four were unavailable for post-testing. Three of the four were ill with influenza and the other child withdrew from school prior to posttesting.



The above procedures were adapted from those used by Richards (1968).

### Statistical Analysis

To test for the significance of the difference between the mean posttest scores involved in the hypotheses in this study, the analysis of covariance was used (Ferguson, 1966, p. 326) with pretest scores as the covariate.

## RESULTS

Tables 1-5 summarize the results of the analysis of covariance of the mean posttest scores of this study. In all cases the covariate was pretest scores.

Table 1. Analysis of covariance comparing mean posttest scores of the experimental and control groups on the Conservation Test.

	Pretest Means	Posttest Means	Adjusted Posttest Means	F test Value
Experimental Group	2.11	13.82	14.01	138.88
Control Group	2.66	3.61	3.42	

Degrees of Freedom = 1/32 F at .05 level = 4.15 F at .01 level = 7.50

Table 2. Analysis of covariance comparing mean posttest scores of the experimental and control groups on the Information subtest of the WISC.

	Pretest Means	Posttest Means	Adjusted Posttest Means	F test Value
Experimental Group	5.00	5.58	5.52	0.00
Control Group	4.83	5.44	5.50	

Degrees of Freedom = 1/32 F at .05 level = 4.15 F at .01 level = 7.50

Table 3. Analysis of covariance comparing mean posttest scores of the experimental and control groups on the Arithmetic subtest of the WISC.

	Pretest Means	Posttest Means	Adjusted Posttest Means	F test Value
Experimental Group	3.29	3.58	3.80	0.54
Control Group	4.05	4.27	4.07	

Degrees of Freedom = 1/32 F at .05 level = 4.15 F at .01 level = 7.50

Table 4. Analysis of covariance comparing mean posttest scores of the experimental and control groups on the Picture Arrangement subtest of the WISC.

	Pretest Means	Posttest Means	Adjusted Posttest Means	F test Value
Experimental Group	8.94	11.88	11.79	0.70
Control Group	8.77	10.50	10.58	

Degrees of Freedom = 1/32 F at .05 level = 4.15 F at .01 level = 7.50

Table 5. Analysis of covariance comparing mean posttest scores of the experimental and control groups on the Object Assembly subtest of the WISC.

	Pretest Means	Posttest Means	Adjusted Posttest Means	F test Value
Experimental Group	10.94	13.05	13.50	2.67
Control Group	11.88	12.22	11.80	

Degrees of Freedom = 1/32 F at .05 level = 4.15 F at .01 level = 7.50

Considering the above results in terms of the hypotheses to which they pertain, it can be seen in Table 1 that hypothesis 1 was supported in the prediction that the mean posttest score for the experimental group would be significantly higher than the mean posttest score for the control group on the Conservation Test. Significance was obtained at well beyond the .01 level.

Hypotheses 2-5 were not supported. These hypotheses predicted that the mean posttest score for the experimental group would be significantly higher than the mean posttest score for the control group on the Information, Arithmetic, Picture Arrangement, and Object Assembly subtests of the WISC, respectively. As shown in Tables 2-5, none of these posttests score comparisons attained the .05 level of significance.

## DISCUSSION

### Evaluation of Findings

The results of this study indicate that Piagetian conservation can be experimentally induced in previously non-conserving children. This supports the findings of the majority of the research that has attempted to induce conservation in children since 1965. Those studies concerned with the experimental induction of conservation in children are reported in the review of literature.

In teaching conservation to children, the objective was to measure for generalization or transfer to the Information, Arithmetic, Picture Arrangement, and Object Assembly subtests of the WISC. No significant generalization effect was found to any of the subtests.

A generalization effect from training designed to accelerate Piagetian conservation to WISC subtests was hypothesized on the basis of 1. The relationship between Piagetian levels of conservation development and WISC measures of intelligence, and 2. The tentative conclusion by Richards (1968) that teaching children conservation can improve performance in other areas; this conclusion being based on significant increases in posttest scores on the Information and Picture Arrangement subtests of the WISC. Concerning the first factor, it was concluded in the review of literature, on the basis of the research, that Piagetian tasks and WISC measures of intelligence are both sampling cognitive

processes which are highly related. Despite the demonstrated relationship between the Piagetian and WISC measures, this study found no significant generalization from induced conservation to scores on the four WISC subtests used in this study. This is in contradiction to the findings by Richards (1968). Richards reported gains on the Information subtest of the WISC significant beyond the .01 level and gains on the Picture Arrangement subtests of the WISC significant at the .05 level after induction of conservation in his subjects. Due to absence of a control group in Richards study, the cause of the gains in the WISC subtests cannot be determined. He tentatively concluded, however, that teaching children conservation can improve performance in other areas. His conclusion is not substantiated by the results of this study.

It is possible that Richards's findings may be applicable to mentally retarded subjects only, since his study involved mentally retarded subjects and the present study did not. Further research is necessary to test this possibility.

### Observations on Methods and Procedures

#### Selection of subjects

The present research was limited by the use of subjects from only one source: Hillcrest Elementary School, Logan, Utah. The socio-economic background of the students at Hillcrest Elementary School was largely middle class. The results of the study would have wider

application had subjects from a number of elementary schools been utilized, reflecting a more heterogenous grouping of pupils based on socio-economic background. It was decided to limit the selection of subjects to one elementary school, however, because of the great deal of time and materials involved in testing and teaching in this study and, consequently, the difficulty that would have been encountered in moving from one site to another.

Also concerned with selection of subjects, but in a different area than considered above, it was necessary to decide whether only subjects who had made a score of zero on the Conservation pretest should be considered for instruction or whether there should be a cutoff point near the lower end of the possible point range on the Conservation pretest. It was believed that requiring subjects to have a pretest score of zero would exclude the majority of pretested subjects from the study and needlessly delimit the generalization of the findings. Therefore, any subject who made a score of seven or below on the pretest was considered in the population from which a random sample was selected for instruction.

#### Form of questioning

In assessing levels of conservation, the wording of questions is an important variable. The tendency for subjects to repeat the last statement they heard without necessarily believing what they said was noted in the subjects of the present study. For example, after presenting two equal quantities and transforming one, subjects who were asked, "Does

one now contain more than the other or are they still the same?" frequently replied, "They are still the same." without really believing that the quantities were the same. For this reason it was considered important to randomly vary the conservation question (i.e. "Are they still the same or does one now contain more than the other?", "Which one now contains more?", "Is there more here or here, or are they the same?") and to require the subjects to justify their conserving answers by explaining why they gave that answer.

#### Recommendations for Further Research

The Conservation Test used in this study had a maximum possible score of 16 points. On the posttest nine children, all from the experimental group, made a score of 16. It was felt that this reflected the adequacy of the technique used in this study to induce conservation in the subjects. However, to further discriminate the effectiveness of the technique and the performance of the subjects, it is recommended that in future research the maximum possible score on the Conservation Test be increased.

Due to the significant correlation between measures of intelligence and conservation measures, it is also recommended that a replication study using different measures of intelligence (i.e. the Stanford-Binet Intelligence Scale) be undertaken to test for generalization from induced conservation to those measures.



On the basis of the absence of a significant generalization effect in this study from induced conservation to WISC measures of intelligence, and the somewhat contradictory finding of Richards (1968) using mentally retarded subjects, it is further recommended that a replication study be conducted using mentally retarded subjects. It is possible that the mentally retarded are more likely to benefit from the teaching of concepts such as conservation than are normal children.

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## APPENDIXES

Appendix APiagetian Type Conservation Test

One point was given for each justified conserving answer or response. Simply indicating that the items were equal was not enough. Each time a child gave a conserving response he was asked to explain why he gave that particular answer. If his response indicated reversibility, compensation, or invariant quantity as the reasons for sameness, then the child was scored one point for that test item. If no conserving response was given or if the child was unable to justify his conserving response, he was not given a point for that item. A maximum of sixteen points was possible on the test.

I-Conservation of length

(a) Two sticks of equal length (10") were placed vertically in front of the child so that their ends coincided. The stick on the child's right was then moved forward approximately two inches and the child was asked whether one of the two sticks was longer than the other, or if they were the same length.

(b) Same as (a) except different length sticks (6") were used and the left stick was moved.

(c) Same as (a) except the sticks were placed horizontally in front of the child and the top stick was moved to the right.

(d) Same as (a) except different length sticks (6") were used.

(e) A stick and a piece of string of equal length (7") were placed vertically in front of the child so that their ends coincided. The string was transformed into an "S" and the child was asked whether the string or the stick was longer, or if they were the same length.

The above conservation of length items were adapted by the writer from those presented by Piaget, Inhelder, & Szeminska (1960, pp. 91-103).

## II-Conservation of area

(a) Two rectangular sheets of green cardboard measuring 8" by 10" were placed in front of the child. The child was then told that the sheets of cardboard were grassy meadows and he was allowed to place the meadows side by side or on top of each other to verify that they were the same size. A small toy cow was then placed beside each meadow and the child was told that the farmer was going to build a barn on each meadow. A small toy barn was placed in the center of one of the meadows and in one of the corners of the other. The child was then asked which of the cows had the most grass to eat or if they both had the same.

(b) Same as (a) except three barns were used. In one meadow the barns were placed adjacent to each other in one corner of the meadow and in the other meadow the barns were spread over the entire cardboard.

(c) Same as (b) except six barns were used.



The above conservation of area items were adapted by the writer from those presented by Piaget, Inhelder, & Szeminska (1960, pp. 261-273).

### III-Conservation of number

(a) Five paper clips were placed in a row approximately 1" apart in front of the child. The child was then asked to remove an equal number of beans from a cup and place them in a row in front of the row of paper clips. The beans were then bunched together and the child was asked if they were equal in number or if there were more of either the paper clips or beans.

(b) Same as (a) except 10 paper clips were used.

(c) Same as (a) except using poker chips and bottle caps and increasing the distance between them instead of bunching the bottle caps together.

(d) Same as (c) except using 10 poker chips.

The above conservation of number items were adapted by the writer from those presented by Piaget (1961, pp. 65-95).

### IV-Conservation of discontinuous quantities

(a) Two cylinders,  $A_1$  and  $A_2$ , of equal dimensions and containing the same amount of beans were presented to the child. The contents of  $A_2$  were then poured into two smaller containers,  $B_1$  and  $B_2$ . The child was then asked if the amount of beans in  $B_1$  and  $B_2$  was still the same as the amount of beans from  $A_1$ .

(b) Same as (a) except two different smaller cylinders were used in place of  $B_1$  and  $B_2$ .

(c) and (d) Same as (a) only the contents of  $A_2$  were poured into one other container or cylinder of a different shape. Two variations of this were used.

The above conservation of discontinuous quantities items were adapted by the writer from those presented by Piaget (1961, pp. 25-38).

## Appendix B

### Piagetian Tasks Used for Learning Experiences

#### I-Conservation of length

(a) Two sticks, each 7" long, were placed vertically in front of the subject so that their ends coincided. The stick on the subject's left was then moved forward approximately 3 inches, and the child was then asked which of the two sticks was longer or whether they were the same in length.

(b) Same as (a) except the sticks used were 9" long and the right stick was moved.

(c) Same as (a) except the sticks were placed horizontally in front of the subjects and the bottom stick was moved to the left.

(d) Same as (c) except 9" sticks were used and the top stick was moved.

The above conservation of length items were adapted by the writer from those presented by Piaget, Inhelder, & Szeminska (1960, pp. 91-103).

## II-Conservation of area

(a) Two rectangular sheets of green cardboard measuring 9" X 11" were placed in front of the subjects. The subjects were then told that the sheets of cardboard represented grassy lots that needed to be mowed. The lots were placed on top of each other by the writer to verify to the subjects that the lots were the same size. Next the subjects were told that a man was going to build a house on each lot, and a toy house was placed at the center of one lot and in one corner of the other lot. The subjects were then asked which lot had the most grass to mow, or if they both had the same.

(b) Same as (a) except four houses were used. In one lot the houses were placed adjacent to each other in one corner of the lot and in the other lot the houses were spread over the entire cardboard.

(c) Same as (b) except eight houses were used.

The above conservation of area items were adapted by the writer from those presented by Piaget, Inhelder, & Szeminska (1960, pp. 261-273).

## III-Conservation of number

(a) Six 3 X 5 cards were placed in a row approximately 1" apart in front of the subjects. They were then asked to remove an equal number of pennies from a cup and place them in a row in front of the row of 3 X 5 cards. The pennies were then bunched together and the

subjects were asked if the pennies were equal in number to the 3 X 5 cards, or if there were more cards or more pennies.

(b) Same as (a) except nine 3 X 5 cards were used.

(c) Same as (a) except using pencils and pens and increasing the distance between the pens instead of bunching them together.

(d) Same as (c) except using eight pencils.

The above conservation of number items were adapted by the writer from those presented by Piaget (1969, pp. 65-95).

#### IV-Conservation of discontinuous quantities

(a) Two cylinders,  $A_1$  and  $A_2$ , of equal dimensions and containing the same amount of macaroni were presented to the subjects. The contents of  $A_2$  were then poured into two smaller containers,  $B_1$  and  $B_2$ . The subjects were then asked if the amount of macaroni in  $B_1$  and  $B_2$ , from  $A_2$ , was still the same as the amount of macaroni in  $A_1$ .

(b) Same as (a) except using two different smaller cylinders in place of  $B_1$  and  $B_2$ .

(c) and (d) Same as (a) only the contents of  $A_2$  were poured into one cylinder of a different shape. Two variations of this were used.

The above conservation of discontinuous quantities items were adapted by the writer from those presented by Piaget (1961, pp. 25-38).

The above tasks were explained carefully to the subjects and reasons were given for the equality of the quantities after the transformations. The reasons that were given included reversibility,

compensation, or invariant quantity. The subjects were then questioned and requestioned, as the materials were manipulated, until each subject in the group gave, and was able to justify, conserving answers.

## VITA

Leland J. Winger, Jr.

Candidate for the Degree of

Master of Science

Thesis: The Effects of Training Designed to Accelerate Piagetian Conservation in Children on WISC Subtest Scores.

Major Field: Counseling Psychology

Biographical Information:

Personal Data: Born in Salt Lake City, Utah, September 18, 1945, son of Leland J. and Beverly J. Winger.

Education: Graduated from Jordon High School, Sandy, Utah, in 1963; received the Bachelor of Science degree from Utah State University with majors in Psychology and Education in 1968; received Secondary Teaching Credentials in Psychology from Utah State University in 1968.