3368

NATIONAL LIBRARY OTTAWA

BIBLIOTHÈQUE NATIONALE OTTAWA

NAME OF AUTHOR... André David Joseph Côté...

TITLE OF THESIS... Flexibility and Conservation Acceleration...

UNIVERSITY... University of Alberta...

DEGREE... Ph.D. ...YEAR GRANTED... 1968...

Permission is hereby granted to THE NATIONAL LIBRARY OF CANADA to microfilm this thesis and to lend or sell copies of the film.

The author reserves other publication rights, and neither the thesis nor extensive extracts from it may be printed or otherwise reproduced without the author's written permission.

(Signed)... A. Côté...

PERMANENT ADDRESS:

11736-43 Ave.
Edmonton
Alberta
Canada

DATED... Feb 4th 1969

NL-91

THE UNIVERSITY OF ALBERTA

FLEXIBILITY AND CONSERVATION ACCELERATION

by

© ANDRE D.J. CÔTÉ

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA

SEPTEMBER, 1968

UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Flexibility and Conservation Acceleration" submitted by Andre D.J. Côté in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

Charles C. Anderson
Supervisor

External Examiner

Date . . September. 16 . . . 1968.

ABSTRACT

The primary purpose of the present study was to examine the possibility of using information regarding relative standings on the dimension of flexibility to explain differential rates of conceptual advance in learning situations involving cognitive conflict. Specifically, the current investigation tested the hypothesis that success on cognitive-conflict training directed toward accelerating the acquisition of the conservation of substance is directly related to a high standing on certain flexibility measures.

The results support the hypothesis and offer some hope to those training agents attempting to account for acceleration within a strictly Piagetian conceptual framework. Further, a battery measuring flexibility has been tentatively established - an essential condition for the selection and evaluation of acceleration techniques suitable for individuals operating at various levels of flexibility.

ACKNOWLEDGEMENTS

I am deeply indebted to Dr. C.C. Anderson for the encouragement, advice and guidance provided during my years of graduate study. I doubt that I shall ever be able to adequately express my gratitude for all that he has done for me. The helpful and constructive criticisms of Dr. F.J. Boersma, Dr. J. Chambers, Dr. G.R. Lefrancois and Dr. L.D. Nelson are gratefully acknowledged.

Special thanks are due to Dr. Adrien Pinard who graciously consented to act as my external examiner.

The assistance generously provided by Dr. T.O. Maguire, Mr. W. Muir and Mr. D.P. Flathman in the analysis of the data is acknowledged with gratitude.

Finally, a heartfelt thank you to my dear Andrea who knows well the vicissitudes inherent in thesis writing. Her help and understanding during the past seven years of study have markedly contributed to the reaching of our goal.

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

THEORETICAL ORIGINS OF THE PROBLEM

While a great deal of recent work has been concerned with the problem of conservation acceleration; little effort has been made to assess those aspects of cognitive functioning, such as flexibility and rigidity, which might conceivably determine the extent to which acceleration training affects cognitive development. The present investigation is designed to ascertain whether conservation can in fact be accelerated through cognitive-conflict training, and whether those characteristics which make an individual relatively more flexible also make him more likely to profit from that type of training.

An experimental investigation of the transition from non-conservation to conservation of substance was first reported by Piaget and Inhelder (1941). Their technique involved the deformation of one of two identical plasticine balls - one ball was rolled into the form of a sausage, or flattened into a pancake or otherwise deformed. The subject was then asked to state whether the two balls still contained the same amount of plasticine and then to justify his answers. A subject is said to have an operational notion of conservation when he appreciates that the properties of an object remain invariant in spite of transformations effected upon it. Specifically, a subject has conservation of substance, also referred to as mass or continuous solid, when he realizes that, despite its change of shape, the object remains

unchanged in amount. Piaget and Inhelder claim that a grasp of conservation is clearly a necessary condition for engaging in rational behaviour, a position supported by Bruner (1966) who contends that conservation "...is a powerful idea not only in science but also in the conduct of everyday life (1966, p. 183)."

In light of the importance given to this concept by Piaget, Inhelder, and Bruner, it is not surprising to note that much effort has been devoted to the development of training techniques which might induce the early acquisition of an operational notion of conservation. Consistent support for the hypothesis that conservation acquisition can be accelerated by means of instructional techniques has not been forthcoming (Smedslund, 1959; Wohlwill, 1959; Lovell and Ogilvie, 1960; Wohlwill, 1960; Lovell, 1961; Lovell and Ogilvie, 1961; Smedslund, 1961a, 1961b, 1961c, 1961d, 1961e, 1961f; Wohlwill and Lowe, 1962; Smedslund, 1962; Braine, 1963; Smedslund, 1963; Beilin, 1964; Braine, 1964; Bruner, 1964; Feigenbaum and Sulkin, 1964; Smedslund, 1964; Wallach and Sprott, 1964; Beilin, 1965; Gruen, 1965; Brison, 1966; Bruner, 1966; Carbonneau, 1966; Fournier-Choinard, 1966; Lasry, 1966; Sigel, Roeper and Hooper, 1966; Soenstroem, 1966; Brison and Bereiter, 1967; Carlson, 1967; Kingsley and Hall, 1967; Wallach, Wall and Anderson, 1967; Carlson, 1968; Lefrancois, 1968; Sigel and Hooper, 1968; Smith, 1968; Towler, 1968; Winer, 1968).

The present study takes its point of departure from the work of Smedslund which involves the introduction of various aspects of a

conservation problem in a manner designed to create "cognitive conflict" in the subjects undergoing conservation acceleration training. Those aspects of Smedslund's work which are of direct import to this study are contained in two papers briefly summarized below. The fifth paper in the 1961 series (Smedslund, 1961e), and the first one of direct relevance to the present investigation, describes an experiment designed to test Smedslund's hypothesis that the natural development of conservation originates as a solution to the conflict arising from the complexity and novelty of a situation wherein the incompatible schemata of addition - subtraction and deformation are simultaneously activated. Smedslund's own (1961e) description of his experimental procedure cannot be improved upon.

> Objects of colored plasticine were used. The two objects in each item were always identical in color, form and volume and the children were informed that they contained the same amount. Every item consisted of one deformation and one addition or subtraction, followed by the standard question, and then of the reverse transformation of either the addition/subtraction or the deformation, also followed by the standard question: "Do you think there is more, or the same amount or less plasticine in this one than in that one?" The deformations were either very small and barely perceptible, medium-sized (e.g. change of ball to snake). The pieces that were added or taken away were always small relative to the size of the objects. A piece that was taken away was always placed nearby on the table, and a piece that was added was always stuck lightly on top of the object. If a piece was added prior to a transformation of form, it was taken off during the transformation and then immediately replaced (pp. 157 and 159).

Three practice sessions were given to each subject (N=13). Although 8 Ss did not grasp the addition/subtraction scheme 5 Ss did.

Four of these five acquired conservation during the practise sessions. Smedslund considered the results, although not statistically significant, to be consistent with his hypothesis that the acquisition of conservation was a function of the induction and reduction of cognitive conflict.

The sixth experiment (Smedslund, 1961f) was an elaboration of the foregoing. The main differences were: 1) additional materials in the form of small squares of thin linoleum were introduced for testing the Ss grasp of conservation of discontinuous substance: 2) a larger sample (N=45) was tested where 15 Ss were trained using continuous substance as the training material (Co-group); 15 Ss were trained using discontinuous substance as the training material (Di-group); and 15 Ss served as a no training control group. The results show, 1) that both the Co-group and the Di-group made the transition from non-conservation to conservation more often than the control group; 2) that the acquisition of conservation of discontinuous substance precedes the acquisition of conservation of continuous substance;[1] 3) that practise on discontinuous substance is more effective in accelerating conservation acquisition than practise on continuous substance. Smedslund does not report the significance of his findings. Nevertheless he contends that they support his hypothesis that the acquisition

---

[1]The choice of using continuous substance rather than discontinuous substance in the present investigation was made on the basis of this finding in view of the age of Ss used in the sample.

of conservation can be induced through the use of cognitive-conflict training.

Now Smedslund's training procedure, accepted by Berlyne (1963, pp. 340-341; 1965, p. 375) as promoting the sort of conceptual conflict (disequilibrium) which must precede the attainment of the form of equilibrium appropriate to the individual's developmental stage, has not been found universally effective in accelerating conservation acquisition (Feigenbaum and Sulkin, 1964; Brison, 1965; Mermelstein, 1967; Smith, 1967; Wallach, Wall and Anderson, 1967; Winer, 1967). Why should this be the case?

It will be recalled that since Smedslund's instructional technique depends upon the activation of the process of equilibration, it is held to induce cognitive conflict; as Berlyne says "...Smedslund adopted an expedient that could be expected to produce conflict." (1965, p. 275). If conceptual or cognitive conflict is in fact induced by Smedslund's instructional technique, then one possible explanation for the lack of reliable increases in conservation acquisition through the use of this training procedure might be found in the occasional absence of a factor which determines the ability of certain individuals to function effectively in conflict situations. This entails the assumption that, while conflict-training, in its role as the activator of the equilibration process, is a necessary condition for the development of conservation, it is not a sufficient condition in the absence of some characteristic of the subject which is implicated

in conceptual advance. It is not improbable (Lovell, 1955; Vernon, 1958), that this characteristic refers to a standing on the attribute of reversibility which appears so consistently as a developmental dimension in Piaget's work.

In his later work on the development of performance in tasks requiring a knowledge of concrete operations, Piaget treats reversibility in the more general terms of its psychological correlate, flexibility, which is held to be a significant factor promoting operational performance (Inhelder and Piaget, 1964, pp. 280-281). Two sorts of reversibility[2] are illustrated: the generation of alternative criteria before solution of the task is begun (foresight) (1964, pp. 198-199), and hindsight or the alteration of the current operating criterion, perhaps by differentiating it into sub-categories or by integrating it retroactively with a new criterion to form a matrix of "...true multiplicative responses... (1964, p. 207)." This contention is supported by O'Bryan (1967). Inhelder and Piaget contend that "...this flexibility of hindsight and foresight provides the psychological mechanism for the elaboration of those fundamental structures which are characterized by operational reversibility (1964, p. 196)." They, (1964, pp. 197-231) illustrate this hypothesis by means of

---

[2]In connection with reversibility note has been taken of Berlyne's caution that Piaget's "...eagerness to demonstrate the ubiquity and centrality of reversibility throughout intellectual functioning has led him to interpret reversibility with a great deal of flexibility and at times a little procrusteanly (1965, p. 209)."

protocols, especially those stemming from their work on graphic collections.

At the level of graphic collections there is neither anticipation nor even hindsight, so the subject cannot reconcile new dimensions with an existing classification; each classification in turn is dominated by the graphic properties of the material, very often modified by the perseveration of what seemed most salient earlier on. As development goes on, so the possible rearrangements become increasingly systematic in character. They do so because there is hindsight and then anticipation. The first enables what is new to be integrated with what is old, and the second makes the framework of classification a good deal more flexible (ibid., p. 207).

Inhelder and Piaget (ibid., p. 198, pp. 216-217) also describe techniques for measuring an individual's standing on the dimension of flexibility. These and other measures of flexibility adopted for this study will be described in the following chapter.

An important hypothesis illustrated by Inhelder and Piaget, is that flexibility is markedly associated with the use of a descending classification system[3] which involves a tendency to use a very general criterion for the initial classification of test objects in terms of perceived attributes and to allow this to be differentiated into

---

[3]This hypothesis is supported by a part of the present study not elaborated upon in this paper ($X^2 = 3.44$; $p < .01$; $df = 1$).

subcategories as new items are encountered. This sort of individual according to Inhelder and Piaget (1964, p. 213), must have made a conscious and systematic inventory of the items available, a tactic which promotes both the maximum extension of classes and their minimal intension. They point out that conclusions based on the observed incidence of this tactic's use

> ...might seem self evident and therefore not very instructive. But in fact it is a sure sign that a child is freeing himself from the actual overt behavior of making piles and subdiving them, and is substituting the mental operations of union and dichotomy, which imply the conservation of the whole through any transformation in the spatial arrangement of its parts (Inhelder and Piaget, 1964, p. 125).

Consonant with this is Scott's (1966) definition of flexibility (Fx) as a measure of response variability of an adaptive (equilibrial) sort in which information concerning previous responses is used to direct later responses (p. 371, p. 373). The responses may involve, simultaneously or successively, all three sorts of adaptation: accommodation, in which the organism's behavior matches environmental requirements; locomotion, in which an organism searches for an environment matching his behavior, and construction, in which an organism alters the environment so that its requirements match its behavior (Scott, ibid., pp. 393-394).

The present investigation concerns that aspect of flexibility which Scott (1967) has called accommodative adaptation, the efficient use of which is held to influence the readiness with which an individual makes the transition from non-conservation to conservation. That

is, an individual's ability to deal with the conflict situation engendered by the activation of the process of equilibration is held to be regulated, in large part, by that individual's relative standing on the dimension of flexibility; "flexible individuals" being more capable of dealing with problems involving conflict. Oliver and Ferguson (1951) provide some support for this contention in their discussion of the rationale for many of the investigations dealing with flexibility - rigidity. They state

> ...that prior experience of a given class produces a change of state in the organism, which persists, and restricts, inhibits, or otherwise delimits subsequent behavior of a related class. This means that the existence of an organized behavior pattern, organized on the basis of prior experience, interferes with and inhibits in some way forms of activity which demand some re-organization of the original behavior pattern. Individuals are thought to differ markedly in this ability for behavioral re-organization.[4] In so far as they differ, they may be spoken of as more or less "rigid," more or less "flexible" and the like (p. 50).

It may well be asked how a relatively higher standing on the attribute of flexibility could enhance an individual's chances of moving quickly through the stages leading to an operational notion of conservation? Since the process of equilibration, which leads to conservation acquisition, has been shown to involve a high level of conflict, an answer to this question may be found in the literature concerning the relative performance of flexible and rigid subjects

---

[4]Bitterman (1965) in a series of intriguing experiments with infra-human Ss has shown this ability to be directly related to the organism's phylogenic level.

under conditions of conflict and/or stress.

A necessary preliminary to an attempt at establishing the probable causes of the conflict held to be involved in conservation acquisition, is a consideration of Piaget's (1957) description of the strategies used by the child in arriving at an operational notion of conservation. Four major strategies are employed by the child in conservation acquisition (Piaget, 1957). The first strategy involves attending to only one of either dimension (length or width) but not to both (non-conservation). The child using the second strategy repeatedly centrates on one dimension of the object; and then substitutes a series of centrations on the other dimension while ignoring the first centrated dimension. This strategy may include a sequence of alternations between the two dimensions, but it is characterized by the child's continuing inability to consider both at once (non-conservation). The third strategy results in behavior that is neither clearly conservation nor clearly non-conservation. That is, the child can now consider both dimensions within a single cognitive act; but replies to conservation testing are characterized by a noticeable hesitation and conflict. The fourth strategy results in accepting conservation as being "necessary."

It is contended that the conflict attendant upon the activation of the process of equilibration (Berlyne, 1965, p. 247) should be greatest at stage III (strategy III) where the subject is torn between centrations on one dimension of the deformed object at the expense of the other dimension; and a "mise en relations" of the two centrations

(Piaget, 1957, p. 52). This contention is supported by Berlyne (1965) who claims that in situations of this sort "...there are a number of responses whose momentary strengths fluctuate but whose mean strengths are close together. This is, of course, exactly the state of affairs that is denoted by a "high level of conflict" (1965, p. 282)."

But, does this conflict equally impair operational efficiency for all individuals? There is a fair possibility that some individuals actively seek out such a conflict as a necessary preliminary to productive intellectual functioning (Karlins, 1967; Schroder, 1967; Stager, 1967). Support for the hypothesis that flexibility might be a factor characterizing such individuals is found in recent work (Beier, 1951; Cowen, 1952(a); Cowen, 1952(b); Applezwieg, 1954; French, 1955; Ainsworth, 1958; Rokeach, 1960; Fillenbaum and Jackman, 1961; Smock and Holt, 1962; Rubenowitz, 1963; Cunningham, 1965; Bryant, 1967) which strongly suggests that, especially under conditions of stress or conflict, performance on a variety of tasks, by flexible subjects is superior to the performance of non-flexible or rigid subjects. Conceptual systems theory also has something to offer in this connection. Conceptually complex individuals who generate conflict as a way of reaching superordinate solutions (Stager, 1967), have two conjunctive attributes which relate to the present discussion. Firstly, they are flexible (Schroder, 1967, p, 9, p. 25) and, secondly, they have a habit of searching for novel, non-redundant, information as a way of resolving their conceptual difficulties (Karlins, 1967, p. 269).

This brings us back to Piaget and Berlyne. According to Piaget (1957), the major motivational force of the individual's perceptual and intellectual development is an autonomous tendency for interacting processes to progress from less stable to more stable states of equilibrium. This tendency is the process of equilibration which, Piaget maintains, effects the development of an operational notion of conservation and which Smedslund (1961a) advances as the theoretical basis of his acceleration technique. In discussing equilibration Berlyne concludes that "...Piaget's writings contain plenty of indications that it (equilibration) refers to a kind of learning motivated by conflict, particularly conceptual conflict, and reinforced by conflict reduction (1965, p. 274)."

What can the individual do to reduce this conflict? Berlyne contends that "The symbolic capacities with which human beings are so well endowed makes the expedient of seeking to relieve conflict by the acquisition of information by far the most effective as a rule (1965, p. 253)." If this is the case, it is pertinent to ask what attributes characterize the individual who most efficiently acquires information in conflict situations? It has been suggested and made plausible earlier in this paper that flexibility may be one of the cognitive attributes involved. Accordingly it is postulated that individuals who are shown to be highly flexible within the terms of the measures adopted for this study, will perform more adequately, in problem solving situations involving conflict, than those subjects who are

shown to be less flexible by the aforementioned measures. This should be reflected by significantly fewer transitions from non-conservation to conservation on the part of less flexible as opposed to more flexible subjects in those instances where the acceleration of substance conservation is attempted through the use of an instructional technique based upon conflict induction and its subsequent reduction. Two specific hypotheses derived from this postulate, and two other related hypotheses, are developed in Chapter III.

CHAPTER II

METHOD

Outline of Procedure

All Ss were 1) given a conservation of substance pretest; 2) pretested for abstraction ability; 3) tested on six flexibility measures; 4) exposed either to cognitive-conflict training or a no-training interlude; 5) given a conservation of substance posttest; 6) tested for retention of conservation responses.

Subjects

The sample was selected from the population of all grade one students enrolled in three urban elementary schools of the Edmonton Separate School System. Ss were initially given a three item pretest of conservation of continuous substance (plasticine) and subsequently a pretest of Abstraction Ability (Blum, 1959, p. 298). Only those Ss who failed all items of the former pretest and passed the latter pretest were randomly assigned to experimental and control groups. It should be noted that one important restriction was consciously imposed on the random assignment of Ss by attempting to include proportionally equal numbers of boys and girls in each group. A further restriction arose from the fact that the control group was to be only half as large as the experimental group because of the necessity for economy in testing. 162 Ss were pretested and 24 Ss did not meet the pretest criteria.

The remaining 138 Ss (Mean Age = 75.26 months, S.D. = 4.04 months) were assigned to experimental (N=94) and control groups (N=44). Absentee Ss further reduced the experimental group to 79 Ss (females = 41) and the control group to 40 Ss (females = 21).

PRETESTS

Conservation of Substance

Ss were shown three pairs of plasticine balls of equal size one pair at a time. After Ss had acknowledged that each ball contained the same amount of plasticine, one of the balls in each pair was deformed. For the pair of balls comprising the first pretest item one ball was deformed by changing it into a thick cake. In the second pretest item the deformation involved a change from a ball to a sausage, while in the third item one ball was flattened to form a pancake. After each deformation Ss were asked "Do they (indicating both the whole ball and the deformed ball) still have the same amount or does one of them have more?" Only those Ss who made no correct responses to all three pretest items were selected as nonconservers.

Blum's Pretest of Abstraction Ability

Blum (1959) cautions against interpreting responses, which only indicate a lack of abstraction ability, as indicative of rigidity. Accordingly, he devised an adaptation of the Weigl-Goldstein-Scheerer test for abstract-concrete behavior, which was used to eliminate from

the sample of the present study Ss who did not possess minimal abstraction ability. Specifically, this measure excluded Ss who did not correctly respond to the command, "Put those that go together, together in these plates (Blum, 1959, p. 298)." This command was given after Ss were given nine of the Weigl-Goldstein-Scheerer blocks and asked to sort them into three places which were placed before them. Only Ss who sorted by either colour or form and verbalized their sorting concept were selected for inclusion in the sample.

FLEXIBILITY MEASURES

Introduction

The literature abounds with references to measures of flexibility - rigidity (Hanfmann and Kasanin, 1937; Goldstein and Scheerer, 1941; Kounin, 1941; Luchins, 1942; Thompson, 1944; Werner, 1944; Fisher, 1949; Luchins, 1951; Oliver and Ferguson, 1951; French, 1955; Schaie, 1955; Ainsworth, 1958; Rehfisch, 1958; Blum, 1959; Chown, 1959; Luchins and Luchins, 1959; Rokeach, 1960; Goins, 1962; Rubenowitz, 1963; Baer, 1964; Langer, 1964; Cunningham, 1965; Zigler and Butterfield, 1966; Leach, 1967). However, very few of the measures referred to are appropriate for use with a sample of functionally illiterate five and six year old children.

The Inhelder-Piaget (1964) tasks seem well suited for this purpose. However, the concept of flexibility, as a broad dimension of intellectual functioning affecting cognitive development, is hardly

unique to Piagetian formulations. Therefore, other measures of flexibility, held to add depth and scope to its measurement, were included in this investigation. Some of those measures, notably the Uznadze Set Tests (Uznadze, 1966) and the Children's Embedded Figures Test (Karp and Konstadt, 1963) are procedurally quite different from the Piagetian tasks. Those differences should not obscure the fact that all of these measures claim to assess the effect of an S's initial response on subsequent responses to a stimulus situation. Clearly, this aim is consonant with attempts at assessing Scott's (1967) previously cited definition of flexibility. Support for this contention is inherent in the following description of the flexibility measures used in this study.[5]

The Inhelder-Piaget Measures of Flexibility

Characteristically, the Inhelder-Piaget measurement techniques make no provisions for quantifying responses. Accordingly, those measures were somewhat modified in order clearly to establish discrete test items, within each task.[6] Marks were allotted for the successful solution of each test item, so that an individual's relative rank

---

[5]It should be noted that complete procedural details of the flexibility measures used in the present study are provided in Appendices A, B, C, D, E, and F.

[6]Pilot work leading to the current investigation dictated the adoption of the test modifications used here. The tasks chosen were those which were most clearly understood by the pilot group.

on the Inhelder-Piaget Flexibility Measures could be computed. In spite of the modifications it is held that our version of those measures still clearly presents Ss with situations wherein they must exercise the ability either to change the classificatory criteria when faced with successive presentations of new information; or to mentally anticipate a classificatory system which could order an array of many elements presented simultaneously.

The Inhelder-Piaget Measure of Retroactive Flexibility (IPRET)

This task demands that Ss use the test items to create an initial dichotomy which must be either maintained or reorganized when additional elements are added to the item array. Ss were asked to make as many classifications as possible whenever new elements were introduced. One point was scored each time Ss' successfully solved the problems created by the sequential introduction of new items. Successful solutions were judged to be those which resulted in an internally consistent dichotomous classification of the test elements.

The Inhelder-Piaget Measure of Anticipatory Flexibility (IPANT)

This task presents Ss with elements varying in size, shape and colour. Ss were asked first to describe the scattered elements and secondly to mentally anticipate what sort of classification system might be used to classify all of the elements. Third, Ss were asked to imagine how the elements might be dichotomized, and then they were asked to execute their plan. After each attempt at carrying out the

even to the point of making the occasional correct answer. However, these correct responses are transient and Ss do not consistently report the equality of the objects presented during the critical trials. Ss who overcome the fixed set are held to possess a dynamic set. Dynamic sets may be plastic, in which case the fixed set is gradually suppressed in the process of an orderly progression through the stages of set extinction. Alternatively, dynamic sets may be coarse. That is, Ss may extinguish the fixed set immediately by "...jumping from the stage where they have been from the beginning directly to deciding that the critical objects are equal" (Uznadze, 1966, pp. 48-49).

How does a S's particular type of set relate to his standing on flexibility-rigidity? Is the S with a static set rigid? Are dynamic sets the analogues of flexibility? A quotation from Norakidze's (1966) recent work provides some answers to these questions.

> A dynamic set contributes to the individual's adaptation to a complex and variable environment; it is incapable of protactedly and intensively resisting the environment by which it is being acted upon, nor of prevailing over it for any length of time. The factor of fixation subordinates itself to the environment and, receding into the background, enables the set to conform to the given situation and normally to direct the adaptive activity under complex environmental conditions, in a conflictless way (Norakidze, 1966, p. 187).

Clearly this is the type of corrective adaptive response which Scott (1961, pp. 393-398) refers to as flexibility. On these grounds, and for the purposes of this study Ss demonstrating dynamic sets are held to be more flexible than Ss who demonstrate static sets.

The Children's Embedded Figures Test (CEFT)

The CEFT consists of twenty-five pictures of complex figures in each of which Ss are required to find an embedded simple figure. Correct solutions reflect the Ss' ability to overcome the perceptual distractions of the embedding context.

The CEFT is held to measure a broad conceptual dimension or cognitive style affecting such diverse aspects of individual functioning as perception, personality, intellectual processes and psychopathology (Witkin, Dyk, Faterson, Goodenough, and Karp, 1962). It discriminates between Ss who are Field Dependent and Ss who are Field Independent. Field Dependent Ss are overly susceptible to the misleading perceptual cues present in a given situation, while Field Independent Ss ignore the predominance of misleading cues, and efficiently select the relevant embedded cues leading to a correct problem solution. It must be noted that the CEFT is not usually referred to as simply a measure of flexibility-rigidity. Clearly, its authors (Karp and Kondstadt, 1963) intended the CEFT to be a measure of a much broader aspect of cognitive functioning than that delimited by our concept of flexibility. However, it cannot be denied that Field Independent Ss who successfully solve the CEFT problems are, in fact, exhibiting a flexible approach to problem solving. That is, they readily make corrective adaptive responses which have previously been referred to as indications of flexibility. Accordingly, in the present investigation Ss who are Field Independent are held to be more flexible

than Ss who are Field Dependent.

ADDITIONAL MEASURES

Socio-Economic Status (SES)

Blishen's (1967) Socio-Economic Index for occupations in Canada was used to assess Ss' SES. When information regarding the father's occupation was not available from school records the investigator phoned the home and elicited the necessary information.

Intelligence

Scores obtained on the Lee Clark Reading Readiness Test - which has been shown (Czartoryski, 1967) to correlate significantly with ($p < .05$) with the Verbal and Digit Span scores of the Wechsler Intelligence Scale for Children - were used as a general index of intellectual capability. The Lee Clark Test was administered and scored by the teachers of each classroom respectively.

Procedure

All Ss were seen individually by the investigator who tried to maintain a pleasant but businesslike manner throughout each session. The initial session taking an average of one hour (Range 35-75 minutes) to complete involved all Ss. Three training sessions lasting approximately 15 minutes involved only those Ss assigned to the experimental group. All Ss were subsequently involved in posttests and retention tests of conservation. The presentation order of criterion tasks was

the same for all Ss, since a random assignment of criterion tasks presentation might have resulted in exposing Ss to consecutive presentations of similar tasks. Accordingly the expedient of presenting all tasks in a fixed order was adopted in an attempt to ensure that the lengthy testing sessions would involve sufficient variety to keep Ss interested and attentive. Figure 1 shows the fixed presentation sequences and average time taken for each criterion task.

Flexibility Testing

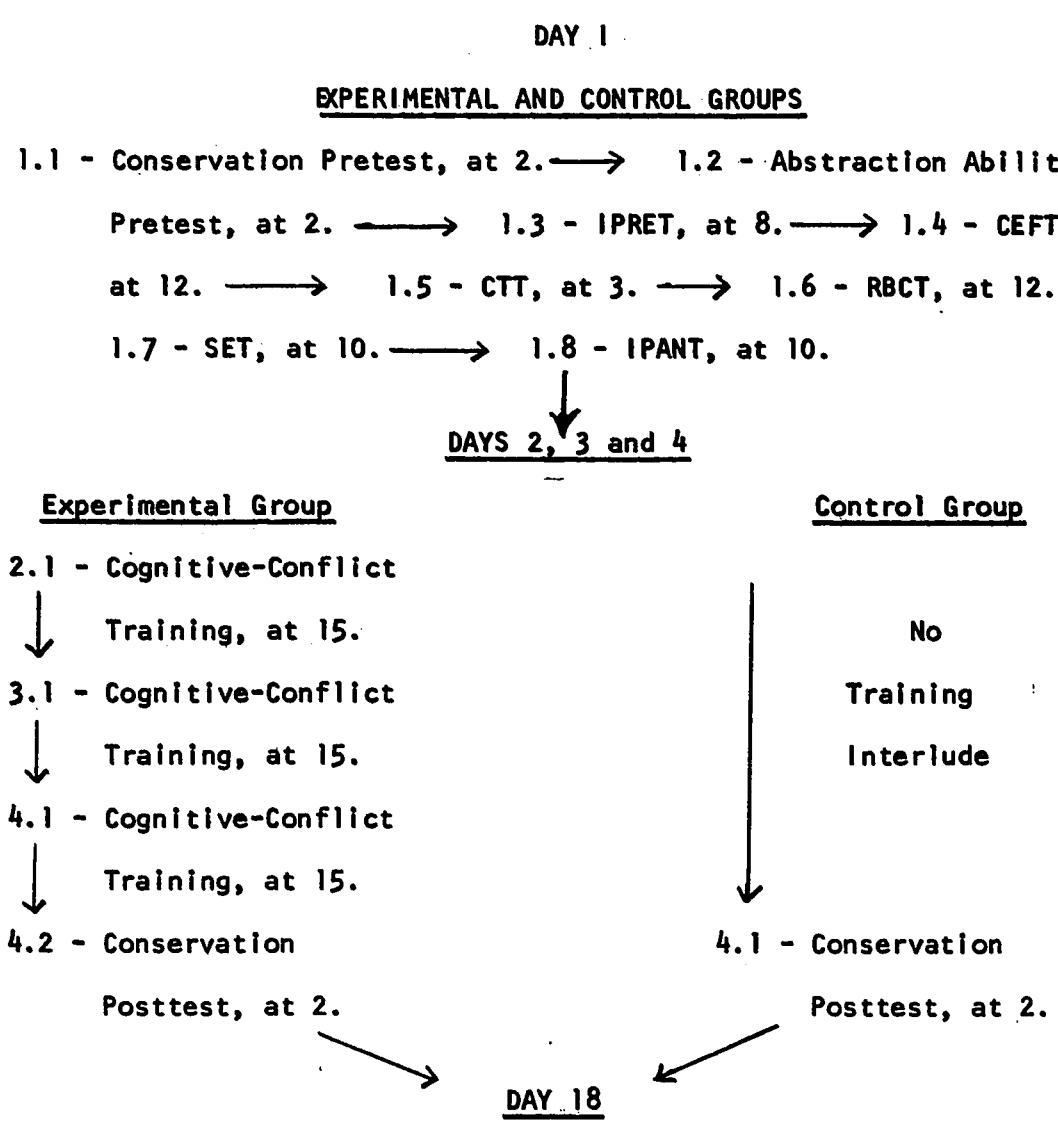
The initial testing session which immediately followed the pretests involved the administration of the six flexibility measures previously described. Details of the administration of each of these measures are presented in the Appendices, as previously noted.

Conservation Training

On three successive days Ss were given a maximum of three cognitive-conflict training sessions; however training was interrupted when the transition to conservation occurred. A complete training session involves five presentations of Smedslund's (1961f) procedure, the details of which are presented in Appendix G.

The posttest and retention test comprises the three items of the pretest and three additional items in which extreme deformations were effected upon the deformed member of the pair of balls. Specifically, those deformations involved changing a ball into the

PROCEDURAL FLOW CHART SHOWING ORDER AND AVERAGE TIMES (AT) OF PRESENTATION



Note: All AT are reported in minutes.

FIGURE 1

shape of 1) a cup; 2) a cross; 3) a circle, for each of the three test items respectively. These three deformation items which are unlike any deformation used in any of the training or pretest sessions were included to counter the suggestion most recently advanced by Almy, et al.(1967) that acceleration training merely provides specific training on certain items presented as posttest trials. Ss were adjudged to have attained conservation of substance only if they claimed that the deformed ball contained the same amount of plasticine as the whole ball and justified this claim by advancing either a symbolic or symbolic-logical explanation (Smedslund, 1961b). Symbolic explanations are those "...which directly or indirectly refer to previous events in the same test item (ibid., p. 74)." For example, a S might advance the following explanation: "They were the same when they were both balls." Symbolic-logical responses are those "...which explicitly state that nothing has been added or taken away, or which in any other way contain an explicit reference to necessity (ibid., p. 74)." All other explanations were judged to be inadequate.

All responses were recorded by the investigator on an especially designed protocol sheet shown in Appendix H.

CHAPTER III

HYPOTHESES

The first hypothesis is concerned with the feasibility of accelerating conservation acquisition through cognitive-conflict training.

H_1: Ss who receive cognitive-conflict training will acquire conservation of substance significantly more often than Ss not receiving cognitive-conflict training.

The second hypothesis deals with the question of whether or not a S's success in cognitive-conflict training is affected by his relative standing on flexibility.

H_2: Ss rated as being highly flexible will attain conservation through cognitive-conflict training significantly more often than Ss rated as being less flexible.

The third hypothesis re-evaluates the first hypothesis in that it proposes to determine whether cognitive-conflict training succeeds in accelerating conservation acquisition when the standings of sample members on measures of flexibility is controlled.

H_3: Ss, rated as being highly flexible, who receive cognitive-conflict training will acquire conservation of substance significantly more often than Ss, also rated as being highly flexible, not receiving cognitive-conflict training.

CHAPTER IV

RESULTS

The results are presented in four parts. The first, third and fourth parts of the analysis evaluate the three main hypotheses advanced by this study; while the second part arises from a desire to state the second and third hypotheses parsimoniously.

ANALYSIS OF DATA, PART I - EVALUATION OF THE FIRST MAJOR HYPOTHESIS

The first hypothesis predicted that cognitive-conflict training would induce the acquisition of conservation. This prediction is evaluated by comparing the posttest performance of Ss receiving Smedslund's acceleration training with the posttest performance of a control group not receiving cognitive-conflict training. Table I shows the results of all Ss's posttest performance, which includes the posttest given immediately after training and a retention test given two weeks after training.

On the basis of the data presented in Table I acquisition of conservation cannot be attributed primarily to Smedslund's cognitive-conflict training, since the experimental group does not attain conservation significantly more often than the control group on the posttest immediately following training ($X^2 = 1.33$; $p. > .10$; $df = 1$). The retention test data indicates that one member of the training

group and one member of the control group acquired conservation during the two week interval between testing sessions; facts which do not affect the non-significance of the observed results ($X^2 = .81$; $p. > .10$; $df = 1$).

TABLE I

POSTTEST PERFORMANCE OF ALL SUBJECTS

SUBJECTS	POSTTEST IMMEDIATELY FOLLOWING TRAINING SESSIONS		POSTTEST TWO WEEKS AFTER TRAINING SESSIONS	
	Conservers	Non-Conservers	Conservers	Non-Conservers
Cognitive Conflict Training (N=79)	11	68	12	67
No Training (N=40)	2	38	3	37

ANALYSIS OF DATA, PART II - FACTOR ANALYSES OF FLEXIBILITY MEASURES AND DERIVATION OF FACTOR SCORES

If individual Ss are to be assigned to one group or another on the basis of their standing on flexibility; then some practical measures have to be taken with regard to ensuring each Ss's continuing membership in either a high flexibility or low flexibility group. Now a

consideration of the second major hypothesis involving a test by test formulation of that hypothesis would be awkward and quite possibly inaccurate, insofar as any one S could be both included in either the high or low flexibility groups on the basis of his score on a particular test and excluded from either of these groups on the basis of his performance on a subsequent test. Accordingly the expedient of generating factor scores for each Ss was adopted. Factor scores express "...the hypothetical constructs - the factors - in terms of the observed variables...(Harman, 1960, p. 337)." That is, the contribution of each test score to the eventual determination of each factor is calculated for all the test scores obtained by each S. Consequently, further considerations of an individual's performance are dealt with in terms of what might be called his "weighted-average" score on that particular dimension which is represented by a factor. The generation of factor scores requires that the data be factor analyzed.

Accordingly, the correlation matrix, generated by intercorrelating the six flexibility measures used in the present investigation, was factor analyzed using the Principal Axes method which offers a unique solution for a given correlation matrix while accounting for the maximum possible variance for a given number of factors. These results are consistent with the author's aim in using factor analytic methods of data analysis. That is, factor analysis as it is used in the present study simply involves an attempt to formulate a

parsimonious statement of the second major hypothesis. However, if flexibility exists as a dimension of cognitive functioning which can be measured by the tests used in the present study, then factor analysis should demonstrate that some degree of relationship among each of these measures can be described in terms of their contribution to the structure of some hypothetical construct, such as a factor. Table 2 presents the correlation matrix derived from the six tests used in the present study.

TABLE 2

CORRELATIONS BETWEEN SIX MEASURES OF FLEXIBILITY

VARIABLES	IPRET	CEFT	CTT	RBCT	SET	IPANT
IPRET	1.00					
CEFT	.480**	1.00				
CTT	.385**	.594**	1.00			
RBCT	.459**	.589**	.556**	1.00		
SET	.229*	.261**	.535**	.356**	1.00	
IPANT	.634**	.422**	.451**	.403**	.376**	1.00

Table 2 shows that all correlations but one are significant at at level of confidence greater than 1%, thus making it not unreasonable to expect that one or two factors will effectively account for a very

substantial portion of the observed variance. This expectation is borne out by the results given in Table 3; which shows the unrotated principal axes factor loadings for the six flexibility measures used in the present study.

TABLE 3

FLEXIBILITY TESTS UNROTATED PRINCIPAL AXES FACTOR LOADINGS

VARIABLES	Factor Loadings I	II	Communalities
IPRET	.623	.552	.692
CEFT	.695	.381	.628
CTT	.808	.017	.654
RBCT	.725	.240	.584
SET	.745	-.489	.794
IPANT	.677	.355	.585
Percentage of Total Variance	50.05	18.05	68.10

Table 3 shows that the first factor accounts for 50% of the total variance. Accordingly this factor will be interpreted as a general flexibility factor. Since all tests load heavily on this flexibility factor it is not unreasonable to propose that factor scores

determined by that factor will accurately approximate a S's performance on the six flexibility measures used in the present study. Factor scores thus computed for all Ss are presented in Appendix H. Since the second factor accounts for a relatively small portion of the total variance (18%) it will not be interpreted nor used for the computation of factor scores in the present investigation.

ANALYSES OF DATA PART III - EVALUATION OF THE SECOND HYPOTHESIS

The second hypothesis stated that Ss rated as being highly flexible would profit more from cognitive-conflict training than Ss rated as being less flexible. Flexibility factor scores (Mean = 50; S.D. = 10) were computed for each S undergoing cognitive-conflict training.

The 15 Ss who had the highest flexibility factor scores (Mean = 62.5; Range = 65-60) along with the 15 Ss who had the lowest flexibility factor scores (Mean = 35.5; Range = 29-40) were designated as a highly flexible (HiFx) group and a less flexible (LoFx) group respectively. The size of each group was determined by the requirement that all Ss selected for the HiFx group must have obtained flexibility factor scores falling at least 1 S.D. above the mean, while all Ss selected for the LoFx group must have obtained flexibility factor scores falling at least 1 S.D. below the mean.

Table 4 shows the conservation acquisition status of Ss belonging to both groups on a posttest given immediately following cognitive-conflict training.

TABLE 4

POSTTEST CONSERVATION RESPONSES MADE BY HiFx AND LoFx GROUPS

SUBJECTS	Ss Not Making Conservation Responses on Posttest	Ss Making Conservation Responses on Posttest
HiFx Group (N=15)	6	9
LoFx Group (N=15)	15	0

The Fisher exact probability test (Siegel, 1956, pp. 96-104) was used to assess the significance of the results which clearly indicate that the possibility of an individual acquiring conservation through cognitive-conflict training is markedly affected by his standing on the dimension of flexibility, as it is measured in the present investigation ($p \leq .005$). Since such is the case a re-evaluation of the first hypothesis, with appropriate consideration given to Ss' flexibility factor scores, is plainly called for.

ANALYSIS OF DATA PART IV - RE-EVALUATION OF THE FIRST HYPOTHESIS USING A HiFx SAMPLE

In light of the findings presented in Table 4 it seems not unreasonable to enquire whether or not conservation acquisition should be attributed solely to a S's standing on the dimension of flexibility. That is, do some Ss acquire conservation simply because they are more flexible than other Ss who do not acquire conservation? The third hypothesis stated that HiFx Ss receiving cognitive-conflict training would acquire conservation significantly more often than HiFx Ss who did not receive such training. The HiFx group receiving training is the same HiFx group designated in the analysis of data - Part III. The no training HiFx control group was formed by choosing those Ss in the control group whose flexibility factor scores fell at least 1 S.D. above the mean (N=9; Mean - 63.7; Range 69-60).

Table 5 shows the conservation acquisition status of Ss belonging to both groups on a posttest given immediately following cognitive-conflict training.

The Fisher exact probability test was used to assess the significance of the results which clearly support the hypothesis that cognitive-conflict training can result in conservation acquisition ($p \leq .02$).

TABLE 5

POSTTEST CONSERVATION RESPONSES
MADE BY HiFx GROUPS

SUBJECTS	Ss Not Making Conservation Responses on Posttest	Ss Making Conservation Responses on Posttest
HiFx Group Given Cognitive-Conflict Training (N=15)	6	9
HiFx Group No Training (N=9)	13	2

In assessing the significance of the current findings it is pertinent to enquire whether the groups compared, were in fact drawn from the same population. Accordingly, three specific formulations of that question are presented and evaluated in the following paragraphs. In all three cases group comparability on 12 population parameters (CA, Lee Clark Test Scores, SES, IPRET Score, CEFT Score, CTT Score, RBCT Score, Number of Trials to Fix Set, Number of Trials to Extinguish Set, Dynamism of Set, IPANT Score, Flexibility Factor Score) was evaluated in terms of the Mann-Whitney U test (Siegel, 1956, pp. 111-116).

Question 1. Are the experimental and control groups drawn from the same population?

Table 6 shows the values of U and their associated probabilities for each of the 12 variables describing experimental and control groups.

The results shown in Table 6 indicate that it is feasible, with some confidence, to assume that the experimental and control groups are drawn from the same population with respect to every parameter except chronological age.

In this latter case the experimental group (Mean Age = 74.76 months, S.D. 4.08 months) differs significantly ($p < .03$) from the control group (Mean Age - 76.27 months, S.D. = 3.71 months). The design of the present study does not require that the control group should be older than the experimental group. And, the investigator is unaware of any systematic bias which might account for the results shown in Table 6. However, those fortuitous results are cautiously welcomed since they appear to lend some support to the hypothesis claiming that cognitive-conflict training can occasion the appearance of conservation some time earlier than it might appear naturally.

TABLE 6

COMPARISONS OF EXPERIMENTAL (N=79) AND CONTROL (N=40) GROUPS ON THE MANN-WHITNEY U TEST

VARIABLES	U	p (2 tailed) df
Age	1192.0	$<.03$
Lee Clark Scores	1311.5	$>.10$
SES	1580.0	$>.90$
IPRET Scores	1385.5	$>.25$
CEFT Scores	1337.0	$>.15$
CTT Scores	1577.5	$>.85$
RBCT Scores	1523.0	$>.70$
Number of Trials to Fix Set	1395.0	$>.20$
Number of Trials to Extinguish Set	1438.0	$>.40$
Set Dynamism	1426.0	$>.20$
IPANT Scores	1424.0	$>.35$
Flexibility Factor Scores	1525.0	$>.75$

Question 2. Are the HiFx-experimental and LoFx-experimental groups drawn from the same population?

Table 7 shows the values of U and their associated probabilities for each of the 12 variables describing HiFx and LoFx groups.

The results presented in Table 7 show that although the HiFx and LoFx groups appear to be drawn from the same population in terms of chronological age, SES and Lee Clark scores, they are not drawn from the same population with respect to the flexibility measures used in the current investigation.

Question 3. Are the HiFx-experimental and HiFx-control groups drawn from the same population?

Table 8 shows that the HiFx-experimental and HiFx-control groups do not differ significantly with respect to their relative standings on the 12 comparison variables.

TABLE 7

COMPARISONS OF HiFx-EXPERIMENTAL (N=15) AND LoFx-EXPERIMENTAL (N=15) GROUPS ON THE MANN-WHITNEY U TEST

VARIABLES	U	p (2 tailed)
Age	112.0	$>.10$
Lee Clark Scores	81.5	$>.10$
SES	99.0	$>.10$
IPRET Scores	6.0	$<.002$
CEFT Scores	9.5	$<.002$
CTT Scores	.5	$<.002$
RBCT Scores	3.5	$<.002$
Number of Trials to Fix Set	37.5	$<.002$
Number of Trials to Extinguish Set	0.0	$<.002$
Set Dynamism	22.5	$<.002$
IPANT Scores	2.0	$<.002$
Flexibility Factor Scores	0.0	$<.002$

TABLE 8

COMPARISONS OF HiFx-EXPERIMENTAL (N=15) AND HiFx-CONTROL (N=9) GROUPS ON THE MANN-WHITNEY U TEST

VARIABLES	U	p (2 tailed)
Age	54.0	$>.10$
Lee Clark Scores	43.5	$>.10$
SES	57.5	$>.10$
IPRET Scores	52.0	$>.10$
CEFT Scores	43.5	$>.10$
CTT Scores	64.0	$>.10$
RBCT Scores	63.5	$>.10$
Number of Trials to Fix Set	67.5	$>.10$
Number of Trials to Extinguish Set	41.0	$>.10$
Set Dynamism	67.5	$>.10$
IPANT Scores	49.5	$>.10$
Flexibility Factor Scores	49.0	$>.10$

CHAPTER V

DISCUSSION

There are certain significant points arising from a consideration of the results of the present study which must be emphasized. Firstly, a battery of six tests, held to determine an individual's standing on the dimension of flexibility, has been employed successfully. In the sense that sizeable and significant intercorrelations among performance in the six measures comprising the battery allow the inference of a general factor of flexibility which - accounting for an impressively large portion of the total variance existing among those six measures - probably represents an adaptive process reflected in the ability to efficiently produce responses to rapidly changing environmental requirements (Scott, 1966).

Now if this is the case and if, as will be emphasized later, the presence of flexibility is a necessary condition for the promotion of that sort of conceptual advance reflected in a grasp of conservation, then the current battery may be profitably used to measure the individual's performance in flexibility, and from this to predict the likelihood of his success in particular kinds of training. These possibilities have implications clearly at odds with Mermelstein (1967) who subsequent to the completion of studies which attempted to accelerate conservation through the use of four techniques developed by Beilin (1962), Bruner (1964), Sigel (1967), and Smedslund (1961)

respectively, concluded that, in general, training which attempts to accelerate conservation is not successful.

These findings stand in sharp contrast to those of other notable investigators, but Mermelstein explains this inconsistency through the simple expedient of claiming "...that the success in training that Bellin, Bruner, Sigel and Smedslund report relates not to the concept of conservation of substance as Piaget sees it, but rather to some other concept or some deformation of the concept of conservation (1967, p. 197)." Now clearly, the theoretical rationale underlying Smedslund's position is consonant with Piaget's formulations; this follows logically from Mermelstein's own position. Therefore it would seem inappropriate to discount completely the possibility of explaining conservation acceleration within a Piagetian framework.

Secondly as noted previously the current finding is that conservation can be accelerated in highly flexible individuals through cognitive-conflict training. This finding at once re-opens the controversy surrounding conservation acceleration and makes a contribution to it which may well solve the impasse implicit in that controversy. Two points must be emphasized. Some acceleration techniques claim only to activate latent schemas while others claim to develop or create those subordinate cognitive structures necessary to the development of superior levels of cognitive functioning (Towler, 1968). Acceleration techniques following the former course are clearly reconcilable with

the Piagetian position on conceptual advance. However, acceleration techniques adopting the latter course are not so readily fitted into the Piagetian mould.

Now Smedslund's training procedure implicitly assumes the prior existence of such schemas as negation, reciprocity and thus reversibility. His technique does not purport to create or initiate new subordinate schemas. However, it is advanced as an efficient activator of those dormant abilities already possessed by the child. That is, by activating the equilibration process cognitive-conflict training occasions the occurrence of some sorts of conceptual advance in a manner consistent with Piagetian theory. Why then is Smedslund's procedure only occasionally successful in accelerating conservation acquisition? The current finding shows that a high standing on the dimension of flexibility enhances the possibility of developing a grasp of conservation through training. Why should this be the case? It may well be that highly flexible individuals, in Cole's (1968) terms, are more readily capable of discriminating between irrelevant and relevant principles thereby arriving more efficiently at a formulation of the correct principle through the appropriate conjunction of relevant variables. Flexibility then can be viewed as a function which expedites the processing of the stuff of those encounters which constitute all of a child's experience. But, has any real progress been made in articulating those experiental factors which account for the ultimate acquisition of conservation? Sigel claims that

"Articulation of the type, quantity, and quality of particular experiences and their direct relationship to the acquisition of logical structures has yet to be done (1968, p. 509)." Clearly, more daring approaches to the solution of that problem must be explored. Techniques as radical as Engelmann's (1967) or as conservative as Smedslund's (1961f) might well be reassessed and their efficacy increased by giving due consideration to the relative flexibility of those for whom their training measures are intended. As Sigel says: "Personality characteristics play an influential role in determining how the child will interact with the environment, how susceptible he is to its variegated influences, and how capable he is in modifying them to his own ends (ibid., p. 509).

For example, it has been shown (Harvey, Prather, White and Hoffmeister, 1968) that a disproportionately large number of teachers are, in Schroder, Drive and Streufert's (1967) terms, cognitively simple and exhibit the well known correlates of that state - dogmatism and rigidity. This emphasizes the desirability of promoting flexibility training in the schools for students and teachers alike; a position made salient by Joyce and Harootunian (1967) on the basis of evidence from conceptual systems theory. They stress the value of this educational goal with comments such as:

> Flexibility in teaching is the extent to which a teacher modifies his behavior in response to student behavior. This has meaning only insofar as the teacher is sensitive to what is happening in the classroom. It is clearly impossible for the teacher to modify his behavior to account for the learner

> if he is unaware of what the learner is thinking and doing (ibid., p. 154).

If many teachers are lacking in flexibility (Harvey, et al. 1968) and if this deficit is transmitted to their students, then the matter of flexibility training both for teachers and students becomes urgent in light of the current findings.

BIBLIOGRAPHY

BIBLIOGRAPHY

Ainsworth, L.H. Rigidity, insecurity and stress. Journal of Abnormal and Social Psychology, 1958, 56, 67-74.

Almy, M., Chittenden, E., and Miller, P. Young children's thinking: studies of some aspects of Piaget's theory. New York: Teachers College Press, Columbia University, 1966.

Anderson, C.C. The psychology of the metaphor. Journal of Genetic Psychology, 1964, 105, 53-73

Anderson, C.C. A cognitive theory of the nonintellective correlates of originality. Behavioural Science, 1966, 2, 284-294.

Anderson, C.C. Galbraith, technology and education. Alberta Journal of Educational Research, 1968, 14, 5-14.

Applezweig, D.G. Some determinants of behavioral rigidity. Journal of Abnormal and Social Psychology, 1954, 49, 224-228.

Baer, D.J. Factors in perception and rigidity. Perceptual and Motor Skills, 1964, 19, 563-570.

Beilin, H. Perceptual-cognitive conflict in the development of an invariant area concept. Journal of Experimental Child Psychology, 1964, 1, 208-226.

Beilin, H., Kagan, J.,and Rabinowitz, R. Effects of verbal and perceptual training on water level representation. Child Development, 1966, 37, 317-328.

Berlyne, D. Conflict, Arousal and Curiosity. New York: McGraw-Hill, 1960.

Berlyne, D.E. Structure and Direction in Thinking. New York: Wiley, 1965.

Blishen, B.R. A socio-economic index for occupations in Canada. The Canadian Review of Sociology and Anthropology, 1967, 4, 41-53.

Blum, A.H. The relationship between rigidity-flexibility in children and their parents. Child Development, 1959, 30, 297-304.

Braine, M.D.S. Development of a grasp of transitivity of length: A reply to Smedslund. Child Development, 1964, 35, 799-810.

Braine, M.D.S. and Shanks, B.L. The conservation of a shape property and a proposal about the origin of the conservations. Canadian Journal of Psychology, 1965, 19, 197-207.

Brison, D.W. Acceleration of conservation of substance. Journal of Genetic Psychology, 1966, 109, 311-322.

Brison, D.W. and Bereiter, C. Acquisition of conservation of substance in normal, retarded and gifted children, in Recent research on the acquisition of conservation of substance, Brison, D.W. and Sullivan. E.V. (Eds.). Educational Research Series, The Ontario Institute for Studies in Education, 1967, 2, 53-72.

Brison, D.W. and Sullivan, E.V. (Eds.) Recent research on the acquisition of conservation of substance, 1967, Educational Series, 2, The Ontario Institute for Studies in Education.

Bruner, J.S., Olver, Rose R., and Greenfield, Patricia, M., et al. Studies in Cognitive Growth. New York: Wiley, 1966.

Bryant, P.E. Two causes of failures in children to sort by two different dimensions on successive trials. The British Journal of Educational Psychology, 1967, 37, 320-328.

Callaway, E. and Dembo, D. Narrowed attention: a psychological phenomenum that accompanies a certain physiological change. AMA Archives of Neurology and Psychiatry, 1958, 79, 74-90.

Carbonneau, M. Apprentissage de la notion de conservation de surfaces. Paper presented at the meeting of the Canadian Psychological Association, Montreal, June, 1966.

Carlson, J.S. Effects of instruction on the concept of conservation of substance. Science Education, 1967, 51, 138-145.

Carlson, J.S. Learning and the conservation of substance. Paper presented at the meeting of the Western Psychological Association, San Diego, March, 1968.

Cattell, R.B. The riddle of preservation. Journal of Personality, 1946, 14, 229-267.

Chown, S.M. Rigidity-a flexible concept. Psychological Bulletin, 1959, 56, 195-223.

Cole, H.P. An analysis of the effects of a structured teaching approach developed from the work of Piaget, Bruner and others. Paper presented at the meeting of the American Educational Research Association, Chicago, February, 1968.

Cowen, E.L. and Thompson, G.G. Problem solving rigidity and personality structure. Journal of Abnormal and Social Psychology, 1951, 46, 165-176.

Cowen, E.L., Wiener, H., and Hess, J. Generalization of problem-solving rigidity. Journal of Consulting Psychology, 1953, 17, 100-103.

Cunningham, J.D. Einstellung rigidity in children. Journal of Experimental Child Psychology, 1965, 2, 237-247.

Czartoryski, M. Language as a non-formative factor in cognitive performance. Unpublished master's thesis, University of Alberta, 1967.

Dienes, Z.P. Concept formation and personality. Leicester University Press, 1965.

Dodwell, P.C. Children's understanding of spatial concepts. Canadian Journal of Psychology, 1963, 17, 141-161.

Elkind, David. Children's discovery of the conservation of mass, weight, and volume: Piaget replication, Study II. Journal of Genetic Psychology, 1961, 98, 219-227.

Elkind, D. Conceptual orientation shifts in children and adolescents. Child Development, 1966, 37, 493-498.

Elkind, D. Piaget's conservation problems. Child Development, 1967, 38, 15-27.

Elkind, D. Koegler, R.R. and Go, E. Studies in perceptual development II: Part-whole perception. Child Development, 1964, 35, 81-90.

Elkind, D. and Scott, L. Studies in perceptual development: I The decentering of perception. Child Development, 1962, 33, 619-630.

Engelmann, S. Cognitive structures related to the principle of conservation, in Recent research on the acquisition of conservation of substance, Brison, D.W. and Sullivan, E.V. (Eds.), Educational Research Series, 2, The Ontario Institute for Studies in Education, 1967, 25-52.

Feigenbaum, K.D. and Sulkin, H. Piaget's problem of conservation of discontinuous quantities: a teaching experience. Journal of Genetic Psychology, 1964, 105, 91-97.

Ferguson, G.A. Statistical analysis in Psychology and Education. New York: McGraw-Hill, 1959.

Fillenbaum, S. and Jackman, A. An extension of Rokeach's results. Journal of Abnormal and Social Psychology, 1961, 63, 212-214.

Fisher, S. An overview of trends in research dealing with rigidity. Journal of Personality, 1949, 17, 342-351.

Fleischer, G. and Cohen, I.S. The relationship between test anxiety and tests of creativity. American Psychological Association Proceedings, 1965, 311-312.

Fournier-Choinard, E. La generalisation de l'apprentissage d' une structure logique. Paper presented at the meeting of the Canadian Psychological Association, Montreal, 1966.

French, E.G. Interrelations among some measures of rigidity under stress and non-stress conditions. Journal of Abnormal and Social Psychology, 1955, 51, 114-118.

Goins, A.E. Measures of rigidity. Merrill-Palmer Quarterly, 1962, 56, 317-325.

Goodenough, D. and Eagle, C.J. A modification of the embedded figures test for use with young children. Journal of Genetic Psychology, 1963, 103, 67-74.

Goodenough, D. and Karp, S.A. Field dependence and intellectual functioning. Journal of Abnormal and Social Psychology, 1961, 63, 241-246.

Goldstein, K. and Scheerer, M. Abstract and concrete behaviour, an experimental study with special tests. Psychological Monographs, 1941, 53 (2).

Gottfried, N.W. and Elliot, D.L. A study of the relationship between the concepts of conservation of length and number. Paper presented at the meeting of the Midwest Psychological Association, Chicago, 1966.

Greco, P.L. L'apprentissage dans une situation a structure operatoire concrete. Les inversions successives de l'ordre lineaire par des rotations de 180°. Etudes d'Epistemologie Genetique, 1959, 7, 68-112.

Griffiths, J.A., Shantz, C.A., and Sigel, J.E. A methodological problem in conservation studies: the use of relational terms. Child Development, 1967, 38, 841-848.

Gruen, G.E. Experiences affecting the development of number conservation in children. Child Development, 1965, 36, 963-980.

Gruen, G.E. Note on conservation: Methodological and definitional considerations. Child Development, 1966, 37, (4), 977-983.

Halpern, Esther. The effects of incompatibility between perception and logic in Piaget's stage of concrete operations. Child Development, 1965, 36, 491-498.

Hanfmann, E. A study of personal patterns in intellectual performance. Character and Personality, 1941, 9, 315-325.

Hanfmann, E. and Kasanin, J. A method for the study of concept formation. Journal of Psychology, 1937, 521-540.

Harman, H.H. Modern factor analysis. Chicago: University of Chicago Press, 1960.

Harvey, O.J. (Ed.). Experience, structure and adaptability. New York: Springer, 1966.

Harvey, O.J., Prather, M., White, B.J., and Hoffmeister, J.K. Teacher's beliefs, classroom atmosphere and student behavior. American Educational Research Journal, 1968, 5, 151-166.

Held, R. Plasticity in sensory-motor systems. American Psychologist, 1965, 84-94.

Inhelder, B., Bovet, M., Sinclair, H., and Smock, C.D. On cognitive development. American Psychologist, 1966, 21, 160-164.

Inhelder, B. and Piaget, J. The early growth of logic in the child. London: Routledge and Kegan Paul, 1964.

Jackson, D.N., Messick, S., and Myers, C.T. Evaluation of group and individual forms of embedded-figures measures of field-independence. Educational and Psychological Measurement, 1964, 24, 177-192.

Joyce, B.R., and Harootunian, B. The structure of teaching. Chicago: Science Research Associates, 1968.

Kagan, J., Moss, H., and Sigel, J.E. Psychological significance of styles of conceptualization. In Wright, J.C., and Kagan, J. (Eds.), Monographs of the Society for Research in Child Development, 1963, 28, 73-112.

Kagan, J., Pearson, L., and Welch, L. Conceptual impulsivity and inductive reasoning. Child Development, 1966, 37, 583-584.

Karlins, M. Conceptual complexity and remote-associative proficiency as creativity variables in complex problem-solving task. Journal of Personality and Social Psychology, 1967, 6, 264-278.

Karp, S.A. and Konstadt, Norma, L. Manual for the children's embedded figures test. New York: Cognitive Tests, 1963.

Khojava, I. The role of set in habit interference. Proceedings of the Sixteenth Congress of Psychology, Moscow, 1966.

Kidd, A.H. Closure as related to manifest anxiety and rigidity. Perceptual and Motor Skills, 1965, 20, 1177-1181.

Kingsley, R.C., and Hall, V.C. Training conservation through the use of learning sets. Child Development, 1967, 38, 1111-1126.

Kohnstaam, G.A. An evaluation of part of Piaget's theory. Acta Psychologica, 1963, 21, 313-356.

Kounin, J. Experimental studies of rigidity: I. The measurement of rigidity in normal and feeble-minded persons. Character and Personality, 1941, 9, 251-273.

Langer, R., and McKain, C.W. Rigidity and the SQRT. Journal of Clinical Psychology, 1964, 20, 489-492.

Lasry, J.C. Empirico-didactical learning of the notion of inclusion. Paper presented at the meeting of the Canadian Psychological Association, Montreal, 1966.

Laurendeau, M.A., and Pinard, A. Causal thinking in the child. Montreal: International Universities Press, 1962.

Leach, P. A critical study of the literature concerning rigidity. British Journal of Social and Clinical Psychology, 1967, 6 (1), 11-22.

Lee, U.M., and Clark, W.W. Manual: Lee-Clark reading readiness test. Monterey, California: California Test Bureau, 1962.

Lefrancois, G.R. The acquisition of the concept of conservation. Unpublished doctoral dissertation, University of Alberta, 1966.

Lefrancois, G.R. Conservation acquisition. Canadian Journal of Psychology, 1968. In press.

Lovell, K. The growth of basic mathematical and scientific concepts in children. London: University of London Press, 1962.

Lovell, K., and Ogilvie, E. A study of the conservation of substance in the junior school child. British Journal of Educational Psychology, 1960, 30, 109-118.

Luchins, A., and Luchins, E.H. Rigidity of behavior: A variational approach to the effect of Einstellung. Eugene, Oregon: University of Oregon Press, 1959.

Luchins, A.S. The Einstellung test of rigidity: its relation to concreteness of thinking. Journal of Consulting Psychology, 1951, 15, 303-310.

Luchins, A.S. Mechanization in problem solving - the effect of Einstellung. Psychological Monographs, 1942, 54, (6), 1-95.

Mermelstein, E., Carr, E., Mills, D., and Schwartz, J. Training techniques for the concept of conservation. Alberta Journal of Educational Research, 1967, 13, 185-200.

Meyer, W.J. Young children's acquisition of cognitive skills under various conditions of redundancy, punishment, and perceptual input. Paper presented at the meeting of the American Educational Research Association, Chicago, February, 1968.

More, A. Apprentissage d'une structure logique concrete (inclusion). Effets et limites. Etudes d'Epistemologie Genetique, 1959, 9, 15-83.

Murray F. Conservation of illusion - distorted lengths and areas by primary school children. Journal of Educational Psychology, 1965, 56, 62-66.

Norakidze, V.G. Character types of personality and fixated set. Proceedings of the Sixteenth Congress of Psychology, Moscow, 1966.

O'Bryan, K.G., and MacArthur, R.S. A factor analytic study of Piagetian reversibility. Alberta Journal of Educational Research, 1967, 13, 211-220.

Oliver, J.A., and Ferguson, G.A. A factorial study of tests of rigidity. Canadian Journal of Psychology, 1951, 5, 49-60.

Osgood, C.E., and Tannenbaum, P.H. The principle of congruity in attitude change. Psychological Review, 1955, 62, 42-55.

Palmer, E.L. Differential adaptivity in the judgments of children. Unpublished doctoral dissertation, Michigan State University, 1964.

Palmer, E.L. Factors related to persistence in inquiry. Alberta Journal of Educational Research, 1967, 13, 15-25.

Palmer, E.L. The equilibration process: Some implications for instructional research and practise. Paper presented at the American Educational Research Association, Chicago, February, 1968.

Pascual-Leone, J. Piaget's period of concrete operations and Witkin's field dependence: A study on college students and children. Paper presented at the meeting of the Canadian Psychological Association, Montreal, 1966.

Piaget, J. Logique et equilibre dans les comportement du sujet, in Apostel, L., Mandelbrot, B., and Piaget, J., Logique et Equilibre, Etudes d'Epistemologie Genetique, 1957, 2, 27-117.

Piaget, J. Judgment and reasoning in the child. Paterson, New Jersey: Littlefield, Adams, 1964.

Piaget, J. The child's conception of number. New York: Norton, 1965.

Piaget, J. Response to Brian Sutton-Smith. Psychological Review, 1966, 73, 111-112.

Piaget, J. Six psychological studies. New York: Random House, 1967.

Pratooraj, S., and Johnson, R.C. Kinds of questions and types of conservation tasks as related to children's conservation responses. Child Development, 1966, 37, 343-353.

Rehfisch, J.M. A scale for personality rigidity. Journal of Consulting Psychology, 1958, 22, 11-15.

Rokeach, M. The open and closed mind. New York: Basic Books, 1960.

Rubenowitz, S. Emotional flexibility - rigidity as a comprehensive dimension of mind. Stockholm: Almquist and Wiksell, 1963.

Russell, C., and Russell, W.M.S. Human Behaviour. London: Andre Deutsch, 1961.

Schaie, K.W. A test of behavioral rigidity. Journal of Abnormal and Social Psychology, 1955, 51, 604-610.

Schroder, H.M., Driver, M.J., and Streufert, S. Human information processing. New York: Holt, Rinehart and Winston, 1967.

Scott, W.A. Flexibility, rigidity and adaptation: Toward a clarification of concepts, in Harvey, O.J. (Ed.), Experience, structure and adaptability. New York: Springer, 1966, 369-398.

Shantz, C.V., and Smock, C.D. Development of distance conservation and the spatial coordinate system. Child Development, 1966, 37, 943-948.

Siegel, Sidney. Non parametric statistics. Toronto: McGraw-Hill, 1956.

Sigel, I.E. Reflections, in Sigel, I.E., and Hooper, F.H. (Eds.), Logical thinking in children. New York: Holt, Rinehart and Winston, 1968, 504-528.

Sigel, I.E., and Hooper, F.H. (Eds.). Logical thinking in children. New York: Holt, Rinehart and Winston, 1968.

Sigel, I.E., Roeper, A., and Hooper, F.H. A training procedure for the acquisition of Piaget's conservation of quantity: A pilot study and its replication. British Journal of Educational Psychology, 1966, 36, 301-311.

Smedslund, J. Apprentissage des notions de la conservation et de la transitivite du poids. Etudes d'Epistemologie Genetique, 1959 9, 85-124.

Smedslund, J. The acquisition of conservation of substance and weight in children. I. Introduction. Scandinavian Journal of Psychology, 1961a, 2, 11-20.

Smedslund, J. The acquisition of conservation of substance and weight in children. II. External reinforcement of conservation of weight and of operations of addition and subtraction. Scandinavian Journal of Psychology, 1961b, 2, 71-84.

Smedslund, J. The acquisition of conservation of substance and weight in children. III. Extinction of conservation of weight acquired "normally" and by means of empirical controls on a balance scale." Scandinavian Journal of Psychology, 1961c, 2, 85-87.

Smedslund, J. The acquisition of conservation of substance and weight in children. IV. An attempt at extinction of visual components of the weight concept. Scandinavian Journal of Psychology, 1961d, 2, 153-155.

Smedslund, J. The acquisition of conservation of substance and weight in children. V. Practice in conflict situations without external reinforcement. Scandinavian Journal of Psychology, 1961e, 2, 156-160.

Smedslund, J. The acquisition of conservation of substance and weight in children. VI. Practice on continuous versus discontinuous material in conflict situations without external reinforcement. Scandinavian Journal of Psychology, 1961f, 2, 203-210.

Smedslund, J. The acquisition of conservation of substance and weight in children. VII. Conservation of discontinuous quantity and the operations of adding and taking away. Scandinavian Journal of Psychology, 1962, 3, 69-77.

Smedslund, J. Patterns of experience and the acquisition of conservation of length. Scandinavian Journal of Psychology, 1963, 4, 257-264.

Smedslund, J. Concrete reasoning: A study of intellectual development. Monographs of the Society for Research in Child Development, 1964, 29, No. 2 (Serial No. 93).

Smedslund, J. Performance on measurement and pseudomeasurement tasks by five to seven year old children. Scandinavian Journal of Psychology, 1966, 7, 81-92.

Smith, I.D. The effects of training procedures upon the acquisition of conservation of weight. Child Development, 1968, 39,515-526.

Smock, C.D., and Holt, B.G. Children's reactions to novelty: An experimental study of "curiosity motivation". Child Development, 1962, 33, 631-642.

Soenstroem, A.M. On the conservation of solids, in Bruner, Olver, Greenfield, et al. Studies in Cognitive Growth. New York: John Wiley and Sons, Inc., 1966, 208-224.

Stager, P. Conceptual level as a composition variable in small-group decision making. Journal of Personality and Social Psychology, 1967, 5, 152-161.

Stein, D.D. The influence of belief systems on interpersonal preference. Psychological Monographs, 1966, 80 (8).

Sullivan, E.V. Acquisition of conservation of substance through film modeling techniques, in Recent research on the acquisition of conservation of substance, Brison, D.W., and Sullivan, E.V. (Eds.). Educational Research Series, 2, The Ontario Institute for Studies in Education, 1967, 11-24.

Sullivan, E.V. Experiments in the acquisition of conservation of substance - an overview, in Recent research on the acquisition of conservation of substance, Brison, D.W., and Sullivan, E.V. (Eds.). Educational Research Series, 2, The Ontario Institute for Studies in Education, 1967, 1-10.

Sutton-Smith, B. Piaget on play: A critique. Psychological Review, 1966, 73, 104-110.

Thompson, J. The ability of children of different grade levels to generalize on sorting tests. Journal of Psychology, 1944, 11, 119-126.

Towler, J.O. Training effects and concept development: A study of the conservation of continuous quantity in children. Paper presented at the meeting of the American Educational Research Association, Chicago, 1968.

Uzgiris, I.C. Situational generality of conservation. Child Development, 1964, 35, 831-842.

Uznadze, D.N. The psychology of set. New York: Consultants Bureau, 1966.

Wallach, L., and Sprott, R.L. Inducing number conservation in children. Child Development, 1964, 33, 1057-1071.

Wallach, L., Wall, J.A., and Anderson, L. Number conservation: The roles of reversibility, addition-subtraction and misleading perceptual cues. Child Development, 1967, 38, 425-442.

Werner, H. The concept of rigidity: A critical evaluation. Psychological Review, 1946, 53, 43-52.

Werner, H., and Kaplan, E. The acquisition of word meanings: A developmental study. Monographs of the Society for Research in Child Development, 1950, 15, (Serial No. 51).

White, S.H. Evidence for a hierarchical arrangement of learning processes. In Lipsitt, L.P., and Spiker, C.C. (Eds.). Advances in child development and behaviour, Vol. 2, New York: Academic Press, 1965.

Winer, G.A. Induced set and acquisition of number conservation. Child Development, 1968, 39, 195-205.

Witkin, H.A. Some implications of research on cognitive style for problems of education. Estratto da Archivio di Psicologia, neurologia e psichiatria, Anno XXVI (1965) - Fasc. I.

Witkin, H.A., Dyk, R.B., Faterson, H.F., Goodenough, D.R., and Karp, S.A. Psychological differentiation: Studies of development. New York: Wiley, 1962.

Witkin, H.A., Lewis, H.B., Hertzman, M., Machover, K., Meissner, P.B., and Wapner, S. Personality through perception. New York: Harper, 1954.

Wohlwill, J.F. A study of the development of the number concept by scalogram analysis. Journal of Genetic Psychology, 1960, 97, 345-377.

Wohlwill, J.F. From perception to inference: A dimension of cognitive development. In Kessen, W., and Kuhlman, C. (Eds.). Thought in the young child. Monographs of the Society for Research in Child Development, 1962, 27, 87-106.

Wohlwill, J.F., and Lowe, R.C. Experimental analysis of the development of the conservation of number. Child Development, 1962, 33, 153-167.

Wright, J.C., and Kagan, J. Basic cognitive processes in children. Monographs of the Society for Research in Child Development, 1963, Vol. 28, No. 2.

Zigler, E. A Measure in search of theory. Contemporary Psychology, 1963, 8, 133-135.

Zigler, E. and Butterfield, E.C. A further of the Lewin-Kounin formulation. Journal of Abnormal Psychology, 1966, 71, 224-231.

Zimiles, H.A. A note on Piaget's concept of conservation. Child Development, 1963, 34, 691-695.

APPENDIX A

ADAPTATION OF THE INHELDER-PIAGET MEASURE OF RETROACTIVE FLEXIBILITY (IPRET)

APPARATUS

1. Two cardboard boxes 4 in. by 8 in. by 1 in.
2. Three circles 2 in. in diameter and three crosses 2 in. in height and width, all cut from one sheet of green construction paper.
3. Three stars of the same size cut from yellow construction paper.
4. Three rhombi with 2 in. sides cut from purple construction paper.
5. Three semi circles 2 in. in diameter cut from purple construction paper.
6. Three 2 in. equilateral triangles cut from brown corrugated cardboard.
7. Three ovals (long axis = 2 in.) cut from brown corrugated cardboard.

PROCEDURE

Ss were presented with each of the seven items in succession and asked to sort them into the two boxes provided.

INSTRUCTIONS

The investigator begins by saying: "Here are two boxes. I am going to give you some cut outs which you will have to put into these boxes. In each box I want you to put the cut outs which go

together."

A test item is presented and then the investigator says: "Now put the cut outs that 'go together,' together in the same box.

APPENDIX B

ADAPTATION OF THE INHELDER-PIAGET MEASURE OF ANTICIPATORY FLEXIBILITY (IPANT)

APPARATUS

1. Four large circles 3 in. in diameter and four small circles 1 in. in diameter cut from red construction paper.
2. Four large circles 3 in. in diameter and four small circles 1 in. in diameter cut from blue construction paper.
3. Two 3 in. squares and two 1 in. squares cut from red construction paper; two 3 in. squares and two 1 in. squares cut from blue construction paper.
4. Two large circles 3 in. in diameter, two small circles 1 in. in diameter, two 3 in. squares and two 1 in. squares, all with jagged edges and cut from red construction paper.
5. Two large circles 3 in. in diameter, two small circles 1 in. in diameter, two 3 in. squares and two 1 in. squares, all with jagged edges and cut from blue construction paper.
6. Two large aluminum pie plates.

PROCEDURE

Ss are asked to describe the objects and then to form internally consistent dichotomies classifying all of the objects.

INSTRUCTIONS

The investigator spreads all the items on a table and says:

"What do you see on the table? How would they go together if you were to put them in those two plates?" After each response the question is repeated until Ss can no longer generate alternate dichotomous classifications.

APPENDIX C

THE CHILD TRANSITION TEST (CTT)

APPARATUS

Five cards showing a dog to cat transition constructed according to Blum's (1959, p. 299) instructions.

PROCEDURE

Ss were shown each of the cards successively and asked to state what kind of animal they saw on the card.

APPENDIX D

THE RESTRUCTURING BY CLASSIFICATION TASK (RBCT)

PROCEDURE

The procedure used in the current investigation is identical with Zigler and Butterfield's (1966) method which follows:

> Each subject demonstrated that he was able to sort cards which differed in color only (black, yellow, green, pink, and red) and cards which differed in form only (triangle, square, circle, cross, and five-pointed star). The subject was then asked to sort a deck of 25 cards which differed in both these colors and forms (five triangles, one of each color; five squares, one of each color, etc.). The subject was then asked to sort this deck again. If he did not change his basis for classification (from shape to color or from color to shape) he was asked to sort them again. If he still had not changed his classification scheme he was told to "try to find a different way they're alike," and given six more opportunities to sort the cards. The measure employed was the trial upon which the subject switched his classification principle.

APPENDIX E

THE FIXATION AND EXTINCTION OF SET IN THE HAPTIC MODALITY (SET)

APPARATUS

1. Three wooden spheres equipped with handles, one being 100 mm. in diameter the other two being 70 mm. in diameter and each weighing 300 grams.
2. A portable cloth screen used in lieu of a blindfold. The screen effectively shielded the spheres from the view of the Ss.

PROCEDURE

The procedure follows that which was previously outlined in Chapter II.

INSTRUCTIONS

"I am going to put one ball in each of your hands. Feel them each time I put them there and tell me if they are the same size or different sizes. If one is bigger tell me which one?"

APPENDIX F

THE CHILDREN'S EMBEDDED FIGURES TEST (CEFT) - REFERENCED

The method adopted in the current study followed exactly that of Karp and Konstadt (1963), and is therefore not reproduced here.

APPENDIX G

SMEDSLUND'S COGNITIVE-CONFLICT TRAINING PROCEDURE

The present study followed Smedslund's (1961f) training procedure. Accordingly his instructions and a schema of his instructions are present in the following:

A and B are the two identical balls or piles with which each item starts. The child will always be informed at the beginning of an item that the two balls (piles) contain exactly the same amount. I - IV and a - e are the various steps and substeps in the item. Def A means deformation of object A, +A means that a piece is added to A, and -A means that a piece is taken away from A. The standard question will be asked after each deformation, addition or subtraction. $A > B$ means that there is more in A than in B, $A = B$ means that there is the same amount in both, and $\neq$ means $<$ or $>$. The sequence +A -A always refers to the addition and subtraction of the same piece.

TRAINING SCHEMA

I

(a) Def A

If child says A > B then:

(b) -A

(c) +A

If child says

A < B then:

(b) -B

(c) +B

In both cases proceed to II

If child says A = B

(b) Def B

In the following:

If child says ≠,

↳ Return to Ia, if = Continue:

II

(a) Def B and -B

(b) -A

(c) +B

Proceed to III

III

(a) Def A and -A

(b) -A

(another piece)

(c) +A

(d) +A

Proceed to IV

IV

(a) Def B and -B -A

(b) +A +B

PROCEED TO NEXT ITEM

I (continued)

(c) Def A

Introduce two new objects C and D.

(d) Def C

(e) Def D

POSTTEST.

NOTE: An item can be completed by going from a to e in Step I or by going from Step I to Step IV.