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**The role of external and cognitive conflict in children's
conservation learning**

Bodlakova Ward, Vera, Ph.D.

City University of New York, 1988

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**THE ROLE OF EXTERNAL AND COGNITIVE CONFLICT
IN CHILDREN'S CONSERVATION LEARNING**

by

VERA BODLAKOVA WARD

A dissertation submitted to the Graduate Faculty in
Educational Psychology in partial fulfillment of the
requirements for the degree of Doctor of Philosophy,
the City University of New York.

1988

1988

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This manuscript has been read and accepted for the Graduate Faculty in Educational Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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Abstract

THE ROLE OF EXTERNAL AND COGNITIVE CONFLICT IN CHILDREN'S CONSERVATION LEARNING

by

Vera Bodlakova Ward

Advisor: Professor Barry J. Zimmerman

The purpose of this study was to examine the role of external (social) and internal (cognitive) conflict in children's learning to conserve weight. Piaget's theory of intellectual development rests on two assumptions: (1) moderately discrepant experiences of external conflict between two external events or rules, or between subjects of different operational levels generate internal cognitive conflict (disequilibrium); and (2) cognitive conflict is a necessary precondition for stage progression.

This study employed a 3 (degree of modeled external conflict) x 5 (pretest, treatment, social learning, immediate and delayed posttests) repeated measures factorial design with dangling control group. One hundred nonconservers and transitional kindergarten and first grade children were randomly assigned to one of four conditions: No Conflict (0% disagreement between two adult models about conservation of weight); Intermediate Conflict (50% disagreement); High Conflict (100% disagreement); and Control Group. A critical addition to this research design was the inclusion of "prediction of models' performance" which served as a measure of social

learning. Two measures of internal cognitive conflict were employed: behaviorally assessed latency scores and subjectively assessed certainty scores.

No Conflict modeling treatment was significantly more effective in generating acquisition of conservation than either of the two conflict treatments. Children who received Non-Conflicting modeling were able to predict models' responses more accurately than children in the two conflict groups. Also, children who accurately predicted models' judgments and explanations attained significantly higher immediate and delayed Posttest conservation scores on both training and transfer tasks than children who predicted models' performance less accurately. Children in the Intermediate Conflict condition had significantly lower certainty scores than children in the High Conflict condition but no difference emerged among the other groups. Although response latencies were shorter for the No Conflict group than for all the other groups, this effect was not uniformly significant across all phases of the study. These findings indicate that while external social conflict generated some internal cognitive conflict, this conflict had the opposite effect on children's learning of conservation of weight to that predicted by the Piagetian hypothesis. The results were interpreted as supportive of social learning view of cognitive development. Educational implications for instruction are discussed.

ACKNOWLEDGMENTS

I would like to express my gratitude to Dr. Barry J. Zimmerman for his ongoing guidance, support, and enthusiasm during the preparation and writing of this dissertation. I want to thank the other members of my committee, Drs. Shirley Feldmann and David Rindskopf, who made many valuable suggestions; Drs. Marian Fish and Philip Saigh, my outside readers, for their helpful comments; and Dr. Manuel Martinez for his assistance with statistical analysis of the data.

I wish to thank the principals, teachers, and children of P.S. 198 and New Lincoln School for their cooperation and gracious assistance in carrying out this research; and Ms. WendiLee Lyon for her patience and conscientiousness in typing this manuscript.

Finally, I want to thank my husband, Eugene Ward, who sustained me with his interest, patience, understanding, and encouragement.

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CHAPTER I

Introduction and Statement of the Problem

The notion of conflict has long been an intriguing and attractive concept for philosophers and psychologists (e.g., Hegel, Marx, Freud, Lewin, Berlyne, and Piaget). Several investigators (Berlyne, 1960, 1970; Smedslund, 1961; Murray 1967; Murray, 1972; 1982, 1983, a, b; Piaget 1975/1985; Pinard, 1981; Bearison, 1982; Doise & Mugny, 1984) have examined the possibility that internal conflict (psychic, conceptual, cognitive) is involved in some crucial way in a wide variety of learning situations. Berlyne (1960, 1970), has defined conceptual conflict as two or more incompatible responses that are simultaneously aroused in the organism. Such conflict, which can arise from various forms of external conflict is assumed to serve as a motivating force. Berlyne distinguished several types of conceptual conflicts, and analyzed the ways in which conflict can be relieved or resolved. Conflicts can occur in the form of doubt, ambiguity, perplexity, contradiction, conceptual incongruity, confusion, or irrelevance. Most of these conflict situations lead to states of high uncertainty since the subject is faced with a number of alternatives that are more or less equally probable.

Conflict between two incompatible beliefs is the closest to Piaget's description of the role of conflict in cognitive development. According to Piaget, states of cognitive conflict and disequilibrium are responsible for the development of such concepts as conservation, and also for the acquisition of logical operations which form the structure of children's thought during each of his four stages of development.

Conservation refers to the understanding that certain characteristics of an object remain invariant despite changes in its appearance (e.g., changing the shape of a piece of clay does not alter its weight, volume etc.). The development of conservation is thought to proceed in three major steps: (1) cognitive equilibrium at a lower developmental level (the nonconservers usually focus his attention on only one stimulus dimension such as height and ignore other dimensions such as width); (2) cognitive disequilibrium or conflict induced by awareness of contradictory discrepant information; and (3) cognitive re-equilibration at a higher development level caused by reconceptualizing the problem, whereby the contradictions are resolved. Berlyne (1970) succinctly described Piaget's notion of equilibration as a "form of learning limited by maturational factors, that is motivated by conflict and reinforced by conflict reduction" (p. 968). Since progressive equilibration

leads to increased assurance and ability to predict, it therefore seems a "matter of relieving subjective uncertainty." (p. 968).

Piaget's equilibration model of cognitive growth has stimulated a great deal of interest and research. In earlier studies (e.g., Smedslund, 1961), investigators concentrated on testing conflict in isolation from the social context, however, recently considerable interest has centered on the possibility that the main sources of conflict may be social (Doise and Mugny, 1984; Bearison, 1982).

Although Piaget (1961, 1964, 1970), postulated "social transmission", as one of the factors of development, he studied it only during his early studies on egocentrism. Until relatively recently, few investigators endorsing Piaget's position have empirically studied the impact of social experience. During the past decade, however, this situation has changed rapidly, and a new field, "social cognition", has emerged. Earlier interpretations of Piaget's theory that emphasized the distinction between social (moral concepts) and nonsocial knowledge (logical, mathematical and physical), have been challenged, and an increasing number of investigators have begun to examine the role of social interaction on cognitive development and learning. The predominant Genevian experimental paradigm, that of

"testing of the young child - as - scientist, in solitary reflection, wrestling with problems of math or science" (Damon 1979, cited in Bearison 1982, p. 205) is now less popular. Piagetian researchers both in America and Geneva have begun to use new social interaction and observational methods which are in many ways quite similar to those used by social learning theorists for the past twenty five years (e.g., observational learning, modeling, participant modeling, provision of rules in social situations, peer tutoring, etc.).

There seems now to be fundamental agreement between most Piagetians and Social Learning Theorists at least with regard to the social origins of knowledge. The acquisition of knowledge is essentially a social process that cannot be studied independently from the social-environmental context from which it originated (Zimmerman, 1983). Similarly, Bearison (1982) wrote: "All knowledge is inherently social in that the ontogenesis of mental development is motivated and maintained by social discourse." (p. 202).

Although both theorists agree that the origin of knowledge is to be found in social sources, there is controversy concerning which mechanism may be responsible for cognitive development. Piagetian researchers work from a constructivist view, i.e., "the concept of knowledge is constructed and reconstructed by the individual over time through equilibration and the

complimentary processes of assimilation and accommodation ... and social milieu creates the necessary context within which those processes occur." (Shulman, 1985, p. 96). A basic assumption of this position is that social interaction is a source of developmental change insofar as it produces conflict. A correlative assumption is that social (inter-individual) conflict generates cognitive (intra-individual) conflict. By contrast, social learning theorists make no assumption that conflict is a pre-existing condition to learning; rather acquisition of knowledge is explained as a social process involving rule abstraction and generalization through vicarious learning.

From this perspective, social influences may foster cognitive changes, however, these changes seem unrelated to level of cognitive conflict. Indeed, as Bandura (1986) wrote "Models who figure prominently in children's lives do not merely cause cognitive perturbations. They serve as indispensable sources of knowledge that contribute to what and how children think" (p. 486).

The present study has been designed to address the following question: Is conflict a necessary precondition for cognitive development and learning?

The review of this literature is organized in two sections. In the first section, Piaget's equilibration theory is described and critically examined. The second section consists of a review of studies in the following

domains: Conflict of Physical Origin; Conflict of Social Origin; and Social Learning studies which focus on the effects of various kinds of modeling on learning.

Following the review of the literature, the research questions and the hypotheses of the present study are stated, and the methodology is presented.

CHAPTER II

Piaget's Theory of Equilibration

The concept of equilibration is a major component of Piaget's model of development. In his theorizing concerning the acquisition of knowledge, Piaget (1961, 1970, 1975/1985) described equilibration as the fundamental internal regulating factor behind development. All other contributory factors (i.e., maturation, experience, and social interaction) are subordinated to this process. What Piaget meant by "equilibration" has been construed (e.g., Furth, 1981; Mischel, 1971) as a largely biological self-regulatory process which (a) maintains a balance between assimilation and accommodation; (b) compensates for internal and external disturbances; and (c) leads to the development of more complex, integrated, and advanced knowledge structures. Each of the three components are discussed in turn below.

Assimilation and accommodation are two simultaneous and complementary processes. A child's efforts to understand new experiences in terms of an existing schemata or structures is known as assimilation. It is a process of adapting external stimuli to one's cognitive structure. In contrast, accommodation occurs when a child

changes his/her structures to assimilate incoming information and new experiences. To use the analogy of digesting food, (as did Flavell, 1977; and Brainerd, 1978 a) an organism simultaneously accommodates the particular structure of the food (e.g., chew hard or easy, contract the muscles of the stomach, release various enzymes depending on the type of food), and assimilates the food into its own physical structure (e.g., change its appearance, convert it into energy, and discharge unused or processed parts).

In cognitive adaptations, children simultaneously assimilate new experiences into existing cognitive structures and accommodate the structures to agree with ever-changing reality. This process takes place through the mechanism of equilibration. During each of Piaget's stages of cognitive development, there are definite limits concerning how much information can be assimilated into a child's cognitive structures. If the child is exposed to experiences that are cognitively too advanced, little or no learning may result because certain mental structures necessary for understanding of a given problem are lacking. Therefore, only a child who shows some evidence of being in transition to a higher developmental stage is assumed to be able to derive a benefit from advanced experiences.

Equilibration is used by Piaget as a main concept to

explain the sequential character of development (i.e., the progress through a series of stages in constant order). The process of equilibration consists of three basic steps. Initially, the child's cognitive system is in equilibrium at a lower developmental level (cognitive structures which govern that level can process only simple information). Subsequently, the child encounters new experiences in his interaction with the environment that are perceived as conflicting or disturbing (i.e., which the system cannot assimilate or accommodate). These encounters produce a state of disequilibrium in the cognitive structures. Eventually, the state of disequilibrium induces cognitive restructuring resulting in a new, more advanced, and more stable state of equilibrium.

Piaget's equilibration theory has been frequently criticized on both conceptual and empirical grounds. Bruner (1959) dismissed the equilibration concept as "surplus baggage" contributing nothing useful to theory or experimental design (p. 356). Mischel (1971) has described the mechanism of equilibration as a "rather misleading metaphor" (p. 325) for the cognitive process that Piaget was analyzing. Mischel argued that Piaget did not make it clear whether his equilibration model is an empirical theory or a rational reconstruction of the development of thinking. He pointed out inconsistencies

in Piaget's equilibration model regarding the internal vs. external conflict. There seem to be no need for "external intrusions" in order for equilibration to occur.

Equilibration may occur as a response to internal conflict between the subject's conceptual schemas (cognitive structures) rather than as a response to any outside disturbance. "Equilibration is more a matter of achieving what Piaget calls 'the accord of thought with itself' rather than a matter of establishing the 'accord of thought with things'" (Mischel 1971, p. 324). Mischel expressed doubts that equilibration can provide a psychological explanation for the process of development and learning. Murray (1983) also criticized Piaget's theory for failing to explain what in fact the equilibration process itself consists of, as well as how it gets initiated.

Piaget revised his equilibration theory several times, and in his final model (1975/1985), he assigned an increasingly important role to the notion of cognitive conflict as initiating, driving, and sustaining the mechanism of equilibration. Piaget (1975/1985) wrote, "The most influential factor in acquiring new knowledge structures is perturbation or conflict" (p. 33). He equated conflict, disequilibrium, contradiction, and perturbation, and used these constructs interchangeably. Many of his statements were vague and unclear, and some appear to be contradictory. For example, in a chapter

entitled "The reason for disequilibrium and their initial frequency," Piaget stated, "From the point of view of equilibrations, it is obvious that one of the sources of progress in the development of knowledge must be sought in disequilibria. Disequilibria alone force the subject to go beyond his current state" (p. 10). Compare this assertion with his statement two pages later, "As for cognitive development it is difficult at least in our current state of knowledge to maintain that disequilibria or contradictions are inherent characteristics of thought. . . . It is not an inherent property of operating structures." (p. 12). According to Piaget "conflicts constantly arise between subject and object, between one subsystem and another, and between sub- and super-ordinate system. . . ." (p. 13). Paradoxically, the system which is responsible for the disturbances in the first place then is said to compensate to overcome the disturbances. But why would the same system create conflicts if they were seen as noxious?

Disequilibria/conflicts, according to Piaget, are most frequent during the beginning of developmental periods, because children have not yet developed reasoning strategies to cope with new experiences. The implication seems to be that as a child gets older, there will be fewer conflicts. However, complete equilibrium is never achieved even in the most mature adults.

Flavell (1977) succinctly pointed out the major flaws in Piaget's conflict equilibration model. In order for equilibration to take place the child is assumed to be able to attend to four things in sequence: (1) a child must notice both of the apparently conflicting elements in the situation; (2) interpret and appreciate them as conflicting and therefore problematic (something one would not assume a young child would automatically do); (3) respond to the sensed conflict by progressing rather than regressing (e.g., by trying to explain it, rather than by clinging defensively to his initial belief for refusing to have anything more to do with the problem); and (4) come up with a better conceptualization of the situation that can resolve the apparent conflict, and thereby "reequilibrate" his mental structure at the higher developmental level. Since a given child could lack one or more of these four prerequisites in relation to some specific cognitive problem, it follows that he/she may not be able to complete (or possibly even begin) the Piagetian process of equilibration.

Despite its ambiguities, vagueness, and conceptual flaws, Piaget's equilibration model has been nevertheless very influential in current thinking about the process of development and learning, and stimulated a considerable amount of research.

CHAPTER III

EXPERIMENTAL STUDIES

Training studies examining the role of conflict in acquisition of knowledge can be divided into three areas:

(1) Studies using training methods based on conflict of physical origin, i.e., conflict resulting from counterdemonstrations invalidating the child's anticipation of accepted rules or conflict between strategies (Smedslund, 1961; Bryant, 1964, 1982; Pinard, 1981).

(2) Studies using methods based on conflict of social origin, that is, conflict resulting from confrontation of two subjects of different age, operational levels, or simply different viewpoints on a particular problem (Murray, 1972; Botwin and Murray, 1975; Murray, Ames and Botwin, 1977; Ames and Murray, 1982; Doise and Mugny, 1975; Doise, Mugny, and Perret-Clermont, 1976; Mugny and Doise 1978; Doise and Mugny, 1984; Emler and Valiant, 1982; Bearison, Magzamen and Filardo, 1986; Bearison and Weinstein, 1985).

(3) Studies employing modeling techniques where the child does not participate in the experiment in the sense of actively performing the training exercises but rather observes a model (or models) demonstrating the correct or

incorrect rules (Charbonneau and Robert, 1977; Robert and Fortin, 1983; Zimmerman and Blom, 1983; Vitaro, 1985).

Conflict of Physical Origin

Some of the earliest conservation training studies utilizing conflict methods were employed by Smedslund. Smedslund (1961) proposed that a state of cognitive conflict was a precursor of the cognitive reorganization underlying conservation. He conceptualized conflict as between two schemas: the addition/subtraction schema and the deformation schema. Although he never defined "schema", it seems that the former is roughly equivalent to a conceptual judgment, while the latter refers to a perceptual judgment. He argued that if a child is confronted by situations in which both schemas are activated in equal strength, this would lead to a conflict between them. For example, if a ball of clay is rolled into a sausage, and a piece is taken off, then the conflicting judgments might be "more in the sausage because it's longer" (deformation schema) and "Less in the sausage because you took some off: (addition/subtraction schema). Since the addition/subtraction schema has "greater clarity, simplicity, and consistency", it will gradually or suddenly begin to dominate the deformation schema that "has a high degree of ambiguity, complexity and internal contradiction". (Smedslund 1961, p. 157).

In order to test his theory, Smedslund (1961) attempted to induce conflict in nonconservers using the basic method described above. He tried to train conservation with a sample of five and six year old children using a series of tasks. In each task he used deformation and addition and/or subtractions of two objects with the intention that the two schemas would come into conflict (i.e., that the child would want to judge "More in the snake because it's longer," but also "More in the ball because a piece was added"). The training study was not very effective because four out of fifteen children shifted from nonconservation to conservation on the posttest. Furthermore, Smedslund found very little evidence of conflict (in the form of hesitation) being aroused by these tasks, and the nonconservers almost always responded consistently on the basis of perceptual appearances (information judgments), rather than on the basis of conceptual judgments (addition/subtraction).

In a later investigation, Smedslund (1964) succeeded in training conservation in six out of fifteen children, using a discontinuous quantity task (sets of linoleum squares). However, other researchers who attempted to replicate his results using similar methods of conservation training obtained results that were not significant.

In addition, it is not clear why the child should

resolve a conflict between the deformation and the addition/subtraction schemas in Smedslund's theory. Moreover, Smedslund does not make it explicit what are the "ambiguities" and "contradictions" inherent in the deformation schema, and why, as a result, the child should adopt the addition/subtraction schema. In his later writings, Smedslund changed his view to a more social orientation.

In contrast to Smedslund's view emphasizing the necessity of some kind of conflict experience (of physical and social origin), Bryant argued (1982) that it is the agreement and not conflict between strategies that produces intellectual change in young children. He argued that conflict informs preoperational children that something is wrong but not what is the right concept such as conservation. Bryant's hypothesis was that checking one strategy against another will produce a much more convincing answer when the two strategies agree rather than when they disagree. If the child reaches the same solution with the help of two different strategies, he/she can be reasonably sure that both strategies are appropriate. If, on the other hand, these strategies produce conflicting results, the child has nothing to tell him/her whether both are wrong, or whether one (and which one?) is correct. Based on this analysis, Bryant designed several studies in which children were taught Piagetian

tasks by methods that involved conflict between strategies vs. methods that involved agreement between strategies. In these studies, he found that conflict failed to have any effect on children's willingness to measure, and that agreement between strategies improved their measurements (on a modified conservation of length task). Bryant concluded that his findings fail to support Piaget's equilibration hypothesis since the evidence of the effects of conflicts was particularly weak, and that children will learn more when strategies are in agreement rather than in conflict.

Bryant's conclusions are more consistent with a social learning theorist's explanations of cognitive development and differ from a Piagetian conflict hypothesis.

Conflict of Social Origin

In one of his early experiments, Murray (1972) hypothesized that conflict in communication would be an effective conservation training procedure. He based his reasoning on Piaget's early work on egocentrism, Flavell's research on perspective taking skills, and Smedslund's ideas concerning the role of conflicts in communication. The procedure consisted of pretest, treatment, and post-test, with an experimental but no control group. During the pretest 108 children were given Form A of the Goldschmid & Bentler Concept Assessment Kit, and based on

their scores, the children were divided into nonconservers (scores 0-4) and conservers (scores 10-12). In the treatment phase, Murray grouped the children into groups of three comprising a nonconservor and two conservers and gave them the pretest problems to solve. The children were instructed that they could not receive a score until all of them agreed on the answer to each problem. One week later the children were posttested individually with all three versions of the Concept Assessment Kit (Forms A, B, and C). The results showed that all children scored significantly higher on the posttest than on the pretest on all forms of the test. Based on these results (in the absence of a control group), Murray rejected the idea that the improvement could be attributed to practice or maturation effects, and concluded that the improvement was due to the social interaction. While he interpreted the data as supporting the conflict hypothesis, he admitted that "it is not clear what the conservers learned in the social situation that sustained them in the individual situation" (p. 5). Murray entertained several explanations for his findings; the effects may have been due to: (1) modeling, (2) peer interaction, and/or (3) learning of rules, such as reversibility and invariant quantity. Although Murray's study indicated that social interaction can be an effective way to learn new concepts, there is not way to determine which mechanism was

responsible for the learning due to the problems inherent in his design (no control group, no separate measures of conflict).

To explore the above issues further, Botwin and Murray (1975) compared modeling and social conflict methods of instruction, but this time a control group (pretest-posttest), and a modeling group were also included in their design. In the social conflict condition, the same method as in Murray's 1972 study was used, except that the children were assigned to work on a conservation task in groups of five (three conservers and two nonconservers). Children were instructed to "talk their answers over with other kids" and to explain their reasons to each other (within a five-minute period), and then agree on an answer. Children in the modeling condition were instructed to simply watch the social interaction group from a distance of about ten feet. During that time the experimenter distracted them by engaging them in a discussion about school activities. The results revealed no significant differences in conservation posttest between the modeling and the social conflict treatments; both groups made significant gains.

The Botwin and Murray study indicated equal effectiveness of learning based on modeling and on social interaction. The authors concluded that the social conflict effect may be attributed more parsimoniously to

the modeling effects than to the effects of communication conflicts. Nevertheless, they also speculated that the reverse explanation, i.e., that both modeling and social conflict methods had created sufficient cognitive conflict to produce cognitive gains, is plausible. Botwin's and Murray's conclusions again remain highly speculative since no definition or separate measure of conflict was provided.

Murray, Ames and Botwin (1977) conceptualized conflict and Piaget's equilibration process as being similar to Festinger's cognitive dissonance mechanism, and they designed a conservation training procedure based upon a cognitive dissonance experimental paradigm. In two experiments, conservers, transitional conservers, and nonconservers were directed to pretend that their judgments and explanations to several conservation problems were the opposite of what they really were. The dissonance-inducing procedure consisted of the experimenter instructing the nonconservers to role-play the position of a conserver in front of another child. Each child was actually individually taught how to apply the identity rule. Conservers were provided with the opposite perceptual appearance judgment to role play. Murray, et al., predicted that the dissonance between the nonconserver's pretense and his true belief will motivate cognitive change. After the dissonance-inducing procedure which presumably introduced a conflict between what the

subject believed and what he said, subjects were questioned about their true belief.

The results indicated that the role playing procedure was effective for nonconservers and transitional subjects, but not for conservers who did not regress as the cognitive dissonance theory would predict. However, there were signs of regression among transitional conservers where their nonconservation pretenses conflicted with their original judgments. The authors interpreted their results as being consistent with Piaget's theses of unidirectional development and with his conflict/equilibration theory. Although it is plausible to assume that the dissonance between the nonconserver's pretense and his true belief motivated the learning of the conservation concepts, an equally plausible and a more parsimonious explanation based on a social learning theory can be offered. The gains in conservation in a so-called conflict dissonance situation may be due to the subjects' recognition that the information in the conservation pretense was true, that is, due to learning of a correct rule. Without a separate measure of cognitive conflict there is no guarantee that the subjects actually experienced the conflict, and thus, the conclusion that the experience of conflict is responsible for cognitive gains is unwarranted.

In a more recent study, Ames and Murray (1982) made a

distinction between conflict (in peer interaction) and content (the information contained in peer interaction), and hypothesized that social conflict alone would not generate cognitive growth in a form of conservation judgments. Nonconserving subjects in all four experimental groups were given information about conservation tasks that conflicted with their prior nonconservation judgments. All social procedures, social interaction, dissonance, conflicting peer modeling, and non-peer conflict conditions had a significant effect on children's conservation posttest scores. Moreover, the children in a social interaction situation had higher scores than children in all the other groups. The authors concluded that exposure to incorrect information that conflicts with a prior but equally erroneous belief can stimulate cognitive growth (i.e., "two wrongs make a right") and that exposure to correct information is not always necessary for the generation of that information. They also suggested that a critical component of the equilibration process may be simply the conflict between children's beliefs, whatever the content of those beliefs may be.

Closer inspection of Ames and Murray's (1982) data, however, shows that the posttest conservation gains, although significant, were , in fact, rather modest. While the possible range of scores in their study was

0-18, the highest mean obtained in the posttests was 8.25 (second grade social interaction group). Based on the data reported by social learning theorists (e.g., Zimmerman and Blom, 1983), it would appear that exposure to consistent information or correct rules may be more effective in promoting children's learning than exposure to conflicting information. Another problem already discussed with reference to previous Murray, et al., studies (1972, 1975, 1977) is that since no measures of cognitive or social conflict were collected, it makes it rather difficult to establish what aspects of the conflict situations may be responsible for the reported gains in cognitive growth.

Following Murray (1972) and Piaget (1975), Charbonneau and Robert (1977) hypothesized that observational learning of conservation can be explained in terms of cognitive conflict between the nonconservers and the conserving model's answers. In accordance with Piaget's equilibration model, they also predicted that increasing degrees of conflict between the model's answer and the children's conviction would generate increasing levels of acquisition as assessed through generalization and stability criteria. Five degrees of conflict were defined according to the activity interpolated between the experimenter's question and model's answer. These were the following: (1) intervening activity was unrelated to

conservation; (2) no specific activity was suggested during observation; (3) children were asked to think about their answer; (4) children were asked to give their answer; and (5) children were requested to predict the model's answer. In the control situation observation was not interrupted. All six groups were shown a videotape of an adult model performing a task on conservation of quantity. The results revealed that in all treatments except (1) irrelevant task, children showed considerable learning of the conservational rule on immediate and seven weeks delayed posttest. Charbonneau and Robert (1977) interpreted their findings as being consistent with the social learning explanation of rule learning rather than with explanations based on equilibration theory. They also questioned the validity of the concept of conflict and concluded that precise operational measures of the conflict construct are needed; until then no conclusions can be made regarding its role in development.

One interesting aspect of Charbonneau and Robert's (1977) study is that one of their treatment conditions (5) was to predict the model's answer. Children in that condition were instructed to "speak your answer as if you were the lady shown on television." Surprisingly, the children in that condition obtained the highest posttest score (22.40 out of 24; the posttest scores for the other groups ranged from 8.40 to 21.20).

In an unrelated concept formation study, Liebert and Swenson (1971, a & b) found that the presence of a common dimension facilitated recall of the model's responses and led children to predict other nonmodeled behaviors of the model governed by the same rule. In contrast, children in the no common dimension failed to predict that the model would behave inconsistently. Liebert and Swenson's study supports the hypothesis that exposure to consistent information is a more effective procedure for learning than exposure to conflicting information. Their study also showed that relatively young children can both abstract the common feature of a task governed by a rule and use this information to make social predictions.

In a series of training studies, Doise and his colleagues have sought to provide empirical verification for the thesis that social interaction plays a causal role in cognitive development. Doise and Mugny (1984, 1985) argued that social interaction can be effective only if it creates a "sociocognitive conflict" between children's divergent solutions. The essential aspect of their argument is that cognitive conflict created by social interaction between children whether at different levels of cognitive development or simply with different viewpoints will lead to cognitive growth. Conflict arising from social interaction is presumed to create disequilibrium, that is at once both social and

cognitive. Through the process of equilibration, cognitive structures of both participants in the interaction get reorganized and restructured, and the new, more coordinated, complex, and stable cognitive structures will gradually give rise to operational thinking. According to Doise (1985), the progress is not unidirectional, rather, it is circular and spiral.

Doise and his associates also argued that collective conflict is more effective in inducing cognitive change than individual conflict. The main method of Doise, et al., (1976, 1979, 1984) for inducing such conflicts was to pair children with different viewpoints (e.g., conserver vs. nonconserver, conserver vs. transitional), who were asked to work together and to reach an agreement to a conservation task or a spatial perspective task. These researchers have reported that pairs of children (dyads) generally made greater progress on posttest measures than children working alone on the same tasks. Since the children differed with respect to their responses on the pretest, Doise, et al., concluded that sociocognitive conflict was the mechanism that led to increased scores on the posttest.

Although the children in these studies have demonstrated cognitive gains, it is not at all clear what aspects of the social interaction produced these gains; interaction, communication, physical manipulation of

objects, compliance, etc., are all confounded in these designs. Furthermore, since no operational definition of the construct of sociocognitive conflict was provided, and no separate measures of conflict collected, there is no evidence that cognitive conflict actually occurred. The risk in studies like these, as Botwin, et al., (1977) noted, is that "the child will not experience a conflict because the inconsistency of observation will be a) simply unnoticed, b) tolerated as a paradox or mystery, c) not seen as an inconsistency but as two independent events, or d) resolved prematurely by the discard or discount of one of the observations" (p. 520). Similar skepticism has been expressed by Pinnard (1981), who observed in many conservation experiments that "young children seem to be quite impermeable to contradictions" (p. 83) and "Children tend to be quite sure of their judgments, and it is very difficult to make them aware of a conflict" (p. 127). Although the conflict situation may produce internal conflict in older children, this may not be the case in a younger age group. Subjective certainty may be a result of children's insensitivity to conflict, and not the other way around. There may also be individual differences with regard to the degree of sensitivity to social or cognitive conflict. Pinnard (1981) concluded that, while the notion of cognitive conflict has a considerable theoretical appeal, it is much less simple to show that it is not a

"mere theoretical fiction." Similarly, Murray (1983) emphasized that the "critical issue is always. . . whether the subject not the researcher experienced the conflict" (p. 56). Murray (1982) pointed out that "The Genevan explanation lacks parsimony and it should come as no surprise that it might be possible to explain the workings of social interaction procedures with more parsimonious mechanism, such as imitation or modeling" (p. 264).

Doise and Mugny (1984) admitted that their results cannot exclude the possible effects of modeling, and indeed, they went into a great deal of trouble to rule out social learning as a mechanism of cognitive development. They argued that "sociocognitive conflict cannot be reduced to 'modeling' effects" (p. 136), and proposed that the perspective can be inverted to offer an explanation for the modeling effects in terms of sociocognitive conflict. Since their "revision" of social learning is quite interesting, it is outlined below. Briefly, they suggest that the utility of a model depends on his/her capacity to engender sociocognitive conflict in the subject. Doise and Mugny (1984) defined a "model" as the "cognitive characteristics of a proposed solution to the problem" (p. 136), and proceeded to make a distinction between a "progressive", a "similar", and a "regressive" model. "Progressive model" can be either "correct" (able to solve problems correctly) or "intermediate" (problem

resolution superior to the subject solution, but not quite correct yet). "Regressive model" is the one that offers solution inferior to that of a child, and a "similar model" is the one that offers the same solution as the subject being studied.

Following review of several studies that utilized the social learning paradigms and some of their own studies, Doise and Mugny (1984) concluded that the effect of a "correct progressive model" is almost always unanimously strongly positive because of its capacity to engender both social and cognitive conflict. Also no systematic regression has been observed in subjects confronted with a correct model. Thus, his type of model appears to be particularly effective in ensuring cognitive development. Ironically, the same position is advocated by social learning researchers who view presentation of consistent rules as a more effective procedure than presentation of inconsistent information in teaching children concepts such as conservation (Zimmerman and Blom, 1983). However, the mechanism postulated to be responsible for the improvements is quite different from that of Doise and Mugny.

With regard to the effect of "intermediate models", Doise and Mugny accept Kuhn's (1972) proposition that the ideal model should be the one that is at a cognitive level just superior to that of the subject, and no necessarily

as "correct model" which may be at a too great "cognitive distance". Maximum progress occurs when subjects are confronted with a model at "plus-one" level, i.e., just superior to the subject's own initial level of response. Though the progress may be attributed to the mechanism of imitation, there is, nevertheless, a strong emphasis on the constructive and progressive activity of the subject in the interaction. With regard to "similar models", it can be expected that children who observe a model at the same level as their own would not exhibit much cognitive gains because their viewpoints are not in conflict with each other. In the absence of conflict, no progress can be expected.

In Doise, et al., studies, all the emphasis is placed on the conflict mechanism (especially the sociocognitive conflict) as a cause of cognitive development. Attempts to replicate Doise, et al., (1975, 1976, 1979) results outside of Geneva have not been very successful, and the reported findings are inconsistent and conflicting. Bearison, Magzamen, and Filardo (1986) found that children who worked in dyads did not have significantly higher posttest scores on a spacial perspective coordination task than children who worked individually. Bearison, et al., then carried out post hoc analysis of the dyads data to distinguish among dyads who made significant cognitive gains and those who failed to do so.

Based on these analyses, the researchers concluded that random assignment of children to collective or individual condition is not sufficient to demonstrate the facilitating effects of social interaction on cognitive development. They also proposed that critical features of the sociocognitive conflict model that need to be considered in future research are: (a) expression of verbal disagreements justified by the partner; (b) production of optimal range of disagreements (i.e., optimal level of conflict); and (c) mutual balance between partners in the expression of conflict. Even if all these factors could be controlled, which seems to be a rather difficult task, there is still no guarantee that social conflict will generate sociocognitive conflict that is postulated to be the mechanism responsible for cognitive development. Unless some operational measures of sociocognitive conflict are developed, the conclusion based on research designs of this kind are unwarranted.

Using similar methodology, as Doise, et al., (1975, 1976, 1979) and Bearison, et al., (1986), Emler and Valiant (1982) carried out two experiments comparing paired training and solitary practice. They found that paired training resulted in more improvement than solitary practice but was no more effective than individual training designed to induce intra-individual conflict. They questioned the discrepancy between their and Doise

and Mugny's findings (i.e., superiority of socially-induced conflict over intra-individual conflict) and speculated that task and cultural variables may be partially responsible for the differences. They also questioned the lack of any direct evidence that the inter-individual conflict training did indeed generate conflict in the subjects. With respect to this issue, Emler and Valiant wrote, "From informal observations, it was clear that disagreements occurred and were sometimes quite intense. The extent of disagreement, however, was not quantified in any way so it was not possible to make a direct check on the reliability of the procedure as a method for generating social conflict. In some pairs there appeared, overtly at least, very little disagreement" (p. 299).

In the second study, Emler and Valiant (1982) operationally defined social conflict as the amount of disagreement that occurred and predicted that the effectiveness of collective training would be a function of the amount of disagreement. In the inter-individual conflict condition (collective training), the amount of disagreement was measured for each pair of children by noting every instance in which one child made a physical change in a placement made by the other. These disagreements presumably reflected the occurrence of cognitive conflict. No measures of internal conflict were

taken for children in the intra-individual conflict condition. The results showed that the children in both conflict groups significantly improved their posttest scores, while the children in the no training-control group showed no improvement. Despite the absence of any measures of intra-individual conflict, the authors concluded that development can be induced by training which provides opportunities for the experience of conflict. However, their data did not support the superiority of the inter-individual (social) conflict over the intra-individual conflict hypothesis. They questioned the validity of the assumption that conflicts must necessarily originate in social interaction, and attributed their finding to childhood egocentrism (i.e., social interaction may not be sufficient to break down egocentrism). Emler and valiant also questioned the lack of evidence that opposing points of view always produce disagreement; and that, even when disagreement is manifested, it will not necessarily produce cognitive conflict and developmental change.

To further support the socioconstructivist hypothesis that sociocognitive conflict has a causal role in cognitive development, Weinstein and Bearison (1985) carried out a study in which 80 six-year-old children were assigned to one of the three conditions; social interaction, social observation, and individual control.

The social observation condition was included to control for the simple exposure to task-relevant information. Following the pretest with the Conservation Concept Assignment Kit, nonconservers and intermediate conservers of the same sex were paired, presented with a conservation task by the experimenter, and asked to discuss the problem and to agree on an answer. Note that the children who were conservers were excluded because in some of Doise, et al., studies, it was found that most successful dyadic combinations were those in which subjects who functioned at intermediate levels of mastery worked together. These pairs of children comprised the social interaction group. Subjects in the social observation group (nonconservers and intermediate conservers) were instructed to just watch the other children playing games. Control group children were individually administered pretests and posttests, but received no treatment.

Weinstein and Bearison (1985) found that subjects in the social interaction condition had significantly greater conservation gain scores than subjects in the social observation and control condition. There were no significant differences between conservation gain scores of subjects in the social observation and control groups. As the researches expected, the subjects in the social interaction group gave more novel explanations than the subjects in the other two groups. The "novel

explanations", although it is not explicitly stated, were presumably viewed as some kind of indicators of sociocognitive constructive (i.e., equilibration) process at work. Another "dramatic" finding was that 85% of the transitionals (paired with nonconservers) in the social interaction condition advanced to the level of conservers compared with only 10% in each of the other two groups. Interestingly, 60% of the subjects in observation condition regressed, while in the social interactive group, only 5% regressed to the level of nonconservers. The authors interpreted their results as supporting the sociocognitive conflict model of development, and rejected the explanation that cognitive gains could be attributed to subjects' simple exposure to task relevant information. They contrasted their findings with those that were reported by social learning theorists (e.g., Zimmerman and Blom, 1983) and concluded that "modeling effects might be better understood as a particular instance of the general effects of sociocognitive conflict" (p. 343).

Weinstein and Bearison (1985) also challenged social learning theorists that they "could not explain how the subjects in the present study who interacted with less advanced partners showed as much cognitive gains as subjects who interacted with more advanced partners or how interacting subjects showed greater progress than

observing subjects, a form of modeling according to Zimmerman and Blom (1983)" (p. 343).

Imitation is not the only form of learning according to social learning theorists (Zimmerman, 1983; Bandura, 1977). Individuals can learn new concepts through performance accomplishments, verbal persuasion, participant modeling, vicarious experience, rule abstraction, etc.

Intervening variables (such as children's expectation, interpretation, intentions, and attributions), cognitive processes (attention and retention), and motivation play a role in the acquisition of knowledge. Weinstein and Bearison's (1985) findings could be more easily explained in terms of participant modeling, rule learning, and the related processes (e.g., attention, retention, motivation), than in terms of sociocognitive conflict. More specifically, the children in the social interaction group were expected to participate in the discussion, and because there were required to come to an agreement, they may have been more motivated to pay attention to the other children's responses. In contrast, the children in the social observation group were instructed only to watch the children play. If these children did not find the task too interesting (which may be the case), their attention dwindled, and consequently, their cognitive gains were lower.

Observational Rule-Learning Studies

In contrast to the studies reviewed so far, the Zimmerman and Blom (1983) study is, to our knowledge, the only one in which various forms of conflicts were clarified and the measures of conflict were operationally defined. Also, Zimmerman and Blom's (1983) research design which utilized videotaped modeling techniques allows much greater experimental control over the treatment conditions than the social interaction/sociocognitive conflict design employed by Piagetian researchers (Doise, et al., 1984; Bearison, et al., 1986). In the latter, many variables (e.g., language skills, styles of interaction, physical manipulation of objects, interpretation of instruction, nonverbal communication compliance) cannot be adequately controlled and are, thus, confounded. The occurrence of disagreements and agreements between children (the only overt measure of social conflict or a lack of it) may well depend on a set of factors that have been totally ignored in this kind of research. If these children are drawn from the same classes, as is usually the case, they have already established some kind of relationship with each other (friendships, dominance, enmity, animosity, etc.), which are likely to influence the course than the social interaction

will take. Random assignment of children to pairs or groups does not seem to provide enough control over these variables. Inconsistent findings from the studies utilizing these designs may be partly due to these effects.

Another problem is that, in most of the social interactions/conflict studies, the concept of conflict was the major variable, yet no adequate measures of conflict were provided. In the few studies where external conflict was measured, it involved only disagreements (between responses between peers), and these may not always be expressed verbally or overtly. Various coding or scoring systems (e.g., manipulation of physical objects, verbal disagreements, novel responses) developed by these investigators appear to be imprecise or confusing, and depending on which system one chooses to use, different interpretations of the results can be made.

By comparison, Zimmerman and Blom (1983) approached these controversial issues from a different theoretical and methodological perspective. The primary goal guiding their research was to critically examine Piaget's hypothesis that cognitive conflict (disequilibrium) is a precondition

for intellectual development, and to compare these conflict explanations with a rule-consistent modeling hypothesis. Using Sigel's (1975) analysis, the authors drew a distinction between three different kinds of conflicts: (a) internal cognitive conflict (between two competing ideas); (b) external social conflict (between two external events or sources of information); and (c) internal-external conflict (between an internal and external event). The measures of conflict were operationally defined to make a clear distinction between the three kinds of conflicts described above. External conflict was defined as two incompatible judgments between two models. To separate this measure of external conflict from other forms of social influence, videotapes of modeling situations were made in which degrees of disagreement were experimentally controlled. The internal-external conflict was created in the usual way by exposing nonconserving children to conserving adults (models). Based on Berlyne's (1960, 1970) and Sigel's (1979) work, two measures of internal cognitive conflict (which is the most difficult to operationalize) were designed. These were subjective uncertainty and response latency. The children's degree of uncertainty (about conservation answers) was taken as an indicator of

their level of internal conflict or disequilibrium. In addition to the subjective measure of internal conflict (provided by the subjects themselves), response latency was chosen as a second, more objective, and more behavioral measure.

The research design of Zimmerman and Blom's (1983) study consisted of pretest, treatment, posttest, and delayed posttest design, in which conservation, certainty, and latency judgments were the dependent variables. There were three treatment groups and one control group.

In the rule-consistent modeling, both models agreed on a conservation answer and judgment (invariant quantity) to each of the four conservation of weight tasks. In the conflicting modeling treatment, one of the models invariably conserved and the other invariably denied conservation. The third condition, rule-inconsistent modeling, the two models also disagreed in their conservation responses, but traded roles as a conserver and nonconserver across trials. Control group received pretest and posttests but no treatment.

The results revealed that significant acquisition, transfer, and retention of conservation were found for only those children who were exposed

to the nonconflicting (rule-consistent) modeling treatment. There were no significant differences in the posttest conservation scores of the three other groups. This finding suggests that consistency in modeling experiences lead directly to acquisition of conservation rules. Neither of the two measures of cognitive conflict predicted acquisition of conservation. In fact, the lack of variation on these two measures across the four groups would suggest that children do not experience much conflict despite conflict-inducing procedures. This interpretation is consistent with behavioral observations of other researchers who have expressed strong doubts about the preoperational children's ability to experience conflict in situations where older children or adults may (Pinnard, 1981; Vuyk, 1981; Bryant, 1982; Zimmerman and Ringle, 1981). If no conflict is experienced and children still show evidence of cognitive acquisitions across time and tasks, then Piaget's equilibration theory does not provide an adequate explanation for children's cognitive development. Social learning accounts of acquisition of knowledge in terms of modeling and rule-learning appear to be more accurate and precise (Zimmerman and Rosenthal, 1974; Bandura, 1986).

Zimmerman & Blom's (1983) study stimulated a considerable amount of interest and academic discussion. Murray (1983a) and Cantor (1983) responded with diverse reactions to the conceptual and methodological issues involved in the study. Cantor suggested some ways in which the study could be extended.

Murray (1983, a) expressed strong doubts as to whether Piaget's equilibration mechanism can be operationally defined, noting that Piaget has never clarified precisely what the equilibration process entails. For example, is it a conflict-reducing or conflict-inducing process? How is equilibration manifested behaviorally? How is it related to other mechanisms such as maturation, learning and imitation? Murray argued that the notion that there is only one way to develop cognitively is not plausible. For example, in conservation training studies, many procedures that allowed children to employ cognitive dissonance, modeling, equilibration, verbal rule learning, conformity, etc. have been successful in promoting cognitive development. Murray concluded that "cognitive conflict is sufficient, but not necessary to bring about cognitive change" (p. 54).

However, Murray's (1983) skepticism that conflict can be operationally defined is inconsistent with conclusions he had reached in other writings. Murray and his

colleagues have made several attempts to conceptualize equilibration variously as "cognitive conflict" (a conflict between the original and transformed state based on reversibility, 1967); as "social conflict" (1972, 1975); and as "cognitive dissonance" (1977; 1982), a procedure that "guarantees an experience of conflict" (1977, p. 520). In a review article published the same year as his reply to Zimmerman & Blom's study Murray (1983,b) concluded that "conflict qua conflict is not only cognitively motivating, but the resolution of conflict is likely to be in the progressive direction described by the equilibration model (1983, b, p. 245).

Although Murray (1983) was skeptical that Piagetian constructs such as equilibration and conflict can be operationally defined, Cantor (1983) found Zimmerman and Blom's (1983) approach to be innovative, laying the groundwork for future research directed towards examining the role of conflict/equilibration in learning and development. Cantor believed that the latency measure of conflict is "invulnerable to criticism" because hesitation is one of the hallmarks of conflict. However, he expressed doubts about the measure of uncertainty in young children because (1) their introspections may be unreliable; and (2) low variability and high certainty were found in previous studies that utilized a 3 point

scale (e.g., Zimmerman & Ringle, 1981; Zimmerman and Blom, 1983).

To examine transfer and generalizability of training effects, Cantor suggested that more clearly differentiated training and testing items should be used. He also questioned Zimmerman and Blom's use of consistent, conflicting and inconsistent modeling treatments, suggesting that degree of conflict should be manipulated from 100% agreement to 100% disagreement. Finally, to obtain results that would be relevant to Piaget's formulations, Cantor proposed including transitional subjects, as against only nonconservers, in future studies.

Cantor's suggestions for improvement of research methodology deserve consideration and are incorporated in the design of the present study.

CHAPTER IV

Rationale and Purpose of the Present Study

It is clear from the review of the empirical studies to date that have attempted to test Piaget's equilibration theory that the issue of the effect of conflict on learning and development have not yet been satisfactorily resolved. Because Piaget provided neither an operational definition nor a clear description of the equilibration process, investigators (Smedslund, 1961; Doise & Mugny, 1984; Murray, Ames & Botwin, 1977; Zimmerman & Blom, 1983) have conceptualized equilibration as:

(a) conflict of physical origin (i.e., conflict between physical properties of an object, conflict between perceptual and conceptual judgments, or conflict between different schemes, rules or strategies);

(b) conflict of social origin (i.e., conflict resulting from confrontation of two or more subjects of different operational levels or simply different viewpoints).

(c) cognitive dissonance (i.e., conflict between true and pretended beliefs, such as nonconservers pretending conservation);

(d) Subjective uncertainty and response latency

(the former is a subjective self-report measure indicative of a child's awareness of internal conflict; the latter is a more objective behavioral measure that aims to measure cognitive conflict manifested by the child's hesitations and oscillations).

The resolution of conflict is central to the Piagetian approach to cognitive development and learning, yet most studies designed to test the validity of this assumption (e.g., those falling into the categories a, b, c, above) have not adequately shown that so-called conflict training situations do in fact produce conflict in the child. It is not at all certain that pre-operational children experience conflicts while older children or adults may. (Pinnard, 1981; Vuyk, 1981)

If no conflict is experienced, even successful training will not prove that conflict is necessary for the acquisition of knowledge. Despite the absence of operational measures of conflict, and often in the absence of proper control groups (i.e., a control group that is given exactly the same kind of training, same materials, same number of trials, except for the conflict experience in question), most Piagetian researchers interpret the results of their studies as supportive of the equilibration conflict hypothesis. Limited experimental evidence exists to suggest that discrepant influences foster some cognitive changes, but these

changes seem to be unrelated to the level of cognitive conflict. Also, children seem to feel greater self-efficacy in non-conflict than in conflict situations (Wheeler & Ludd, 1982).

Furthermore, presentation of information in a consistent way (such as training of conservation through rule learning) appears to be a more effective procedure for improving children's reasoning skills than conflict training procedures (Zimmerman & Blom, 1983).

Comparisons within and across studies suggest that the acquisition of cognitive skills is affected more by the clarity and consistency of presented rules than by internal disequilibrium states created through exposure to inconsistent and conflicting information. However, the evidence with respect to these issues is limited.

The main purpose of the present study is to further examine the role of external and cognitive conflict in learning of conservation. More specifically, the present research is designed to address the following questions:

Is conflict both a necessary and a sufficient precondition for learning to occur?

Are modeling experiences which present information in a nonconflicting manner more effective in generating acquisition of conservation than conflicting modeling situations?

Will children exposed to nonconflicting modeling more

accurately predict models' performance than children who are exposed to conflicting modeling?

Will children who can accurately predict what models will do differ in the extent to which they acquire conservation compared with children who cannot accurately predict models' performance?

Do the different treatments produce differences in the degree of cognitive conflict they engender (as assessed by both subjective and objective measures of cognitive conflict, i.e., certainty and response latency, respectively)?

Will, cognitive conflict (as assessed by either certainty or response latency measures, or both) interact significantly with treatments with regard to differential acquisition of conservation of weight?

Finally, will differences in immediate posttest conservation scores between different treatment groups remain the same on the delayed posttest (Contrary to Piaget's prediction that the conflict group will improve with time)?

The proposed study seeks to extend the existing research on cognitive conflict by measuring internal cognitive conflict, by manipulating the level of external conflict in a novel way, and measuring its impact on internal conflict. The degree of conflict (disagreement between models) in the three treatment conditions is

varied from 0% to 100% (see page 44 and Fig. II on page 45). In addition, the proposed study will include a more stringent test of transfer than was included in prior research. Finally, this proposed study seeks to test the viability of an alternative social learning hypothesis by introducing a measure of a new intervening variable, "social rule learning."

Experimental Hypotheses

The hypotheses formulated are based on conceptualization derived both from social learning theory, and available empirical evidence. It is hypothesized that:

H1: Subjects who receive non-conflicting modeling treatment (i.e., where both models agree 100% on a conservation rule) will score higher on the conservation posttest (immediate and delayed) than subjects in both Conflicting Modeling Treatment Groups i.e., Intermediate conflict (50% agreement;) and High conflict (0% agreement).

H2: Subjects who receive non-conflicting modeling treatment will more accurately predict responses of both models than children in the two conflicting groups.

H3: Subjects who accurately predict models' answers and explanations will have significantly higher immediate

and delayed posttest conservation scores than subjects who predict models' performance less accurately.

- H4: Conflict modeling treatments will generate greater degree of internal conflict (as assessed by either certainty or latency measures, or both) for subjects in both conflict modeling treatment groups, than for subjects who receive non-conflicting modeling treatment. Subjects in non-conflicting modeling treatment will have significantly lower response latency and significantly higher certainty scores than subjects in the two conflict modeling groups.
- H5: Subjects who experience lower internal conflict (as reflected by low response latency scores, and high certainty scores) will obtain significantly higher immediate posttest and delayed pretest conservation scores than subjects who experience higher degrees of internal conflict.
- H6: No significant progress nor regression in subject's conservation scores will occur from immediate to delayed posttest for subjects in either of the three treatment groups.

CHAPTER V

MethodSubjects

The sample consisted of 55 males and 45 female kindergarten and first grade children from two New York City schools (80 children from a public school and 20 from a private school). The ethnic composition of the sample included approximately equal numbers of White, Black, and Hispanic children. Because of random assignment procedures, each treatment group consisted of approximately equal numbers of children from each ethnic group. Initially, 118 children were pretested, however, 18 were determined to be conservers and were, therefore, excluded from further participation in the study. The mean age of the remaining 100 children was 6 years, 5 months, and the range was 5 years, 5 months to 7 years, 1 month. Within each grade and each sex levels, children were randomly assigned to treatment conditions. Parental permission for the children's participation in the study was obtained. A white female graduate student, who did not appear in any videotapes (to control for social conformity), served as the experimenter throughout the study. The distribution of children to treatment groups by sex, grade, and transitional status are presented in Table 1.

Table 1

Number of Children in Each Treatment Condition by Sex, Grade, and
Transitional Status.

	Treatment Group - Level of Conflict										
	0%		50%		100%		Control		Total		
Kindergarten											
	M	F	M	F	M	F	M	F	M	F	T
NC	2	1	2	3	2	7	3	3	9	14	23
T1	1	3	3	2	2	1	3	6	9	12	21
T2	1	2	0	0	1	1	1	2	3	5	8
Total	4	6	5	5	5	9	7	11	21	31	52
First											
	M	F	M	F	M	F	M	F	M	F	T
NC	2	4	5	4	0	1	1	0	8	9	17
T1	5	2	4	1	5	0	3	1	17	4	21
T2	2	0	0	1	5	0	2	0	9	1	10
Total	9	6	9	6	10	1	6	1	34	14	48

Note. NC = Nonconservers (pretest score = 0)
 T1 = Transitional (pretest score = 1)
 T2 = Transitional Advanced (pretest score = 2)
 M = Males; F = Females
 N = 25 in each treatment group
 T = Totals

Table 2

Number of Children in Each Treatment Condition Colapsed by Sex, Grade,
and Transitional Status.

	Treatment Group - Level of Conflict				Total
	0%	50%	100%	Control	
Male	13	14	15	13	55
Female	12	11	10	12	45
Kindergarten	10	10	14	18	52
First	15	15	11	7	48
Nonconservers	9	14	10	7	40
Transitional	11	10	8	13	42
Transitional Advanced	5	1	7	5	18

Note. N=25 in each group

Design

The experiment employed 3 (modeling treatment conditions) x 5 (phase) repeated measures factorial design, with a dangling control group (pretest, no treatment, posttest). Based on pretest results (Phase 1), non-conservers (score 0) and transitional subjects (scores 1, 2, or 3) were randomly assigned to one of four groups (three treatments, one control). (See Figure 1). Conservers (score 4) were excluded from further participation in the study.

The three treatment groups differed with regard to the degree of external conflict between two models (videotaped presentation) on 4 conservation of weight items. There was a 100% agreement in the No Conflict modeling group; 50% agreement in the Intermediate Conflict modeling group; and 0% agreement in the High Conflict modeling group. Immediately following treatments (Phase 2 - videotape training), each child was asked to predict the performance of both models (Phase 3 - social learning) on a parallel task (Set 3 materials). The social learning phase was followed by immediate posttest (with Sets 4 and 5 materials), and approximately three weeks later, by delayed posttest again, employing Sets 4 and 5 materials (posttest - Phase 4; delayed posttest - Phase 5). (See Figures 1 and 3). Response latency and certainty measures were collected for each item during all phases of the study.

PHASE	LEVEL OF CONFLICT			NO TREATMENT CONTROL GROUP
	NONE 100% Agreement	INTERMEDIATE 50% Agreement	HIGH 0% Agreement	
1 Pretest				
2 Training				
3 Social Learning				
4 Immediate Posttest				
5 Delayed Posttest				

Fig. 1. Modeling Treatment Conditions by Phases

Independent Variables:

Treatments - Degree of external conflict between two videotaped models:

1. No Conflict - 100% agreement -
Each model gives 4 conserving answers.
2. Intermediate Conflict - 50% agreement -
Each model gives 3 conserving and 1 nonconserving answers.
3. High Conflict - 0% agreement -
Each model gives 2 conserving and 2 nonconserving answers.
4. Control Group - No treatment, no social learning phase, pretest/posttests only.

Pretest Scores:

On Set 1 Conservation Materials (Transitional Status: Nonconserving=0; Transitional=1; and Transitional Advanced=2)

Sex and Grade:

Effects are examined in supplementary analysis.

Conservation Items (Set 2)	100%			50%			0%		
	M1	M2	100%	M1	M2	50%	M1	M2	0%
1(E) Sausage	C	C	A	C	C	A	C	Nc	D
2(E) Doughnut	C	C	A	C	Nc	D	Nc	C	D
3(I) Sausage	Ci	Ci	A	Nc	Ci	D	Ci	Nc	D
4(E) Pancake	C	C	A	C	C	A	Nc	C	D
	4C	4C		3C	3C		2C	2C	
				1Nc	1Nc		2Nc	2Nc	

Fig 2. Level of Agreement Between Two Models on the Videotapes

NOTE. E = Equality items.
 I = Inequality items.
 C = Conserving answer - equality item.
 Ci = Conserving answer - inequality item.
 Nc = Nonconserving answer
 A = Agreement.
 D = Disagreement.
 M1 = Model 1.
 M2 = Model 2.

Dependent Variables:

1. Performance -
Scores on conservation tasks.

Immediate posttest training task (Clay 1 - Set 4)
 Immediate posttest transfer task (Corn 1 - Set 5)
 Delayed posttest training task (Clay 2 - Set 4)
 Delayed posttest transfer task (Corn 2 - Set 5)

2. Social learning -
Prediction of models' answers (judgments and reasons) on Set 3 items.
3. Measures of cognitive conflict
Response latency scores
Certainty scores.

Measures and Materials

Conservation

The conservation measures were derived from the Conservation Concept Assessment Kit (Goldschmid and Bentler, 1968) and from conservation of weight tasks employed by Zimmerman & Blom (1983). Five sets of conservation items were devised. (See Fig. 3). All sets involved conservation of weight, with the exception of Set 1 which also included number and length. Each set consisted of four tasks: three equality items and one inequality item (to serve as a control for response bias). Materials employed included: chips (two colors), sticks (2 colors), yellow plasticine, corn, and glasses of different heights and widths. To enhance the generalizability of training effects, differing sets were employed for the five phases of this study. The conservation sets are described below.

Set 1 (Pretest)

Following Cantor's (1983) recommendation to include transitional subjects as well as non-conservers, in order

to obtain results that bear relevance to Piaget's formulations, Set 1 consisted of three conservation domains of emergence (number, length, and weight). This procedure was adopted instead of simply using conservation of weight items in order to provide the most sensitive measure of children's degree of transition. (See Fig. 3).

For the conservation of number, one of early conservation domains to emerge developmentally (Brainerd, 1978 a), the problems consisted of compressing one of two rows of chips (for the equality item, there were six chips in each row; for the inequality item there were four chips in one row and six in the other). For the conservation of length, the problem involved rearranging of one of two equal-length sticks (consisting of three segments) into a zigzag configuration. For the conservation of weight, one of late conservation domains to emerge developmentally (Brainerd, 1978 a), the problem consisted of transforming one of two equal clay balls into a carrot-shape. (See Fig. 3).

Each of the problems involved three steps: (1) the child's acknowledgment that the two objects were initially equivalent to the dimension in question; (2) the child's judgment as to whether they were still equivalent following the transformation by the experimenter; and (3) the child's explanation to question, "Why?"; "What makes you say that?"; or "Why do you think so?".

Set 2 (Treatment - Videotaped Modeling Training)

Three videotapes were created to portray varying degrees of external conflict between two female adult models (i.e., 100% agreement - No Conflict; 50% agreement - Intermediate Conflict; and 0% agreement - High Conflict). For each episode, the male experimenter introduced the two adult models and then presented the first pair of equal stimuli (from the Set 2 materials). The experimenter then transformed one of the stimuli, and each model was asked to give a judgment and an explanation for the answer.

In the No Conflict modeling videotape, both models gave identical conserving answers and reasonings (based on invariate quantity explanation for each weight conservation problem).

In the Intermediate Conflict condition, both models agreed on the conservation answers to Items 1 and 4 and disagreed on Items 2 and 3. Each model gave three conserving answers and one nonconserving answer with explanations. The explanation for conserving answers was based on the same rule as in the No Conflict videotape (i.e., invariant quantity). For nonconserving answers, a perceptual explanation was given (e.g., "This one weighs more because it looks bigger.").

In the high-conflict condition, the models switched their roles as conserver and non-conserver for each

conservation of weight item. (See Fig. 2). Verbatim descriptions of experimenter's questions and model's answers are given below:

EXPERIMENTER

MODEL

Conservation -
Equality Items (C)

We are here today to talk how much things weigh. This is Model 1 (name) and this is Model 2 (name). Here are two balls of Play Doh. They both weigh the same (pointing). I am changing this one into a (name of the transformed object). Now do they both weigh the same or does one weigh more? Why?

Conserving Answer -
Equality Items (C)

Yes. They both still weigh the same. They both weighed the same before. You did not take any Play Doh away from either one. So both of these (pointing) must still weigh the same.

Nonconserving Answer - (Nc)

No. The (name of the transformed object) weighs more because it is bigger now. So it must weigh more.

Conservation -
Inequality Items (Ci)

Here are two balls of Play Doh. This ball (pointing) is heavier than this one. They do not weigh the same. This ball weighs more. Now watch what I am going to do. I am changing this one into a (name of the transformed object). Now do they both weigh the same or does one weigh more? Why?

Conserving Answer -
Inequality Items (Ci)

No. They do not weigh the same. The ball weighs more. The ball weighed more before. You did not take any Play Doh away from either one, so the ball must still weigh more.

Nonconserving Answer - (Nc)

No. The (name of the transformed object) weighs more because it is bigger now. So it must weigh more.

Sets 3 and 4

(Prediction of models, posttest, and delayed test)

Sets 3 and 4 consisted of conservation of weight items with the same materials (i.e., Play Doh) that were used in Set 2. After being presented with two sets of equal or unequal stimuli, the experimenter transformed one of the stimuli into a different shape (see Fig. 3) and asked the child if both weighed the same or if one weighed more or less. Set 3 was used for prediction of models performance (for a more detailed description, see Procedures). Set 4 was used during posttest and delayed posttest.

Equality items - Two equal balls of plasticine were presented following which one of the balls was transformed by the experimenter into different shapes in succession. (See Fig. 3).

Inequality items - One large ball and one small ball of plasticine were presented - the smaller ball then was transformed by the experimenter into different shapes in succession. (See Fig. 3).

Set 5

To ensure transfer of conservation learning to different materials, corn - rather than plasticine - was employed. Again there were three equality items and one inequality item. Initially, equivalent amounts of corn were presented in two glasses of the same size. For transformations, the corn was poured from one of the

glasses into containers of differing shapes, heights, or widths. (See Fig. 3). The experimenter's questioning format was identical to that used by Goldschmid and Bentler (1986) in their standardized test of conservation, except that the children were asked to judge weight, not discontinuous quantity.

Scoring of Conservation

One point was given for each response to a conservation problem that included both correct judgment and supporting reason. Three explanations were accepted: 1) invariant quantity (e.g., nothing was added, nothing was taken away, therefore, they have to be the same); 2) reversability (e.g., it can be put back the way it was); and 3) compensation (e.g., this one is longer, but it is also skinnier; that one is shorter and also fatter). Other explanations, such as perceptual (e.g., it looks the same), magical (e.g., my mother told me); no explanation merely judgment (e.g., insisting on sameness) were noted, however, children in such instances received a score of 0. Since there were four items in each set, scores ranged from 0-4.

Scoring of Social Learning

As will be elaborated later in the procedure section, after each conservation item was presented, the experimenter stopped the videotape with both models remaining on the screen. She then introduced "live" a new

	<u>Conservation Domain</u>	<u>Item</u>	<u>Transformation</u>	
<u>Set 1</u> (Pretest)	Number			E
	Number			I
	Length			E
	Weight			E
<u>Set 2</u> (Treatment)	Weight			E
	(plasticine)			E
				I
				E
<u>Set 3</u> (Prediction of models)	Weight			E
	(plasticine)			E
				I
				E
<u>Set 4</u> (Posttest & Delayed Test)	Weight			E
	(plasticine)			E
				I
				E
<u>Set 5</u> (Posttest & Delayed Test)	Weight			E
	(corn)			E
				I
				E

Fig. 3 - Conservation Materials for each phase of the study.

conservation of weight item (see Fig. 3) to obtain the children's prediction of what each model would say. Depending upon the treatment condition, either the children had just seen both models agreeing on a conservation answer and a reason or the two models disagreeing with each other, one giving the conserving answer, the other giving a nonconserving answer (see Fig. 2).

The children were given one point if they predicted the same two types of responses they had just witnessed, That is, the children in the No Conflict condition and the children in the Intermediate Conflict condition who had just witnessed the model agreeing on a conservation item needed to predict that both models would give a conservation judgment and a reason to receive credit.

The children in the High Conflict condition and those in the Intermediate Conflict condition who had just seen the models disagree on the item that was presented were credited with one point only if they predicated a conservation response for one model and a nonconserving response for the other model on the new item. Because the models in the Intermediate and High Conflict conditions alternated in giving a conserving answer across successive items, no penalty was assessed to children who reversed the two models answers on the new item. However, this occurred only infrequently. Three possible answers that

would not receive a credit for prediction were: (1) witnessing both models conserve but predicting that only one would; (2) witnessing the models disagreeing with each other but predicting that both would conserve; and (3) witnessing the two models disagreeing but predicting that neither would conserve. However, the only types of errors that were obtained fitted into category 3.

Since there were four items in Set 3, the scores ranged from 0-4.

Certainty Measure

To assess children's self-reported certainty about their conservation answers and about their guesses of models' conservation answers, children were first afforded practice with a 4-point certainty rating scale. The following four verbal descriptors were given: (1) not at all sure; (2) maybe; (3) quite sure; and (4) very sure. It was established that young children are capable of using such rating scales (Bodlakova and Zimmerman, 1984, unpublished study; Bodlakova, 1986, Pilot Study; Newman and Wick, 1987). Certainty scores were collected for each item separately. For each phase, the possible range of scores was 4-16, the lower numbers indicating low certainty, the higher numbers indicating high certainty.

Latency Measure

Response latency was measured in the same way as in Zimmerman & Blom's 1983 study. The experimenter used a

silent stop watch to measure (as unobtrusively as possible) children's response latency in rendering a conservation judgment for each item. Timing began as soon as the experimenter finished asking each question. The watch was stopped as soon as the child began to give a judgment (e.g., "They weigh the same" or "This one weighs more.").

Procedure

Pretest

Each child was taken individually from the classroom to a separate room and pretested with Set 1 stimuli. If a conserving answer plus a logical explanation were given to all four conservation items (score of 4), the child was classified as a conserver and was excluded from further participation in the study (18Ss). The remaining children were classified as non-conservers (Nc) if they obtained a score of 0 (40Ss); as transitionals (T1) if they obtained a score of 1 (42Ss); and as advanced transitionals (T2) if they obtained a score of 2 (17Ss). Only one girl obtained a score of 3, and she was included in the T2 category. Following pretesting, each child was randomly assigned to one of four groups (three modeling treatment condition or the control group). Table 1 presents the number of children in each condition by their pretest scores.

Social learning

Following the pretest phase, the child was seated at a table facing the experimenter and the television monitor. The experimenter explained the procedure to the child: "Now we are going to watch some people on television play a game with Play Doh. After you see them play the game, we will play similar games together. Alright? Please pay attention to what the ladies on TV say. I will ask you some questions about it." The monitor was then turned on and Item 1 in Set 2 stimuli was presented. After watching the first item, the videotape was stopped (pause mode so that the picture was still visible on the TV monitor). The experimenter then presented "live" Item 1 in Set 3 stimuli and the child was asked to "take a guess what do you think the ladies on TV would say? What would Model 1 (name) say and what would Model 2 (name) say?", (pointing to TV monitor to identify the two models). After the child answered, he/she was prompted to explain the model's reasoning, "Why?"; "Why would they think that?"; "What makes them think that?".

Following the child's explanation of his version of the models' answers and judgments, the child was presented with a rating scale and was asked: "How sure are you that you guessed correctly what the ladies would say?" The child's answers were recorded and latency measures were taken. The experimenter then proceeded administering the remaining three items in a same manner as described above.

Immediate Posttest

Following the prediction of both models' performances, each child was individually administered Set 4 and Set 5 materials. Set 5 measured transfer of conservation learning to different materials. (See Fig. 3). The experimenter's questioning format was identical to that used by Goldschmid and Bentler (1968) in their standardized test of conservation, but for the corn materials, the children were asked to judge weight rather than discontinuous quantity.

Delayed Posttest

The delayed posttesting phase (approximately three weeks later) was intended to assess the stability of training results and to determine if further improvements or regression had occurred as a result of conflict training treatments. During this phase, children were administered Set 4 and Set 5 materials again in the same way as during the immediate posttesting.

After delayed testing, the children were thanked and given a small box of crayons and escorted back to their classrooms.

CHAPTER VI

Results

To examine the main and interaction effects of different treatments on children's learning to conserve weight, a series of multivariate and univariate analysis of variance were performed. Multivariate analysis of variance (MANOVA) allows simultaneous testing of all the variables and examines the effects of one or more independent variables upon several dependent variables combined. Separate multivariate analyses were carried out for (a) conservation scores, (b) certainty scores, and (c) latency scores. Univariate effects (i.e., each dependent measure considered separately) were examined in a series of analysis of variance (ANOVA) tests.

To assess changes in outcome measures across different phases of the study (immediate to delayed posttest), a series of repeated measures analysis of variance were also performed. Where the effects of treatments were significant post hoc pairwise comparisons among the four treatment groups' means were conducted using Newman Keuls tests.

To examine the role of the various types of conflict in acquisition of conservation and to explore possible causal links among selected variables, series of path

analyses were also performed. The adequacy of the postulated path-analytic models was assessed by using the criteria proposed by Biddle and Marlin (1987).

Curvilinearity was tested using a quadratic polynomial regression model (Nie, et al., 1975).

Conflict Training Effects

The primary dependent variables, the children's pretest and posttest conservation scores on training and transfer tasks, were examined using analysis of variance procedures. The initial analysis a 4 (treatment group: 0% conflict; 50% conflict; 100% conflict; control) x 3 (transitional status: non-conserver; transitional; transitional advanced) x 4 (type of task: Play Doh posttest; Play Doh delayed posttest; corn posttest; corn delayed posttest) multivariate analysis of variance (MANOVA) was performed to test for multivariate main and interaction effects across the four conservation scores. The means for each experimental and control group (sexes combined) by phase are presented in Table 2. A significant multivariate main effect was found for treatment, $F(12,225.18) = 7.24$, Wilks lambda = .422, $p < .001$, while the transition factor and the interaction effects of group by transition were not significant. Examination of the univariate effects revealed significant differences between the groups on all posttests

conservation scores due to treatment effect. (For the Play Doh posttest scores $F(3,88) = 32.96$; $p < .001$; for the Play Doh delayed test scores $F(3,88) = 37.02$; $p < .001$ for the corn posttest scores $F(3,88) = 12.93$, $p < .001$; and for the corn delayed test scores $F(3,88) = 20.38$, $p < .001$).

A separate 4 (levels of treatment) x 3 (transitional status) x 4 (type of task) MANOVAs were also applied to the self-assessed certainty scores and to the behaviorally-assessed latency scores. None of the main or interaction multivariate effects were statistically significant for either certainty or latency measures. The means for each treatment group (combined for sexes) are presented in Table 2.

In order to assess changes in outcome measures (conservation, certainty, latency) from immediate to delayed posttest, a series of unweighted means analysis of variance repeated measures were conducted. The data from each dependent measure was analyzed separately. A 4 (treatment levels) x 3 (levels of transition) x 2 (type of task) x 2 (phase) ANOVAs with repeated measures on the last two factors yielded basically the same results as the MANOVA analysis. The main effect for treatments on conservation scores were as follows: Play Doh, $F(3,88) = 24.22$, $p < .001$; corn, $F(3,88) = 13.07$, $p < .001$. Subsequent Newman Keuls pairwise post hoc tests

Table 3

Treatment Group Means and Standard Deviations by Phase for Conservation, Certainty, and Latency.

Phase	Treatment Group - Level of Conflict							
	0%		50%		100%		Control	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Conservation								
Pretest	.84	.75	.48	.59	.88	.83	.96	.70
Prediction	3.12	1.39	1.32	1.65	.56	1.23	-	-
Clay 1	3.12	1.45	.84	1.49	.44	1.12	.04	.20
Clay 2	3.20	1.56	.76	1.36	.36	1.11	.00	.00
Corn 1	1.76	1.76	.20	.65	.36	1.00	.04	.20
Corn 2	2.48	1.80	.32	.99	.44	1.16	.08	.40
Certainty								
Pretest	13.76	2.09	12.88	2.35	13.04	2.57	12.76	1.92
Prediction	13.56	2.57	12.12	3.14	13.56	2.36	-	-
Clay 1	13.52	2.97	12.24	3.19	13.92	3.11	13.08	1.82
Clay 2	14.12	2.39	11.92	2.69	14.08	2.72	13.32	2.30
Corn 1	13.44	2.83	12.28	2.57	14.04	2.80	13.08	2.40
Corn 2	13.64	2.77	13.40	2.40	14.52	1.96	13.60	2.08
Latency								
Pretest	11.56	14.99	10.84	5.65	12.52	7.35	15.64	7.80
Prediction	10.84	7.28	15.04	6.86	14.08	9.11	-	-
Clay 1	7.00	3.46	9.68	5.18	9.04	5.76	9.88	4.36
Clay 2	6.72	4.08	8.92	4.28	8.80	4.96	9.00	3.62
Corn 1	7.52	3.98	9.04	4.44	9.56	7.38	8.68	3.89
Corn 2	7.32	4.05	8.28	3.70	8.04	5.93	8.20	3.63

Note. N = 25 in each treatment group;

Range of Scores: Conservation 0 - 4; Certainty 4 - 16; Latency 4 - 40;

Clay 1 = Posttest training items; Clay 2 = Delayed test training items;

Corn 1 = Posttest transfer items; Corn 2 = Delayed test transfer items;

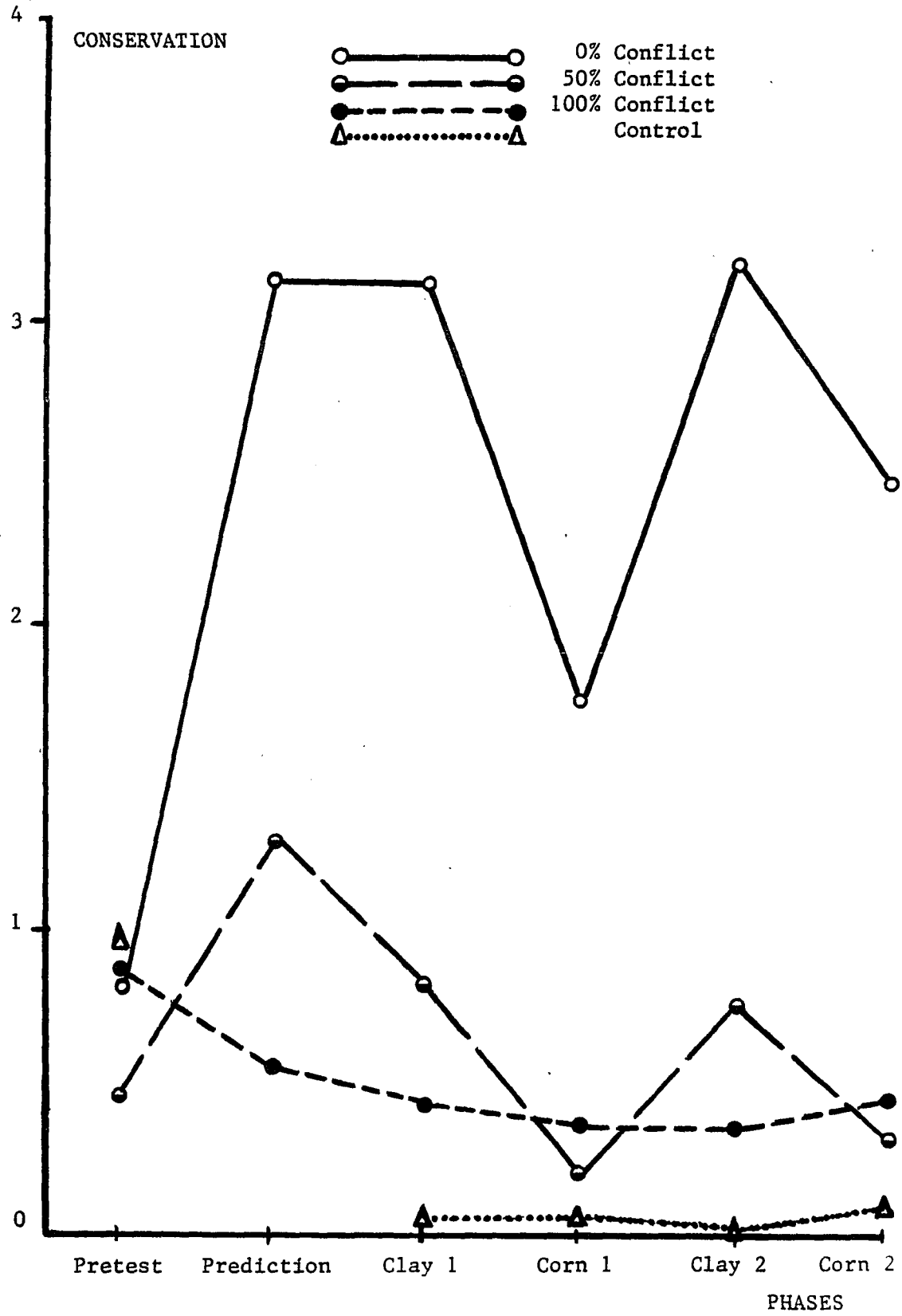


Fig.4. Conservation Scores of the Four Groups Across All Phases.

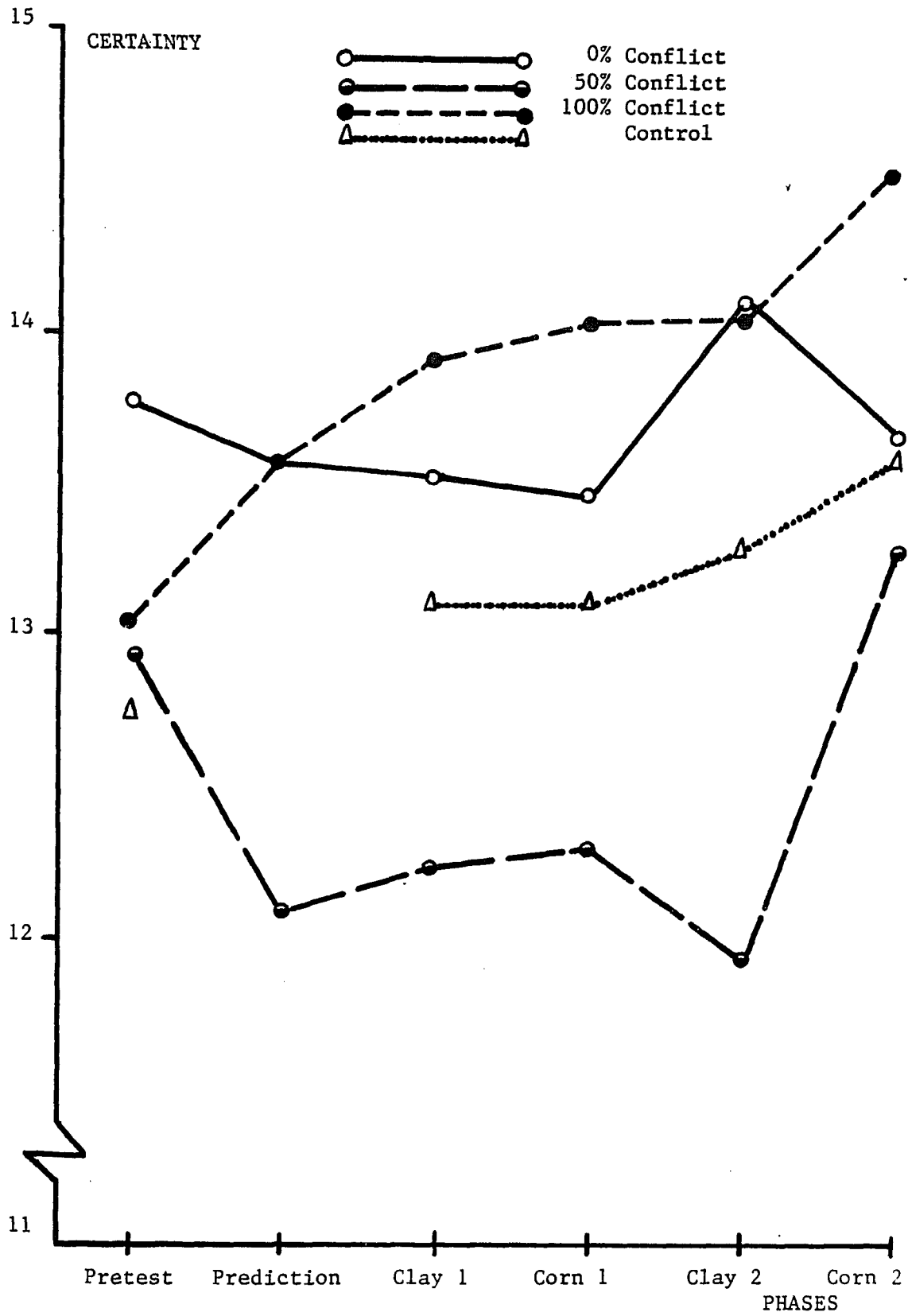


Fig.5. Certainty Scores of the Four Groups Across All Phases.

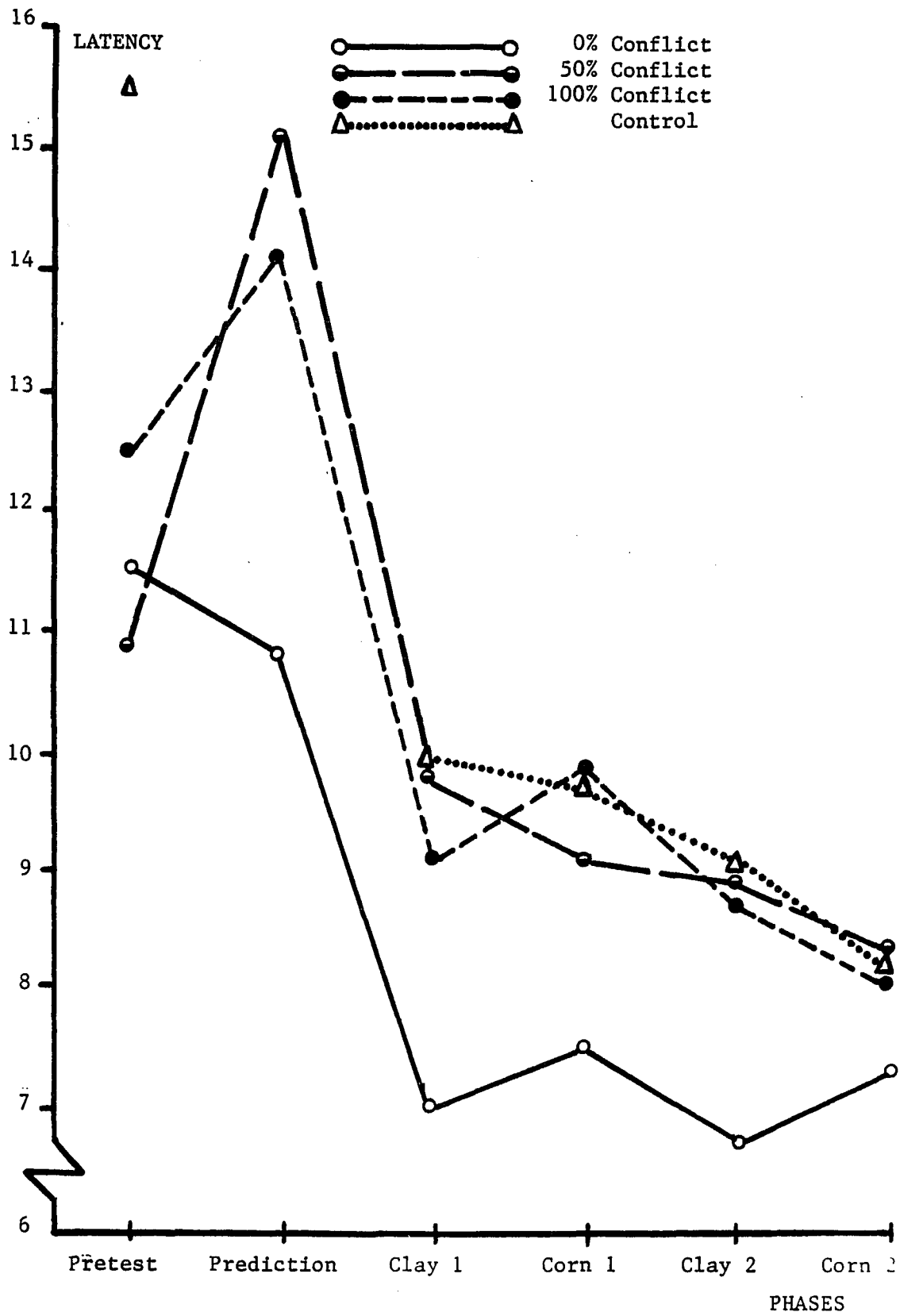


Fig.6 Latency Scores of the Four Groups Across All Phases.

indicated that subjects in the No Conflict condition attained significantly greater conservation scores ($M = 3.29$) than subjects in the Intermediate Conflict condition ($M = .56$); the High Conflict condition ($M = .44$); and the control condition ($M = .01$); (all four p s $< .05$). The mean scores of subjects in the other three groups did not differ significantly from each other.

A significant main effect for phase $F(1,88) = 6.58$, $p < .01$, and interaction effect for phase by group $F(3,88) = 3.08$, $p < .03$, were also found for the transfer task (corn). Comparisons of the means indicated that subjects in all groups showed some improvement in their conservation scores from posttest to delayed test. The Newman Keuls post hoc tests showed that the differences between means reached statistical difference for the No Conflict group only ($M = 1.8$ for Corn 1 versus $M = 2.6$ for Corn 2, $p < .05$). For the three other groups, the posttest and the delayed posttest means on the transfer conservation tasks (corn) were as follows: 50% conflict ($M = .13$ versus $M = .23$); 100% conflict ($M = .39$ versus $M = .49$); and control group ($M = .03$ versus $M = .05$).

No other main or interaction effects attained statistical significance. The absence of a main effect for transitional status (pretest conservation scores) or interactions involving this variable confirms the initial comparability of the four groups. For that reason, the

pretest conservation scores were excluded from further statistical analysis.

The same 4 x 3 x 2 x 2 repeated measures analysis of variance model was also applied to the children's certainty judgments and latency measures. Only the group main effect on certainty scores on the training task (Play Doh) reached statistical significance $F(1,88) = 2.71$, $p < .05$. Children in the 50% conflict group seemed to be the least sure of themselves on the Play Doh posttest and delayed posttest tasks compared to the other three groups (for means see Table 2). Post hoc comparisons with Newman Keuls tests revealed that the children in the 50% conflict group were significantly less certain of their conservation answers than the children in the No Conflict group ($M = 11.88$ versus $M = 14.18$, $p < .05$). Other pairwise comparisons between the groups did not reach statistical significance ($M = 14.18$ for the No Conflict group; $M = 11.88$ for the 50% Conflict group; $M = 14.01$ for the 100% Conflict group, and $M = 13.17$ for the control group).

To examine whether any sex differences existed, a 4 (treatments) x 2 (sexes) x 2 (posttests/delayed test phases) x 2 (training/transfer items) unweighted means analysis of variance repeated measures model was applied to the children's conservation, certainty, and latency scores. With regards to the treatment group and phase

effects, this analysis showed the same pattern of results as the previous analysis. There was a significant main effect for treatment on Play Doh conservation scores $F(3,92) = 36.47, p < .001$; and on corn conservation scores $F(3,92) = 18.67, p < .001$. Again, the phase and the group by phase effects were significant only for the corn conservation scores (transfer task), not for the Play Doh conservation scores (training task). The F values were $F(1,92) = 10.18, p < .002$ for the former and $F(3,92) = 5.03, p < .003$ for the latter. As in the previous analyses, Newman Keuls post hoc tests confirmed that only the No Conflict training group showed statistically significant improvement from posttest to delayed posttest on the transfer task.

Sex main effect was statistically significant for corn certainty scores $F(1,92) = 6.57, p < .02$ (for males $M = 12.95$; for females $M = 14.13$) indicating that females were more sure about their conservation judgments than males. Similar trends were obtained for the Play Doh certainty scores (the means were 12.88 for males and 13.76 for females), but these differences did not reach statistical significance. No other sex effects, main or interaction, have emerged in the analysis.

Supplementary analysis using grade level as one of the factors in the 4 (group) x 2 (grade) x 2 (phase) x 2 (task) ANOVA repeated measures (on the last two factors)

revealed that first graders obtained higher conservation scores than kindergarten children on the Play Doh task ($M = 1.37$ versus $M = .76$) and on the corn task ($M = .90$ versus $M = .52$), but these differences reached statistical significance for the Play Doh conservation scores only $F(1,92) = 6.56, p < .02$. The treatment group main effect for the same variable (i.e., Play Doh conservation) was also, as expected, statistically significant $F(3,92) = 32.57, p < .001$. The sizes of these two main effects were compared in terms of their sums of squares. Grade accounted for 3% of the variation, whereas the treatment group effect accounted for 49% of all variation. No other grade, main or interaction effects, attained statistical significance for the conservation, certainty, or latency scores. The absence of interaction effects involving this variable confirms the random assignment of kindergarten and first grade children across treatment groups. In other words, first graders showed greater improvement than kindergarten children uniformly across all treatment groups.

The Role of Conflict and Prediction Variables in Acquisition of Conservation

To examine the role of conflict and prediction variables in children's conservation learning and to test the validity of the postulated causal model, the technique of path analysis was employed. In path analysis, a model

is constructed which hypothesizes the causal relationships among a set of variables. A multiple linear regression equation is derived for each dependent variable in the model consisting of those variables believed to influence that particular dependent variable. The primary purpose of path analysis is to separate correlations among selected variables into causal and noncausal components to enhance the interpretation of relationships as well as the pattern of the effects of one variable on another. Path analysis is not a method for discovering causes, but a method applied to a causal model formulated by the researcher on the basis of knowledge and a priori theoretical considerations (Pedhazur, 1982; Wolfe, 1980). It is "a method for explicitly formulating theory, and attaching quantitative estimates to causal effects thought to exist on a priori grounds." (Wolfe, 1980; p. 183).

To determine the direct and indirect (via certainty, latency, and prediction of models) influences of external conflict (videotaped conflict modeling treatments) on children's conservation learning, two types of path models were tested. The first, simpler model examined the relationships between three conflict variables (i.e., external conflict, and two measures of internal conflict, subjectively-assessed certainty scores and behaviorally-assessed latency scores), prediction of models, and conservation scores for each experimental phase separately.

In each regression equation, a variable taken as dependent was regressed on variables upon which it was assumed to depend (i.e., conservation was regressed on external conflict, certainty, latency, and prediction; and certainty, latency, and prediction were regressed separately on external conflict). Four regression equations were employed, one for each dependent variable. The same path model was applied successively to conservation scores in each phase.

The second model dealt with the effects of conflict treatments on conservation responding across all phases simultaneously. This model was tested by five multiple regression equations (separately for training and transfer tasks). Dependent variables were added one at a time, each new dependent variable having its own set of independent variables, including the variable that was dependent at the prior stage of analysis. In this analysis, the first dependent variable was prediction of models' conservation judgments, followed by certainty of prediction, latency of prediction, and immediate and delayed posttests, in that order.

Both models were restrictive models because not all possible relationships were examined, only those that were considered theoretically relevant. Both models were also recursive, that is, the causal flow in the model was unidirectional. In other words, one given variable could

not be both the cause and the effect of another specific variable. In both path analytic models, only the scores of the three conflict training groups were used (75 Ss), the control group scores were excluded because they would obscure the interpretation of the results (i.e., control group received no treatments and made no predictions of models).

The first hypothesized path model for relations among external conflict, internal conflict, prediction, and conservation learning is presented in Figures 7-10. The same model was applied to children's: (a) posttest conservation scores on the training task (Clay 1); (b) delayed test conservation scores on the training task (Clay 2); (c) posttest conservation scores on the transfer task (Corn 1); and d) delayed test conservation scores on the transfer test (Corn 2). The one-way arrow represents the hypothesized patterns of influence between the variables.

External conflict was hypothesized as an exogenous variable (presumed cause) influencing learning and retention (as measured by conservation posttests and delayed posttests), both directly and indirectly through each of the two measures of internal conflict (certainty and latency) and through prediction of models' conservation responses. The zero-order correlations are presented in parentheses and the path coefficients

calculated through multiple regression are presented next to it. Path coefficients (standardized regression values) derived from regressing conservation on external conflict, certainty, latency, and prediction, indicate the direct effects of the presumed cause variable on the presumed effect variable, while all other independent variables are held constant. The indirect, total, and spurious (noncausal) effects calculated for all bivariate relations specified within the causal model are presented in Tables 4-7. For the relationships between external conflict, prediction, and conservation scores, path analysis allows us to determine how much of the causal relationships between them can be "interpreted" by the intervening variables (i.e., certainty, latency, and prediction). These coefficients revealed that the indirect effects were statistically significant across all phases (i.e., .44 for Clay 1; .36 for Clay 2; .28 for Corn 1; and .29 for Corn 2 conservation scores). Further decomposition of the indirect effects indicate that only the path from external conflict via prediction of models reached statistical significance; the other two alternative paths from external conflict to conservation scores via certainty and latency added nothing to the causal explanation based on external conflict. As can be seen from Tables 4-7, the same holds true for conservation scores across all phases.

It is interesting to note that the strongest direct

influence upon conservation was not from external conflict but from prediction of models' conservation responses ($P = .70$, $p < .001$; and $P = -.18$, $p < .01$, respectively). The negative path coefficients indicate that the greater the degree of external conflict during training, the less the children were able to predict models' responses and, consequently, the less acquisition of weight conservation they displayed. This finding is consistent with the previous statistical analysis (MANOVAs and ANOVAs repeated measures) which revealed that only the No Conflict modeling treatments led to significant acquisition of weight conservation across all the phases of the study. By including prediction of models as an intervening variable during learning, the analysis was substantially enhanced.

The path coefficients in Figures 7-10 and the Decomposition Tables 4-7 also revealed significant direct effect of certainty judgments on conservation scores across all phases, except the immediate posttest on Clay 1 ($p < .05$). Although the coefficients for latency mediated paths were in the predicted direction (e.g., more conflict \rightarrow longer latency \rightarrow less conservation), statistical significance at $p < .05$ was reached for one phase only (immediate posttest - Clay 1). The first finding can be interpreted as indicating that children who are more certain of their own capabilities learn more conservation than those less certain of themselves. With regards to

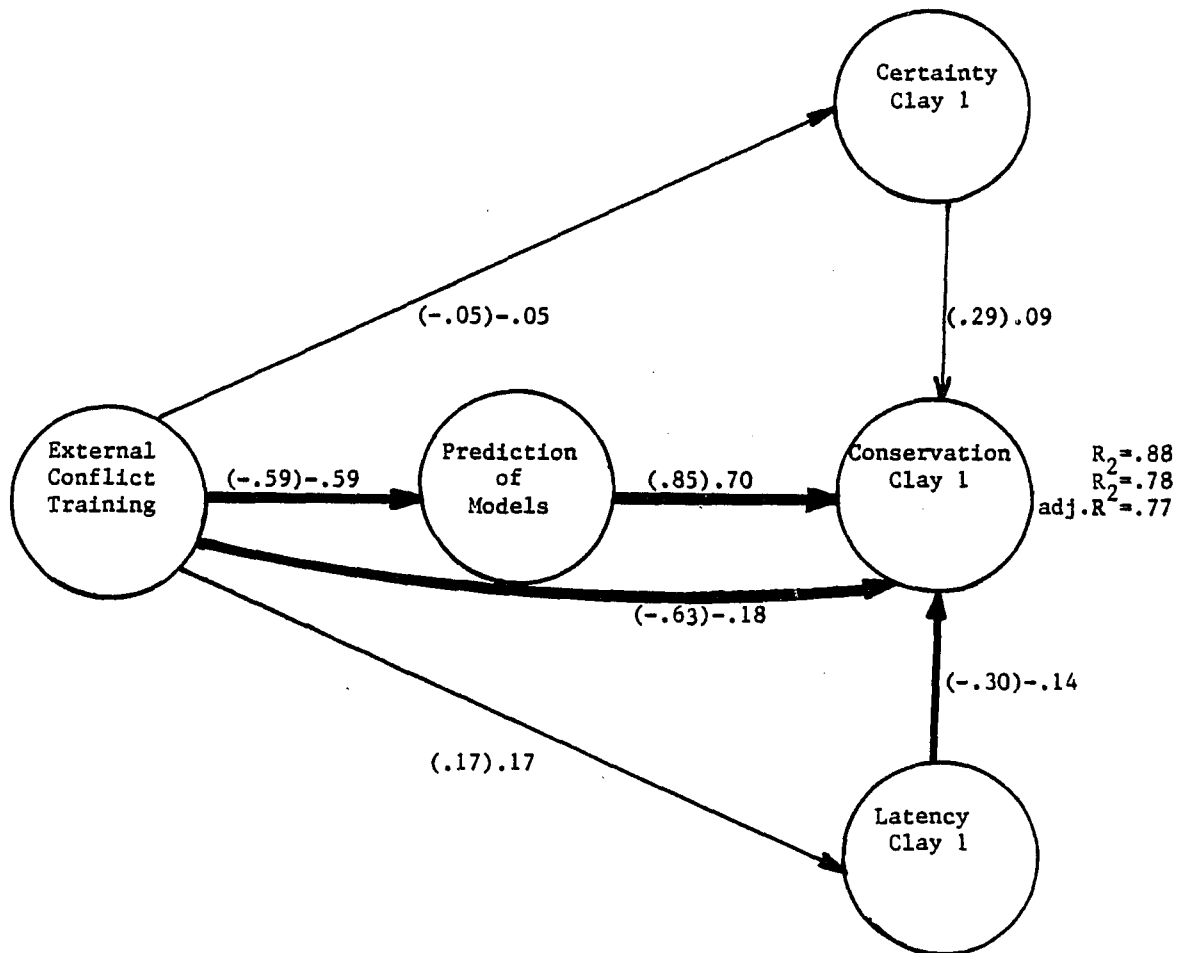


Fig. 7. A Path-Analytic Model of the Effects of Conflict Variables (i.e. External Conflict; Certainty; and Latency) and Prediction of Models' Conservation on Children's Conservation Scores on Immediate Posttest Training Task (Clay 1). Correlations are Presented in Parentheses. The Path Coefficients are Standardized Regression Coefficients. Significant Paths are Identified by Thick Lines.

Note. For decomposition of causal paths of this model see Table 4.

Table 4. Decomposition of Causal Paths Between Conflict Variables (External Conflict; Certainty; and Latency), Prediction of Models' Conservation Responses, and Conservation Scores on Immediate Posttest Training Task (Clay 1).

Predictor Variable	Criterion Variable	r coeff.	Direct Effect	Indirect ^a Effect	Total Effect	Spurious Effect
External Conflict	Conservation (Clay 1)	-.63**	-.18*	-.44** ^a	-.62**	-.01
Prediction	Conservation (Clay 1)	.85**	.70**	-	.70**	.15
Certainty	Conservation (Clay 1)	.29**	.09	-	.09	.20
Latency	Conservation (Clay 1)	-.30**	-.14*	-	-.14*	-.16
External Conflict	Certainty	-.05	-.05	-	-.05	.00
External Conflict	Latency	.17	.17	-	.17	.00
External Conflict	Prediction	-.59**	-.59**	-	-.59**	.00

Indirect^a Effect: Via Prediction = $-.41^{**}$; Via Certainty = $.00$; Via Latency = $-.03$

* = $p < .05$; ** = $p < .001$

Note. For the graphic representation of this table see Fig. 7.

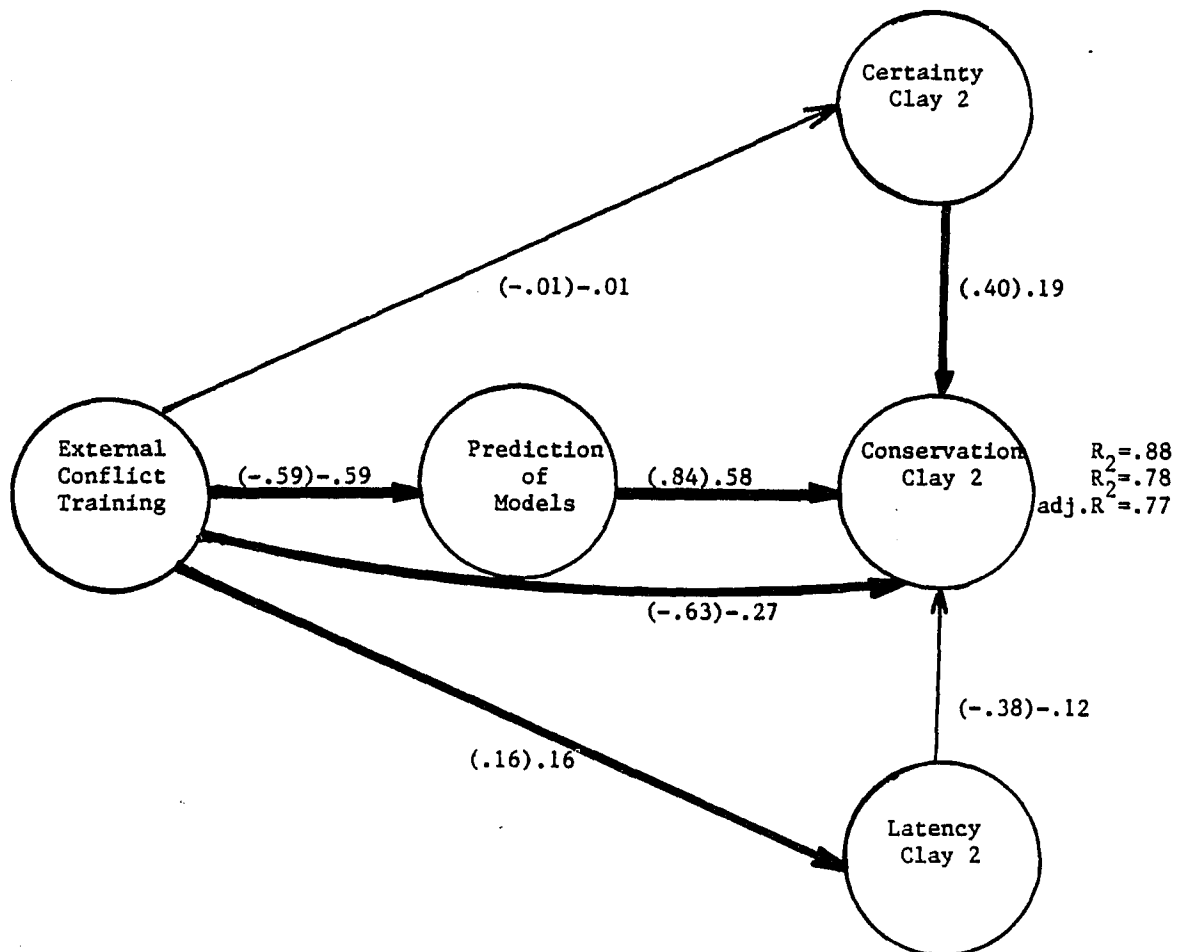


Fig.8. A Path-Analytic Model of the Effects of Conflict Variables (i.e. External Conflict; Certainty; and Latency) and Prediction of Models' Conservation on Children's Conservation Scores on Delayed Test Training Task (Clay 2). Correlations are Presented in Parentheses. The Path Coefficients are Standardized Regression Coefficients. Significant Paths are Identified by Thick Lines.

Note. For decomposition of causal paths of this model see Table 5.

Table 5. Decomposition of Causal Paths Between Conflict Variables (External Conflict; Certainty; and Latency), Prediction of Models' Conservation Responses, and Conservation Scores on Delayed Test Training Task (Clay 2).

Predictor Variable	Criterion Variable	r coeff.	Direct Effect	Indirect ^a Effect	Total Effect	Spurious Effect
External Conflict	Conservation (Clay 2)	-.63**	-.27**	-.36** ^a	-.63**	.00
Prediction	Conservation (Clay 2)	.84**	.58**	-	.58**	.26
Certainty	Conservation (Clay 2)	.40**	.19*	-	.19*	.21
Latency	Conservation (Clay 2)	-.38**	-.12	-	-.12	-.26
External Conflict	Certainty	-.01	-.01	-	-.01	.00
External Conflict	Latency	.16*	.16*	-	.16*	.00
External Conflict	Prediction	-.59**	-.59**	-	-.59**	.00

Indirect^a Effect: Via Prediction = $-.34^{***}$; Via Certainty = $-.00$; Via Latency = $-.02$

* = $p < .05$; ** = $p < .001$

Note. For the graphic representation of this table see Fig.8.

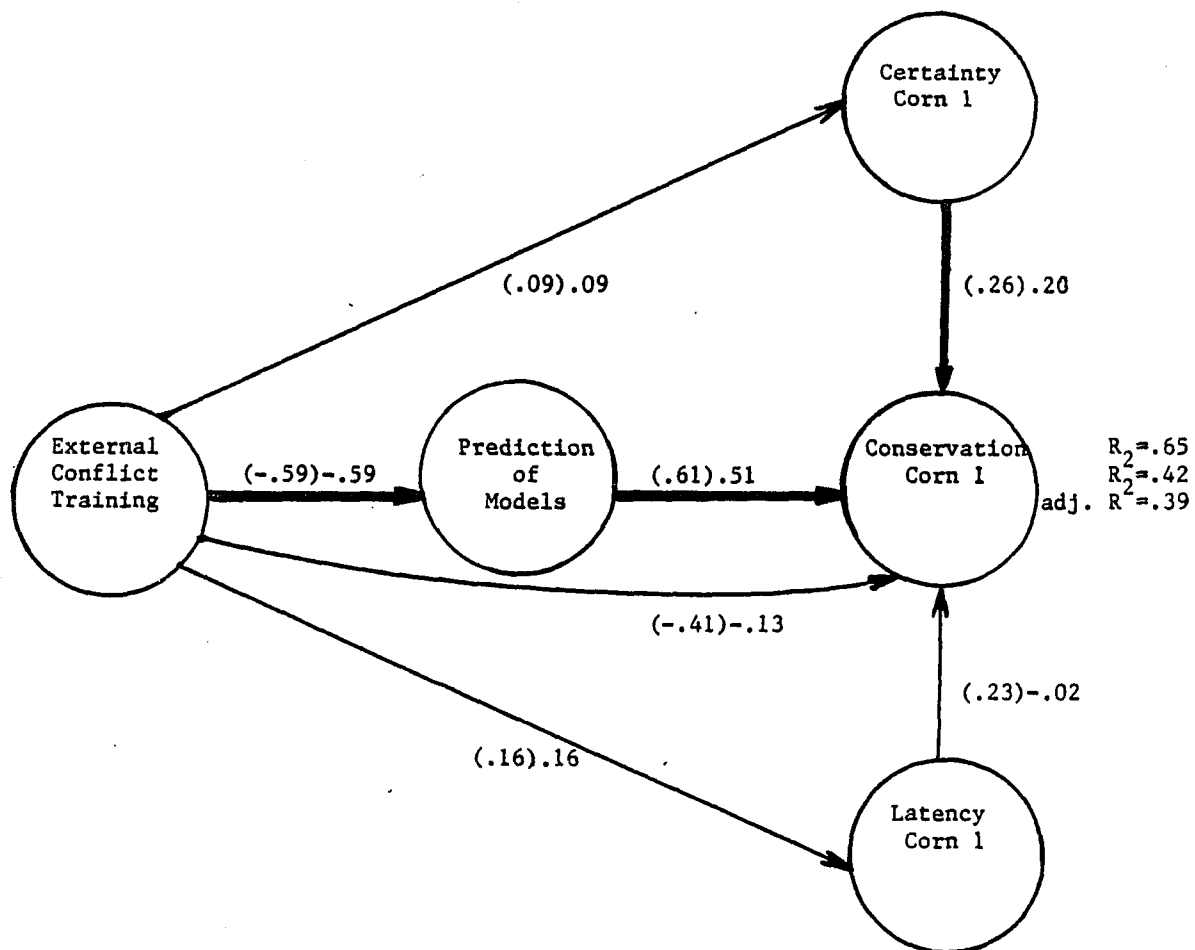


Fig.9. A Path-Analytic Model of the Effects of Conflict Variables (i.e. External Conflict; Certainty; and Latency) and Prediction of Model's Conservation on Children's Conservation Scores on Immediate Posttest Transfer Task (Corn 2). Correlations are Presented in Parentheses. The Paths Coefficients are Standardized Regression Coefficients. Significant Paths are Identified by Thick Lines.

Note. For decomposition of causal paths of this model see Table 6.

Table 6. Decomposition of Causal Paths Between Conflict Variables (External Conflict; Certainty; and Latency), Prediction of Models' Conservation Responses, and Conservation Scores on Immediate Posttest Transfer Task (Corn 1).

Predictor Variable	Criterion Variable	r coeff.	Direct Effect	Indirect ^a Effect	Total Effect	Spurious Effect
External Conflict	Conservation (Corn 1)	-.41**	-.13	-.28** ^a	-.41**	.00
Prediction	Conservation (Corn 1)	.61**	.51**	-	.51**	.10
Certainty	Conservation (Corn 1)	.26*	.20*	-	.20*	.06
Latency	Conservation (Corn 1)	.23*	-.02	-	-.02	.25
External Conflict	Certainty	.09	.09	-	.09	.00
External Conflict	Latency	.16	.16	-	.16	.00
External Conflict	Prediction	-.59**	-.59**	-	-.59**	.00

Indirect^a Effect: Via Prediction = $-.30^{**}$; Via Certainty = $-.02$; Via Latency = $.00$

* = $p < .05$; ** = $p < .001$

Note. For the graphic representation of this table see Fig.9.

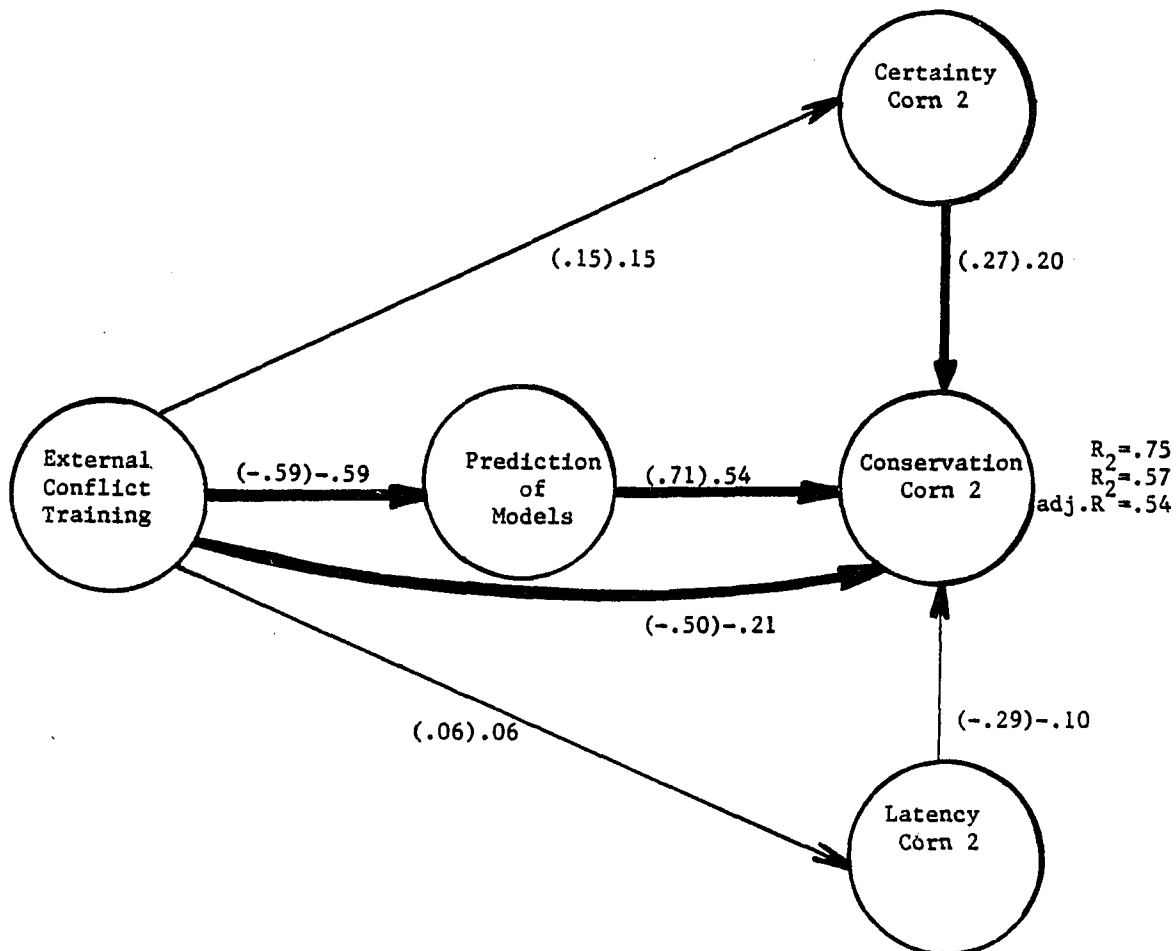


Fig.10. A Path-Analytic Model of the Effects of Conflict Variables (i.e. External Conflict; Certainty; and Latency) and Prediction of Model's Conservation on Children's Conservation Scores on Delayed Test Transfer Task (Corn 2). Correlations are Presented in Parentheses. The Path Coefficients are Standardized Regression Coefficients. Significant Paths are Identified by Thick Lines.

Note. For decomposition of causal paths of this model see Table 7.

Table 7. Decomposition of Causal Paths Between Conflict Variables (External Conflict; Certainty; and Latency), Prediction of Models' Conservation Responses, and Conservation Scores on Delayed Test Transfer Task (Corn 2).

Predictor Variable	Criterion Variable	r coeff	Direct Effect	Indirect ^a Effect	Total Effect	Spurious Effect
External Conflict	Conservation (Corn 2)	-.50**	-.21*	-.29** ^a	-.50**	.00
Prediction	Conservation (Corn 2)	.71**	.54**	-	.54**	.17
Certainty	Conservation (Corn 2)	.27**	.20*	-	.20*	.07
Latency	Conservation (Corn 2)	-.29**	-.10	-	-.10	-.19
External Conflict	Certainty	.15	.15	-	.15	.00
External Conflict	Latency	.06	.06	-	.06	.00
External Conflict	Prediction	-.59**	-.59**	-	-.59**	.00

Indirect^a Effect: Via Prediction = $-.32^{**}$; Via Certainty = $.03$; Via Latency = $-.02$

* = $p < .05$; ** = $p < .001$

Note. For the graphic representation of this table see Fig. 10.

the latency coefficients, although not significant across all phases, the negative path coefficients suggest an inverse relationship between latency scores and conservation learning.

A second path model was devised to further explore the causal effects of external and internal conflict and prediction on conservation scores across all phases simultaneously. This model required solution to five regression equations (one for each dependent variable). The same model was applied to conservation scores on training tasks (Clay 1, Clay 2) and to conservation scores on transfer task (Corn 1, Corn 2). This model and the resulting coefficients are presented on Figures 11 and 12 and in Tables 8 and 9. Most of the findings are basically consistent with the finding of previous path analysis, however, Figures 11 and 12 show that the optimal explanatory path for delayed conservation of weight on both training (clay) and transfer tasks (corn) includes the results of preceding learning measures (i.e., prediction of models and conservation posttest), as well as consideration of external conflict. This improvement in causal explanation was reflected in the increase of size coefficients across phases from $-.58$ to $.93$ for the training task and from $-.58$ to $.64$ for the transfer task. The multiple correlation between the variables specified in Figure 11 was $.98$ which indicates that altogether this

model accounts for 96% of the variance in posttest conservation scores (Clay 2) when R^2 is corrected for shrinkage. (For Corn 2, $R = .90$, $R^2 = .81$, adjusted $R^2 = .80$). Further examination of Tables 8 and 9 reveal that most of the variation in conservation of weight during delayed testing (on both types of tasks) can be explained on the basis of training experiences and earlier measures of learning.

To judge the adequacy of the postulated path-analytic models, Biddle and Marlin (1987) proposed to examine the following criteria: (1) explained variance in intervening and dependent variables (R^2); (2) significance or size of coefficients; (3) relative effect magnitude (i.e., judging the relative size or statistical significance of differences among regression coefficients); (4) capturing of paths (i.e., if the intervening variables are chosen properly, the investigator should find few or no residual direct paths connecting independent and dependent variables in the analysis; (5) measures of fit (insignificant χ^2); (6) covariance among disturbances (estimates of errors for measured variables, i.e., statistically insignificant covariances "confirm" a model); (7) model comparisons (exploratory data analysis by comparing different models, but the authors warn that, while the "ex-post-facto mucking with data can generate insight; it certainly does not 'confirm' a causal model");

and (8) sample comparisons (models' assessment with new samples or data). By utilizing the above criteria for examining the seven path-analytic models postulated here, all of these models were found statistically and theoretically adequate or "confirmed".

A further question of interest concerns the possibility of nonlinear relationships between measures of conflict and acquisition of conservation. Some investigators have suggested that the relationship between conflict and learning may be curvilinear rather than linear. (Berlyne, 1969, 1970; Bearison, 1986). Specifically, they proposed that (a) low conflict would be insufficient; (b) high conflict would be interfering; and (c) intermediate conflict would be optimal for learning. To test for a curvilinear component, new variables were created by squaring all independent and intervening variables and by entering the new transformed variables into the regression equations. (For all additional analyses, a significant increase in R^2 would have suggested a significant curve component (Nie, et al., 1975). These analyses revealed no evidence of curvilinearity between external and internal measures of conflict or between certainty, latency, prediction of models, and conservation performance. (The largest increase in R^2 was from .743 to .765, all $ps > .05$).

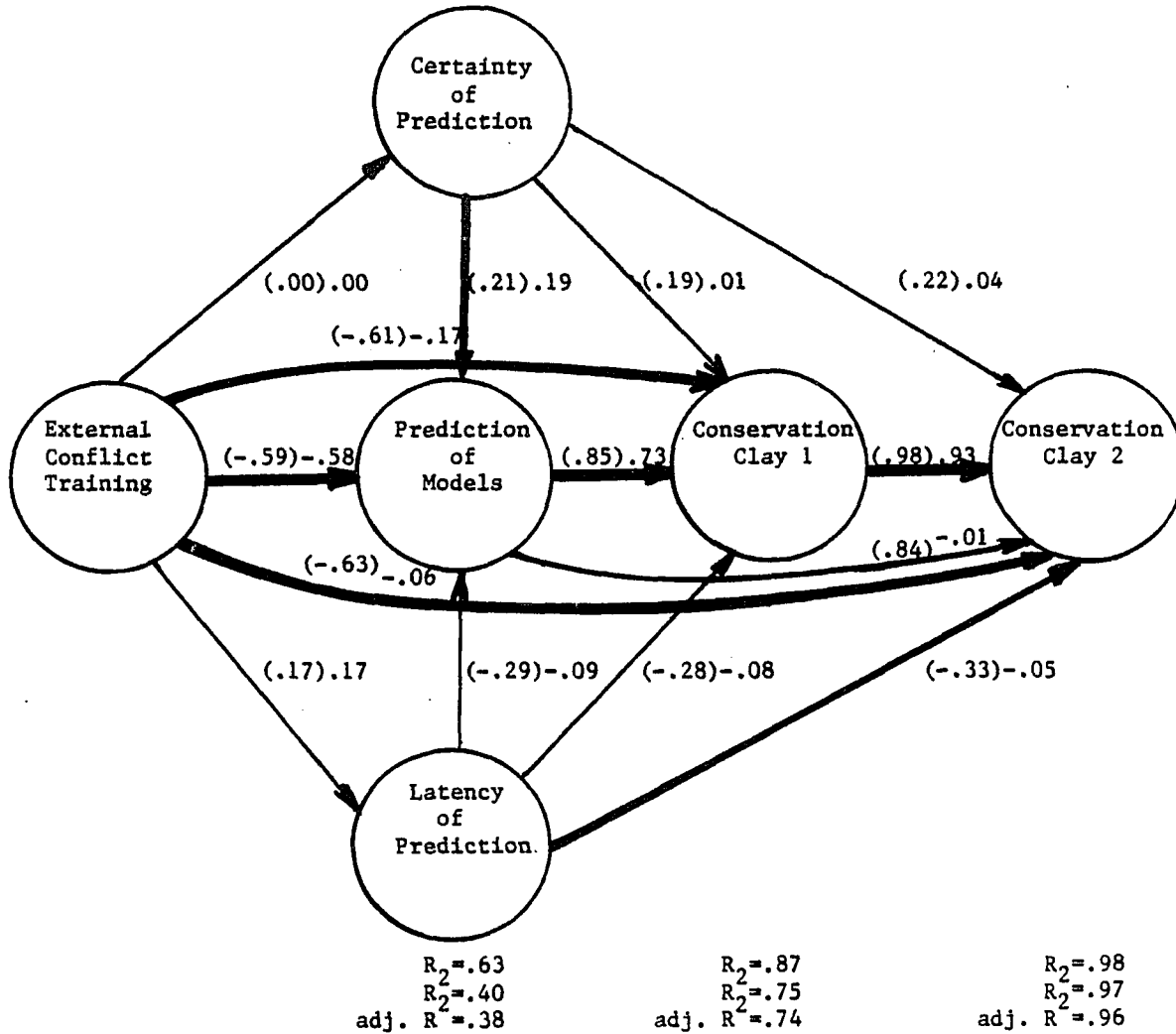


Fig.11. A Path-Analytic Model of the Effects of Conflict Variables (i.e. External Conflict; Certainty; and Latency) and Prediction of Models' Conservation on Children's Conservation Scores on Immediate and Delayed Posttests Training Tasks (Clay 1 and Clay 2). Correlations are Presented in Parentheses. The Path Coefficients are Standardized Regression Coefficients. Significant Paths are Identified by Thick Lines.

Note. For decomposition of causal paths of this model see Table 8.

Table 8. Decomposition of Causal Paths Between Conflict Variables (External Conflict; Certainty; and Latency), Prediction of Models' Conservation Responses, and Conservation Scores on Immediate and Delayed Posttests Training Tasks (Clay 1 and Clay 2).

Predictor Variable	Criterion Variable	r coeff	Direct Effect	Indirect Effect	Total Effect	Spurious Effect
Ext. Conf.	Prediction	-.59**	-.58**	-	-.58**	-.01
Ext. Conf.	Clay 1	-.61**	-.17*	-.44**	-.61**	.00
Ext. Conf.	Clay 2	-.63**	-.06*	-.55**	-.61**	-.02
Ext. Conf.	Certainty	.00	.00	-	.00	.00
Ext. Conf.	Latency	.17	.17	-	.17	.00
Certainty	Prediction	.21*	.19*	-	.19	.02
Certainty	Clay 1	.19*	.01	-	.01	.18
Certainty	Clay 2	.22*	.04	-	.04	.18
Latency	Prediction	-.29**	-.09	-	-.09	-.20
Latency	Clay 1	-.28**	-.08	-	-.08	-.20
Latency	Clay 2	-.33**	-.05	-	-.05	-.28
Prediction	Clay 1	.85**	.73**	-	.73**	.12
Prediction	Clay 2	.84**	-.01	.69**	.68**	.16
Clay 1	Clay 2	.98**	.93**	-	.93**	.05

* = $p < .05$; ** = $p < .001$

Note. For the graphic representation of this table see Fig. 11.

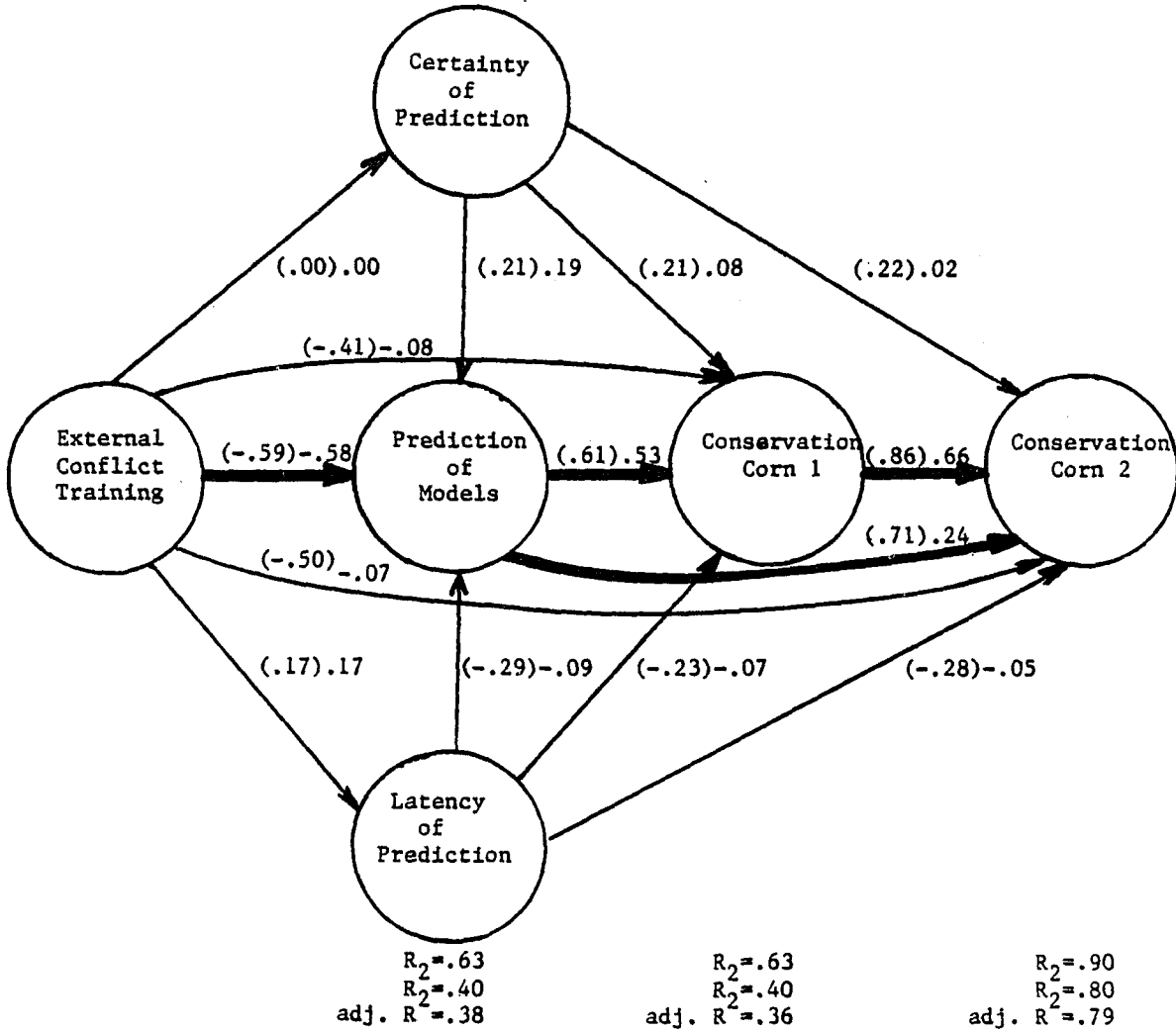


Fig.12. A Path Analytic Model of the Effects of Conflict Variables (i.e. External Conflict; Certainty; and Latency) and Prediction of Models' Conservation on Children's Conservation Scores on Immediate and Delayed Posttests Transfer Tasks (Corn 1 and Corn 2). Correlations are Presented in Parentheses. The Path Coefficients are Standardized Regression Coefficients. Significant Paths are Identified by Thick Lines.

Note. For decomposition of causal paths of this model see Table 9.

Table 9. Decomposition of Causal Paths Between Conflict Variables (External Conflict; Certainty; and Latency), Prediction of Models' Conservation Responses, and Conservation Scores on Immediate and Delayed Posttests Transfer Tasks (Corn 1 and Corn 2).

Predictor Variable	Criterion Variable	r coeff	Direct Effect	Indirect Effect	Total Effect	Spurious Effect
Ext. Conf.	Prediction	-.59**	-.58**	-	-.58**	-.01
Ext. Conf.	Corn 1	-.41**	-.08	-.32**	-.40**	-.01
Ext. Conf.	Corn 2	-.50**	-.07	-.39**	-.46**	-.04
Ext. Conf.	Certainty	.00	.00	-	.00	.00
Ext. Conf.	Latency	.17	.17	-	.17	.00
Certainty	Prediction	.21*	.19	-	.19	.02
Certainty	Corn 1	.21*	.08	-	.08	.13
Certainty	Corn 2	.22*	.02	-	.02	.20
Latency	Prediction	-.29*	-.09	-	-.09	-.20
Latency	Corn 1	-.23*	-.07	-	-.07	-.16
Latency	Corn 2	-.28*	-.05	-	-.05	-.23
Prediction	Corn 1	.61**	.53**	-	.53**	.09
Prediction	Corn 2	.71**	.24**	.35**	.59**	.12
Corn 1	Corn 2	.86**	.66**	-	.66**	.20

* = $p < .05$; ** = $p < .001$

Note. For the graphic representation of this table see Fig. 12.

CHAPTER VII

Discussion

The main purpose of this study was to examine the role of external (social) and internal (cognitive) conflict in children's learning of conservation. The results obtained provide relatively little support for Piaget's equilibration/conflict explanation of learning. Contrary to Piaget's position, the present findings indicate that conflict is neither a necessary nor a sufficient precondition for learning to occur.

Six hypotheses were formulated at the outset which are now reconsidered in light of the data. As hypothesized (H1), No Conflict modeling treatment (i.e., where both models agreed 100% on a conservation rule) was significantly more effective in generating acquisition of conservation than either of the conflict treatments (i.e., Intermediate Conflict - 50% agreement and High conflict - 0% agreement). In his analysis of Zimmerman and Blom's (1983) study, Cantor (1983) suggested that a more precise manipulation of external conflict variables (from 100% agreement to 100% disagreement) could improve the research concerned with the role of conflict in learning. This

suggestion was followed in the present study. The data that emerged from this manipulation are even more clear-cut than those of Zimmerman and Blom (1983), which showed that conflict not only failed to produce learning but actually inhibited it. Only the No Conflict group in the present study displayed learning.

A critical addition in the present research design relative to previous conflict conservation studies was the inclusion of a new intervening variable, "social rule learning" (prediction of models' performance) which provided support to an alternative social learning hypothesis. Prediction of models' performance is a measure of social learning. If the models' actions follow a rule, this will permit the observer to predict future actions of the models, which, in turn, will increase measures of their own learning, retention and transfer. As hypothesized (H2), children who received non-conflicting modeling treatment were able to predict responses of both models (judgment and reasoning) more accurately than children in the two conflict groups. Also, children who accurately predicted responses of both models' answers and explanations attained significantly higher immediate and delayed posttest conservation scores on both training and transfer tasks than children who predicted models' performance less accurately (H3).

These findings indicate that more advanced and

efficient forms of learning occur when the models' responses follow an identifiable rule and when the rule is presented in a clear and consistent manner. Presentation of conflicting rules creates confusion for the observers, reduces their ability to predict models' responses in similar situations and impedes their learning. This finding is consistent with previous findings in the area of concept formation research. Liebert and Swenson (1971) found that even young children can abstract an underlying rule from a number of discrete responses and use this information effectively for social prediction.

Observation of a model whose responses consistently manifested an underlying rule markedly facilitated recall of the model's responses and led children to predict that other non-modeled behaviors would be governed by the same rule. Similarly, Charbonneau and Robert (1977) found that the training in which children were asked to "speak your answers as if you were the lady shown on television" produced the highest acquisition of conservation compared with the other four treatment conditions employed in their study.

H4 predicted that conflicting modeling treatments will generate a greater degree of internal conflict (as assessed by certainty and latency measures) than non-conflicting modeling treatment. This hypothesis was supported only partially. Although analysis of variance

revealed a significant main effect for treatments on the training task certainty measures, path analyses indicated relatively low correlations between treatments and certainty measures. Pairwise comparison of the means revealed that, as predicted, children in the Intermediate Conflict condition had significantly lower certainty scores than children in the No Conflict condition, but no differences emerged between No Conflict and High Conflict conditions. There are several possible explanations for this finding: (1) unreliability of certainty measures with young children; (2) the relationship between external conflict and certainty judgment may be curvilinear rather than linear (however, the quadratic polynomial regression analyses revealed no evidence of curvilinearity); and (3) young children tend to be unrealistically optimistic at judging their performance, especially when their proficiency in a specific task domain is low. Based on current research utilizing certainty ratings (e.g., Newman and Wick, 1987), the last option seems to provide the most plausible explanation. Children in the High Conflict group may compensate with optimism for their inability to abstract the correct rule from models who disagree in their answers on every item and accept their own previous performance (i.e., nonconserving answers) as the correct one. Also, certainty ratings were already quite high during pretest ($M = 13.11$, maximum possible score is 16)

and they changed relatively little across the phases of the study.

Although significant, the differences on the certainty measures training task (clay) were relatively small. On the transfer task (corn), the pattern was similar but the effect of training on certainty scores failed to reach statistical significance.

H4 also predicted that subjects in the No Conflict modeling treatment will have significantly lower response latency scores than subjects in the two conflict modeling groups. Although response latencies were shorter for the No Conflict group than for all the other groups, this effect was not uniformly significant across all phases. Again, as indicated by the correlation coefficients in the path model, the effects of treatments on latency measures, even when significant, were relatively small.

In his evaluation of Zimmerman & Blom's (1983) study, Cantor (1983) pointed out that the main issue is not the question whether cognitive conflict can be produced in young children, "We know that it can," (p. 48). The main issue, given the generation of cognitive conflict in conflict modeling groups, is whether that conflict facilitates or impedes the learning process. The evidence from this study, although not conclusive, supports the social learning hypotheses. Careful examination of the path analytic model and the corresponding decomposition

tables indicates that, although the interaction (indirect) effects of treatments on certainty and latency measures did not reach statistical significance, the direct effects of certainty measures on conservation scores were significant across all phases, except the immediate posttest on the training task. For the latency measures, the direct effects on conservation scores reached statistical significance only on immediate posttest on Clay 1. In other words, neither measure of internal conflict (certainty or latency) improved causal explanation for acquisition of conservation based on external conflict via internal conflict measures (indirect effect). However, all certainty and some latency measures contributed significantly to the variation in the conservation scores (direct effects). As noted previously, the magnitudes of these direct effects were minute compared to those of treatment effects. These findings thus provide only partial support for H5, which stated that subjects who experience lower internal conflict (as reflected by low response latency scores and high certainty scores) will obtain significantly higher immediate posttest and delayed posttest conservation scores than subjects who experience higher degrees of internal conflict.

H6 predicted that no significant progress or regression in children's conservation scores will occur from immediate to delayed posttest for subjects in either

of the three treatment groups. Again, this hypothesis received only partial support. There was no significant improvement or decline in children's conservation scores on the training task (Play Doh) from immediate to delayed posttest. However, on the transfer task (corn), the acquisition of conservation was not only maintained over a three weeks' delay, but it actually increased. This increase was significant only for the No Conflict modeling treatment where both models agreed 100% on the conservation rule. Such evidence of continued cognitive growth after training has been suggested by several investigators (e.g., Kuhn, 1974; Murray, 1982, 1983) to be the most demanding criterion for conservation proposed by Piaget. Murray (1983) argued that presenting a nonconserving child with a conservation rule precludes the child from the deduction of the conservation response and, consequently, from experiencing feelings of "logical necessity", (i.e., knowing not only that an event is true but knowing that it has to be true). In his view, conservation assessment is valid only if the feeling of logical necessity is assessed either directly or indirectly by one or more of the following criteria: durability over time; resistance to countersuggestion; specific and nonspecific transfer; and trainability. Although no attempts were made in this study to assess logical necessity, it would appear that almost all of

these criteria were satisfied. Following Cantor's (1983) suggestion, the generalizability of training effects was assessed with two very different materials and the transformations performed with plasticine were clearly different from those carried out with corn. The present data clearly indicate that children learned a general rule, not just a particular response. This rule was: (a) displayed outside the presence of the videotaped experimenter or models, without the social pressure to conform to the models' responses; (b) used effectively to predict models' conservation responses on different tasks (with the same materials, but different transformations); (c) used during judgments of non-modeled new stimuli (with clearly different materials and transformations); and (d) not only retained over time, but actually further refined by the children themselves during the delayed testing period.

The present results do not completely rule out the Piagetian external/internal conflict explanation for conservation acquisition. The No Conflict modeling condition was the most discrepant treatment relative to children's nonconservation pretest scores. This explanation is strained by the evidence from path analysis which revealed that external conflicts did not produce much cognitive conflict according to the certainty or latency measures of internal conflict. Although the

trends were in the direction predicted by the social learning model, not the Piagetian model (i.e., more conflict → less certainty → longer latency → less learning), the effects of external conflict on internal conflict measures, even when significant, were minute compared to the direct effect of external conflict on conservation scores or the indirect effect of external conflict on conservation scores via the prediction of models' responses. These results provide relatively little evidence that children experience conflict while learning. Consistent with the social learning hypothesis, whatever little conflict was experienced had the opposite effects to those predicted by Piagetian hypothesis.

To improve the present study, the measures of internal conflict could be refined further. The inclusion of the social learning variable appears promising, and we would recommend using it in future studies concerned with the role of conflict in learning. The design of this study could be further improved by utilizing other conservation domains in addition to weight in the posttest measures (i.e., nonspecific transfer). It would also be interesting to explore if the measures of cognitive conflict are more reliable and valid when used with older children. This could be achieved by utilizing more complex conservation tasks or tasks of formal reasoning. Children could be tested across a wider range of age

groups by manipulating the level of task difficulty. Older children are more likely to be more aware of their cognitive states and are thus more likely to report more accurately whether they experience cognitive conflict or not and whether this conflict improves or impedes their learning.

Educational Implication of the Study

Based on the findings in this study, the following conclusion is made: conflict is not a necessary condition nor a sufficient condition for conservation learning to occur. Therefore, approaches to instruction based on Piaget's equilibration/conflict model are likely to be less effective in helping children to learn new concepts than approaches derived from social learning conceptualizations. Several methods (Brainerd, 1977) have already been found more effective in improving children's performance on both Piagetian and non-Piagetian tasks than self-discovery or sociocognitive conflict. These methods include, for example, provision of feedback on the child's responses; direct teaching of a rule or rules; and having children observe a model who performs the task correctly. The findings of this research effort indicate, as Zimmerman & Blom (1983) have asserted, that clarity and consistency of socially presented information are far more critical dimensions of instruction than the degree of conflict created through presentation of inconsistent and conflicting information.

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