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ABSTRACT

This study investigated young children's ability to solve probability problems and studied the cognitive processes proposed by Piaget and Inhelder as necessary to solve probability problems. The effects of tutorial and self-discovery training were measured and discussed. Results from 168 first-graders in five training conditions indicated that: (1) tutorial training methods were superior to self-discovery methods; (2) cognitively transitional children performed better than non-transitional children; (3) children demonstrated temporally stable and generalized performance increments following training; and (4) the Genevan view of probability solution was not supported. (Author/PK)

First-Grade Children's Understanding of Probability

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Abstract

This study investigated young children's ability to solve probability problems. The cognitive processes proposed by Piaget and Inhelder (1951, 1975) as necessary to solve probability problems were investigated. The effects of tutorial and self-discovery training were measured and discussed.

Results from 168 first-graders in five training conditions indicated: 1) tutorial training methods were superior to self-discovery methods of training; 2) cognitively transitional children performed better than non-transitional children; 3) children demonstrated temporally stable and generalized performance increments following training and; 4) the Genevan view of probability solution was not supported.

First-Grade Children's Understanding of Probability

Topical Session Preference: Piagetian Behaviors, Problem Solving, Concept Formation, or Cognitive Behavior

This study investigated young children's abilities to solve probability problems. The effects of tutorial and self-discovery learning were measured and discussed, as related to the theories and predictions of Piaget and Inhelder (1951, 1975). In addition, the effect of the children's cognitive state or readiness was related to performance on the probability problems.

The probability problems and training used were designed to test hypothesis by Piaget and Inhelder that children have difficulty separating the "whole from the parts." This difficulty has been argued to be the primary inhibitor for children in solving probability problems in which elements from two classes are mixed to form a group from which the child must select the class of elements "most likely" to be selected at random. A typical example of this type of problem is mixing marbles of two colors in a container and asking the child which color of marble is "most likely" to be drawn on a single random draw from the container.

Method

One-hundred and sixty-eight first grade students were tested in five training and two control conditions. Each student had previously been pretested on their understanding of the word

"more" and to determine that they did not already have the ability to adequately solve the types of probability problems used in the test.

One training procedure was designed to aid the children in "disengaging" the parts from the whole. In this procedure, the children colored circles to match a comparison picture containing varying numbers of two colors of circles. An extension of the procedure required the children to determine the total number of circles, to focus attention to the "whole" number of elements. A third procedure was a verbal statement to the child of the "more" rule. That is, the children were taught that the class of elements most likely to be selected at random was the class with "more" in the container. Combinations of these three training procedures resulted in the five training conditions.

For each child, an initial experimental session was comprised of a pretest, a training phase, and a posttest. The pretest involved six trials of the child predicting which color marble would be selected from ratios of black and white marbles in a bowl. Following each prediction, the experimenter prompted the child for a verbal explanation of their selection. The training or control phase followed the pretest. The posttest repeated the marble test of the pretest and added six trials of a spinner task (predicting the landing of a spinner pointer on a white or black space on the face of the spinner). A follow-up test session four weeks later repeated the marble and spinner tests.

For each trial, the correctness of the child's prediction was recorded. The children's verbal explanation of their predictions were scored as "mature" or "lacking maturity." This categorization was based on the child's reference to number, probability, or accessibility of the two colors of marbles.

Results and Discussion

The results of the pretest indicated that, prior to training, all of the groups were performing equally and at about the chance level. Following training, the children were responding at 71 percent, above the chance level. Detailed analyses illustrated that this improvement was not equivalent across children or training groups.

Analyses comparing the effects of the training procedures clearly demonstrated the superiority of the tutorial teaching of the "more" rule over the self-discovery learning of the part/whole relationships. No significant differences were observed between training conditions which provided emphasis on the parts and not the whole and those which emphasized the parts and the whole. These results do not support the contention of Piaget and Inhelder (1975), Ojemann, Maxey, and Snider (1969), and Hoemann and Ross (1971) that the child must go beyond making a "more" type of comparison and understand the relationship of the part to the whole in order to solve these types of probability problems.

Verbalizations were only increased by the tutorial training of the "more" rule. This result is not particularly surprising,

since the training procedure provided a verbal rule which the children could then use in response to the experimenter probing of why a particular color was chosen.

The results of the spinner task indicated that the training procedures were supporting a development of a generalized knowledge and not task-specific responding. Additionally, the follow-up testing indicated a temporal stability in the learning.

Overall, the results do not support the Genevan claim that the child must understand the relationship of the parts and the whole, nor did they support the more recent findings of Perner (1979). Additionally, the Genevan prediction of the superiority of self-discovery learning was not supported. The learning obtained, though, did meet the Genevan criteria of generalization and temporal stability.

References

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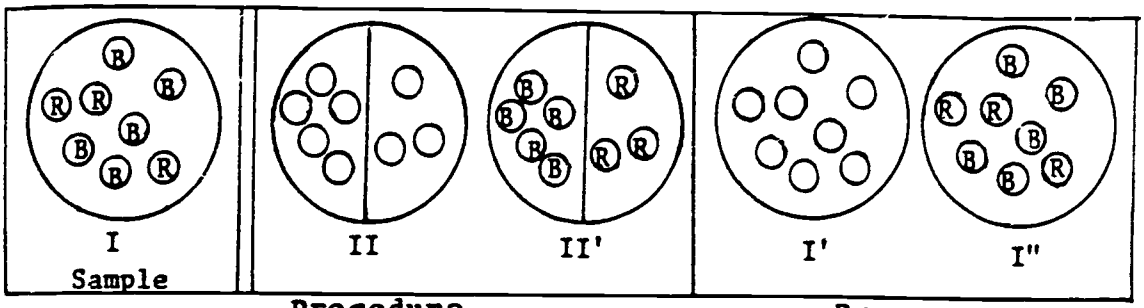
Perner, J. (1979). Discrepant results in experimental strides of young children's understanding of probability. Child Development, 50, 1121-1127.

Piaget, J. & Inhelder, B. (1975). The origin of the idea of chance in children. New York: Norton.

Figure 1. Description of training procedures.



	Procedure	Purpose
T1	(1) state number of R and B	focus on components
	(2) color II-->II'	focus on components
	(3) state total number	focus on total
	(4) "more" rule	"more" rule
T2	(1) state number of R and B	focus on components
	(2) color II-->II'	focus on components
	(3) -----	no focus on total
	(4) "more" rule	"more" rule
T3	(1) state number of R and B	focus on components
	(2) color II-->II'	focus on components
	(3) state total number	focus on total
	(4) -----	no "more" rule
T4	(1) state number of R and B	focus on components
	(2) color II-->II'	focus on components
	(3) -----	no focus on total
	(4) -----	no "more" rule
T5	(1) -----	no focus on components
	(2) -----	no focus on components
	(3) -----	no focus on total
	(4) "more" rule	"more" rule
C1	(1) color I'-->I"	control
C2	(1) color line drawing	control

Note. R and B designate red and blue circles, respectively.

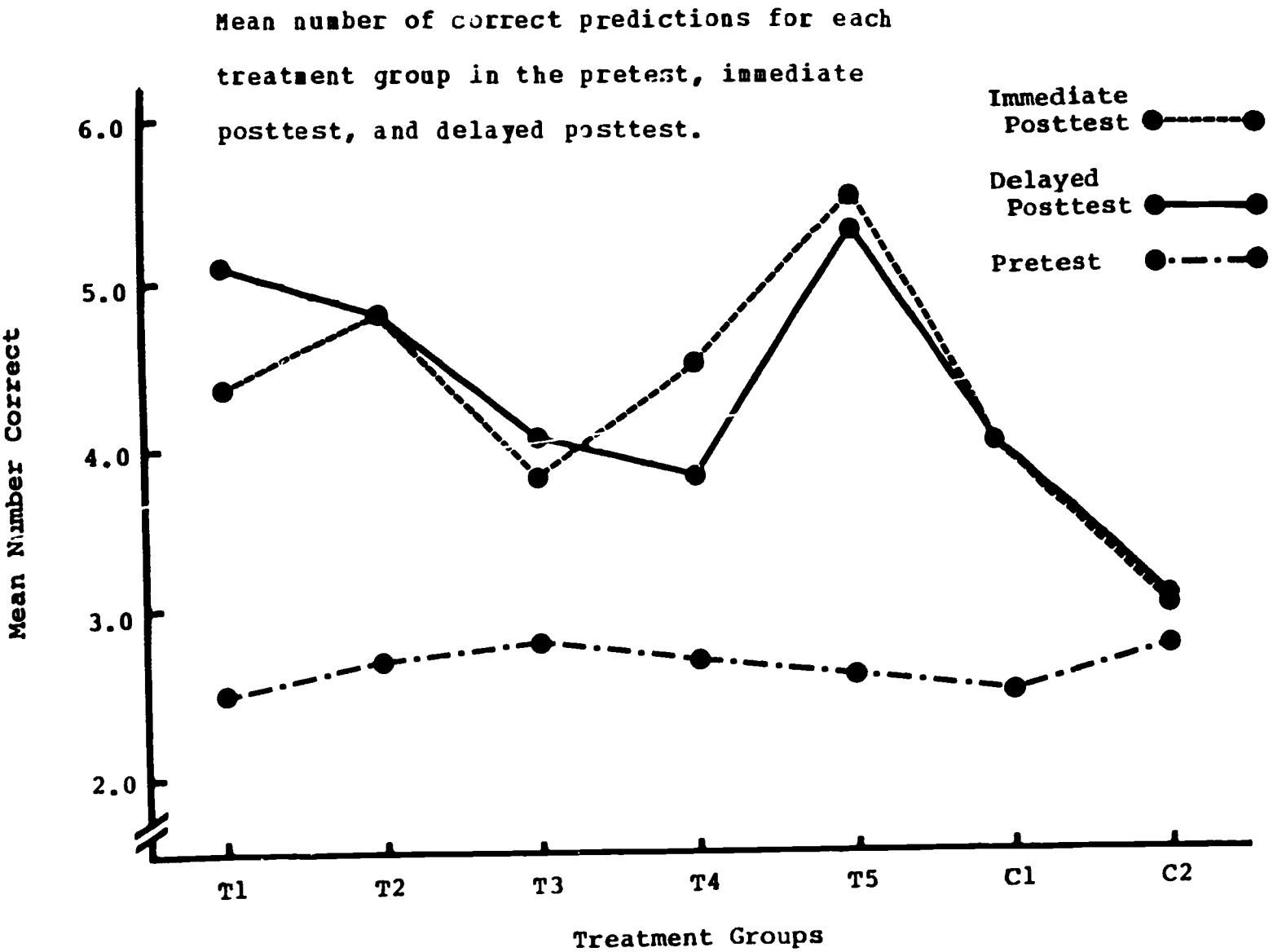

Mean number of correct predictions for each treatment group in the pretest, immediate posttest, and delayed posttest.
Immediate Posttest
Delayed Posttest
Pretest
6.0
5.0
4.0
3.0
2.0
Mean Number Correct
T1
T2
T3
T4
T5
C1
C2
Treatment Groups

Figure 2

Mean number of mature verbalizations for each treatment group in the pretest, immediate posttest, and delayed posttest.

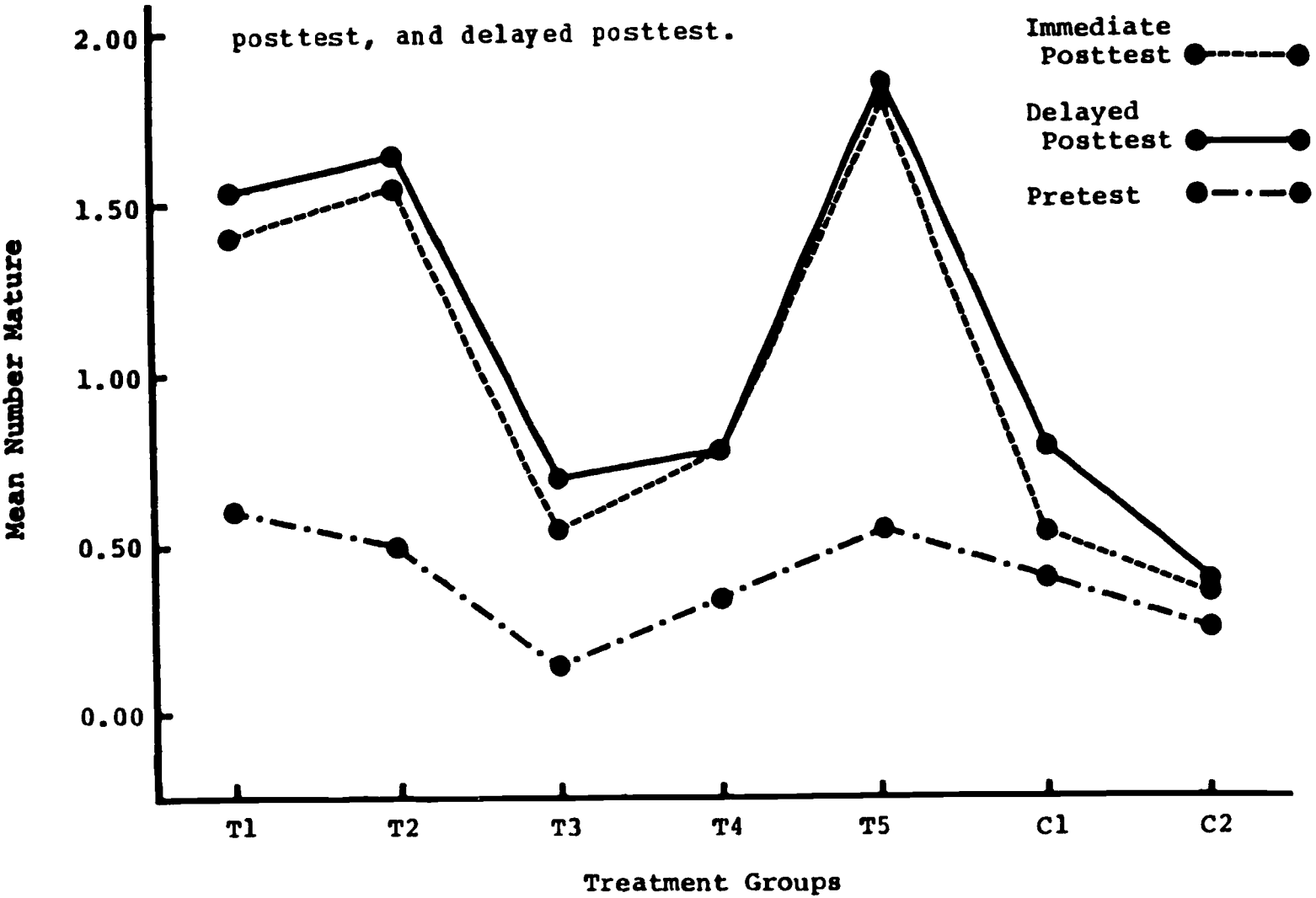


Figure 3

Table 1

Number of Elements for Pretest

of the Word "More"

	Number of Elements in Picture 1	Number of Elements in Picture 2
Chairs	2	8
Balls	6	4
Stick Figures	5	3
Triangles	3	4
Bugs	7	3
Hats	5	6

Table 2

Number and Color of Circles

in Each Sample Picture

Order of Presentation	Elements in Each Sample Picture		Total Number of Elements	Majority Color
1st	4Y	3R	7	Y
2nd	3B	2G	5	B
3rd	5G	2Y	7	G
4th	4R	2B	6	R
5th	6Y	2G	8	Y
6th	5R	3G	8	R

Note. Y = yellow; R = red; B = blue; and G = green.

Elements Involved in the Test Problems

Presentation Order	Number of Whites	Number of Blacks	Target Color
1st	6	2	W
2nd	1	7	B
3rd	3	5	B
4th	7	1	W
5th	2	6	B
6th	5	3	W

Note. W = white; B = black.

Means for Stratification X Task X Time Interaction for Verbalization Scores

	Marble Task		Spinner Task	
Stratification	Immediate	Delayed	Immediate	Delayed
4	1.15	1.23	1.08	1.31
3, 2, 1, 0	0.86	0.93	0.90	0.91