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ABSTRACT

To replicate the findings of a previous experiment in which it was shown that the systematic presentation of rules and feedback on conservation and conservation-related problems can be employed to teach young children the traditional (Piagetian) liquid quantity problem rapidly, an analysis was made of the role of two others variables: (1) use of three different types of problems vs. repeated presentation of the conservation task, and (2) age of the subject. It was predicted that rule and feedback training would again facilitate conservation performance; that exposure to conservation-related problems would facilitate performance on them without impeding mastery of the conservation problem, per se; and that performance would be directly related to age. It was expected that older children would benefit from mere exposure to the problems, but that younger children would not. The subjects were 80 children (40 kindergarten children with mean age of about 64 months, and 40 first graders with a mean age of 77 months). The criterion for participation was failing to respond acceptably to a pretest of liquid quantity conservation. An equal number of boys and girls were randomly assigned within age groups to four experimental conditions. Pretests and posttests were administered on three liquid quantity measures. All children received 18 training trials following posttests. Analyses of variance were performed on posttest data. Results of the study showed that 70% of the children who received conservation and conservation-related problems with rule and feedback training mastered the conservation of liquid and quantity task; 60% of kindergarteners and 80% of first graders mastered the problem. (DB)

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LEARNING OF LIQUID QUANTITY RELATIONSHIPS AS A FUNCTION OF RULES AND FEEDBACK, NUMBER OF TRAINING PROBLEMS, AND AGE OF SUBJECT

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In a recent experiment (Siegler & Liebert, 1972), it was shown that the systematic presentation of rules and feedback on conservation and conservation-related problems can be employed to teach young children the traditional (Piagetian) liquid quantity problem rapidly. The present study represents an initial effort to analyze the role of two other variables in the context of replicating the basic earlier finding: (*a*) use of three different types of problems vs. repeated presentation of the conservation task and (*b*) age of *S*. A 2 (Presence or Absence of Rule and Feedback Training) X 2 (Age of *S*s: kindergarten or first grade) X 2 (Type of Training Problem: conservation only or conservation and conservation-related) factorial design was employed. It was specifically predicted that rule and feedback training would again facilitate conservation performance, that exposure to conservation-related problems would facilitate performance on them without impeding mastery of the conservation problem, per se, and that performance would be directly related to age. It was also expected that the older children would benefit from mere exposure to the problems, while the younger children would not.

METHOD

Participants and Testing

The *S*s were 80 children, 40 kindergarteners (mean CA = 64 mo.) and 40 first graders (mean CA = 77 mo.), enrolled in public schools in a middle-class area of Long Island. The criterion for participation was failing to respond acceptably to a pretest of liquid quantity conservation. Equal numbers of boys and girls were assigned randomly within age groups to the four experimental conditions. Two adult females trained equal numbers of children in each group while a third adult female, blind to the child's experimental training, administered the pre- and postmeasures. These identical tests included three liquid quantity problems, one that tested mastery of the conservation task and two that tested mastery of related tasks. In each instance, three identical drinking glasses, partially filled with water, and one empty glass that was taller and thinner (in the case of the conservation problem and one of the related problems) or shorter and wider (in the case of the remaining conservation-related problem) than the other three glasses were presented. After obtaining the child's agreement that the three identical glasses had the same amount of water, *E* poured (*a*) some of the water from one glass, (*b*) all of the water from one glass, or (*c*) all of the water from one glass and additional water from another glass into the previously empty one. The *S* was asked if the immediately adjacent, untouched glass and the previously empty glass had the same amount of water or a different amount and then: "Why do you say that?" The *E* gave no indication of the acceptability of the child's answers and reasons.

Training

Approximately 5 to 7 days after the pretest, *S*s were brought individually into an empty room in their school. They were told that they would be playing a game and that the more correct answers they gave, the better their prize would be. All children received 18 trials, involving the transfer of liquid among five glass cylinders that differed in dimensions from any used during the pre- and posttests; three of the cylinders were identical standards, while the remaining two were respectively taller and thinner or shorter and wider than the others. Training trials followed the general pattern of the pre- and posttests; i.e., an operation was performed in *S*'s presence, and he was asked to evaluate the outcome against an untouched standard and explain his answer. For those who received only direct conservation training, the entire contents of one of the standards was always poured into the odd glass; those exposed to all three types of problems had 6 conservation trials scattered among the 18. Of the remaining 12 trials for these latter *S*s, half concerned the results of pouring only some of the water from a standard into the odd glass, and the remainder involved the results of pouring all of the water from one standard and some from another into the odd glass. Children in the rule and feedback conditions were told whether they had provided acceptable answers and reasons, as well as being given the relevant rule after each trial regardless of whether their performance had been correct. The remaining *S*s were not given this information. The necessary reliability data, as well as a more complete description of the rules and training procedures are available in Siegler and Liebert (1972).

RESULTS AND DISCUSSION

Analyses of variance on posttest data were performed for (*a*) all problems, (*b*) conservation problems only, (*c*) conservation-related problems only, and (*d*) number of children advancing acceptable responses on all three problems.[1] Analyses *b* and *d* were performed on dichtomous data; recent evidence indicates, however, that such procedures do not result in significant biases (Lunney, 1971).

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[1] An acceptable response involved both a correct answer *and* an appropriate reason. Earlier research showed that this measure produces results comparable to those obtained using answers alone as a criterion, but is more stringent.

Effects of Exposure to Conservation-Related Problems

Children exposed to both conservation and conservation-related problems during training advanced acceptable reasons on a greater total number of questions ($F = 5.30$, $p < .025$) and on a greater number of conservation-related questions ($F = 9.62$, $p < .01$) than did those exposed only to conservation problems. In addition, more of those in the former group provided acceptable answers and reasons on all three problems ($F = 11.62$, $p < .01$) On conservation problems, no differences were found between children who received 18 conservation trials and children who received 6 conservation and 12 conservation-related trials ($F < 1$). These findings support the original prediction that presentation of conservation-related problems will lead to a more general understanding of the conservation concept with no decrement in conservation performance, narrowly defined.

Effects of Rule and Feedback

Providing rules and feedback after each trial resulted in a greater total number of acceptable answers and reasons ($F = 18.31$, $p < .01$) and a greater number of such responses both on conservation ($F = 34.44$, $p < .01$) and conservation-related ($F = 7.79$, $p < .01$) problems. On the remaining measure, number of children who met the criterion on all three posttest problems, a significant interaction was found between presence or absence of conservation-related problems and rule and feedback during training ($F = 4.77$, $p < .05$). As seen in Table 1, children who received rule and feedback as well as as exposure to the conservation-related problems were better able to master all three problems than were those in the remaining groups.

TABLE 1

Percentage of *S*s Responding Acceptably on Both the Conservation and the Two Conservation-Related Problems

Percentage of *S*s	Training	
	Conservation and conservation related	Rule and feedback
60	Yes	Yes
20	Yes	No
5	No	Yes
10	No	No

Relationship between Experimental Treatments and Age

First graders advanced a greater number of acceptable responses on all problems ($F = 14.72$, $p < .01$), on the conservation problem ($F = 13.19$, $p < .01$), and on the conservation-related problems ($F = 11.63$ $p < .01$) than did kindergarteners. Also, a greater number of first graders performed acceptably on all three problems ($F = 7.77$ $p < .01$).

Interactions

The predicted Age X Rule and Feedback interaction was not obtained, nor did any of the other possible interactions not previously mentioned approach significance.

Replication and Continuity vs. Discrete State Interpretations

In an exact replication of earlier findings (Siegler & Liebert, 1972), 70% of the children who were given conservation and conservation-related problems with rule and feedback training mastered the conservation of liquid quantity task. Examination of the relationship between age and performance on the conservation problem yielded an ascending linear function, at least for the age groups thus far tested. In the current study, 60% of kindergarteners (mean CA = 64 mo.) and 80% of first graders (mean CA = 77 mo.) mastered the problem; in the earlier study, 70% of the *S*s (mean CA = 70.5 mo.) did so. A similar pattern emerged from analysis of numbers of children responding acceptably to all three questions (40% of the youngest, 60% of the oldest, and 50% of those intermediate in age). Thus, the available evidence supports a continuity interpretation of children's ability to benefit from training on conservation problems.

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