Effect of an "action" cue on conservation of amount¹

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A modification of Piaget's conservation task was found to be effective in facilitating conservation responses, with the effect depending on the grade level of Ss. The "actions" procedure, designed to underline the initial equivalence of two discontinuous quantities, facilitated judgments of conservation on the task among kindergarten children. Children at first-grade level had little room to improve on the first task but showed a significant transfer effect to a second task, a conservation task involving continuous quantities and the usual Genevan procedure.

Although Piagetian theory stresses the importance of motor action or activity for cognitive development, there has been little experimental work to show its effect or to determine what it is that action contributes. In fact, most of the experimental studies have been with tasks of discrimination learning, and only a few psychologists (e.g., Berlyne, 1965) have attempted to draw together the results and concepts of the two areas.

This background gives a special interest to a Genevan study specifically concerned with the effects of action (Inhelder & Piaget, 1963). The study describes two procedures that yield different results on some conservation tasks. On conservation of liquids, for example, 4% of a 5-year-old sample and 18% of a 6-year-old sample conserve with a "regular" procedure; 23% and 46% conserve with an "actions" procedure. Similar increases from 22% and 54% to 60% and 93% are reported for conservation of discontinuous quantities (Inhelder & Piaget, 1963, pp. 68, 97).

The difficulty is that one cannot be sure the difference in success stems only from the use of motor actions. For conservation of liquids, the two procedures are as follows:

"Regular": The child is shown two identical containers, A and A', already equally filled. He watches as E pours the water from A' to B, a container with a different shape from A. The child is asked if A and B have the same amount.

"Actions": The child is shown two differently shaped containers, A and B, both empty. He watches as E takes paired cups of water and pours them, in a simultaneous

1-to-1 fashion, into the containers. The child is asked if A and B have the same amount.

These procedures differ in E's use of matched actions to fill the containers, and in the presence of a "transvasement" step (pouring A' into B and shifting the comparison from the original A and A' to A and B). The present study aims at clarifying the source of improvement, asking whether the same differences will occur in a comparison of "regular" and "action" procedures when both include the "transvasement" step.

DESIGN

All Ss were given two tasks for conservation of quantity. Task 1—Discontinuous quantities: Ss were given either regular or action procedure. Task 2—Continuous quantities: Ss were given only regular procedure. Performance on Task 1 allows a measure of any direct improvement from an action procedure. Performance on Task 2 allows a measure of any transfer effect to another task. Task 2 is like Task 1 in asking for conservation of quantity, but differs in its stimulus material and in its level of difficulty (children typically succeed on conservation for continuous quantities 1-2 years later than on conservation for discontinuous quantities).

SUBJECTS

Seventy-four 5- and 6-year-olds were drawn from two sources: a day school with children divided into kindergarten and Grade 1 classes, and a private kindergarten divided into morning and afternoon classes, each with its own teacher. The morning kindergarten was judged equivalent in type of work (reading, writing, spelling, and arithmetic) to the day school's first grade. The teacher for the morning kindergarten is known in the community for her stress on academic skills, and tends to attract children who have been in nursery-school and are judged by parents and teacher to be ready for first-grade work. In the two sources combined, 28 children were working at Grade 1 level, the other 46 at a level below Grade 1. Mean age for the total group was 5:9 (range 5:2 to 6:7), for the Grade 1 group, 5:11 (range 5:3 to 6:7), and for Pregrade 1, 5:8 (range 5:2 to 6:2).

PROCEDURE

On Task 1, Ss were divided into boys and girls, and, within each sex group, assigned alternately to either the action or the regular procedure. On Task 2, all Ss were given the regular procedure.

The only difference between procedures lies in the way the initial equality is

established. For the action procedure, E places two identical containers before the child, both empty. E asks for the name of a friend in class, and asks S to pretend that one glass is for the friend (X) and one for S himself. E states: "I am going to give you each some grapes, like this. I'll take one for you and one for X and put them in here like this (dropping the two grapes simultaneously, one into each glass). Can you put some more in like that?" E then pushes a bowl of grapes towards the child, and lets him proceed until there are five grapes in each glass. The grapes are of such a size that the same visual arrangement always results, four covering the base of the glass and the fifth sitting above.

For the regular procedure, on both Task 1 and Task 2, the containers are presented with the material already in them, either grapes in the same number and visual arrangement as with the action procedure, or water up to the same level in both containers.

For both action and regular procedures, the second step (transvasement) is identical. E pours the content of A' into a tall thin container, B. The diameter of A' is 3 in., and of B, 1½ in. The change in diameter results in a marked perceptual difference between

Fig. 1. Effect of "actions" on conservation performance (direct effect shown on Task 1, transfer effect shown on Task 2).

A and B, a 6-in. difference in the water level on Task 2, and a stacked rather than flat arrangement of grapes in Task 1 (the five grapes now form a tower that is one grape wide). Whatever the stimulus material, E asks as he pours: "What if I take X's glass and pour the grapes (or water) into here? How is it now?" If S makes no immediate response, E asks more specifically: "Do you have as many grapes (or as much water) as your friend, or does one of you have more?" Whether the child's answer amounts to "same" or "not same," E asks: "How do you know?"

RESULTS

The use of actions in the initial part of the first conservation task has two effects: (1) It increases the number of correct judgments on that same task. The increase comes from the kindergarteners (the first-graders being already at ceiling) and is statistically significant at the .05 level (one-tailed *t* test, kindergarten Ss). (2) It increases the number of correct judgments on a second, slightly different task. This increase comes from the first-graders; the transfer effect is statistically significant at the .02 level (one-tailed *t* test, first-grade Ss). The kindergarteners show no transfer effect. Figure 1 shows the percentage of children who judge the quantities to be still equal after the transvasement step, and who, when asked "How do you know?" gave sensible reasons ("It's still five," "It's the same as before," "You didn't take anything away," "I put them in the same," "It's like it was before with the grapes," "That glass is bigger but it's skinnier," etc.). Over one-half of the reasons given on the first task referred to the unchanged number of grapes. Both the direct effect and the transfer effect are statistically significant at the .05 level (one-tailed *t* test, all Ss).

DISCUSSION

Within the past decade, a number of studies have attempted to test empirically how concepts of conservation develop. Specifically, procedures have been designed with the aim of accelerating the child's acquisition of conservation. A number of procedures have yielded positive results. These include such strategies as inducing "cognitive conflict" (Smedslund, in Flavell, 1963), screening the compelling appearance of inequality at the final stage and thereby permitting logically based judgments to prevail (Frank, in Bruner et al, 1966), and giving the child active experience with the quantities to be compared in order to emphasize the operations involved (Sonstroem, in Bruner et al, 1966).

Berlyne (1965) has suggested an explanation for the success of such procedures. He views the conservation task as a form of discrimination learning. In this

context, facilitative procedures would be those successfully calling the child's attention to cues relevant to the concept that quantity remains invariant over perceptual transformations. The Russian studies cited by Pick (1964) and the experiments by Jeffrey (1958), Hendrickson & Muehl (1962), and Stollnitz (1965) indicate that the introduction of motor responses has a pronounced facilitative effect in discrimination-learning tasks. Stollnitz (1965) interprets the effect as increasing the probability of an observing response to the relevant stimulus.

The type of explanation offered by Berlyne (1965) and Stollnitz (1965) is a fruitful way of accounting for the effect of the "actions" procedure in the present study. All told, the judgment situation at the end of the task can be regarded as a balance between relevant and irrelevant cues. In the usual Genevan procedure, the child's attention is drawn to the irrelevant cue of level, a cue difficult for children since it is sometimes useful and sometimes not. In the "actions" procedure, the child's actions draw attention away from the irrelevant cue, a function described as the "decentering" role of action in Piagetian terms (cf. Piaget & Inhelder, 1956, p. 35). In addition, they serve a function not stressed in Piagetian theory, namely, a positive drawing of attention to a relevant part of the stimulus, the equivalent composition of the two original amounts.

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Subjects classified and recalled four successive word lists, each of which contained six obvious categories. Three categories were repeated in every list. Words from nonrepeated categories were recalled better than words from repeated categories and words from categories judged to be small were recalled better than words from categories judged to be large.

Sorting words into categories is a very effective strategy for remembering a large number of words (e.g., Mandler, 1967). Category names facilitate recall by serving as cues for the retrieval of individual words. For example, recall can be improved by assuring that category names are available at the time of recall (Tulving & Pearlstone, 1966; Dong & Kintsch, 1968). However, the effectiveness of a category name as a cue for

- word retrieval should depend in part on the S's prior experience with it. More specifically, a category used for classification on successive lists should become less effective in generating recall because of interference produced by category words from the previous list. This proactive inhibition effect has been demonstrated by Shuell (1968). The present study replicates Shuell's results and also demonstrates that recall for words from categories judged to be small is better than recall for words from categories judged to be large.
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NOTE

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Free recall of successive lists: Effect of category size and category repetition¹

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SUBJECTS

Thirty-six Kansas State University undergraduates, enrolled in introductory psychology, were used as Ss.

EXPERIMENTAL DESIGN AND LISTS

Each S recalled all four lists used in the experiment. The presentation of the lists was counterbalanced over four subgroups of Ss so that each list appeared once in each ordinal position.