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To investigate the efficacy of a training procedure designed to facilitate the attainment of the mathematical concept of number conservation, 43 children from grades 1 and 2 were tested for their ability to conserve. Some of the pupils were found to be nonconservers; some, transitional conservers; and some, conservers. Pupils of the first two groups were divided into a training and control group. The training group received special sessions dealing with number conservation; the control group did not. It was found that although the older children had more initial conservers, both the younger and older children responded similarly to the training program. The training group children all learned how to conserve. The control group remained generally unable to perform conservation tasks. Retesting indicated that the abilities gained from the training sessions were surprisingly permanent. (WD)

SUCCESSFUL NUMBER CONSERVATION TRAINING[1]

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The revival of interest in Jean Piaget's theories of child development is directly related to a revival of interest in cognitive development. Specifically it is based on the "need" to test and better understand his theory of the stages and processes involved in intellectual functioning. An important concommitant of the latter are attempts to develop new techniques and methods to facilitate the preparation for and learning of the basic tools and concepts related to specific school subject content.

This study, which is part of a larger research project concerned with the general area of emergence of number concept and mathematics training, specifically investigates the efficacy of a training procedure designed to directly facilitate the attainment of the concrete operation of number conservation.

A number of studies have attempted to induce conservation or facilitate its emergence in a particular area of the concrete operations stage. Reprinted and reviewed so ably by Sigel and Hooper (1968), these studies represent a range of theoretical orientations, involving, for example, such considerations as "cognitive conflict" (Smedslund, 1961), reinforcement, inference, and differentiation (Wohlwill and Lowe, 1959), experience with logical prerequisites (Sigel, Roeper and Hooper, 1966), and training

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involving specific "actions" such as reversibility and addition/subtraction in the case of number conservation (Wallach, Wall and Anderson, 1967). Success has varied with these procedures.

Interestingly, what is repeatedly cited as characteristic of non-conservers, that is, the inability to disregard irrelevant perceptual cues, has not been empirically investigated except indirectly. Yet it is precisely this ability which may define conservation or nonconservation, for implicit in a child's attainment of conservation in general and number conservation in particular is the fact that he has stopped using the misleading perceptual cue of "how it looks." This would suggest that training which enables the child to resolve and ignore irrelevant perceptual cues may, in and of itself, facilitate the attainment of number conservation.

Method

Subjects were 43 children (20 males, 23 females) ranging in age from 5-7 to 8-3. One third of the Ss (mean age: 6-2) were tested just prior to their entering first grade and will be referred to as First Graders; the remaining Ss (mean age: 7-1) were tested nine months later at the completion of their first grade year and will be referred to as Second Graders. Criterion for sample inclusion was that Ss understand and be able to deal with the concepts "more," "less," and "same number."

Presence or absence of conservation was determined in identical pre and post tests by the classical Piaget procedures. That is, S first made a row "just like" E's row, then one row was manipulated either by extending or contracting the stimuli. The rows were returned to their original position of correspondence after each manipulation.

From the responses, Ss were designated as non-conservers (incorrect responses on all extension and contraction manipulations) transitional conservers (some correct and some incorrect responses on extension and contraction manipulations) and conservers (correct responses on all extension and contraction manipulations). Pretest non-conservers and transitional conservers were randomly assigned to a training or control group.

The training procedure differed from the pre and post conservation tasks in that cardboard spacers were used to determine distance between the objects. "Neutral" cardboard pieces (1-1/2 inches) were used in the initial construction of the rows and in each return to correspondence. In the extension manipulation, "long" cardboard pieces (2-1/2 inches) replaced the neutral spacers; in the contraction manipulation, "short" (1/2 inch) cardboard pieces replaced the neutral spacers.

Each training manipulation -- extension, contraction or return to original -- was preceded by E asking S to predict "What is going to happen when I put these in your (my) row?" If -- and only if -- S made an incorrect prediction E said, "But I'm not changing the number, I'm only changing how long the row is." This sentence was used only in the event of an incorrect prediction and at no other time in the training sequence. Following the actual manipulation, S was asked to judge whether the two sets of stimuli were equivalent, and if correct, was asked how he could tell. If S judged inequality on an extension or contraction manipulation, S was given from one to three additional opportunities to reconsider whether the two sets of stimuli were equal. In the first instance, S was asked to count the stimuli in each row and judge whether the two sets were equal; if incorrect, E exchanged -- pair by pair -- the spacers in E's and S's row so that the "short" row became the "long" row and vice versa. Then S again made a judgment about their equality. If incorrect in this second instance, S again counted each set of stimuli and gave his third judgment. Each of these three opportunities was presented only with continued assertions of inequality although at no time was S told he was incorrect.

Ss were administered the pretest and first training session on one day. The two days were consecutive except in the event of S absence or weekends. Pre and post tests were separated from training sessions by irrelevant "games." The procedure for controls was the same except that in the place of the training session on each testing day, controls performed a number matching task.

Results

On the basis of pretest responses for combined First Graders and Second Graders, 17 Ss were designated non-conservers, 5 Ss transitional conservers and 21 Ss conservers. Ss were likewise designated non-conserver, transitional conserver,and conserver on the post test and, in the case of the Second Graders, on the basis of retest responses. Thus performance change can be assessed.

A comparison of the performance of control Ss versus training Ss for the combined First and Second Grader groups indicates almost no change in performance in the case of the controls, and almost universal change in performance in the training group. Of the 12 control Ss, only one S changed his performance from pre to post test. The three original transitional conservers remained transitional conservers on the post test and eight of the nine pretest non-conservers remained at that level on the post testing. The one control change in performance was the one non-conserver who "became" a post test conserver.

In the training group the picture is nearly the reverse. Of the ten training Ss, eight were pre test non-conservers, two were transitional conservers. Post test designations were: 1 transitional conserver, nine conservers; closer analysis of the data reveals that the one transitional post test conserver was a pretest non-conserver; thus, all training Ss changed in performance from pre to post test.

It was possible to retest the Second Graders from three to four weeks following post testing. The Second Grader control group of 6 Ss gave a performance identical to their performance on the post test. The Second Grader training group of 6 Ss, on the other hand, revealed complete or partial maintenance of gains in all but one case. Half of the six Ss were still classified as conservers, while the other two post test conservers were now transitional conservers. The one post test transitional S reverted to non-conservation.

Separate analysis were also carried out for each of the two age groups of Ss, namely First Graders and Second Graders. As would be

expected, initial range of "ability" differed for the two age groups in the direction of a higher percentage of conservers appearing in the older group in the initial testing. Twenty-nine percent of the First Grader group were pre test conservers as compared to 59% of the Second Graders. In terms of trainability, however, there was no difference between the two age groups. No control First Grader changed his performance from pre to post test and only one control Second Grader changed his performance. In contradistinction to this, all training Ss in both First and Second Grader groups changed their performance. All First Grader training Ss became post test conservers as did all but one Second Grader training S; he became a transitional conserver.

While the training procedure included up to three additional opportunities for Ss to count and to see the spacers reversed in the rows in the event that he gave an inequality response on either or both of the extension or contraction manipulations, it is interesting to note that four of the ten training Ss (combined First and Second Graders) never made an incorrect response in the training sequence, three Ss made incorrect responses on Day 1 only and all three remaining Ss who made incorrect responses on Day 2 training made them only on the extension manipulations or, in other words, they were transitional conservers during Day 2 training.

Interesting secondary findings were obtained. All transitional conservation subjects indicated conservation in contraction manipulation, but made non-conservation responses during extension manipulations.

Discussion

Since this training was successful in inducing relatively enduring transitional or full conservation, it would indicate that we have both a theory and method from which to suggest that the acquisition of this concrete operation is amendable to both laboratory and classroom training, independently of age. This would appear to be particularly important to the development of number concept and mathematical ability in young children, especially since even some second graders, who are often assumed to have "mathematics" readiness, indicated a complete lack of conservation ability, or worse, could not deal with such verbal concepts as "more," "less," and "the same."

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