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ABSTRACT

A total of 100 second graders were pretested for conservation of length and weight. Fifty pairs were then formed, each pair consisting of one conserver and one nonconserver. During the second session, the children attempted to resolve their opposed answers on the conservation tasks and on two control questions as well. On both length and weight, the conserver's answer prevailed significantly more often than the nonconserver's; there were no differences on the control tasks. Analysis of the interaction revealed several measures on which conservers differed from nonconservers, and winners of the argument from losers. The results are discussed in terms of two issues: the certainty with which operational concepts are held, and the role of peer interaction in cognitive change. (Author/CS)

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# PEERS, PERSUASION, AND PIAGET: DYADIC INTERACTION BETWEEN CONSERVERS AND NONCONSERVERS

Scott A. Miller and Celia A. Brownell

University of Michigan

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# PEERS, PERSUASION, AND PIAGET: DYADIC INTERACTION BETWEEN CONSERVERS AND NONCONSERVEF

Scott A. Miller and Celia A. Brownell

University of Michigan

Two theoretical issues underlie the study to be reported here. The first concerns the certainty with which children experience Piagetian concepts. Piaget (e.g., 1971) has argued that concepts such as conservation, once fully understood, are experienced as logically necessary truths. Evidence in support of this proposition has been difficult to obtain. Conservers are not notably resistant to the extinction of their beliefs (Miller, 1971), nor do they express much surprise when conservation is apparently violated (Miller, 1973). By neither measure, in fact, do conservers appear any more certain about conservation than nonconservers do about nonconservation. Yet both Piaget's theory and common sense suggest that the former belief should be held with more certainty than the latter.

There are, it is true, methodological limitations in the kinds of research just considered. Most of the studies have focused on conservation of weight, making conclusions about conservation in general uncertain. And both the extinction and the surprise paradigms have challenged the child's belief with disconfirming evidence from an adult authority figure. The social pressures in such settings may well have obscured any feelings of certainty that the child still possessed. The present study attempts to overcome these limitations.

The second issue to be examined is the role of peer interaction in cognitive development. Attempts to explain the child's progression through Piagetian stages have typically emphasized either adult teaching or the child's interaction with the physical world. Training studies, in particular, have been limited almost exclusively to situations in which the child interacts with an adult experimenter who presents certain selected physical materials. The possibility that peers may play an important role in cognitive change has been largely ignored. This neglect has occurred despite the fact that Piaget's early writings suggest a central role for peer interaction. Specifically, Piaget (1932) argued that the conflicts which arise in interchanges between peers are an important source of decentering and hence of cognitive change.

The procedure for examining both of these issues is to pair children with opposing solutions to a problem and require them to discuss the problem and arrive at a common solution. The problems of greatest interest are two Piagetian tasks: conservation of length and conservation of weight. Certain control problems are also included; these are an attempt to assure that any differences between conservers and nonconservers are specific to conservation and not a reflection of general differences in social influence. Such a procedure can yield two kinds of evidence relevant to the issues of peer interaction and cognitive certainty. One source of evidence is the interplay of arguments and counter-arguments as each child attempts to convince the other of his solution. And the second, of course, is the solution eventually reached.

Two studies by Silverman and associates (Silverman & Geiringer, 1973; Silverman & Stone, 1972) are the closest previous analogues to the current experiment. In both, conservers and nonconservers were paired and required to discuss their answers to conservation problems, and in both the conserver won the argument significantly more often than the nonconserver. These studies provide some beginning evidence, then, that beliefs in conservation are in fact held with more certainty than beliefs in nonconservation. Since neither study included any control tasks, however, it is not clear whether the outcome is specific to the conservation problem or a reflection of the general dominance of conservers. Also, neither report provides much information about the interaction between the children prior to solution. Without such information, it is impossible to obtain a full answer to either of the questions identified above: how certain are children about their beliefs in conservation or nonconservation, and how do they go about attempting to convince each other when they find that their beliefs are in conflict. The present report attempts to provide a fuller picture of the children's discussions prior to agreement.

## Method

### Subjects

The final sample consisted of 100 second graders (58 boys and 42 girls) from two predominantly middle-class schools in Ann Arbor, Michigan. These children were selected from an initial sample of 223 on the basis of their performance on the conservation pretests. During the second (interaction) session, some children were tested only on length, some only on weight, and some on both concepts. Table 1 indicates the number of children in each of the various conservation

Insert Table 1 about here

categories, as well as their mean ages and distribution by sex. The final sample included six black children.

### Procedure

The testing was divided into two sessions. Two Piagetian concepts were assessed in the first session: conservation of length and conservation of weight. The stimuli for the length trials were colored sticks 20.5 cm. in length. Length trials began with two sticks aligned horizontally to show their equal lengths. On the first trial the top stick was moved forward about 5 cm.; on the second trial the bottom stick was made into a zigzag. The conservation question was "Are the two sticks still the same length, or is one longer than the other?"

followed by "Why is that?" On the second trial the child was also asked whether someone walking along the two sticks would walk the same or different distances.

The stimuli for the weight trials were clay balls. A balance scale was used to indicate the initial equality of the two balls. On the first trial one ball was made into a sausage; on the second trial one ball was broken into six smaller balls. The conservation question was "Do the red and blue (for example) still weigh the same, or does one weigh more than the other?" followed by "Why is that?"

The length and weight trials were balanced for order across subjects. The first session concluded with the two questions that were to be used as control items during the later interaction session: "What is the most dangerous animal in the world?" and "What is the very best TV show?"

On all of the questions in the first session, the child gave his answer orally and then wrote it on a piece of paper with his name on it. This paper was used in the second session to remind the child of his answers.

Children were paired for the second session on the basis of their pretest performance. The pairs always included one conserver and one nonconserver. A child was considered a conserver for a given concept if he answer both questions for that concept correctly and also provided logical explanations for his answers. He was considered a nonconserver if he answered both questions incorrectly. Any other pattern was regarded as transitional. Whenever possible, children were paired on both concepts; if necessary, however, they were paired on just length or just weight. The pairs were formed randomly from the available conservers and nonconservers, subject to three constraints: children were paired only if they differed on at least one of the control questions; members of a pair were always from the same classroom; members of a pair were always of the same sex. The last constraint derived from pilot test data which suggested that productive interaction was much likelier for within-sex than between-sex pairs.

It was not possible to make the length of time between sessions the same for all children. The modal interval (for 37 of 100 children) was two days; the range was one to eight days.

The second session began with the experimenter explaining that she was going to ask some of the same questions that she had asked before, but that this time she would ask both children together. She told them that she would check their answers from the previous time; if the answers were different, then she would ask them to discuss the question and try to agree on the same answer. The general lead-in stressed several points: that the children would have to give reasons for their answers; that the important thing was to work together to arrive at the best answer; and that it was all right for a child to change his mind, if he really believed that the other child's answer was best.

The question about "most dangerous animal" was always administered first, followed by "best TV show," followed by the conservation problem or problems. In the case of conservation, only the first of the two pretest trials was used, the staggered sticks problem for length and the sausage problem for weight. The order of the length and weight tasks was balanced for subjects receiving both.

On each interaction trial, the experimenter posed the question to be discussed, stated the children's answers from the first session, and reiterated the instructions about discussing the question to arrive at a common solution. The children were always allowed at least 10 seconds to begin talking before the experimenter first intervened. For the most part, both the first intervention and later interventions were couched in general terms (e.g., "Remember that you have to give each other reasons."); occasionally, however, a specific child was prompted. Interventions were used both to elicit conversation when the children were not talking and to redirect conversation when it wandered from the topic. Conversation continued until the children had clearly agreed on one answer, or until the experimenter decided that they were hopelessly deadlocked.

At the conclusion of the dyadic session, the child who had changed his answer on conservation stayed behind for an individual posttest (the choice of which child stayed was made to appear random through use of a "guess the number closest to mine" game). The posttest was a repetition of both pretest trials for the conservation or conservations on which the child had given in. The entire second session, including the individual posttest, was tape-recorded.

Scoring

Two judges independently rated the adequacy of the explanations that accompanied conservation judgments on both the pretest and the posttest. Explanations of the following types were considered adequate: Reversibility, Compensation, Addition/Subtraction, Previous Equality, Irrelevancy of Transformation, and (for weight only) Same Amount of Clay. The percentage of agreement with respect to adequacy of explanation was 96% for pretest explanations and 95% for posttest explanations.

The categories that were used in scoring the discussions of conservation tasks are shown in Table 2, along with the percentages of agreement obtained by

Insert Table 2 about here

the two judges who independently scored the tapes. In cases of disagreement, the judges listened to the tape together to arrive at a common judgment.

## Results

Pretest

As noted, subjects were considered as conservers for a particular concept if they answered both questions correctly and provided logical explanations for their answers, as nonconservers if they answered both questions incorrectly, and as transitional if they showed any other pattern. The pretest for conservation of length yielded 35% conservers, 39% nonconservers, and 26% transitional; the figures for weight were 46% conservers, 27% nonconservers, and 26% transitional.

A sign test revealed that conservation of weight was significantly easier than conservation of length ($Z = 4.12$, $p < .001$; here and throughout, all $p$ values are based on two-tailed tests). On neither task was there a significant sex difference.

Interaction

The control problems (the questions about most dangerous animal and best TV show) yielded 90 usable trials across the 50 pairs. Conservers won the argument on 41 of these trials, nonconservers on 38, and there were 11 stalemates. There was no evidence, therefore, that conservers and nonconservers differed in relative social influence.

The picture on the conservation trials was quite different. On conservation of length, conservers won out 27 times, nonconservers 3 times, and there were 3 stalemates ($Z = 4.20$, $p < .001$ by the normal approximation to the binomial). On conservation of weight, conservers won 25 times, nonconservers 5 times, and there were 6 stalemates ($Z = 3.47$, $p < .001$). The superiority of conservers appeared somewhat more marked for male pairs than for female pairs. Male conservers prevailed on 34 of 36 trials on which there was eventual agreement; for females the figure was 18 of 24.

As indicated in Table 1, it was possible to form only one pair in which each child served as the conserver for one concept and the nonconserver for the other. The results from this pair fit the overall pattern: The conserver prevailed in each case.

Table 3 presents the analysis of the interactions. Results for males and

Insert Table 3 about here

females have been combined, since in general the patterns for the two sexes were quite similar. The data are presented in two ways, conserver vs. nonconserver and winner vs. loser. These comparisons are, of course, overlapping, given the high proportion of trials on which the conservers were the winners. They are not identical, however, since there were eight trials on which nonconservers won and nine trials which ended in stalemates.

As Table 3 indicates, significant differences between conservers and nonconservers emerged on several measures. (Unless otherwise noted, all comparisons are based on Fisher's Exact Test.) On the weight task, conservers were more likely than nonconservers to assert their answer at least once ($p <.02$); a similar comparison on the length trials approached significance ($p < .10$). This finding reflects the fact that on 17 of the 68 trials (5 on length, 12 on weight) the nonconserver gave in without even stating his original answer. Similarly, on the length problems conservers were more likely than nonconservers to offer at least one explanation in support of their answer ($p < .01$); the difference on the weight trials did not reach significance. On length, in fact, there was no trial on which the conserver did not both assert and explain his answer.

The remaining differences between conservers and nonconservers reached significance only on the length trials. Conservers were more likely than nonconservers to produce a Counter to the other child's explanation ($p < .01$). Conservers were also more likely to move or suggest moving the stimuli ($p < .02$). The fact that the latter difference did not appear on the weight trials may reflect a difference in the meaning of the "moves stimuli" response on the two tasks. Instances of this category on the length trials seemed to consist mainly of demonstrations of an answer (e.g., moving the stick back to show reversibility), whereas occurrences on the weight problems were often simply requests for a solution (e.g., "Could we put them on the scale and see?").

A comparison of winners vs. losers reveals significant differences in all of the above-mentioned cases in which conservers and nonconservers differed (all $p$s $< .05$ by Fisher's Exact Test), and in several additional cases as well. All of the additional differences appeared on the weight trials. On these trials, the child who eventually won the argument was significantly more likely than the other child to utter the first task-relevant statement ($Z = 2.83$, $p < .01$ by the normal approximation to the binomial) as well as the first explanation in support of his answer ($p = .01$, binomial test). The eventual winner on weight was also more likely to offer an explanation for his answer ($p < .01$), as well as to attempt a Counter of the other child's explanation ($p < .05$). These latter differences parallel similar differences on the length trials.

Part of the information provided by an analysis of the interactions is descriptive rather than comparative in nature. The degree of discussion generated by the conservation problems can best be described as moderate. This conclusion is suggested not only by the proportions reported in Table 3 but by certain other results as well. For example, the average number of times a subject asserted his answer was 7.1 on the length trials and 4.7 on the weight trials. The average number of explanations offered was 4.0 for length and 2.3 for weight. The average time per trial was 178 seconds (median = 114 seconds) for length and 131 seconds (median = 47 seconds) for weight. It should be noted, however, that the distribution of times was decidedly bimodal. Thus, while 31 of the 68 trials were resolved in less than 50 seconds, 28 of the remaining trials lasted for 3 minutes or more. There seemed, then, to be two sorts of pairs: those in which one child (usually the nonconserver) gave in quickly, and those which engaged in a fairly protracted discussion.

A final analysis concerns the variety of explanations offered. The great majority of the nonconservers' explanations were simple variants of a perceptual theme (e.g., "It's skinnier now.") The great majority of the conservers' explanations were logically adequate justifications. Of the five major types of explanation (Reversibility, Compensation, Addition/Subtraction, Previous Equality, and Irrelevancy of Transformation), the most common was the Irrelevancy argument, which was used on 62% of the trials (an example of such an argument would be "You just pushed it up."). All of the arguments appeared with some frequency, however, and it was quite common for a conserver to resort to several distinct explanations when faced with a recalcitrant nonconserver. Thus, on 20 of the 68 trials the conserver produced three or more distinct explanations; on 10 trials he produced four or more different explanations. And, of course, the appearance of multiple explanations would have been greater had the nonconservers offered more resistance. Of the 28 trials which lasted for more than 3 minutes, 17 contained at least three distinct explanations by the conservers.

Posttest

The proportion of conservation judgments by nonconservers on the posttest was 50% for length and 54% for weight. In both cases, 93% of the judgments were accompanied by logically adequate explanations. And in both cases, performance was better on the first trial (the problem which had been discussed during the interaction) than on the second. With both concepts combined, there were 73% conservation judgments on trial 1 and 31% on trial 2.

Since the nonconserver prevailed on only eight trials during the interaction, data concerning the posttest performance of conservers are limited. What data there are, however, seem similar to those for nonconservers. Conservers gave 44% nonconservation answers on the posttest--75% on trial 1 and 13% on trial 2. All of the nonconservation judgments were accompanied by perceptual explanations.

## Discussion

The results from the analysis of yielding confirm and extend those of Silverman and Stone (1972) and Silverman and Geiringer (1973). As in their studies, the conserver's answer prevailed on the great majority of conservation trials. The inclusion of control tasks permits an important clarification, however: The superiority of conservers is specific to conservation, and not a reflection of general social dominance. In contrast to data from extinction and surprise studies (e.g., Hall & Simpson, 1968; Miller, 1973), the interaction paradigm indicates that a belief in conservation is in fact more firmly held than a belief in nonconservation.

It should be noted that the certainty that can be identified in such a paradigm is largely a relative certainty. The fact that conservers are more certain than nonconservers does not indicate the absolute level of the conservers' confidence; in particular, it does not indicate that conservers experience conservation as a logically necessary truth. Statements that might have reflected feelings of necessity were rare. The initial scoring system included two categories intended to encompass such feelings: a measure of explicit assertions of certainty in one's own answer (e.g., "I know I'm right."), and an index of statements from which necessity might be inferred (e.g., "They have to weigh the same."). Occurrences of such responses were so infrequent, however, that both categories had to be abandoned. This finding is similar to the results of extinction research, in which explicit statements of necessity are also rare. If conservers do experience conservation as logically necessary, they seldom put their experience clearly into words.

The measurement of certainty through peer persuasion is relative in a second sense as well. The extent to which conservers or nonconservers win the argument must surely depend on the developmental level of the sample. Specifically, the more advanced the sample, the greater should be the dominance of conservers: Not only should the conservers' concepts become more solid with increasing age, but the nonconservers should become more willing to abandon their belief in nonconservation. Conversely, a very young sample might show a more substantial proportion of nonconservation solutions than that obtained here. The attempt in the present study was to draw subjects from an initial pool in which conservation and nonconservation were about equally likely. The fact that the sample for weight deviated from this 50% point may account for the relatively large number of weight trials on which the nonconserver offered no resistance. Similarly, Silverman and Geiringer's focus on first graders may explain why the superiority of conservers on length problems was somewhat less marked in their study than here.

The analysis of the interactions suggests two general conclusions about processes of peer persuasion in the context of conservation problems. First, many children (mostly nonconservers) were apparently so uncertain of their original answer that mere exposure to an opposing answer was sufficient to produce giving in. Thus, on 25 trials the loser never offered an explanation, and on 20 of these trials he never even asserted his original answer. Silverman also found (personal communication) that the mere presentation of a contradiction seemed to be a major element in the efficacy of peer interaction. Presumably, effective contradictions would not have to be social in origin; a number of studies (e.g., Brainerd & Allen, 1971; Miller, 1973) have reported positive training effects from the presentation of disconfirming physical feedback. It may be, however, that contradictions of a social nature are especially likely to occur in the environment of a young child.

The second conclusion concerns the children who engaged in a more prolonged discussion. In such pairs, the qualities that seemed to distinguish the conservers were the variety and adaptability of their approach. Conservers and nonconservers did not differ significantly in tendency to initiate the discussion, nor in the total number of times that they asserted their answers, nor in the total number of times that they offered explanations. The conservers, however, were more likely to attempt to rebut the other child's explanation, more likely (on the length trials) to manipulate the stimuli, and more likely to generate a variety of different explanations in support of their answer. The nonconservers, in contrast, seemed to be limited largely to restatements of their original perceptual response, with little ability to supplement their reasoning or to counter the other child's reasons.

Performance on the posttest suggests that the degree of genuine training or extinction was modest at best. Similar studies which have included more interaction trials (Murray, 1972; Silverman & Geiringer, 1973; Silverman & Stone, 1972) have produced more impressive training effects. As was noted earlier, however, the interest in this study was not in posttest performance per se. Any review of conservation training studies (e.g., Beilin, 1971) suggests two conclusions: a great variety of training procedures can induce significant gains in conservation, and none of these procedures (including peer interaction) has much direct resemblance to the way in which children acquire conservation outside the laboratory. The obvious implication is that research should focus less on posttest gain and more on identifying the potentially generalizable aspects of the processes by which change comes about.

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Footnotes

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2. Requests for reprints should be sent to Scott A. Miller, Department of Psychology, University of Michigan, Ann Arbor, Michigan 48104.

Table 1

Number, Mean Age, and Sex of Subjects Tested in the Dyadic Interaction Session

| | Tested on Length Only | | | | Tested on Weight Only | | | | Tested on Both Length and Weight | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Conservers | | Nonconservers | | Conservers | | Nonconservers | | Conservers on Both | | Nonconservers on Both | | Conserver on One, Nonconserver on the Other | |
| | N | Mean Age | N | Mean Age | N | Mean Age | N | Mean Age | N | Mean Age | N | Mean Age | N | Mean Age |
| Boys | 9 | 7-6 | 9 | 7-5 | 8 | 7-5 | 8 | 7-6 | 11 | 7-8 | 11 | 7-7 | 2 | 7-3 |
| Girls | 5 | 7-6 | 5 | 7-5 | 9 | 7-8 | 9 | 7-4 | 7 | 7-5 | 7 | 7-6 | 0 | |
| Combined | 14 | 7-6 | 14 | 7-5 | 17 | 7-6 | 17 | 7-5 | 18 | 7-7 | 18 | 7-6 | 2 | 7-3 |

| | Total Tested on Length | | | | Total Tested on Weight | | | |
|---|---|---|---|---|---|---|---|---|
| | Conservers | | Nonconservers | | Conservers | | Nonconservers | |
| | N | Mean Age | N | Mean Age | N | Mean Age | N | Mean Age |
| Boys | 21 | 7-7 | 21 | 7-6 | 20 | 7-6 | 20 | 7-6 |
| Girls | 12 | 7-6 | 12 | 7-5 | 16 | 7-7 | 16 | 7-5 |
| Combined | 33 | 7-6 | 33 | 7-6 | 36 | 7-7 | 36 | 7-6 |

Table 2

Categories Used to Score the Discussions of Conservation Problems

| Category | Description | Percentage of Inter-rater Agreement |
|---|---|---|
| First Relevant Statement | Utters the first statement relevant to the problem | 94% |
| First Explanation | Utters the first explanation in support of an answer | 91% |
| Asserts Answer | States own answer from the pretest | 96% |
| Total Number of Assertions | Number of distinct statements of own answer | 88% |
| Explains Answer | Offers an explanation in support of own answer | 99% |
| Total Number of Explanations | Number of distinct occurrences of explanations in support of answer | 88% |
| Type of Explanation (Conservers only) | Assignment of explanations to the various logical types (e.g., Reversibility, Compensation) | 77% |
| Number of Distinct Explanations (Conservers only) | Number of different types of explanation offered | 86% |
| Counters Other | Provides an argument against an explanation just advanced by the other child (must be in response to the other child's statement) | 86%<br>86% |
| Questions Other | Asks a task-relevant question of the other child | 97%[a] |
| Moves or Suggests Moving Stimuli | Moves or suggests moving the sticks or clay balls | 96%[a] |
| Time | Total time for trial | 87%[b] |

[a] Since neither of these categories was scored with much frequency, a percentage of agreement based on the total number of trials is somewhat inflated. If the agreement is calculated on the basis of the number of trials on which at least one rater scored the response, the percentages are 90% for Questions Other and 88% for Moves Stimuli.

[b] Agreement was credited if the two raters' times were within 5 seconds of each other.

Table 3

Proportion of Subjects Giving at Least One Instance of the Different Categories of Response[a]

| | Length | | | | Weight | | | |
|---|---|---|---|---|---|---|---|---|
| | C | NC | Winners | Losers | C | NC | Winners | Losers |
| First Relevant Statement | .45 | .55 | .50 | .50 | .56 | .44 | .79** | .21 |
| First Explanation | .64 | .36 | .67 | .33 | .56 | .44 | .78** | .22 |
| Asserts Answer | 1.00 | .85 | 1.00 | .83 | .91 * | .66 | 1.00** | .48 |
| Explains Answer | 1.00** | .73 | 1.00** | .70 | .77 | .63 | .83** | .45 |
| Counters Other[b] | .71** | .30 | .71** | .23 | .36 | .21 | .57** | .16 |
| Questions Other | .33 | .27 | .33 | .23 | .23 | .20 | .24 | .07 |
| Moves or Suggests Moving Stimuli | .48 * | .18 | .47 * | .13 | .29 | .40 | .24 | .34 |

Note.—C=Conservers NC=Nonconservers

[a]One pair tested on weight was omitted from this analysis because the tape recorder failed. This pair is included, however, in the analyses of yielding and of posttest performance.

[b]Percentages for this category are based on the number of trials on which the other child offered an explanation.

*$p$ of the difference between groups $<.05$.

**$p$ of the difference between groups $<.01$.