When collaboration leads to regression: Some consequences of socio-cognitive conflict

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Abstract:

Piagetian scholars have argued that cognitive development is fostered by peer social interaction, brought about by 'socio-cognitive conflict' between conserver-non-conserver pairs. The nonconservers often attain conservation after having discussed their different opinions with conserving peers, whereas the conservers do not regress to non conservation. These results are generally taken to indicate the beneficial impact of such peer interaction.

In this research, carried out with one sample in the United States and one in the Soviet Union, socio-cognitive conflict was engendered between pairs of 5–7 year-olds who were differentiated by their level of thinking about a mathematical balance beam. Contrary to the results reported by the Piagetians, regression was found to be at least as likely as development. The results are discussed in terms of differences between research in the domain of conservation and research in a related domain in which children's levels of thinking and degree of confidence are not confounded.

Keywords: collaboration | Piaget | United States | Soviet Union | child development

Article:

Researchers working in the Piagetian tradition have, over the course of the last fifteen years, examined the effects of peer social interaction on the cognitive development of the participants. They have argued that this type of interaction has beneficial consequences for the less advanced children and does not adversely effect those who are more advanced (for example, Ames & Murray, 1982; Bearison, Magzamen, & Filardo, 1986; Damon, 1984; Doise & Mugny, 1984; Murray, 1982; Perret-Clermont, 1980).

To what extent are those uniformly beneficial findings a result of the type of task most often used by these researchers? Because their theoretical perspective is derived from Piaget, the most commonly used task is from the domain of conservation; conservation of number, or liquid, or spatial perspective-taking. The basic form that the research has taken is as follows. Children (generally between the ages of five and seven) are pretested, individually, to determine whether they have yet attained conservation. In the experimental phase, pairs of children work at the same task. For example, a child who does not have conservation of liquid is paired with one who does. The children agree that two beakers hold identical amounts of liquid, and then see liquid from one beaker poured into another of different dimension. The children are then asked to decide, jointly, whether the liquid in the third beaker holds the same amount. Argument between the conserver (who holds that the amounts are the same) and the nonconserver (who does not) generally results in the nonconserver attaining conservation (Murray, 1982). The effects are not temporary, moreover; researchers who have included a second posttest have reported that the former nonconservers continue to provide conservation responses up to a month later (Ames & Murray, 1982; Robert & Charbonneau, 1977, 1978; Silverman & Geiringer, 1973; Silverman & Stone, 1972). Equally importantly, the initially conserving partners do not regress.

The mechanism driving cognitive development is held to be ‘socio-cognitive conflict’ brought about by discussion between peers who bring different perspectives to bear on the task. Piaget (1926, 1928, 1977) held that this type of discussion is one way in which children learn to ‘de-center’; the ability to hold two variables in mind simultaneously is necessary for conservation. (For more discussion in Piaget’s views on the effects of social interaction on development see Tudge and Rogoff, in press.)

Some scholars have argued that the effective mechanism promoting development has nothing to do with cognitive conflict, but relates to imitation of a model who has provided the correct answer (Rosenthal & Zimmerman, 1972, 1978; Zimmerman & Lanaro, 1974). In other words, the crucial factor is not discussion based on a difference of perspectives, as the Piagetians argued, but rather observation and imitation. Unlike the Piagetian theoretical position, which predicts that development is the most likely result of discussion, scholars in the social learning tradition argue that change can occur in any direction, depending upon what is being observed.

To test this hypothesis, Zimmerman and his collegues paired conservers with adults who provided nonconservation responses. If imitation of a model is the crucial factor, they argued, the conservers should regress. This is precisely what happened. However, the children may have accepted the adult’s position primarily because of the social pressure resulting from their unequal power relations. The work of Donaldson (1978), Light (1986; Light & Perret-Clermont, in press) certainly gives credence to the view that adults can detract from a child’s peformance solely by the type of questioning used in the experimental situation. The crucial measure in the case of the conservers who regressed would be an assessment of whether they continued to provide nonconservation responses when the adult was no longer present. Unfortunately, as Zimmerman and his colleagues had not used posttest measures, it was impossible to assess the stability of the regression. By contrast, Robert and Charbonneau (1977, 1978) reported that regression by conservers occurred only in the presence of adult modelers and was a temporary phenomenon; children who regressed reverted to conservation soon after, thus supporting the view that the initial regression was solely a response to social pressure. Research designed explicitly to compare the effectiveness of socio-cognitive conflict and observation of a model has supported the Piagetian position-that socio-cognitive conflict drives development and that regression is at worst a temporary phenomenon (Ames & Murray, 1982; Weinstein & Bearison, 1985).

A second interpretation of the Piagetian results is they do not apply to the effects of peer social interaction *in general* but only to one type of interaction, interaction between an expert and a novice (Tudge, 1985). Conservers are tantamount to experts, in that they can develop no further within that domain of conservation and are highly unlikely to regress in their thinking, given that one mark of conservers (at least for Piagetians) is that they are aware of the ‘logical necessity’ of their views (Murray, 1982, 1987). The available evidence at least suggests that conservers are highly confident of their responses (Miller, 1986; Miller & Brownell, 1975; Miller, Brownell, & Zukier, 1977). Conservers are thus unlikely to be swayed by the arguments of nonconservers and are therefore unlikely to regress. The “regression” reported by Zimmerman and his colleagues (Rosenthal & Zimmerman, 1972, 1978; Zimmerman & Lanaro, 1974) occurred solely in the presence of adults who provided incorrect nonconservation responses, and may have been only a temporary phenomenon.

Tudge (1985) paired 5-year-olds who differed in their levels of thinking on a mathematical balance beam task (Siegler, 1976, 1981), and found that although the less advanced member of a pair in some instances was led to advance, in other pairs the more advanced member of the pair regressed in his or her thinking. Unlike the results reported by Zimmerman and his colleagues, both development and regression were stable phenomena, persisting over the course of 2 subsequent individual posttests, approximately one week and five weeks after the pairing.

Because children generally do not attain conservation until around the age of six or seven, the Piagetian research has been primarily conducted with children somewhat older than those who participated in Tudge’s (1985) research. It is thus possible that these results, which run counter to those reported by the Piagetians, can be explained by the relative youth of the sample; namely that the children’s thinking at this age is more susceptible to regression than at a later age. The study presented here is an extension of the 1985 research, using children aged between five and seven in the United States and the Soviet Union.

METHODS

Subjects

Of the 84 five- to seven-year-olds who participated in this study, 42 (17 girls and 25 boys, mean age 6 years 3 months, *SD* 7.7 months) were from a public elementary school in Ithaca, New York, and 42 (17 girls and 25 boys, mean age 6 years 4 months, *SD* 9.2 months) were from a state-run kindergarten in Moscow, USSR. Three children in Moscow left school before the posttest was administered. The Ithaca subjects were part of a larger sample and were chosen from that group so as to match the characteristics of the Moscow sample in terms of the children’s initial stage of reasoning about the experimental task, their ages, and (where possible) their gender.

Materials

A mathematical balance beam was used (see Figure I), similar to that employed by Siegler in his extensive research on the development of rule-based thinking in children (Siegler, 1976,1978,1981; Siegler & Klahr, 1982). This task was used because is allows for greater differentiation of cognitive level than is the case with conservation, because each level requires thinking that deals with the relevant variables in a more sophisticated way than previous levels, and because no children of the age of interest were likely to be 'experts'. Moreover, the more sophisticated levels require that children take two variables into account simultaneously, as is the case with conservation.

The beam had eight removable sticks placed at equal distances from the central fulcrum, and was held stable by wooden blocks supporting it at both ends. The blocks were removable to allow the children to observe free movement of the beam at the start of the experiment, but thereafter remained in place. Metal nuts which fitted over the sticks were used as the weights in the pretest and two posttests. In the treatment, when the children were paired, the content of the task was similar but the form was different; the sticks were replaced by clear plastic beakers and the weights were replaced by identical plastic figures which were placed into the beakers. This was done so that the participants would be less tempted to 'remember' configurations they had seen in the previous session (in fact configurations were not repeated), as well as to discover whether solutions to the problems generated in response to one type of visual array would generalize to a different type of array. The actual configurations were taken, with minor variations, from those used in Siegler's (1981) research. In each session there were 14 different configurations, varying by number of weights and distance from the fulcrum. In each case, the weights were placed on only one stick on each side of the fulcrum, with a maximum of six weights on any one side and a maximum of ten on both sticks.

Assignment to rule

Siegler (1981) identified four basic 'rules' (and one variant) which children used to predict the movement of a balance beam when different numbers of weights are placed at varying distances from the fulcrum. During pilot testing, however, it became obvious that finer degrees of differentiation were possible. Seven rules can be identified, ranging from a reliance totally on guesswork (no identifiable rule is used at all) to the ability to predict precisely what will happen when any configuration of weights is placed on the beam.

1. **Rule 0.** No understanding either of the idea of balance or of what will happen when one side of the beam has more weights. Children using this rule did not participate further.
2. **Rule 1.** No understanding of the idea of simple balance, but a belief that the beam will tip to the side with the greater number of weights. Children using this rule only attend to the dimension of weight, and can therefore predict with confidence all configurations in which one side of the beam had more weights. However they are uncertain when the number of weights is identical.
3. **Rule 2.** A belief that the beam will tip to the side with the greater number of weights, and that it will balance when the number of weights are equal. Children using this rule attend only to the dimension of weight, and can predict with confidence all configurations.
4. **Rule 3.** A belief that the beam will tip to the side with the greater number of weights. Where the weights are equal some attention is paid to distance from the fulcrum, but not in

consistent fashion. For children using this rule confident predictions can be made when one side of the beam has a greater number of weights; when the number is identical and the distance from the fulcrum is different there is uncertainty.

5. **Rule 4.** The variables of distance and weight can be considered simultaneously. Distance is consistently treated as an important variable, but only when the number of weights are equal. In other cases, there is a belief that the beam will tip to the side with the greater number of weights. For children using this rule all configurations can be predicted with confidence.
6. **Rule 5.** Distance is viewed as an important variable even when the number of weights is different. However, there is no means of ascertaining precisely under which conditions greater distance but fewer weights will overrule lesser distance but more weights; confident predictions cannot be made when children are presented with configurations of this type.
7. **Rule 6.** An understanding of what will happen in each configuration is gained by multiplying the number of weights by the distance from the fulcrum. All configurations can be predicted with confidence. No children used this rule.

Each session (the pretest, treatment, and both posttests) was audiotaped, and the experimenter and a second coder determined which rule each child used in that session. This was determined by the pattern of predications for the fourteen configurations. Inter-rater reliability of assignment to rule was never less than 0.92 for the pretest, treatment and posttests. When there were disagreements the protocols were rescored blind by both coders and discussed until disagreements were resolved. The outcome measure of development (improvement or decline) was the difference between the rule used at the time of the pretest and the rule used at the time of the treatment and posttests.

Procedure

Pretest: Having spent several days in each classroom, the experimenter (male, English- and Russian-speaking) explained and demonstrated the working of the apparatus to each child, individually, after which 14 configurations (different numbers of weights at different distances from the fulcrum) were presented. The number of weights and degree of distance varied systematically so as to exemplify each of the six types of configurations used by Siegler (1976, 1981). The child was asked to guess whether the beam would stay balanced or tip one way or the other if the supports were removed (they never were removed), and to justify that prediction.

Treatment: The treatment phase occurred at least two days after pretesting in each class (mean 3.87 days in Ithaca, *SD* 1.37; mean 3.52 days in Moscow, *SD* 1.60). Participants were assigned to one of four treatment conditions:

1. A control group, in which subjects had no partner, and were always tested individually;
2. An ‘equal rule’ group, in which each child was paired with another child who, in the pretest, had used the same rule as themselves;
3. ‘Lower partners’ group, in which each child was paired with another child who, in the pretest, had used a higher rule;
4. ‘Higher partners’ group, in which each child was paired with another child who, in the pretest had used a lower rule. Assignment to treatment condition was random, except that pairs were of the same sex and school class.

Members of pairs took turn to be the first to predict each configuration. When a disagreement occurred about the prediction the children were asked to explain their reasons to one another and reach agreement on one prediction. At this point, the experimenter moved out of obvious earshot, returning when the children had reached agreement.

Posttest: The children were again tested individually, to determine whether or not there had been any change in their rule use two days after the treatment (mean 2.68 days in Ithaca, *SD* 2.22; mean 2.43 days in Moscow, *SD* 0.91). A second posttest was given, to determine the stability of any changes that might have taken place at least four weeks after the first posttest (mean 32.65 days in Ithaca, *SD* 4.12; mean 29.11 days in Moscow, *SD* 1.36). Stability was assessed from the Ithaca sample because the second posttest could only be administered to nine subjects in Moscow.

RESULTS

The Piagetian model would predict that lower partners and higher partners would both benefit from interaction; neither lower nor higher partners had reached their developmental ceiling, and both had experienced socio-cognitive conflict. Because both lower and higher partners had the opportunity to discuss the different perspectives they brought to the task they should have done better from the interaction than the equal rule partners (who, by virtue of the fact that they used identical rules at the time of the pretest, did not bring different perspectives to bear) and the individual (control group) children, who did not have any opportunity for discussion.

One member of each pair (chosen at random) was included in the analyses, to allow independence of the unit of analysis. Analyses of variance were run, to determine whether the types of pairing made a difference in subsequent individual performance, and whether these effects varied by culture, age, or gender. The dependent variables were the changes from the rule used at the time of the pretest to the rule med at the treatment, first posttest, and second posttest. A change of rule use to the next higher was given a score of 1, a decline of two rules given a score of -2, and so on. The results did not differ by culture or age or any interaction of them with treatment group. For this reason, the data were collapsed across age and culture, and I will focus on the effects of type of pairing and gender.

As can be seen from Table 1, the main effect of treatment condition was significant at the time of the treatment, first posttest, and (Ithaca data only) second posttest. The most striking factor is the amount of regression that occurred. Interaction, far from being uniformly beneficial, was harmful for all children except those who were lower partners. That is, on average, children fared worse from interacting with a partner whose initial level of thinking was lower than their own. The fact that the higher partners declined most, on average, is particularly striking as it runs counter to the Piagetian model of the effects of social interaction on cognitive development. The only children who improved in their thinking were the lower partners, those paired with a child who had used a higher rule at the time of the pretest.

Some of this change from one rule to another may be attributable to regression artifacts-higher partners had, on average, necessarily used a higher rule at the time of the pretest than the lower partners. But it should be noted that higher partners did not exclusively use the highest rules. A rule 2 user, paired with a child who used rule 1, would be a higher partner; a rule 4 user, paired with a child who used rule *5,* would be a lower partner. Lower partners, on average, improved their pretest scores, whereas higher partners, on average, declined, irrespective of how high or low their initial scores were.

Table 1. Mean cognitive change from pretest, by condition (1 member of each pair)

	Mean	*SD*	*N*
Individuals			
treatment	–0.05	.51	20
1st posttest	–0.20	.62	20
2nd posttest	0	.86	9
Equal rule pairs			
treatment	–0.36	.74	14
1st posttest	–0.14	.53	14
2nd posttest	–0.43	.79	7
Lower partners			
treatment	0.90	.57	10
1st posttest	0.80	.92	10
2nd posttest	1.0	.71	5
Higher partners			
treatment	–0.37	1.19	8
1st posttest	–0.62	.92	8
2nd posttest	–0.67	.58	3

The independent main effect of type of pairing in a 4 (condition) X 2 (gender) ANOVA:
Treatment $F_{3,44} = 12.20$, $p < 0 .0001$
1st posttest $F_{3,44} = 8.79$, $p < 0 .0001$
2nd posttest $F_{3,16} = 4.43$, $p < 0.02$ (Ithaca sample only)

There was also a significant interaction of condition by gender at the time of the treatment ($F_{3,36} = 8.42$, $p < 0.001$), first posttest ($F_{3,36} = 4.11$, $p < 0.02$), and (Ithaca data only) second posttest ($F_{3,16} = 3.29$, $p < 0 .05$). This was caused almost exclusively by the very poor performance of three higher partner girls from Ithaca. (I should emphasize that the main effect of treatment group discussed earlier was the effect after the variance attributable to the interaction term was accounted for.)

The stability of changes in rule use

The stability of the effects of being paired with no-one, with a peer who used the same rule, or with a peer who used either a higher or lower rule, can only be examined in the Ithaca sample, which was given a second posttest four weeks after the first. The effects of membership in the different treatments were stable, showing only little evidence of reversion to use of the pretest rule. Over all Ithaca subjects, the Pearson correlation coefficients between first and second posttest were as follows: $r = .94$ (individuals), $r = .92$ (equal rule condition), $r = .79$ (lower partners), and $r = .92$ (higher partners).

THE PROCESSES OF CHANGE

So far, I have concentrated on the results of interaction rather than upon the processes involved. But it is important to understand the reasons for development or regression, and to provide an indication of what actually happened during the collaboration that may be seen as exerting a causal influence. Two factors appear to be of most significance. The first has to do with the amount of confidence each child had in the predictions he or she made. The second has to do with the reasoning each child used to support the predictions.

The influence of confidence

It would be a mistake to believe that all lower partners (children paired with a partner who used a higher rule) improved; some children in this treatment group did not improve. Similarly, being paired with a lower partner or with one who had used the same rule at the time of the pretest did not automatically lead to decline. To understand why this **is** the case, it is necessary to refer to the nature of the rules.

Two rules (rules 2 and 4) can be characterized as allowing certainty of prediction, for they allow a child to apply that rule to all configurations of weights and distances. For example, a rule 2 user (one who believes simply that equal numbers of weights will result in balance, and that when the beam has unequal numbers of weights it will tip to the side with the greatest number) can apply that rule equally to all problems presented. Rules 1, 3, and *5,* however, necessarily incorporate some degree of uncertainty when thinking about certain types of configurations. A rule 5 user, for example, believes that weight *and* distance have to be considered, but has no means to judge what will happen when on one side of the beam fewer weights are placed at a greater distance from the fulcrum. As Siegler (1976, 1981) pointed out, for these types of configurations guessing is the only solution.

As Table 2 shows, approximately twice as many children who had used a 'confident' rule at the time of the pretest continued to use that rule as did those children who had used a rule that incorporated some uncertainty, irrespective of type of pairing. Children whose rule did not encourage confidence of prediction were likely to improve if they were paired with a higher partner whose rule allowed confident predictions, but they were likely to decline if their partner's rule was lower than their own but was one which allowed confidence of prediction.

Table 2. The influence of type of rule used (percentage of children regressing, not moving, or improving)

	Treatment	
	Rules 2 and 4 (n = 32)	**Rules 1, 3, and 5 (n = 20)**
Improve	17.7	35.0
No move	68.7	30.0
Regress	12.5	35.0
Chi square (2) = 7.68, p <0.02		
	1st possttest	
	Rules 2 and 4 (n = 32)	**Rules 1, 3, and 5 (n = 20)**
Improve	9.4	25.0
No move	78.1	45.0
Regress	12.5	25.0
Chi square (2) = 5.98, p = 0.05		

This lack of confident prediction associated with certain of the rules explains why some individuals and some children in the equal rule group declined. Virtually all who did so had used a rule which did not allow confidence about all predictions; they were highly likely to drop to the rule immediately below, in effect trading cognitive sophistication for an increase in certainty.

An example of this process is taken from 2 girls, aged six. Van. had used rule 2 at the time of the pretest, predicting simply according to the number of weights and paying no attention to distance. Kir., on the other hand, was a rule 3 user. When presented with 3 weights on the stick second from the fulcrum and 3 on the fourth stick over she picked the side with the weights furthest from the fulcrum. Furthermore, she justified her prediction by specifying that it was closer to the end. Kir. clearly was not certain of the rule played by distance, however, for on three other problems of a similar nature she predicted 'balance' on the grounds that there was the same number on either side. When paired, 5 days later, Van. was chosen, at random, to predict the first configuration. 4 weights were in the 3rd beaker (clear plastic beakers replaced the sticks and identical figures acted as the 'weights' during the paired sessions) on the 'green' side while on the 'red' side 2 weights were placed in the 3rd beaker. Van. unhesitatingly picked the green side, as did Kir. For the second problem Kir. went first. 2 weights were in the 2nd beaker on the green side, 4 were in the 1st beaker on the red side. Kir. predicted that the red side would tip, and Van. agreed. Both children had justified their answers by referring to number of weights, and both predications were those expected of both rule 2 and rule 3 users.

The third problem was the first on which Kir. might have been expected to mention the importance of distance. 3 weights were in the 3rd beaker on the green side and 3 were in the 4th beaker on the red side. However, Van. went first and predicted 'balance,' and Kir. followed her lead. Neither her tone nor her words were particularly confident, however: 'I think it will stay balanced, kind of.' Kir. also followed Van's lead in her subsequent justification: 'Because there's 3 on both sides.' The next 2 problems were those on which agreement was expected; it was duly forthcoming. The 6th problem was, in retrospect, crucial. On the green side 1 weight was in the 1st beaker, while on the red side 1 weight was in the 4th beaker. Kir. made the first prediction:

> Kir.: Hmmmm . . . let's see . . . *maybe* it would balance, I'm not sure. Maybe.
> Exp.: Why aren't you sure?
> Kir.: Because . . . this is way up here and that's way up there. I mean it's way down there and that's all the way up here.
> (Van. laughs at this point.)
> Kir.: *So* it would . . . I don't know what side it would tip over on.
> Exp.: You're not sure? OK
> Van.: I think it would stay . . .
> Exp.: Which side would you, if you Just had to make one guess, if I pulled the blocks away now, what side would you guess it would, or what would you guess would happen?
> Kir.: Uh, I think it would balance.
> Exp.: What do you think?
> Van.: I think it would stay balanced.
> Exp.: OK, why do you think it would stay balanced, Kir.?
> Kir.: Because there's one on that side and one on this side.
> Exp.: OK, why do you think it would stay balanced, Van.?
> Van.: One on that side and one on that side.

What the transcripts cannot adequately indicate is the hesitation in Kir.'s voice, and Van.'s fast, confident answers. Faced with her own lack of certainty, and her partner's clear confidence that only number of weights was important, Kir. adopted that view, and for the remaining configurations simply mentioned number of weights.

It is quite possible, of course, that in the social situation in which her partner is making a different prediction to the one Kir. was tempted to make she just went along with Van., perhaps not wanting to argue. When conservers are led to agree with adults who provide nonconservation answers, there is some justification for believing that the children are simply acceding to the adult, for when retested later (individually) they simply revert to conservation responses (Robert & Charbonneau, 1977, 1978). In the present instance, however, the regression was not temporary. When tested individually 2 days following the paired session, Kir. made her predictions solely on the basis of number of weights. And one month later, at the time of the second individual posttest, she continued to refer only to the number of weights in making her predictions.

The influence of the quality of reasoning

The second important factor relating to the *process* of reasoning is the type of reasoning the partners used. In the course of the interactions, whenever the partners disagree in their predications discussion (or socio-cognitive conflict) ensued. In the course of this discussion, each partner used arguments to justify his or her prediction about the movement of the beam. The type of reasoning to which each partner was exposed could be below his or her initial level of thinking (as reflected in the pretest rule used), at the same level, or above.

Table 3. Mean change from pretest, by quality of reasoning

	Mean	***SD***	***N***
Lower reasoning			
treatment	–0.83	.98	6
1st posttest	–0.33	1.03	6
2nd posttest	–0.67	.58	3
Same level reasoning			
treatment	–0.07	.80	15
1st posttest	–0.20	.68	15
2nd posttest	–0.25	.50	4
Higher reasoning			
treatment	1.00	.50	9
1st posttest	0.78	.97	9
2nd posttest	0.83	.75	6

The independent main effect of type *of* pairing in a 4 (condition) X 2 (gender) ANOVA:
Treatment $F_{2,27} = 11.07$, $p < 0.001$
1st posttest $F_{2,27} = 4.60$, $p < 0 .05$
2nd posttest $F_{2,10} = 6.40$, $p < 0.05$ (Ithaca sample only)

The effect of the quality of reasoning was striking. When this factor was added to the model, the main effects of condition, culture, and gender were not significant; neither were the interaction terms. The data were therefore collapsed across treatment group, culture, and gender. This revealed that the influence of reasoning at the time of the interaction itself had a powerful effect upon the partner's thinking and any change induced at that time was very likely to remain in effect during the individual posttests. As Table 3 shows, children who were exposed to reasoning at a higher level were overwhelmingly likely to begin to use a higher rule. Children who heard reasoning at the same level as their own pretest rule were likely to continue to use that same rule. Children who heard reasoning at a lower level either continued to use the same rule or regressed to a lower rule.

As might be expected, the children were most likely to hear reasoning at a higher level if they were paired with a child who had used a higher rule at the time of the pretest, although there was no one-to-one correspondence. Of the 9 children who heard reasoning at a higher level during the course of the interaction, 7 were paired with a child who had used a higher rule. Similarly, 9 of 15 children hearing reasoning at the same level had been paired with a partner who had used the same rule, while 4 of 6 children hearing reasoning at a lower level had been paired with a partner who had used a lower rule.

By 'hearing reasoning at a higher level' I mean the child's partner presenting arguments in the course of the discussion which were more cognitively sophisticated than those of the child under consideration. For example, in the session described above, Kir. indicated in one of her responses that distance might be an important factor: 'It's [the one weight on the green side] way down there and that's [the single weight on the red side] all the way up here.' In that instance, she was not convinced that distance has a bearing on the problem, and quickly shifted to a consideration solely of number of weights. In other cases, however, a rule 4 user, paired with a rule 2 user, would make a strong case for the effects of distance. Two kindergartners, Jes. (who used rule 4) and All. (a rule 2 user) disagreed on a problem in which 3 weights were on the 3rd beaker on the green side and 3 were on the 4th beaker on the red side. Jes., who went first, predicted that the red side would tip. Al. justified her answer by saying: 'I think it would stay balanced because there's 3 in each cup.' Jes. responded: 'I think it would tip to the red side because this one is farther over . . . than that one,' whereupon Al. quickly accepted that view: 'I think so.'

It must be pointed out that being presented with arguments embodying a more sophisticated cognitive rule did not *necessarily* lead to an understanding of that rule, even if the partner's view was accepted at the time of the pairing. In the case of Jes. and All., for example, despite the fact that All. accepted her partner's point of view she did not use the higher form of reasoning during subsequent posttests. Nevertheless, as is clear from Table 3, by and large children who were exposed to more cognitively sophisticated reasoning at the time of pairing were by far the most likely to use that higher level of thinking during the posttests.

DISCUSSION AND CONCLUSION

Piagetians who have examined the effects of social interaction on cognitive development have argued that socio-cognitive conflict in the course of discussion between peers leads to development. The data they present are persuasive, for in many studies nonconservers are led to attain conservation in the course of discussion with conserving peers. The interaction is not only beneficial for the nonconservers; it has no deleterious effects upon their conserving partners. In fact, regression of conservers appear to occur solely in specifiable contexts (when a child is faced with an adult who provides incorrect answers) and even then the regression is short-lived.

However, in research in which a conserver and a nonconserver discuss a conservation task, expertise and interaction are necessarily confounded. One way of teasing apart these confounding variables is to pair a nonconserver with a 'partial conserver'-a child who has progressed further than a nonconserver but has yet to show full appreciation of the logical status of conservation-or two nonconservers who differ in their understanding of the task. The results in these cases have been inconsistent, however; in some cases nonconservers have advanced (Perret-Clermont, 1980; Weinstein & Bearison, 1985), while in othrs they have not (Russell, 1982).

The primary motivation for the research reported here was thus to examine the effectiveness of peer social interaction in a situation other than conservation and in which the more advanced member of a pair was not an expert at the tast to be solved. The balance beam task is similar to tasks used by Piagetians; children using rules 1 and 2 are only able to take one variable into account at once (the number of weights), whereas children using rules 3 to 5 are able to take two variables into account in increasingly sophisticated ways. The parallels with conservation are clear. Moreover, just as in research pairing conservers with noncnservers, in which the children receive no independent confirmation of their opinions, the participants in the balance beam research did not find out whether their predictions were correct. The main differences were crucial; that even the most advanced children were not expert, and they did not (unlike conservers) have any sense that their views were 'logically necessary.'

Under these conditions, the Piagetian model that stresses the benefits of socio-cognitive conflict for later development is not supported. In fact, the reverse is true; children whose thinking was at a more advanced level than their partner actually regressed in their thinking as a result of socio-cognitive conflict. This regression, moreover, was a stable phenomenon; changes in thinking at the time of the interaction between partners were very likely to remain in effect over the course of two individual posttests several days and several weeks after the paired session. Regression also occurred for many of the children paired with a child whose initial level of reasoning was the same. The group of lower partners (children paired with a partner who had used a higher level of thinking at the time of the pretest) was the only group to benefit from interaction; their development was as stable as the regression of the children in the two other groups in which children were paired.

The implication of these findings is that the exclusively beneficial influence of social interaction on cognitive development that has been reported by the Piagetian scholars may not generalize beyond those situations in which the more advanced partner is akin to an expert-both knowledgeable and confident. In other situations, in which the more advanced child still has room for development and in which she does not necessarily feel more confident of her opinions, the question of who is likely to convince whom remains open. Socio-cognitive conflict, in this situation, appears at least as likely to lead to regression as to development.

Virtually identical findings were obtained in the two sub-samples (Moscow and Ithaca) comprising this research. Some differences were noted, however. In Ithaca, boys tended to fare much better (in terms of improvement from pretest and posttests) than girls, who were more likely to regress, whereas in Moscow these gender differences were not found. In both sub-samples the pairs were same-gender pairs, so it was not the case that boys benefitted at the expense of girls. One speculation (Tudge, 1986) is that in the United States boys are socialized to think of themselves as more adept at scientific or mathematical tasks than girls, and that they were therefore more motivated by the task. In the USSR, on the other hand, girls are not brought up to think of themselves as inferior to boys in this sphere. Alternatively, if it is the case that American girls are socialized to be more 'affiliative'(Gilligan, 1982), it is possible that they were more ready to agree with their partners solely to remain friends, even if that meant taking a less sophisticated cognitive position. The number of subjects used in this research is hardly large enough to place much weight on the gender differences found in the two cultures.

Despite the amount of regression that was found in this study, it would be wrong to assume that social interaction among peers in the course of problem-solving necessarily has negative consequences for all children other than those working with a more advanced partner. In order to allow a meaningful comparison with the Piagetian research, feedback to the children could not be provided. In other words, they could not discover whether their predictions were correct. In many problem-solving situation, however, particularly in school, children working on tasks do receive feedback. They find out whether their solutions to problems were correct. In a study in which children worked in pairs on the balance beam but received feedback after each prediction, regression was not found (Tudge, 1987, in press). The effects of feedback were so powerful, in fact, that children without a partner improved as much as those who were able to engage in social interaction. However, ceiling effects may have masked the effectiveness of interaction, a hypothesis that is currently under investigation by the author.

In any event, it seems clear that any model of the relationship between peer collaboration and cognitive development must take into account the *processes* of interaction themselves, in particular the nature of the information being provided (whether at a lower or higher level of thinking), the confidence with which opinions are held, and whether or not the children receive feedback. The simpler Piagetian model, which portrays social interaction as being exclusively beneficial for the children involved, appears insufficient to deal with the complexities of peer collaboration.

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