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The Role of Social Interaction in Children's Problem Solving

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Recently, developmental psychologists have become interested in studying the relation between children's performance on cognitive tasks and the social context in which problem solving occurs (Damon, 1984; Grossen and Perret-Clermont, 1984). Previous work in this area conceptualizes the domains of cognition and social knowledge in one of three ways: first, as basically separate content domains; second, as reciprocal in nature; and third, as mediated, with cognitive structures embedded in the social.

According to the first view, which is not stated as a coherent principle but rather adopted in practice, concept acquisition comprises various formal logical relations, derivable by task analysis of some sort. Knowledge of social topics such as rules of the game or school rules are separate from such content as classification or principles of proportionality. I would argue that the phenomenon of moral development, literature distinct from work on perspective-taking in problem solving, illustrates this traditional categorical division.

In addition to separation on the basis of content, the social and the cognitive domains are separated often on the basis of method: individual performance is measured as cognition while group performance is measured as social outcome. Because there is a lot of evidence to show that people in groups don't do the same things that they do on their own, the two situations are often considered as discontinuous. Although this issue has been recognized for a long time, it is usually social psychologists who have attempted to solve the measurement issues (e.g., Anderson, 1961).

A second way in which social and cognitive topics are juxtaposed is as reciprocal. Piaget is the primary proponent of this viewpoint, claiming that social cooperations and individual operations are characterizable by the same formal properties and develop simultaneously.[1] While Piaget's work examines the emergence of perspective-taking in studies of younger children, studies of older children emphasize the domain of the operations. That is, the nature of the reciprocity of the cognitive and the social in the more fully developed child was not experimentally examined. Although they allow that alternate viewpoints are available through contact with others, "it is meaningless," write Inhelder and Piaget, "to wonder whether it is the cognitive cooperation (or cooperations) which engender the individual operations or the other way around" (1969, p. 118). They are manifestations of the same organizational level from the point of view of the action of the individual child.

Thirdly, there is Vygotsky's claim of mediated individual development: socio-cultural history gives rise to specific material conditions and social relations which in turn shape the development of individual thought. When Soviet researchers find a discontinuity between individual and group performance, they are likely to seek transformative

principles which may connect the two situations by a broader contextual model (see Istomina, 1975; Lomov, 1978). Many of their studies demonstrate the "leading" nature of social situations for the formation of individual concepts. At the same time correspondences similar to Piaget's have been noted, in which individual cognitive development correlates with a type of group interaction (Rubstov, 1981). It is the Soviets who pose the problem of how to track the directionality of concept development (as distinct from the problem of measuring task performance) in group versus individual conditions.

My own work with groups of children doing Piagetian tasks together sought to distinguish between the reciprocal and mediated viewpoints. The problem was difficult because at some very fundamental levels children are equally inept at cooperating and at solving problems. It is not at all clear how one could say there is a "leading" factor one way or the other to test.

In many ways too, the positions taken by Piaget and Vygotsky are similar: they both view the child as constructing knowledge; they both distinguish internal from external psychological functions; both claim generally that the social and cognitive develop together; and both are materialists in the sense that they posit the necessity of accommodatory stuff upon which to act.

A methodological issue involved in distinguishing the positions of the two also concerns the correspondence between what's out there in the world to what gets patterned inside the individual: on the group level, cross-cultural work demonstrates the effects of context on cognitive development; on the individual level, we know that differences in performance are found in supposedly homogeneous groups following the same training procedure. So, because of contextual influences on basic thought structure as well as individual variation within similar contexts, two further problems arise: what to include as evidence or, obversely, what to treat as noise across individual and group problem-solving situations, and, how to represent what is changing during the learning process under consideration.

In order to address these problems, I began with a task which is of interest to contemporary cognitive psychologists: the balance scale (Siegler, 1981; Wilkening & Anderson, 1982). The scale has the further advantage of embodying cultural properties of interest to both Piaget and Vygotsky: its functioning can be described by formal logic and the same formal principles may be accessed through a variety of apparatuses.

I had children solve balance scale problems individually and in groups and measured changes in their understanding of the scale according to a rule system delineated by Siegler. Precedence for this type of pre-/posttest design exists in recent work done by Perret-Clermont and her colleagues and in recent Soviet work. Both these sets of studies had limitations, however, in that they did not compare explanatory models and therefore, only derived measures consistent with one analysis. In the Swiss work, for instance, there is an assumption that the same jars and liquids are always signifying the same task; or, in the earlier work, that the comments of the experimenter are outside the analytic frame. Most seriously, there is an assumption that social situations are ephemeral and that new behavior under group conditions is less authentic than individual acquisitions, which are taken as a measure of internal restructuring. Given this assumption, which amounts to a lack of theory concerning the interactive conditions, one can never test whether individual change among children of different operational levels is maintained by a particular form of social exchange or not; one can only say that following a group experience someone of a particular level changed or not.

In work published in 1981, V. V. Rubtsov of the Soviet Union looked at groups of children organized to solve classification tasks. His analysis showed that children who engaged in different cooperative structures of exchange made differential gains; however, the children's knowledge of classification was not categorized prior to the group situation, so his results could not address the reciprocity issue.

In order to study group effects on individual problem-solving, it was necessary to design a procedure and measures that permitted a test of differences between Piaget's and Vygotsky's models. Because Vygotsky views the components of complex thought to be transmitted and located in relation to each other by the teaching/learning process, specific experiences in time become crucial to analyze when accounting for the development of an individual's thinking. That is, a theory of children's interactions had to be

developed.

So that I could trace the appearance of new understanding in individuals over the course of group sessions and individual sessions, I created a coding system for behaviors according to the various explanatory models I was testing. The coding scheme included variables that were taken to be measures of individual schemata and of behavior that occurred as a function of being among a group of peers. For example, right or wrong answers were regarded as evidence of individual concepts, while the number of times a child got into an argument could only be a function of being in the presence of another child. Behaviors were also classified according to whether they pertained to the balance scale task and according to whether they occurred when the child was with a group or working alone. Data from group conditions and from tests conducted with each child alone yielded forty-one variables, which were hypothesized to cluster according to their inter-individual or intra-individual nature.

The clusters were validated by factor analysis (Martin, 1983). The results of the factor analysis meant that tests using both the variables of interest and the factors could be grouped into models and compared by means of multiple partial correlation procedures. With these procedures, five models predicting pre- to posttest changes in children's individual conceptualizations of the balance scale principles were tested. These ranged from a simple individual "Rule Use" model to a Vygotskian interindividual factor model.

Testing the models, I found that an individual child's initial cognitive level only partially predicts learning. Group level, or the sum of individual cognitive levels of a problem-solving group, adds to the prediction but does not account for all the variation. According to the best fitting model, the most powerful predictors of learning, after previous learning is partialled, are measures of on-task activity occurring because of the presence of others.

The results of the multiple partial correlations allowed me to conclude that a child's tendency to engage in particular kinds of on-task interactions is a good predictor of subsequent gains, beyond initial skill level. They suggest that inter-individual exchange concerning a task may be more important to look at in a group setting than individual cognitive indicators such as correct answers, when assessing children's problem solving. The results of the analyses, however, supported only the idea that individual and group cognitive activity are complementary; they did not clarify the nature of the complementarity.

In addition to being grouped according to group and individual problem-solving settings, I coded separately the variables comprising the categories of the current analysis for the three group problem-solving conditions each child experienced. In order to delineate the functional nature of the variables in each interactive condition, conducted tests for significant changes in frequencies among the seven variables coded by condition. I examined also the polarity of the relation of each variable in each condition to posttest scores. I discuss the results below and at the same time discuss the problem-solving conditions for the balance scale.

By including three problem-solving settings which were designed to elicit varying forms of cooperative interchange among children, a test of the origins of proportionality concepts, in this particular case, was made possible. By having a theory about each situation and by delineating the functional nature of the variables of interest in those situations, a demonstration could be engineered of how different social arrangements result in different interchanges, and, in different learning.

The basic design of the study had involved pretesting second and third graders on a set of balance scale problems and categorizing the performances according to Siegler's method (Siegler, 1980). The children were matched in groups of four such that group members' skill levels were either mixed or homogeneous (all Rule I users, all Rule II users, or half Rule I and half Rule II). There were nine groups altogether. Three sets of balance scale problems to solve were given in the group situation, each followed by an individual posttest; a final posttest was given to each child about one month after the group experiences. Order of condition was not varied; control groups were included to test for order effects but those results are not important for the present discussion. Children's answer patterns on the individual tests were analyzed along with the coded videotaped record of their performance during the group situations.

The variables comprising the categories of the

current analysis were coded separately for the three group problem-solving conditions each child experienced, in addition to being grouped according to group and individual problem solving settings (e.g., correct answers on tests and in group discussion). According to the factor analysis, some variables did not cluster solely on the basis of formal structural similarity but rather showed variability due to task organization differences. This in itself gives some support to the Vygotskian position.

Below, are descriptions of the arrangements of each group condition and of how the behaviors seemed to function in each.

Condition 1: Team Conflict

The design of Condition 1 was patterned on the task arrangement of the individual pretests. I anticipated that by presenting teams of two children with preselected problems to pose to each other, by asking the teams to judge the scale outcome and not to calculate it, and by asking the teams to score each other, that social competitive behavior would be greater relative to on-task behavior. Furthermore, teams should be less likely to exchange information about the scale features in a cooperative manner. In fact, according to the factor analysis in which certain Condition 1 variables clustered, this condition did accentuate individual differences in the tendency to argue and to be "Social." Those measures which, according to post-Piagetian work, should influence the development of individual knowledge, namely, cognitive conflict measures, did not. Children in Condition 1, in total, engaged in significantly more on-task argument than in the other conditions but this related negatively to gain. Apparently, the competitive arrangement of Condition 1 induced counterproductive arguments.

A Number of Arguments Measure did not distinguish remarks directed at a teammate from those directed at the opposing team. A separate category, Cross-Observations, which signified remarks a child made about a problem an opposing team member was working on, measured cross-team interaction. There were fewer Cross-Observations in Condition 1 were associated negatively with gain.

Condition 1 produced more Accurate Predictions on the part of children relative to the second condition, so in one sense, the problems were easier. It also generated a greater proportion of "Social" responses (e.g., "Ha ha, you're wrong") in comparison to "Attention" responses to what happened to the scale (e.g., "Did you see what it did?") for all the groups. Although these patterns did not seem to be related to learning they do reflect the competitive context of Condition 1. Accurate Predictions in Condition 1 were negatively related to gains in posttest scores. In sum, the On-Task group variables in Condition 1 were not beneficial for children's problem-solving, and the tendency to engage in argument was not totally accounted for by cognitive skill level.

Condition 2: Scale Conflict

In Condition 2, the problems given the children demanded that they consider both weight and distance dimensions simultaneously in order to arrive at a solution. Condition 2 procedures, however, focused children's actions on the scale itself by delimiting the place in which they could operate. By having one team place weights on one arm and asking the other team to make the scale balance work on the second arm, the task organization encouraged children to focus on only one arm of the scale. The children were unable to go beyond that which was available in the physical array to integrate weight and distance dimensions on an abstract plane. All groups, some to a greater extent than others, tended to change the questions they asked each other to "which side will go down, ours or yours," a simpler prediction about the differences between the two scale arms rather than one about their proportional relation.

The arrangement of Condition 2 was seen to have heightened children's individual differences in task performance accuracy and in their tendencies to respond to the task with social markers. These results further challenge the view that individual skill differences influence performance consistently across task arrangements. Children working in Condition 2 argued somewhat less than they did in Condition 1 (but significantly more than they did later in Condition 3). Argument and Length of Argument were negatively related to gains. This task arrangement led to a low number of "Attention" responses relative to "Social" ones, as well as to a higher proportion of errors and fewer Cross-Observations.

Condition 3: Experimenter Conflict

The task arrangement of Condition 3 was designed to generate coordinated activities that would lead to proportional thinking about the scale dimensions. This was done by making teams responsible for one dimension each, weight or distance, and asking them to calculate joint moves against the experimenter who had placed weights on one side of a scale. Condition 3 served to reduce Social responding and increase Attention significantly. On-task conflicts decreased but Accuracy and Cross-Observations increased. A greater number of Arguments and Cross-Observations in Condition 3 were related positively to higher posttest scores.

The design of Condition 3 included the participation of an adult in the problem-solving activity. This may seem to account for the reduction in both on- and off-task dialogue, however, the way in which the adult participated was not simply as a suppressor of talk. According to the transcripts, the experimenter interacted with the children as much in the other conditions. The effect of the task structure in Condition 3, which was to establish the goal of joint team coordination against the adult's moves, was what resulted in differences in the frequencies of certain behaviors and in the value of communication for problem solving.

Regardless of initial Rule, children who responded to the Condition 1 arrangement by arguing about the scale were also more likely to remark on the opposing team's operations (although the absolute frequency of Cross-Observations then was low) and less likely to be those who make gains; children who responded with less on-task arguing in Condition 1 were less likely to make Cross-Observations and more likely to be those who made gains. In Condition 3, overall amount of on-task arguing went down significantly, and Cross-Observations increased significantly, but those who did argue were more likely to express Cross-Observations and to make gains. Children who didn't argue in that condition also were not likely to take into consideration the other team's activity and coordinate it with their own.

Conclusion

In a general way, the kind of interactions a child engages in are complementary to a child's cognitive level, as Piaget and Vygotsky both claim. However, in the present work it was found that an individual's initial cognitive level only partially predicts learning. Group level, or the sum of individual cognitive levels of a group, adds to the prediction but does not account for all the variation seen. According to the best fitting model, the most powerful predictors of learning, after previous history is partialed, are measures of on-task activity occurring because of the presence of others.

The variables comprising the categories used to analyze children's problem solving interactions showed variability due to task organization differences. Here, the nature of the relation of task organization to problem solving activity and, in turn, to the probability of individual learning occurring, as measured on posttests, suggests that while "Cognitive" and "Social" development generally co-vary, responsiveness to task organization, a "Social" factor, precedes learning on a particular task. Children's responsiveness to the differences in task arrangements, assessed by the on-task interindividual measures in each condition, may be an overall prediction of how well information that is available in the interaction can be utilized by children of each cognitive level (also see Webb, 1980).

Surprisingly, the occurrence of a particular kind of cognitive interaction (e.g., arguing about the task) is not necessarily an indicator of informative exchange, because it can occur in a context where the task structure (designed to promote interpersonal competition) may vitiate its formal value. For instance, Condition 1 was designed to promote competition by setting up team conflict. The scale was not integrally involved in the organization of the competition, because any task would do. Decentering, or considering another's viewpoint, in that case could relate to the task goal in two ways: it could be unadaptive, since the idea is to keep your information to yourself and win, or, it could be put into the service of preventing the other team from accessing information. Although this was not done for the present analysis, the protocols could be checked to see whether, in Condition 1, on-task arguing was obstructively initiated, as when the challenge

"You're wrong!" is uttered as an opponent makes a move.

Functioning with what Siegler calls Rule I (only noticing the dominant dimension of weight on a scale) indicates a failure to distinguish the distance dimension on a scale task and also says something about the likelihood of making correct guesses about a problem. It does not give an indication of the tendency to engage in on-task argumentation with others. The present data show that the tendency to argue is more or less likely and more or less productive depending on task organization. Under certain conditions, children can be organized to engage in interchange that can promote the creative solution of problems.

The current work did not support a distinction of "Social" and "Cognitive" as they are often juxtaposed. Interindividual activity is both on-task and off-task. As such, on-task conflict may be said to be "Social" control executed in relation to a problem. If we suppose that lower level learners are generally under less interindividual as well as task control, higher level learners might serve as models and challengers, not primarily because of the information they possess but because of their interindividual responsiveness to the task arrangements.

By studying only one instance of a task arrangement, as is the case in most research, the contribution of the "Social" in relation to the task content is untestable. We need to observe carefully the child's world and how scientific information is variously marked and made available by the community. Only then can we begin to account for what in an individual's later school performance appears to be the development of a correspondence between the world abstracted and abstract thought.

Notes

[1]Piaget's position on this point changed; his early work assumed the necessity of socially derived input for schema development.

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Thus [with symbols] man built a new world in which to live. To be sure, he still trod the earth, felt the wind against his cheek, or heard it sigh among the pines; he drank from streams, slept beneath the stars, and awoke to greet the sun. But it was not the same sun! Nothing was the same anymore. Everything was "bathed in celestial light"; and there were "intimations of immortality" on every hand. Water was not merely something to quench thirst; it could bestow the life everlasting. Between man and nature hung the veil of culture, and he could see nothing save through this medium. He still used his senses. He chipped stone, chased deer, mated and begat offspring. But permeating everything was the essence of words: the meanings and values that lay beyond the senses. And these meanings and values guided him -- in addition to his senses -- and often took precedence over them. (L. White, 1958 cited in M. Sahlins, 1976, pp. 105).

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Famous Theories and Local Theories: The Samoans and Wittgenstein

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> His idea of his book is not that anyone by reading it will understand his ideas, but that some day someone will think them out again for himself, and will derive great pleasure from finding in this book their exact expressions. I think he exaggerates his own verbal inspiration, it is much more careful than I supposed but I think it reflects the way the ideas came to him which might not be the same with another man. . . . He says I shall forget everything he explains in a few days; . . . It's terrible when he says 'Is that clear' and I say 'no' and he says 'Damn it's *horrid* to go through that again.' Sometimes he says 'I can't see that now we must leave it.' (From a letter the British mathematician F. P. Ramsey wrote to his mother in 1923 while visiting Wittgenstein in Austria -- cf. Wittgenstein, 1973, p. 78.)

Introduction

A commonplace in anthropology is that a fieldworker should always try to balance a good knowledge of past and current theories with an open-mindedness toward new data and new observations (cf. Malinowski, 1922, pp. 8-9). In fact, in the mundane world of conferences, journals, departments, and academic parties, one often finds anthropologists, as well as other social scientists, accusing one another of being either too close to their data or too distant from any data. I think, however, that this contrast is more ideological than anything else and that in fact over the years we leave behind the question of whether we are seeing the forest or the trees. Instead, to many of us, the people we lived with and studied helped us open a new window on a slice of the universe we couldn't see before. By then, a funny metamorphosis may have taken place. The "local theories" we have been discovering become the tools with which we make sense of the famous theories we were given by our disciplines. We create new audiences for old speakers. Across time and space, local theories not only illuminate famous theories, they may also replace them as the leading paradigm in our own science.

In this paper, I will make this process overt by using what I consider the Samoan theory of language and social practice to illuminate some aspects of Wittgenstein's theory of language and rule-governed behavior. I will first point out some striking similarities between the Samoan theory and Wittgenstein's "later" theory. After briefly considering the Samoan notions of meaning and task accomplishment as always joint, cooperative enterprises, I will suggest that a similar view must have been held by Wittgenstein, at least as revealed by some of his writings and his style of lecturing.

The Two Wittgensteins

It is well known that Wittgenstein's *Philosophical Investigations,* which is considered as the official document of his "later" philosophy, did not meet the same amount of approval and enthusiasm in the philosophical world as the earlier *Tractatus.* For one thing, it is true that *Philosophical Investigations* is not as precise and as organized as the *Tractatus* -- its author seemed to be aware of this and in fact worried about the negative consequences of his own style (Malcom, 1984). I would like to suggest that the "imperfections," as well as its incompleteness, are a part of the message. Wittgenstein's later philosophy is, for one thing, an extremely dialogical genre in which an imaginary interlocutor is constantly asking questions or raising objections, and one can at times lose track of which one of the many voices expressed is the author and which one the commentator. It has been said that Wittgenstein's writing is "therapeutic." I would like to add that Wittgenstein's work, his philosophical "praxis," must be understood as requesting the crucial role of a committed and creative audience. Such a role and the need for conceiving of meaning and interpretation as cooperative achievements are made apparent by comparing some basic points of Wittgenstein's later philosophy with Samoan local epistemology and praxis.

Samoan Theory of Meaning and Social Action

Let me briefly summarize here what I have elsewhere presented as my interpretation of the Samoan theory of meaning and social action (Duranti, 1984). I have been arguing that Samoans do not share what Silverstein (1979) characterizes as the "reflectionist point of view." That is, they do not share the idea that language