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THE RELATIONSHIP OF COGNITIVE DEVELOPMENT TO INTERACTION INEQUALITY

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ABSTRACT

Cognitive and social-emotional development have clear markers for individual progress through sequenced patterns of change. These markers define stages for the individual maturation process. The use of groups of learners to enhance pedagogical success does not take account of these patterned markers of maturity. In addition, interaction processes in groups structure the patterns of who talks and who listens in the group. Such differential levels of activity affect who learns how much in the group. The extent to which individual development affects levels of participation is the focus of this paper. We review the research on development and interaction inequality, describe a coding scheme for identifying levels of cognitive behavior (development), and examine the extent to which cognitive behavior developmental differences are correlated with the emergence of inequality in task groups charged with learning tasks. Data analyzed for this project were collected in groups composed of undergraduate and graduate students.

Working in groups with peers is espoused as an effective strategy to increase student success at mastering cognitive content, developing social skills, and improving academic skills for students at all levels of education. The practice involves assembling groups of students, giving the group a task to accomplish, providing resources and guidance on how to proceed, and monitoring the activity as they work to solve the problem.

What is of note to us is the fact that so little research has examined the extent to which this approach has the desired consequences for students across developmental levels. Research on interaction in task groups, the group type employed in learning exercises, has a robust set of findings and theory that shows that inequality always emerges when groups work together. This inequality patterns who talks and who listens, and presumably, who learns.

Cognitive markers for individual progress across boundaries in cognitive development are well known. Children learn conservation of number as they become pre-operational, conversation of volume as they move to concrete operations, and symbolic/logical reasoning as they enter formal operations. Similarly, some adults learn to synthesize, create, and assess new information. Social (emotional) development has similar markers for transitions as individuals develop. Egocentric orientations change, confidence in interaction increases, and interaction styles change as a consequence of maturation.

Research linking development levels to interaction in task groups is virtually non existent. Differences in cognitive development may affect the emergence of inequality in groups if members of the group are at different cognitive development levels. The same consequences may occur if members are at different social (emotional) development levels. We do not know whether the dynamics of interaction, the mechanism by which inequality emerges, varies by developmental levels of group members. This paper addresses how to integrate these two strands of research to examine learning environments. In the process, we hope to be able to contribute to our understanding of social interaction and individual development.

As we began to examine the research on social inequality in student learning groups, we were struck by three points. First, most of the studies are carried out in middle school classrooms with children between the ages of ten and thirteen . Second, amelioration of social inequality is the focus of much of this work to the exclusion of discussion of differences in behavior that result from developmental differences for children at this age (cf. Cohen and Lotan 1995 and Chizik, et al. 2003). Third, little attention has been paid to social and emotional development as it affects interaction in learning groups. This paper presents one approach to an empirical examination of issues of social inequality and cognitive development. We defer consideration of social and emotional development to later work.

We first develop a brief review of the principal findings relating to inequality processes in groups, both in the general sense and in their specific application in pedagogical contexts. The next section of the paper reviews research on individual development. This is followed by a brief review of group learning research. Issues identified in these reviews are highlighted and a research program to address them is sketched. Data collected in groups is analyzed to determine the extent to which development and interaction dynamics affect learning and interaction. We conclude the paper with a discussion of implications for learning in groups of integrating the strands of research on inequality in task groups and cognitive and social development.

INEQUALITY IN TASK GROUPS

The study of inequality in task groups has a long history in social psychology. Its original development focused on groups of individuals who begin their interaction together as social equals. The research resulted in identification of emergent properties of interaction that reflect differential contributions to joint outcomes observed by researchers and recognized by group members. Subsequent research demonstrated similar effects in groups composed of individuals with varying social attributes. Beginning with the identification of performance expectation states, the explanation of inequality in task groups has developed tools to explain and expand our understanding of these processes (cf. Webster 2003).

Four fundamental issues are addressed by research in the expectation states tradition. First, how do individuals who begin working together as social equals evolve patterns of inequality recognized by external observers as well as the group members? Berger (1958, Berger and Conner 1969) first addressed this problem and was able to articulate a sequence of interaction including socially distributed chances to contribute to the group task, evaluations of these contributions, and the exercise of influence. Aggregation of these experiences by each group member leads to expectations for future performance which become a self-fulfilling prophecy. Fisek and Ofshe (1970) show that interaction differences observed by researchers were reflected in assessments group members made of contributions to solving the group task, including themselves. This process occurs very rapidly, even in groups of strangers who are initial social equals (Shelly and Troyer 2001). These differences lead to a pattern of interaction in which advantaged members of the group, those expected to perform better at the task, talk more, make more contributions to task solutions, and are more influential in organizing the group and producing a task outcome. Individuals who are disadvantaged, those expected to perform poorly at the task, talk less, react to the suggestions of advantaged members, and are less influential.

Secondly, what is the role of culturally defined social inequality in the organization of activity in groups? Strodtbeck, James, and Hawkins (1957) showed that group members pattern interaction based on social differences members bring with them as they enter a group. Differences based on occupation, age, education, race, appearance, and gender have been identified as creating behavioral differences in task groups. Early demonstration of these effects focused on the exercise of influence in a joint decision making task in which members of the group believed they had higher or lower educational status than their partner (Moore 1968) or higher or lower military rank than their partner (Berger, Cohen, and Zelditch 1972). Status characteristics valued by the larger society, and their associated performance expectations, are reflected in open interaction in task groups as well. The combination of status information to form aggregated expectation states proceeds according to a combination principle in which all positive information is assembled, all negative information is assembled and an aggregated state emerges for self and other (Berger, et al. 1992).

Third, how do group members come to know the relative standing of one another during an interaction? This occurs when group members give off cues that explicitly place them (indicative cues, e.g. "I know because I am an attorney."), or implicitly locate them (expressive cues, e.g. an accent or posture) in a particular location in the status system of society. Such cues also make claims about task skills or category membership. Thus, information sent and received in the course of conversation is the mechanism by which group members transmit knowledge of their relative standing in socially heterogeneous groups (Berger, et al. 1986, Ridgeway, Berger and Smith 1986).

The fourth issue of interest to us is the behavior observed by researchers who study group activity. Five abstract elements of interaction are of interest. The provision of opportunities for others to contribute, the contributions those individuals make, the positive and negative reception of contributions, and the exercise of influence constitute the observable activity in the in group interaction. The aggregation of this information is referred to as the observable power and prestige order of the group. Recent studies have shown that a number of different measures of this observable ordering are highly reliable and correlated with one another (cf. Shelly and Troyer 2001).

DEVELOPM,ENTAL CHARACTERISTICS AND ACTIONS

Piaget's studies of cognitive development (Piaget and Inhelder 1969, Flavell 1963, Forman and Sigel 1979, Sund 1976) demonstrated that children think qualitatively differently at different ages. The developmental differences have been validated and extended by other cognitive psychologists. Since we are interested in verbal expressions characteristic of learning in more advanced stages, we touch only briefly on the characteristics of the two earliest stages posited by Piaget and his collaborators. The first stage, Sensorimotor, generally occurs in children from birth to age two. Schema learned at this level are based on behaviors and perceptions and are generally non-verbal. Pre-operational children are characterized as those with formal language development (approximately age two), egocentrism, and a sense of the irreversibility of events. Reasoning at this stage is not like adult reasoning. It is non-linear and shows a lack of understanding of conservation with object transformation thought to be invariant across space.

As children emerge into concrete operations around age six or seven, they reflect the effect of social construction of knowledge and skills. This stage is characterized by a more mature, adult-like logic and the ability to differentiate one's own views from those of others. Reversibility and an understanding of conservation (volume, mass, number, etc.) are considered common cognitive markers for children in this stage of development. Reasoning is limited to concrete reality with physical manipulation of objects a common activity as the individual reasons through a problem.

The development of formal operations is highly dependent on children's interaction with challenging, problem-oriented experiences and strongly reflects the social constructivism that characterizes cognitive development. In this stage, logical reasoning is applied to abstract ideas as well as concrete representations. The learner develops the ability to deal with abstract, hypothetical, and contrary-to-fact ideas and the learner is able to engage in hypothetical arguments and debates. One of the most valuable skills that can develop with practice is the ability to think about thinking (meta-cognition).

Patricia Arlin (1975) and others have posited a fifth stage of development, sometimes referred to as mature formal operations or heuristic operations. An adult level of development, heuristic operations is characterized by holistic reasoning and more creative "left brain" problem solving. Sometimes this has been referred to as the "problem finding" stage. Individuals who reach this stage display an ability to synthesize seemingly disparate ideas or patterns of thought to produce new ideas and creative outcomes.

CODING SCHEMA FOR INTERACTION IN LEARNING GROUPS

Coding social interaction in groups has been common practice for sociologists for over a half century. Early schemes developed by Robert Bales (1950) have been refined and modified as technological developments have permitted more and more detailed analyses of interpersonal behavior (Shelly and Troyer 2001, Skvoretz, Webster, and Whitmeyer 1999). Each of these coding schemes identifies an initiator of activity, the target, and classifies the activity into a category scheme. Modern technology has made possible time stamping of the coding so that dynamics may be analyzed with greater precision than in the past.

Various partitions of activity have been employed, with the most common the act. An act is the expression of a socially meaningful idea either verbally or nonverbally. Acts may include utterances such as "yes," "I think that is a good idea," or "let's try this approach." When coding transcripts for verbal action, the units of analysis are translated from acts to clauses. While acts may include nonverbals such as rolling ones eyes, nods of the head, and looking away, we do not attempt to code this information for this analysis. Reliability measures for these schemes are reported in the .75 to .90 range, depending on the detail coded and co-present training of coders.

We employ a conceptually simple coding scheme developed by Berger (1958) for our analysis of interaction. Action opportunities are pauses in speech, direct questions, or nonverbal glances directed to another member of the group. Performance outputs are contributions to the group task and efforts to organize the group for its task activity. Reward actions are categorized as positive (agreements with the speaker, praise for the idea, or head nods) or negative (disagreements with the speaker, criticism of an idea, shaking of the head, or immediate offering of alternatives).

Social inequality is reflected in higher rates of initiation for task contributions, more successful influence, and the receipt of more agreements from others for socially advantaged members of a group. Lower rates of task contributions, less influence, and the origination of agreements are characteristics associated with the disadvantaged members of groups. This observable power and prestige order is one of the most robust findings in social research.

CODING SCHEMA FOR COGNITIVE DEVELOPMENT

A similar research history does not support the study of cognitive and socio-emotional development in human interaction. Studies of individuals and their development suggest we should be able to code for conservation of number and volume, ability to reason analytically, evaluation of ideas, and synthesis of ideas to delineate various cognitive stages. The coding scheme we have developed for this purpose is designed to differentiate individuals at the concrete operations level of development from those at the formal operations level. In addition, we hope to be able to differentiate those at the formal operations level of development from those capable of heuristic operations.

We expect activity by individuals at the concrete level of operations to be characterized by mental ordering based on a logic of classes, stated criteria, use of examples, and multiple dimensions. Their explanations should employ concrete referents and give rationales based on them. Action representations are specific, with concrete behaviors and directions to others.

Individuals in formal operations should convey hypotheses, provide evaluations, synthesize material, provide problem statements, reflect on relationships, and employ combinatorial logic. We expect such individuals to provide rationales and criteria for hypotheses, evaluations, syntheses, problem statements, reflections, and combinatorial logic. They should also provide criteria for hypotheses, evaluations, and syntheses. Problem statements include originations, while reflections include relationship specifications.

Individuals in heuristic operations should employ allegories and metaphors in their speech, exhibit problem finding attributes, integrate dissimilar information, and verbalize propositional thinking. When using allegories and metaphors we expect such individuals to create them, react to and extend them when expressed by others. Problem finding includes clear expression of the problem, explanation of its dimensions, and reasoning about it. Integration of dissimilar information includes descriptions of the integration as well as a rationale for the proposed combination(s). Propositional thinking includes descriptions of the propositions as well as a rationale. A summary of the coding protocol is presented in Table 1.

Table 1. Cognitive Activity Coding

Concrete Operations: Characterized by concrete and observable information or statements. In each case, the content is very easily validated and the speaker is not using more abstract thinking.	**Formal Operations:** Characterized by more abstract thinking and/or statements. In each case, the content of the statement is verifiable through logical thinking or propositional thinking,
C1 Mental Ordering or Seriation includes classification and the logic of classes using criteria, examples, and perhaps multiple dimensions.	F1 Hypothesis includes a logical possible explanation and usually includes a rationale and/or criteria
C2 Explanation (not hypotheses) includes concrete referent(s) and usually includes a rationale.	F2 Evaluation includes an assessment of data, hypotheses, or thinking and usually includes a rationale or criteria for the evaluation
C3 Action representation includes specific suggestions, behavioral suggestion for group, or directions	F3 Synthesis includes the combining of hypotheses or evaluations and usually includes a rationale and/or criteria
C4 Data input, Presentation of facts	F4 Problem Statement includes a clear reinterpretation of the problem or a new statement of the problem. It is usually an origination statement and usually includes a rationale.
	F5 Reflection includes the speaker feelings about or interpretation of earlier statements. Relationship are specified and a rationale is often given
	F6 Combinatorial Logic includes a the combining of statements into a proposition or a reaction to a proposition. A rationale is usually given
Mature Formal Operations (Heuristic Operations): Characterized by hypothetical thinking or highly abstract thinking. In each case the content of the statement is clearly related to flow of the discussion and usually uses previous statements in unusual ways. Verification is sometimes convoluted.	**Control:** This category includes statements and/or behaviors that are not focused on the content of the discussion. They are indicative of social control and/or operation related statements.

H1	Allegory/Metaphor includes the creation of the allegory or metaphor and is often a reaction to or deeper understanding of the problem or task. The allegory is usually and extension of previous statements.	Op	Operations: Actions which move the group but are not substantive in nature
H2	Problem Finding includes a clear expression of a problem with the dimensions explained and reasoning clarified	Cl	Clarification: restatement, questions of a very specific nature requesting a clearer set of information
H3	Integration of dissimilar information usually includes a descriptive statement and/or a rationale	N	Noise: No substantive content
H4	Propositional thinking includes a clear description of the proposition being developed and a rationale for the proposition		

We expect that coding interaction with these categories will allow us to determine the extent to which behavior of individuals may be characterized by concrete operations, formal operations, or heuristic operations. This characterization is based on modal behaviors observed and the relative frequency of behavioral types. The minimal unit coded for cognitive development is the turn as opposed to the act for measures of inequality. The turn has been used extensively in studies of interaction and has proved a reliable source of information about inequality (cf. Shelly and Troyer 2001). We hope to be able to develop a similar pattern for measuring cognitive development in interaction. The prevalence of these behaviors will be compared to the prevalence of behaviors associated with social inequality to determine whether there is a correspondence between dynamics of inequality and cognitive development.

DATA

The data for this project consists of transcripts of video tapes of discussion groups from a doctoral seminar in Educational Leadership collected during Fall, 2003 and from a research project on group decision making carried out at the University of South Carolina (Smith-Lovin, Skvoretz, and Hudson 1986 and Smith-Lovin and Brody 1989). The members of the seminar are all women, as is the instructor. All are practicing professionals, with career lengths varying from fifteen to thirty-five plus years. We transcribed verbalizations for the current project and were able to code between twenty five and thirty minutes of interaction for each group session as one member of the group presented a case study for the seminar and then lead the group in discussing the case. The participants knew they were being video taped and agreed to participate in the research project. Four students were enrolled in the seminar. Hence, all group sessions include five individuals. The tapes are from week five of a fifteen week semester course. Unfortunately, one of the tapes of a presentation and group discussion was destroyed during data preparation, so we have data on only three sessions. We elected to employ only the groups from the South

Carolina data that were all female in order to avoid introducing gender as a confounding factor in the research at this stage.

RESEARCH QUESTIONS

We expect to replicate the finding that each group will evolve its own hierarchy, with the sessions treated as unique groups because of the shifting roles of group members across sessions. We expect each session to produce a rank order of interaction activity for the group members, such that one member talks the most, a second the second most, and so on. We also expect that we will be able to reliably code activity for cognitive activity in interaction. Our analysis will be exploratory to determine how activities that typically reflect social inequality and activities that reflect different levels of cognitive behavior (development) are related to one another.

RESULTS

The data from the transcripts for each group were coded by one of us and a graduate student to ensure that we had developed reliable coding schemes. We compared the results of the coding to arrive at an assessment of reliability for each of the measures. We found reliability to be high for the summary measure of task related activity when the coding by one of us (RS) was compared to the coding by a research assistant (r = .908, alpha = .946). We decided not to attempt a reliability analysis of the cognitive content coding as our scheme is still being developed. Rather, we coded the transcripts independently for the cognitive activity outlined in Table 1 and then discussed our disagreements. We arrived at a final consensus classification of activity for each speech by an actor in each group.

Table 2. Initiation of Activity in Discussion Groups.

A. Status differentiation: Rank Order Participation

	Ad Hoc Groups	Seminar Groups
Most Active	.374	.411
Second Most Active	.202	.256
Third Most Active	.196	.169
Fourth Most Active	.134	.108
Fifth Most Active	.053	.055
Sixth Most Active	.040	.xxx

B. Cognitive Development Initiation Rank Order Participation:

	Ad Hoc Groups	Seminar Groups
Most Active	.281	.376
Second Most Active	.199	.265
Third Most Active	.187	.164
Fourth Most Active	.148	.122
Fifth Most Active	.101	.074
Sixth Most Active	.083	xxx

Table 2 contains the relative frequency data for each of the measures of task activity and cognitive development activity. Panel A contains the data for measures of inequality in groups and Panel B contains the data for the measures of cognitive activity. The two sets of groups are presented separately for each analysis because of their difference in size and task. First, the data show the pattern of status ordering one would expect in both categories of groups. In the laboratory groups of undergraduates, clear status orders emerge, with a distinct hierarchical array. The most active person contributes just over one third of the activity in these groups, while the least active contributes four percent. A similar pattern is evident in the data for the classroom groups, with the most active person contributing over forty percent of total activity and the least active five percent. The cognitive development measures result in a slightly different picture of interaction in these groups. First, the range of percent of activity initiated by an actor of any rank is smaller, from eight percent to twenty-eight percent for the ad hoc groups, and from seven percent to thirty-seven percent for the classroom groups. The structures in both groups are "flatter" employing the cognitive measures. We think this may be either an artifact of coding speeches rather than acts or the consequence of patterns of cognitive development.

We also compared the percent of activity initiated by members of each group categorized as concrete, formal, heuristic, or control. This data is presented in Table 3. The participants in the ad hoc groups and classroom groups initiate the same percent of their activity as concrete operations, but differ on all other types of behavior. Participants in these classroom groups initiate more formal operations, more heuristic operations, and less control activity than participants in the ad hoc groups.

Table 3. Mean Percent of Cognitive Activity by Type of Group.

Type of Activity	Ad Hoc Groups	Seminar Groups
Concrete Operations [a]	.155	.214
Formal Operations [b]	.089	.248
Heuristic Operations [b]	.011	.035
Control Activity [b]	.745	.503

[a] This difference is not significant
[b] This difference is statistically significant

Table 4 contains correlation data relating status processes to levels of cognitive development in both categories of groups. The small size of the samples for each type of group has limited our analysis to only the total set of groups. Each correlation is based on the frequency of the various activities of the members who composed the groups. First, the level of total activity is significantly correlated with all of the measures of cognitive development expressed in the various forms of verbal activity. These correlations vary in strength from .535 to .800. In addition, the level of total activity is correlated .801 with the summary measure of cognitive development expressed in speech. Unfortunately, the small sample size means we cannot determine whether the differences between the various measures of cognitive activity are significant from one another.

Table 4. Correlations of Total Initiated Activity with Measures of Cognitive Development in Speech.

	Total Task Acts	Concrete	Formal	Heuristic	Control Actions
Total Task Acts		.800	.633	.790	.535
Concrete Speech			.476	.488	.509
Formal Speech				.518	.122
Heuristic Speech					.329
Control Actions					

All correlations except .122 and .329 are significant at the $p < .01$ level.

Of additional interest is the pattern of association between the various levels of cognitive behavior. First, concrete operations behavior is moderately correlated with all of the other forms of developmental expression. All of these correlations are in the range where they account for about twenty five percent of the variation in the two measures. Formal operations behavior is correlated with concrete and heuristic behaviors, but not control activity. These measures of association are of approximately the same magnitude as those linking concrete operations to other measures of cognitive development. Heuristic behavior is correlated with the measure of formal operations at approximately the same level. Control behaviors are not correlated with formal or heuristic speech patterns, though they are correlated with overall activity and concrete operations. This last result may be due to the greater frequency of control behavior in the ad hoc groups as opposed to the seminar groups.

CONCLUDING REMARKS

This section includes a discussion of the status order replication, our success in coding cognitive behavior (development) from interaction, and the correlation between the patterns observed in social interaction in these contrasting task groups. We begin with a discussion of some possible limitations which may affect our research. We conclude with speculative remarks about the relationship between individual developmental differences and status processes.

The limitations of the data we analyze are of two sorts. One is the potential similarity or difference in level of cognitive development of the two different populations. The South Carolina groups are composed of undergraduate students who are nineteen and twenty years old. We would expect their modal level of development to be Formal Operations. The graduate students who compose the groups collected in Ohio are doctoral candidates with substantial experience who are all over thirty five years of age. We would expect their modal level of development to be Heuristic Operations. Hence, positing a range of levels of development across the groups is plausible.

The repeated use of the seminar groups raises two issues that must be addressed. One is the extent to which familiarity with one another may affect the dynamics of interaction, both for development markers and for inequality markers. We do not think this is a concern in this situation as group members rotated roles across sessions. We expect that role assignments affected interaction dynamics as which individual talked the most, and with what content varied by the role played by the individual in the session. The possibility that this is not the case presents researchers in group processes with substantial opportunities to determine the extent to which preexisting patterns of acquaintance may affect interaction patterns and the cognitive content of interaction.

We turn now to the substantive outcomes of our research.

First, we were able to reliably code these data for the interaction measures associated with power and prestige orders in interacting task groups. Given the long history of success measuring these phenomena, we would have been surprised if we had not been able to do this. We are also able to replicate the finding that groups assigned tasks will evolve a power and prestige order such that one person will talk the most, and participation by others is rank ordered. This demonstrates the robust nature of this result and also provides an empirical foundation upon which to build our analysis of cognitive behavior in interaction.

Second, we are able to code interaction for three levels of cognitive development as captured in the behavior in these groups. Our approach of identifying consensus classifications of concrete operational behaviors, formal operational behaviors, and heuristic behavior has great promise. The addition of social control aspects of interaction to this scheme gives us an exhaustive measurement procedure for classifying verbal actions in task groups.

We are particularly encouraged by the empirical results we identify in these groups. Group members' cognitive behaviors apparently vary by group task. The ad hoc groups, with their unstructured task, spend a great deal of time engaged in social control. On the other hand, the seminar groups, with their more structured task, spend more time on task and less on social control activity. This difference in cognitive behavior was unexpected and offers new opportunities for empirical investigation and theory building. We address this issue further below.

Third, the strong correlations between cognitive behaviors and the power and prestige order of these groups suggests that individual development may in fact play an important role in the dynamic processes that govern the emergence of hierarchies in task groups. This has profound implications for the use of task groups in learning settings such as classrooms. If the dynamic processes which govern the emergence of power and prestige hierarchies are susceptible to influence by individual differences, new theory is needed to understand these processes and guide the use of groups in classroom settings.

We see three "next steps" for our research. First, we need to improve the reliability of our coding scheme for cognitive behaviors. This extension and validation exercise is critical to proceeding with our investigations of how individual action affects social products such as power and prestige processes and learning in groups.

Future research needs to assess the role of the situation of action in the expression of cognitive behavior. In particular, the differences in the cognitive behavior for the groups analyzed here suggest that population composition may be a factor in the manifestation of cognitive behaviors. This hypothesis is particularly intriguing since much of the research on learning groups has been carried out with early secondary school students. Does the level of cognitive activity of group members affect the formation and maintenance of the status order in task groups is one question that comes immediately to mind. Another is the extent to which the level of cognitive development of the individual is reflected in the content of their behavior and consequently in their position in the status hierarchy of the group.

How tasks, and their requirements, may affect the behavior observed in a learning group is also an important issue that varies by situation. In addition, assigned roles may affect the manifestation of cognitive behavior. For instance, discussion leaders may exhibit more data presentation or problem finding, depending on their assigned roles in the group. Similarly, groups may vary the amount of control activity they engage in if they face particular task constraints and role structures.

Finally, we have not addressed the role of socio-emotional development in this report. We anticipate that developing a coding scheme for this arena of investigation will be particularly challenging for a variety of reasons. The scheme will require that we develop measures of both verbal and non-verbal behavior that can be reliably scored and that this scoring be done from video records.

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