Doctoral Dissertations 1896 - February 2014

1-1-1992

Learning instructional communication skills in peer collaborative problem solving : a case of moving referent.

Moonja Lee
University of Massachusetts Amherst
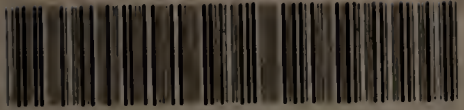
Follow this and additional works at: https://scholarworks.umass.edu/dissertations_1

LEARNING INSTRUCTIONAL COMMUNICATION SKILLS

IN PEER COLLABORATIVE PROBLEM SOLVING:

A CASE OF MOVING REFERENT

A Dissertation Presented

by

MOONJA LEE

Submitted to the Graduate School of the
University of Massachusetts in partial fulfillment
of the requirements for the degree of

DOCTOR OF EDUCATION

May 1992

School of Education

LEARNING INSTRUCTIONAL COMMUNICATION SKILLS

IN PEER COLLABORATIVE PROBLEM SOLVING:
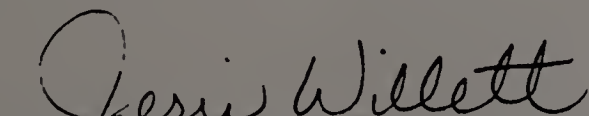
A CASE OF MOVING REFERENT

A Dissertation Presented

by

MOONJA LEE

Approved as to style and content by:

George E. Forman, Chair

Jerri Willett, Member

Alfred B. Hudson, Member

Bailey Jackson, Dean
School of Education

ACKNOWLEDGEMENTS

I owe great debts of gratitude to many people who have helped me through the various stages of my study. Several of them spring to mind immediately. First, to George Forman, whose support and patience have never worn out during the long winding years: he has offered valuable advices for my academic programs, insightful guidance through exciting but sometimes intimidating fields of research, and a great care and friendship which I never expected but most appreciated. I cherish all of the above immensely.

Second, to Catherine Twomey Fosnot, who became my mentor at a crucial point of my academic career. She inspired and encouraged me to pursue the degree in education. She has been and will always be a role model for me.

Third, to my friends, Mi-Sook Kim and Myra Edelstein, who helped me at various steps of my study by coding, transcribing the data, and editing the manuscript. I extend my gratitude to them for their invaluable help.

Finally, to my family whose patience and warm support sustained me through all these years.

ABSTRACT

LEARNING INSTRUCTIONAL COMMUNICATION SKILLS

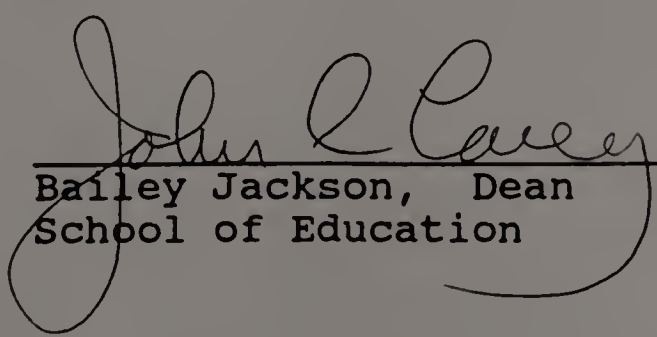IN PEER COLLABORATIVE PROBLEM SOLVING:

A CASE OF MOVING REFERENT

MAY 1992

MOONJA LEE, B.A., SEOUL NATIONAL UNIVERSITY

M.S., SOUTHERN CONNECTICUT STATE UNIVERSITY

ED.D., UNIVERSITY OF MASSACHUSETTS

Directed by : Professor George E. Forman

The present work is an attempt to combine two
traditions of communication study: referential communication
approach and sociolinguistic approach. The purpose was to
examine how children ages 5 and 7 years learn to give
instructions to each other in a peer collaborative problem
solving situation. In an effort to identify interaction
patterns and possible developmental progressions, various
coding and categorization schemes were developed to analyze
the processes of: negotiation of themes, establishing a
common perspective toward the task, co-constructing messages
and shared names. A comparison was made between the
children's development of spatial terms for a stationary
referent and a moving referent.

The analysis shows that 7-year-olds shared themes more
actively, using explicit means, compared to 5-year-olds.
The older children's instructions were more informative and

made in the task-appropriate referential perspective. For
the purpose of establishing shared names, the older children
engaged themselves in the naming process less often because
they used names that can be more easily shared. The
development of spatial terms for a moving referent seems to
lag behind the development of those for a stationary
referent. The children gradually learned, across ages and
sessions, to participate to maximize the team effectiveness.

Finally, dynamic changes in instructional messages were
analyzed using a mode of graphic representation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

During a primary election season, a man in an out-
of-town car asked a group of people on a bench in
New Hampshire, "I want to get to Manchester." The
group talked among themselves for a while and,
finally, one of them replied, "We have no
objection." (from ABC-TV, 'This Week with David
Brinkley', January 26, 1992)

Background

Recently, the importance of social context in cognitive

functioning of children has been highlighted, and there has

been a flurry of research in the area of peer interaction.

However, this topic is not a new one in the educational

setting; peers have long been considered ideal partners in

learning, especially in the form of peer tutoring (Allen,

1976). Also, under the rubric of "cooperative learning"

(Slavin, 1983; Johnson, Johnson & Skon, 1979; Webb, 1982,

1989), many researchers reported successful cases of team

learning in the classroom. More recently, within the

theoretical framework of Piaget and Vygotsky, the role of

peer interaction has been studied in the area of problem

solving, often with positive results (Doise & Mugny, 1984;

Forman, 1986). Then, the next question naturally arises as

indicated in the title of an article by Azmitia (1988):

"When are two heads better than one?" Reviews of research

in this area show that the positive gains from peer

interaction are not automatic and requires much specification (Tudge and Rogoff, 1989). Most studies have focused on discerning variables that produced favorable results. Now studies that focused on the interaction process itself have recently begun to emerge, and the findings are converging to demonstrate the importance of establishing intersubjectivity through effective communication in peer instructional settings.

Three types of constraints common to young children in peer instructional discourse have been investigated in the area of peer learning discourse, according to Cooper and Cooper (1984). They are; limitations in terms of discourse skills like requests and explanations; imitations of information processing capacity for handling the task solution for themselves and the coordination with others; and, finally, metacognitive limitations. Metacognitive skills have been studied in the communication development and found to be one of the areas where children continue to progress throughout middle childhood with the development of conversational and cognitive strategies. The metacognitive limitation of not realizing that they do not understand part of instruction, are found to be common in young children's communicative behaviors. Also, the metacognitive skill of realizing the need to meet situational requirements of the task is not readily exercised in peer instructional exchanges.

Communication skills develop, Robinson (1986) and Deutsch & Pechman (1982) argue, through social interaction, especially when the children are allowed to interact freely to accomplish goals in the problem solving context (Beaudichon, 1981). At the same time, effective communication between dyads seems to facilitate the cognitive change due to the increased level of intersubjectivity in collaborative problem solving, as the body of research on the effects of peer interaction suggests. Therefore, peer interaction is a valuable source and an ideal context for studying children's learning and communication skills.

Statement of the Problem

It is well established that peer interaction can promote understanding in some areas. The dyad often reaches a level that was not available to either of the children previously. For example, in Piagetian tasks, two non-conservers progressed to be conservers through interaction (Doise & Mugny, 1984). Also Forman (1989) reported the case of 11-year-old dyads working on the shadow projection task. They, too, benefited from the peer interaction session, but in a way different measure. They broadened their understanding of the problem by incorporating each other's perspective, even though there was not much gain in terms of the posttest scores.

In the area of communication development, many studies in the referential communication paradigm showed that children often have difficulties in producing and interpreting verbal messages and sought to improve children's communication skills through training methods of giving feedback and role reversal (cf. Dickson, 1981a, 1981b for review). In these studies, the task was usually to describe simple pictures with fixed attributes, allowed no interaction between children, and provided feedback through experimenters, thereby not giving children a chance to construct shared representations of the task. However, there are a few studies that suggested the possibility of improving communication skills by utilizing feedback from peers (Beaudichon, 1981; Lloyd, Baker & Dunn, 1984). They allowed interaction among children in the context of communication games and reported progress in children's communication skills.

Also, it seems that establishing intersubjectivity or shared meaning is at the core of peer interaction benefit. But the process of how they come to share meaning is not well explicated. Then, it seems worthwhile to study how children learn to instruct each other in a complex problem solving context, with the following questions in mind:

* Do children become effective communicators while they are trying to solve the problem? If so, how?

* How do children come to establish the intersubjectivity? For example, how do they negotiate the common perspective toward the task?

* How do peers contribute to each other in establishing the intersubjectivity?

Purpose

The current study investigates how children's instructional communication and problem solving skills change and how the children come to learn to communicate effectively in the particular context of a collaborative peer problem solving task.

The data for this study come from videotapes of children working in dyads to make a battery-powered toy robot obtain a defined goal. Two children are positioned on both sides of a partition. One child, the Operator, moves the robot by pressing buttons on the control panel that is attached through wires to the robot on the other side of the partition. The other child, the Witness, with the robot in his/her view and a tower built with wood blocks, gives instructions to the Operator.   The goal of the game is to knock over the tower or to pick up a block with the robot. The session is repeated three times with role reversals within each session.

The task is similar to the one originally designed by Glucksberg, Krauss and associates (cf. Glucksberg, Krauss &

Higgins, 1975). This original task has been used with modifications since then by many researchers to study the communication process for information exchange. However, the task for this current study differs from the typical referential communication task in several ways. First, unlike the original one that has static figures to identify, this task has a moving referent, a robot. Second, two children do not have the identical referential arrays, even though they have a chance before each session to explore the robot together. Third, this task has a clearly defined goal or purpose to pursue rather than choosing the referent for the sake of identifying. Fourth, this task involves telling how to do something rather than telling which one to pick. And finally, children repeat the task and interact freely to achieve the goal.

Instructional communication itself is a problem solving activity. The peers in this situation need to assess each other's needs, to discover effective means of communication and to organize the instruction so that long term as well as immediate goals can be accomplished (Ellis & Rogoff, 1986). In order to succeed in this task, the Witness needs to give instructions that are referentially unambiguous and functionally informative. The Operator needs to give feedback to the Witness so that they can establish mutual understanding of what is going on. The children need to acquire button function knowledge because it is not known to either of them at the outset of each game and this knowledge

will help make their communication more efficient. And the children have to rely heavily on their linguistic channels due to the presence of the partition.

From the viewpoint that learning is a signifying activity (Perret-Clertmont et al., 1984), this study uses a task in which children can learn by constructing and reconstructing representations of the task situation. By being engaged in the task and trying to reach the solution cooperatively, children should be able to learn to exchange information effectively across trials and gain greater understanding of the task. By examining the process, this study investigates how children succeed in solving the problem as well as improving communication skills.

In previous studies, young children were found to rely heavily on non-linguistic contexts to refer (Hickman, 1987) or to clarify the intention of the speaker (Cook-Gumperz, 1977). In this study, there is a partition to encourage children's use of linguistic channels. Therefore, it is predicted that children will move toward employing the linguistic mode of instructional exchange.

Also, young children are thought to lack the meta-communicative knowledge that messages can be ambiguous (Robinson & Robinson, 1983). This phenomenon is considered a symptom of not being able to differentiate what is said from what is meant, which, in turn, is partly a more general trend in young children's metacognitive development. Young children often do not realize that they do not have enough

information to know for sure what to do (Markman, 1979; Beal, 1990). Therefore, it is predicted that children will move from not working on message clarification toward working on both message clarification and button exploration across sessions, age or both.

Many studies report that the development of communication skills is often pronounced in the manner by which children organize the instruction giving activity (Cook-Gumperz, 1977; Hickman, 1985; Evans & Rubin, 1983). Therefore, an effort will be made to map out the changes in terms of exchange patterns or discourse strategies within, as well as across, problem solving sessions. Also, the process of co-constructing shared meaning will be traced by following how partners adjust to each other's different perspectives or representations of the task.

Significance of the study

Even though many studies have already shed light on the conditions for optimal peer learning, there is still much to be discovered about what happens during the process of interaction. Any study that focuses on the process itself will give more insight on how and why peer interaction works and how children come to be effective communicators.

Within the Vygotskian framework, researchers analyzed adult-child communication to chart the levels of intersubjectivity in problem solving tasks (Wertsch, 1985;

Wertsch & Hickman, 1987) in order to demonstrate how the adult helps the child regulates his/her own problem solving through guidance. However, there is not much research examining the mechanism of peer interaction using peer communication. With insights derived from the process analysis, environments may be designed which encourage children to learn among themselves.

Communication for information exchange or the task-oriented discourse is an important skill in the academic setting. Most of the studies examining information exchange used structured training methods without allowing children to interact freely and the content of the task was often restricted to identifying attributes (Robinson & Robinson, 1983; Sonnenschein & Whitehurst, 1984). By allowing peer interaction and using the type of task that involves telling how to do something, this current study will add information on the communication development in less contrived situations like peer learning. Therefore, this study carries ecological validity and the possibility for educational implication.

Even though young children are found to be very skilled in everyday communication with the support from adults, they may not yet be competent partners when left on their own, especially for exchanging information in task-oriented settings. By providing opportunities to engage in information exchange, adults can help children understand the communication process itself, as well as what to do in

those settings. Therefore, any knowledge about how children develop their communication skills in interactive situations, rather than what works in training experiments, will be valuable in helping children develop their communication skills.

Definition of Terms

1. Peers

    Children within a year of one another in chronological age, usually within the same grade. This relationship also can be defined by the negotiated quality of equivalent status, according to Garvey (1986). In this proposed study, dyads will be within the same grade and within a year of one another in chronological age.

2. Peer Instruction or Peer Learning

    Any type of instruction done in the context of peers helping one another, which is further categorized into 3 subtypes; Peer Tutoring, Cooperative Learning and Peer Collaboration, according to Damon and Phelps(1989a).

    a. Peer Tutoring: An approach in which one child instructs another child in material on which the first is an expert and the second a novice.

    b. Cooperative Learning: A team based learning approach. Usually exercised in small groups of 4

or 5 children. These groups are generally
heterogeneous with respect to students' abilities.
Often the work is divided rather than shared, as
in peer collaboration. The approach relies on the
increased level of motivation among team members,
even though there are wide variations in this
approach.

c. Peer Collaboration: An approach in which a pair
of relative novices work together to solve
challenging learning tasks that neither could do
on their own prior to the collaborative
engagement. This approach will be investigated in
the proposed study.

C H A P T E R II

REVIEW OF LITERATURE

Introduction

There are many theories and studies related to peer learning and children's communication development. In this document, research done only in the area of peer collaboration, as defined previously, will be reviewed. Reviews on children's communication development will cover the area of metacognition using referential communication studies as well as metapragmatics. Also, studies related to the peer learning discourse will be explored in an effort to merge two areas: peer learning and communication development.

Peer Collaboration Studies

This section will review studies of peer collaboration within the frameworks of Piaget and Vygotsky. Many other studies done in the context of peer tutoring and cooperative learning are not included because they do not deal with processes, thus lacking any information on how peer interaction works.

Theoretical Framework

Traditionally, the role of peer interaction has been studied in the area of socialization. In recent years, research on the effects of peer interaction on children's learning and cognitive development has begun to emerge, mostly within the frameworks of Piaget's and Vygotsky's theories.

Even though both Piaget and Vygotsky acknowledged that social interaction plays roles in cognitive development, they differ in emphasis (Tudge & Rogoff, 1989).

Piaget was interested, primarily, in individual development of logic, emphasizing the role of equilibration rather than social interaction in development. However, in his early writings, he argued that the discussion among children has a role in their reasoning development. "Social life is a necessary condition for the development of logic. We thus believe that social life transforms the individual's very nature." (Piaget, 1928, p. 239) As a mechanism, he focused on the "cognitive conflict" that could arise during discussion among children with different perspectives on the problem. He also believes that there is a parallel between how children cooperate and their level of logic development. Therefore, Piaget favors the symmetrical relationship of peers in the form of cooperation.

Vygotsky, on the contrary, put a great emphasis on social interaction or culture as a medium for individual

development. He argues, "Any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane" (Vygotsky, 1981, p. 163). As a developmental mechanism, he used the concept "appropriation" which involves the active transformation of what is social into the individual. Therefore, children, in his theory, come to share the meaning of activities and words with guidance from adults or more capable peers.

Despite the differences, Piaget and Vygotsky shared an emphasis on the importance of understanding each other in an interaction. They both argue for the value of cooperation in terms of shared thinking, which seems to be commonly referred to as "intersubjectivity" (Rommetveit, 1985). Many studies in both Piagetian and Vygotskian tradition cite the concept of intersubjectivity as a key to the benefits of peer interaction. Tudge and Rogoff (1989) define intersubjectivity as the state of ".. joint understanding of a topic achieved by people working together and taking each other's perspective into account" (P. 22).   They conclude that establishing intersubjectivity through active and joint involvement in problem solving is a crucial factor for peer interaction to be effective.

Mechanisms

Most peer collaboration studies are grounded in the Piagetian framework using developmental tasks such as conservation and classification. Based on the proposed mechanism of <u>socio-cognitive conflict</u>, research in the Piagetian tradition focused on peer interaction as a vehicle for cognitive growth (Doise & Mugny, 1984; Perret-Clermont, 1980; Ames & Murray, 1982; Murray, 1983, 1985). This body of research showed a high rate of positive gains in the post-test results. Some argue that this gain is due to the presentation of <u>correct</u> responses through peers by the mechanism of <u>imitation</u> (Rosenthal & Zimmerman, 1978). However, the gains cannot be simply explained by the exposure to better solutions. For example, two incorrect nonconserving responses can make a correct conserving one when those nonconserving responses are based on and derived from two different perspectives (Ames & Murray, 1982; Doise & Mugny, 1984). Also, new conservers often give explanations or justifications that are different, yet correct, from their conserving partners (Perret-Clermont, 1980). Cognitive conflict, therefore, has been generally recognized as a mechanism of growth. However, there is no agreement on the operational definition of cognitive conflict. In Piagetian sense, it is <u>intra-individual</u> in nature, and may or may not be externally observed. While

inter-individual conflict is likely to promote intra-individual conflict, they should be differentiated.

In many situations, the presence of <u>inter-individual</u> conflict itself does not seem to guarantee gains from peer interaction. What happens or how conflicts are resolved during the actual interaction process seems to determine the outcome. Also, the benefit of interaction is greatest when the dyads are required to reach a common agreement on the solution of the task (Glachan & Light, 1982; Bearison et al., 1986; Doise & Mugny, 1984). The collaboration experience seems most beneficial when it shows a balanced, medium-frequency expression of conflict between partners (Bearison et al., 1986), disagreements over the solutions and strategies but not over the roles and behaviors (Damon & Phelps, 1989b), disagreement over the representations of task and the problem solving procedures (Gilly, 1989), and the resolution through genuine collaboration instead of compliance (Doise and Mugny, 1984). Similarly, from the process analysis of peer interaction, some identified the characteristics of effective discourse either as "transactive" (Kruger & Tomasello, 1986) or "dialectic" (Bearison et al, 1982). Transactive discourse "extends, paraphrases, refines, completes or critiques the partner's reasoning" (Kruger & Tomasello, 1986, p. 681). The characteristic of this type of dialogic discourse seems consonant with the suggestion by Piaget that sharing of

ideas through discussion, in other words, establishing
intersubjectivity, is crucial to the interaction outcome.

Away from the view of social interaction as an occasion
for the confrontation of viewpoints, many in Vygotskian
tradition (Youniss, 1980; Forman, 1987; Rogoff, 1990)
recently focused on the process of "co-construction" of
solutions by way of sharing and coordination of
perspectives. Forman (1989) showed how two children
benefited from interaction in the course of social
coordination. Similarly, Rubtsov (1981, 1989) showed, using
classification tasks, that children progressed in their
understanding of classification while they tried to solve
the problem jointly with peers. Also, he reported a
parallel between thought structures and the way they
cooperated to solve the problem.

This concept of co-construction seems to be consistent
with both Piaget and Vygotsky's theories. It seems that the
socio-cognitive conflict can become meaningful only if pairs
co-construct shared understanding of the task through
coordination of perspectives (Bell et al., 1985; Perret-
clermont et al,, 1984). Moreover, in many cases of
successful collaboration, social conflicts between pairs are
rare or are not explicitly verbalized (Damon & Phelps, 1987;
Gilly, 1989). Therefore, we may get valuable insight on
how learning happens during interaction by focusing on the
process of co-construction of shared meanings rather than
focusing on the conflictual aspects of interaction.

Prerequisites

Depending on the age, there seems to be a difference in the extent to which peer interaction can be beneficial. Many report the correspondence between the mode of problem solving and the mode of cooperation (Forman & Cazden, 1985; Rubstov, 1981). The correspondence between the mode of social functioning and that of cognitive functioning is well established within the theories of Piaget and Vygotsky. Therefore, collaboration becomes more effective during late childhood when better means of negotiation can be employed. However, this does not mean that egocentrism prevents young children from interacting effectively. Rather, this egocentrism can be disturbed and broken through social interaction (Musatti, 1986; Beaudichon, 1981). As an example, for the concept of conservation, most of the studies included nonconservers, and found gains in many cases (Ames & Murray, 1982; Perret-Clermont & Schubauer-Leoni, 1981). Also, 4 to 5 year old children often benefited from peer interaction in a balancing task (Cooper, 1980), and a puzzle fitting task (Azmitia, 1988).

On the other hand, children younger than 3 or 4 years old tend to show no benefit from peer interaction, except in motivational measures (Perlmutter et al, 1989; Martinez, 1987). This is likely because young children, during interactions, do not provide explanations to each other. It seems that young children have different modes of

teaching to and learning from each other; they often rely on observational learning rather than discussion (Azmitia, 1988). Some argue that it is the level of difficulty of the task, not the developmental age, that should be considered when we predict the outcome of peer interaction (Perlmutter et al., 1989). Similarly, the type of task to be learned may influence the outcome of peer interaction, depending on the age.

Another kind of prerequisite can be the relative difference in terms of each partner's expertise. Even peers can have different levels of expertise or skill for a given task. There is some evidence that too much cognitive difference between pairs is not optimal for cognitive gains (Kuhn, 1972; Morrison & Kuhn, 1983). However, as many experiments (Mugny & Doise, 1978) in conservation tasks have shown, the pair does not need a conserver to achieve development through interaction. The need for different perspectives does not seem to require different levels of cognitive functioning. Also, in research outside the Piagetian paradigm, many peer dyads showed progress in the problem solution (Rubtsov, 1981; Glachan & Light, 1982) as well as in problem solving strategies (Forman & Kraker, 1985; Forman, 1989). Even though some studies (Azmitia, 1988; Herber, 1981) found no progress, the lack of progress seemed to result from lack of cooperation or a low level of collaboration during the interaction.

Level of Participation

Studies in the Vygotskian tradition, as well as many peer-based learning studies, report the importance of the learners' active participation in the task. In adult-child interaction, as well as in peer tutoring (Ellis & Rogoff, 1986; Radziszewska & Rogoff, 1988), sharing the responsibility for the task between pairs, not simply dividing the labor, was found to be effective (Gauvin & Rogoff, 1989). Unlike adult-child interaction in which adult assumes the responsibility of task definition, peers in collaborative problem solving need to define the task situation by themselves (Forman, 1989; Rogoff, 1990). In the course of trying to coordinate their activities with each other, they construct, negotiate and modify shared understanding of the situation or intersubjectivity through the symmetric control of communication (Rommetveit, 1985). Since any communication unit is, by nature, temporarily asymmetrical, peers might learn to share the responsibility of establishing intersubjectivity by equally taking turns in leading the communication. In fact, some studies reported that peers took turns in providing the guidance and the organization during the collaborative problem solving (Verba, 1987; Forman & Kraker, 1986; Gilly, 1989; Azmitia, 1988; Perlmutter et al, 1989). When one member of the dyad dominates the interaction (Glachan & Light, 1982) or when

the partners argue too much (Bearison et al, 1986),
successful interaction outcomes are not likely.

Task Type and Analysis

The benefit of peer collaboration can be maximized only
in certain types of tasks; open rather than closed ones, and
those that require insights and conceptual shifts rather
than accurate reproduction skills (Damon & Phelps, 1989a).
The task should be presented in a way that requires the dyad
members to come to a joint decision to maximize the chance
of collaborating. Instead of simply allowing children to
solve a problem together hoping that they will work through
genuine collaboration, one must provide a carefully
structured instructional context as Damon & Phelps (1989b)
argue. The task should also be appealing to children or
academically relevant rather than being purely arbitrary.

For the analysis, Piagetian studies employed a three
step procedure: pretest, treatment with peer interaction,
and post-test. However, the outcome, in terms of individual
posttest performance scores, might not always capture the
changes in problem solving procedures and understandings of
the task (e.g.Forman, 1989). Even though the outcome shows
"success" for different pairs, the strategies or the
approaches pairs adopt might be different (e.g. Light &
Gilly, 1988 ; Lloyd, 1991). What is crucial in peer problem
solving seems to be the degree of intersubjectivity achieved

by the members of the dyad. Therefore, it seems necessary to perform a microanalysis when studying the collaborative interaction process. In this way, one may be able to understand peer collaboration as an evolving system by looking at three interrelated components: representation of the task, problem solving procedures and the interaction mode of dyads (Gilly, 1989). We also would be able to observe how peers come to share the responsibility for the task and provide stimulation and support to each other as partners in discovery.

Development of Instructional Communication Skills

There are two approaches in the study of communication skills: Referential communication studies and sociolinguistic studies. Topics relevant to the development of children's instructional communication skills will be discussed in these two frameworks.

Referential Communication Studies

The ability to convey information clearly and informatively is an important aspect of instructional communication. The area of referential communication seems relevant to the topic being studied because any peer learning or instructional exchange will include the component of referring.

Children's communication skills were studied in terms of effectiveness in referring certain items out of the array. Children often fail to refer the intended item uniquely for the listener, which is defined as "referential ambiguity," until they are around 7 years old (cf. Dickson, 1981; Robinson, 1983). Similarly, as listeners, children often do not distinguish between ambiguous and informative utterances (Markman, 1979; Robinson & Robinson, 1983).

In referential communication tasks, according to Robinson(1981), young children around the age of 5 would blame the listener for communication failure because they do not realize that the message can be ambiguous. Later, around the age of 6 or 7, messages become explicit and they tend to blame the speaker or the message for the communication failure. Children also seem to focus on the speaker's meaning (what was meant) rather than on the literal meaning (what was said) of the message (Robinson, Goelman & Olson, 1983; Beal & Flavell, 1984), and on the outcome rather than evaluating the message itself (Robinson, 1981; Robinson & Robinson, 1983). In some training studies, this skill was found to be improved by the use of a confrontation method informing the child that the message was ambiguous (Robinson & Robinson, 1983) or a feedback procedure combined with role-reversal (Sonnenschein & Whitehurst, 1984). According to the body of research investigating children's "theories of mind" (Olson & Astington, 1988; Beal, 1988), the meta-communicative

knowledge of the possibility of message ambiguity is related to the distinction between literal meaning and intended meaning, which in turn stems from the awareness of the role of inference in discourse.

In the sociolinguistic tradition, children were often described as competent conversational partners in natural settings. However, young children are found to be "egocentric" in the way they establish mutual attention; they use referring expressions that presuppose too much in situations where listeners cannot see them (Hickman, 1987). In narrative discourse children use deictic expressions like "this" or "that," relying on nonlinguistic context. Children younger than 7 use the deictic nominals repeatedly, not presupposing enough. For example, they use "the boy" at the first introduction as well as at subsequent occasions in the narration, instead of switching to the pronominal "he." However, by the time they are around 10, children usually use more presupposing devices in the discourse context. The development of metapragmatic skill, the ability to use language as its own context, also helps children rely on intralinguistic context instead of nonverbal context. Therefore, as Hickman(1987) pointed out, children's developmental progression in use and interpretations of referential devices moves toward learning to anchor referential forms within discourse which were previously deictic. This pragmatic or functional approach calls for

the consideration of context, not the form itself, to determine the appropriateness of the usage of any device.

Children's Discourse Strategies

The developmental progression from the use of nonverbal channels of communication to that of mainly linguistic channels seems to determine what kind of strategies children use in communication. Studies with adolescents (Brown et al, 1984) show that the ability to inform others clearly using the verbal channel exclusively does not develop automatically, and that these skills are very sensitive to the training using role-reversal technique and interactive sessions.

Cook-Gumperz(1977) analyzed peer instructional exchanges to see how peers accomplished tasks that require reliance on the verbal channel only. Two children, one as a "builder" and the other as an "instructor," built a model using a Tinkertoy^{TM} set. The blindfolded builder followed the directions from the instructor. She reported that children negotiated meanings relying on situational characteristics and using prosodic cues like pitch and intonation, which cause another kind of ambiguity, namely "situational ambiguity." When the negotiation of situated meaning is not possible by way of interpreting back channel cues (e.g.tone or pitch of voice), young listeners seem to guess the intentions of others by choosing the target

without requesting more information (Speer, 1984). Even though adults, too, often guess others' intentions, their guesses are different from children's in the sense that adults make choices based on possible meanings of the message rather than soley on the situation contexts (McTear, 1985).

More recently, Lloyd (1990) and his colleagues studied a variety of children's instruction-giving skills in the task of map route finding. They tried to combine two research tradition: referential and sociolinguistic traditions. Using two sets of identical maps, children were allowed to interact freely to find the exactly matching routes. This study showed that the youngest group of children are less flexible in adopting a combination of strategies while adults demonstrated a variety of strategies to accommodate the listener. This study is meaningful in that children were <u>tested</u> in a rather natural way of using the verbal channel, a telephone. Also, by looking at the strategies children use, they try to get away from the notion of proposing <u>one</u> <u>correct</u> <u>way</u> of communicating. In the same set of studies, young children are not as successful as adults and older children because they are not as skilled in scaffolding each other's communication process.

Children's manner of organizing the information and explaining to others shows developmental differences (Flavell et al, 1981; Scribner, Pratt & Cole, 1977; Cook-

Gumperz, 1977). While young children do not mark the boundary for an instructional episode by using attention focusing statements, older children often use attention getting devices and evaluative statements to produce different sequences of exchanges (Cooper, 1980; Cooper et al, 1986). This seems to be an important metacommunicative strategy because it helps conversants communicate effectively by creating the shared frame of reference. Similarly, young children inform only "do" parts when they explain games to others, not including orienting statements (Evans & Rubin, 1983). For example, they tell what to do in the game ("you throw the dice and move along the road."), without telling the goals and rules of the game.

In initiating instructions, young children often use statements which usually do not get responses from peers. They often use demonstration and pointing to instruct others. On the other hand, older children predominantly use directives or questions as initiations which are found to be effective in getting responses (Cooper, 1984; Wilkinson, 1981). In the study by Cook-Gumperz (1977), instructions were often initiated when the blind builder touched a piece. The instruction strategy, then, seems to depend on the type of available channels, tasks and situations.

Gender Differences in Interaction Patterns

Many studies have reported gender differences in interaction patterns and the kind of games girls and boys play. Girls play sedentary indoor games in small groups, according to the observations made by Lever(1976). They prefer cooperative and non-competitive turn-taking games in which conflicts are unlikely. When conflict arose, they could not deal with it and broke up instead of attempting to settle it. For girls, the concern is, Gilligan(1982) notes, maintaining interpersonal harmony and intimacy in the relationship. The organizational structure of the group is non-hierarchical and based on equality. On the other hand, boys prefer "rough and tumble" play outdoors in large groups (Lever, 1976). They prefer competitive games with rules that potentially involve conflict negotiation. Boys are involved in conflicts more often than girls (Miller et al., 1986; Goodwin, 1980). Boys tend to stress legal elaborations for principles of justice (Piaget, 1965). For them, coordinating the task is handled through hierarchical organization (Goodwin, 1980).

The gender differences are reflected in and achieved through the patterns of language use. Boys and girls seem to have different agendas (Maltz & Boker, 1982). In pretend play settings, 3 to 5-year-old boys use language to command controls and to oppose one another while girls try to construct shared play frames through language (Sheldon,

1990). In Goodwin's study of black children's task
activities, boys were found to use certain forms of talk to
achieve and display controls in the group while girls seemed
to interpret the task as needing relatively little
control(Goodwin, 1988).

The gender differences in conversational style are also
evident in the uses and choices of directives and persuasion
strategies among children. By examining directive-response
sequences, Goodwin(1988) reports that boys use directives in
aggravated forms like imperatives and request for actions
<u>now</u> while girls use mitigated forms to make proposals <u>for
the future</u>. Also, syntactically, girls' directives often
include the issuing party as one of the agents ("Let's",
"We"), while boys' directives differentiate the speaker from
the hearer ("You"). In the sequence of argumentation, boys'
direct commands are often followed by counters, like the
refusal of prior actions as in "No," "I won't do it." On
the other hand, girls counters are supported by the argument
against the appropriateness of suggested actions. For
example, in a house play situation, girls can argue against
the proposed action by saying "I am not going to cook the
meal because babies don't cook. I am supposed to be a
baby." Girls take turns in giving directives while boys
have one person who mostly issues directives. Similarly,
during conflict, boys are more likely to use heavy-handed
persuasion strategies like threats, and girls use more
mitigated strategies like compromise, clarification of

intent and/or avoidance to resolve conflict (Miller et al., 1986; Maltz & Boker, 1982).

Despite the existence of distinctive styles in two gender groups, there are also many aspects both groups share. As researchers expand their areas of observation into various contexts, they report that styles are not mutually exclusive, rather, they are more situation-specific. In the context of "playing house," girls often use aggravated forms of directives and the organization of play resembles the hierarchical structure of boys' activity (Goodwin & Goodwin, 1987). In pretend play (Sheldon, 1990), boys use mitigated forms of directives when they want to make peace with other children. And boys, not girls, shift pretend play frames more frequently. When conflict arises, girls never break out of the frame while boys abandon the theme to get out of conflict. These observations are in contrast with the findings by Lever(1976). Miller et al. (1986) highlighted the fact that most of the girls and boys use "moderate persuasion strategies" rather than either extreme forms, aggravated or mitigated, thus arguing that the difference should be considered in terms of the position in a continuum. These also show that the difference is not in terms of developmental competence, even though Garvey (1975) reported the developmental progression from direct to mitigated forms in children's use of directives. Therefore, the differences seem to be related to style and dependent on contexts or situation. Children seem to choose the

adaptive strategies that suit both the purpose at hand as well as their preferred mode of interaction. While both genders seem to have a variety of repertoires of interaction mode or speech patterns with different emphases and preferences, boys and girls usually have different agendas which also vary according to the situation. Therefore, instead of global generalization of gender differences in children's talk in peer groups, we need to look at the discourse strategies that boys and girls employ in specific situations.

Model of Communication

How do we understand each other in a real communication setting? Do we come to understand each other by thinking about other's thinking, and so on? The studies on recursive thinking with children show that it is a late developing skill. Children begin to think about other's thought around the age of 6 or 7 (Miller, Kessel & Flavell, 1970), and at the age of 7 or 8, they begin to correctly infer other's knowledge state in the second order knowledge attribution task ("John thinks Mary thinks that P")(Perner & Wimmer, 1985). However, it is still later when they can figure out other's false beliefs (Hogrefe, Wimmer & Perner, 1986). Then, how can young children communicate so easily in the natural setting? Instead of engaging in an endless cycle of recursive thinking, Clark and Marshall(1981) argue,

we come to understand each other by appealing to "common ground." The source of common ground information can be physical events (physical co-presence), previous communication (linguistic co-presence) and community knowledge. The common ground of the participants in a conversation, in other words, their mutual knowledge or shared knowledge can be obtained by utilizing one of the evidence types. These all constitute the context for interpreting and producing utterances. Therefore, ambiguous utterances can be turned into informative ones by appealing to common ground. Ackerman(1990) studied young children's use of context information. The children were found to be able to use the context information to infer the meaning of ambiguous utterances, but kindergarten children were not aware that their source of knowledge was from the inference based on the context information while second graders were.

Similarly, Bruner(1987) states, "... referring to something with the intent of directing another's attention to it requires at its simplest some form of negotiation (p.87)." If we conceive communication as a process of negotiation and collaboration between participants, effective communication for an instructional episode takes more than the speaker giving clear instructions to the passive listener. Both participants try to make sure that they understand each other by the process of collaboration, called "contribution" (Clark & Shaefer, 1989). During this collaborative process, the participatns appeal to each

other's common ground and accommodate each other's level of expertise if there are any discrepancies (Isaacs & Clark, 1987). According to this model of communication, partners try to reach the goal of mutual understanding by utilizing both the evidences of understanding and the evidence of trouble. Therefore, positive steps of making the understanding "public", for example, by nodding or saying "yes," as well as repairing the message, are essential to this model. The listener can signal that s/he has understood the message by passing up the opportunity to ask for clarification and initiating the relevant next contribution.

However, young children might have a different model of the communication process. They easily assume the identity of knowledge states, especially when others have access to the source of information like receiving messages (Sodian, 1988). Therefore, young communicators might believe that messages would add information automatically to the ground of understanding (Piaget, 1923). Or at best, they might assume that everything is shared unless there is an evidence of trouble.

Depending on their assumptions about the communication process, their strategy of communication would differ or change. In fact, young listeners often guess the referent and treat the absence of feedback as affirmation (Speer, 1984). On the part of the speaker, they seem to begin the instruction assuming that the other will fill in the missing

part by asking questions (Lloyd, Baker & Dunn, 1984).
Therefore, they rely heavily on the feedback from the
listener during the communication rather than reflect on the
quality of the message.   They assume too much that the
listener is cooperative.   What they do not realize is that
the listener might infer from the context, thus might not
ask any clarifying questions. According to the
collaborative model, the speaker intentionally draws the
listener into the process. Therefore, children seem to need
to move toward this collaborative model of communication.

Referential Perspective

Sharing knowledge or the information about the present
state, rather than assuming identity, is said to be
necessary for successful communication (Shantz, 1981; Clark
& Wilkes, 1986). However, all information is not of equal
value because what is described determines what will be
explained. Every utterance carries with it varying degrees
of presupposition, called "referential perspectives"
(Wertsch, 1985; Issac & Clark, 1989).   The choice of
referential perspectives shows the speaker's level of
assessment of what is needed to be informative to others and
what needs to be focused on (i.e. the speaker's view of the
situation) (Rommetveit, 1985) and what is "on stage" between
the partners (Grosz, 1981). For instructional communication
in problem solving, the participants need to select relevant

and functionally significant aspects of information from the situation and also need to take each other's knowledge state into consideration. However the expert's and the novice's understandings of problem solving tasks differ (Chi, Glaser & Rees, 1982). People bring different assumptions or understanding toward the task (Cole, 1985). Therefore, there is likely to be a mismatch of referential perspectives at the outset of problem solving. Then, how do participants cope with this problem? Adult communicators were found to accommodate to each other's perspectives by assessing, supplying and acquiring expertise (Issacs & Clark, 1987). In adult-child problem solving situations, adults adjust the referential perspectives depending on the level of the child to complete the task (Wertsch, 1985). As a result of interaction, children come to understand the functional significance of certain referential perspectives (Wertsch & Hickman, 1987). Then, in problem solving tasks that require children to cooperate to achieve a pragmatic solution, they might accommodate to each other's perspectives and move toward employing functionally significant referential perspectives as they gain more understanding of the task.

Summary

The majority of referential communication studies did not allow interaction between participants. Most studies

focused on the explicitness of initial message formulation or the judgment of the adequacy of the message. Therefore, it can be considered as a study of referential language development rather than that of communication development. Even though the referential communication paradigm yielded valuable information in its own right, it is far from a complete picture of peer instructional communication. These studies did not explicate how children make sense of each other in an interactive situation. Studies from the sociolinguistic tradition searched for patterns of instructional communication or discourse in the peer learning situation. Still, there are not many studies that explore the peer exchange itself as a vehicle for improving communication skills.

A few studies in the area of problem solving and communication reported children's progress in terms of message informativeness of their instructions over the short period of experimental sessions (Beaudichon, 1981; Lloyd, Baker & Dunn, 1984). In interactive situations, however, children's instructional discourse (Perlmutter et al, 1989; Forman & Cazden, 1985), as well as adults' messages in referential communication task (Clark & Wilkes, 1986), become condensed in the later sessions rather than explicit and unambiguous. These seemingly contradictory results may demonstrate the working of 2 competing maxims by Grice (1975): Maxim of Manner evidenced by message informativeness and Maxim of Quantity evidenced by message condensation.

Conversants try to keep the balance between those two rules and eventually move toward reducing the collaborative efforts of both participants as a unit (Clark and Wilkes-Gibbs, 1986).

Children need to learn that they may not have enough information. Children need to develop new concepts about the communication process and employ new strategies to find out the necessary information. Based on experiments that allow interaction and role reversal, Robinson(1986) argued that feedback during interaction is central to both communication and metacommunication development in children. After all, children were found to try harder during peer communication settings compared to themselves in adult-child interactions (Garvey, 1986). Even though young children are not as good a supporter of the communication process as older children (Lloyd, 1990), with the help of the task structure that maximizes the collaboration, they might learn to be a contributing partner in both the communication and problem solving situations. Therefore, it seems reasonable to expect peer interaction as a possible arena for children to develop communication skills and for researchers to observe how the skills develop.

C H A P T E R III
RESEARCH METHOD

Subjects

Twenty two children aged 5 (M=5:5, range 5:3-6:1) and 7 (M=6:7, range 6:4-7:0) participated in the "robot game" with a peer. Twenty children were drawn from the kindergarten and the first-second grade group of a lab elementary school near a university. For the older group, there were 12 children paired with a same sex partner, thus forming 3 male and 3 female dyads. For the younger group, there were 3 male dyads and 2 female dyads. They were paired by the teachers in the classroom. Most of them claimed that they were good friends. Even though two of the subjects were of foreign origin, the teachers claimed that they performed at the same level as the native English speaking children.

Task and Materials

Materials

A battery-operated robot was constructed out of Milton-Bradely ROBOTIX^{TM} kit, as illustrated in Figure 3.1. The robot was constructed to have five motors connected, with wires, to five corresponding buttons; two for the wheels and three for the limbs on top of the wheels. Each button has

Figure 3.1   Schematic Representations of Robot: Top and Side
Views.

two positions, called BUTTON HALVES, for reversing the direction of the corresponding motor. Since the button configurations are varied across sessions, children need to find out the relationship between the buttons and the robot movements every session. In order to make the robot go forward, two buttons for the same direction (two button halves) need to be pressed. If two wheel buttons for opposing directions are pressed, the robot will make a turn, called 'power turn' because it turns faster and makes a tighter turn than when only one wheel operates to make a turn. The top part of the robot rotates around horizontally (the WAIST move), arches forward or backward vertically (the ELBOW move), and close and open (the HAND move). A colored wood block tower, which was located about 20 inches away from the robot, served as the target. A small white tin can on top of blocks was used as a target to be picked up. The tower can be knocked down either by moving the WHEEL while keeping the top parts stationary or by moving the top part (WAIST, ELBOW, HAND) while keeping the WHEELS immobile.

Task

One child sits behind the partition with the console comprised of five buttons. This child, the **Operator**, cannot see the robot but can control it by pressing the buttons on the console which is connected to the robot with wires. The other child, the **Witness**, can see the robot and the tower.

The Witness does not have access to the buttons but can give instructions to the Operator.

Each dyad participated in 3 **sessions** (less than one week apart between sessions). During one session, each child served in both roles, the Operator and the Witness, thus having two **rounds** per session. They also alternated in taking the role of the Witness across sessions. Every time, they were given a free play period of 4 minutes before they started the game.   The goals of the game varied throughout 3 sessions, each time demanding slightly more complex operations by changing the goals (e.g. "pick up the tin can") and button configurations on the console.

At the first session, between the freeplay session and the real game, the experimenter demonstrated the operation of the robot without showing the console to the children. This was to demonstrate that the robot could actually accomplish the goal. In order to show the children that there is more than one way of "knocking over the tower," the experimenter switched from one type to another type of movement to actually knock over the tower.

Sample transcripts for the Experimenter's (E) Instruction

     E: "I want both of you to play with the robot for a while and see how it works."

(Free Play: 6 minutes for Session 1 and 4 minutes for Session 2 and 3)

(<u>Demonstration</u>: The buttons were shielded from the children's view. Session 1 only)

E. "Now, we are going to play a game. The game is to make the robot knock over the tower. Here,(Operator's name) cannot see the robot. So (Witness's name) needs to tell (Operator) how to make the robot knock over the tower. (Witness), you are not allowed to touch the robot with your hands. And you are going to switch places later."

(<u>Game</u> starts: Round 1 & Round 2)

<u>Goals</u>.

Session 1: <u>To knock over the tower</u>.

> The robot was positioned to face the tower. Therefore, The tower could be reached by moving the robot straight ahead.

Session 2: <u>To knock over the tower</u>.

> The robot was oriented 45 degrees to the right. Therefore, the robot needs to turn and go straight to reach the tower.

Session 3: <u>To pick up a block and drop it</u>.

> The robot was positioned and oriented in the same way as in Session 2.

All the sessions were videotaped in a quiet area of the school where the children attended. Each session usually lasted 20 to 35 minutes depending on the dyad's willingness to go on with the task.

Transcripts and Coding

In this section, the process of making transcripts and establishing the intercoder reliability is presented. The coding schemes are also included.

Transcript

Transcripts of verbal interactions, as well as the gestures and other contextual cues that might be relevant to the task, were made from the video tapes for each dyad, while including the prosodic cues and gestures. The transcripts also include the information on the robot movement.

Coding

The dyadic interactions were segmented into "episodes." An episode is defined as "a sequence of verbal and nonverbal behaviors which involve one intended move of the robot." The episode requires a minimum of two-part exchange, and one of them should be the robot action. Therefore, a lengthy discussion on what to do next is not an episode until the dyads try at least one button pressing following the discussion. The episode is of unspecified length and has thematic coherence. It ends when the theme changes into a new one. This definition is similar to the one proposed by Greenberg (1984). The boundary between two adjacent episodes is often marked by the attention focusing device such as "Now.." at the beginning of an episode, and "Good" or "Okay" at the end of the episode. However, these markers are not commonly found in the early stage of problem

solving. This is a strategy developed by the dyads as a result of collaboration.

The basic structure of an episode consists of 3 elements; **Instruction**, **Robot Act** and **Feedback**. Instruction and Feedback are speech acts made by the Witness. Robot Act (or simply Act) is any movement of the robot executed by the Operator. Some episodes lack either Instruction or Feedback. The following is an idealized episode with all three elements:

Witness:	"Move the arm up."	**Instruction**
Operator:	Elbow up Robot stop	**Robot Act**
Witness:	"Okay, good."	**Feedback**

Many episodes include side sequences for message clarification or button exploration that are jointly produced with the Operator's contributions.

<u>Instruction</u> is defined as a type of request that invites the goal-related action, the robot act, or the goal-related information, the knowledge state information, from the Operator. Instruction for action is composed of information on 3 components: **Part** (wheels, top), **Axis** (horizontal-lateral, horizontal-frontal, vertical, bilateral), and **Direction** ("up/down", "left/right", "to the wall" etc.). Feedback is again subdivided into two types, **Description** and **Confirmation**, depending on the amount of information carried in the speech act. <u>Confirmation</u> signals acceptance or rejection of an action or a proposition in the preceding question. <u>Description</u> carries the information on what is observable in the environment.   While both

categories are responses to the preceding act or utterance, Confirmation is normally highly goal-related while Description is not. These three categories of speech acts can be requested by the Operator, forming 3 additional categories: <u>Request for Instruction</u>, <u>Request for Confirmation</u> and <u>Request for Description</u>. <u>Information</u>, can be issued by either the Witness or the Operator. Most of the task-relevant metastatements belong to this category.

Instructions and Requests for Instruction will be coded for the <u>referential perspectives</u> that differ in terms of the amount of knowledge required of the listener to respond properly. For the Witness, the choice of perspectives indicates the level of assumption she/he holds toward the Operator's knowledge state. For the Operator, it reflects his/her assessment of how much the Witness can or need to help him/her. There are three categories: Robot-Movement relationship perspective, Button perspective and Retro perspective.

> <u>Robot-Movement relationship perspective</u>: RM p. This perspective is about what kind of move the robot needs to make. The use of this perspective requires the Operator's knowledge of which button to press for the desired robot act. "Make the arm go down a little." "Close the hand."
>
> <u>Button perspective</u>: B p. This perspective is about the buttons. The use of this perspective does not require any knowledge of the button on the part of the Operator. "Press the second button on top." "Try every button."
>
> <u>Retro perspective</u>: R p. This perspective is deictically or pronominally anchored to the previous robot act or the Operator's button pressing act. The

use of this perspective does not require any knowledge about the buttons or the types of robot act on the part of the Operator. "Keep doing that." "Do it the other way."

Intercoder Reliability

The intercoder reliability was established for a portion of transcripts (6 out of 33 transcripts), in three types of codes: episode, speech act and perspective. A person independent of this study was trained with the coding scheme until a satisfactory level of agreement was achieved with the author's coding.

Episode. Since the episode itself served as a unit, it was not possible to calculate the intercoder reliability by calculating the rate of the number of agreement divided by the total number. There was no fixed total number. Therefore, each coder coded the episode and checked the number of episodes that coincide between both coders. Also the number of episodes for each coder was recorded. Then the coder reliability was calculated as follows:

$$\frac{2 \times \text{number that coincides}}{\text{total \# by the 1st coder} + \text{total \# by the 2nd coder}}$$

The intercoder reliability for the episode was 81.5% when both age groups are combined. When divided into two age groups, the reliability was 73.6% for the younger group and

87.9% for the older group. This intercoder reliability itself reflects the developmental difference. For younger children, the beginning and the end of episode or frame are often not clearly defined. However, in this study, the definition of the episode is theme-related in this task situation. Therefore it could be different from their natural conversational ability to mark the frame.

Speech Act. For every codable unit, the utterance, agreement by both coders was checked. The number of the absolute agreement between two coders were counted and devided by the total number of units. The absence of coding for a particular unit by both coders was marked as agreed. On the other hand, the absence of coding from only one coder for a partuclar unit was marked as not-agreed. When the coders assigned different numbers of codes to a particular unit, it was also marked as not-agreed. The percentage of agreement for the speech act coding was 76%.

Referential Perspective. Since the referential perspective is a framework of mind, or way of thinking, it does not change every second or every time an utterance is made. Therefore, it seems more reasonable to check the reliability of perspective coding using the episode as a unit. Whenever there was a disagreement over assigning the perspective in an episode, it was marked as non-agreed. Then the reliability was calculated by dividing the number

of agreement by the total number of episode. The author's
episode coding was used for the basis for counting.   The
reliability for the perspective was very high, 94%. This
was due to the nature of categories which could be easily
discernible from the word content. However, disagreement
arose over the cases where children made instructions by
mixing up two main perspectives. The typical example would
be, "Press up." It was not easy to tell what was meant by
"up." (It could mean either "press the top button half" or
" press the button for the arm up.") The decision was made
considering the contextual information around that
particular speech act as well as the prosodic cues such as
the intonation or the stress pattern.

Coding Schemes and Examples

According to the definitions provided above, the task-
related speech acts were coded. All the codings were done
in subcategories. Also for each coding, the content
description of robot act was included.

Speech Acts.

I: INSTRUCTION
    a. ACT
        I(A:)   INITIATING ACTIONS "Lift the hand."
        I(A~)   CONTINUING ACTIONS "Keep doing it."
        I(A.)   TERMINATING ACTIONS "Stop it."

    b. INFORM if the Operator has the knowledge or
    understanding
        I(INF: REF-ID) REFERENT-IDENTIFICATION

                    "Do you remember the blue thing?"
        I(INF: LK)   LABEL KNOWLEDGE
                    "Do you know what clipper is?"
        I(INF: BK)   BUTTON KNOWLEDGE
                    "Do you know how to go forward?"
        I(INF: INS) UNDERSTANDING INSTRUCTION
                    "Do you know what 'up' means?"

RI: REQUEST FOR INSTRUCTION

RI(A) GENERAL: Request for Instruction on what action
to take.
                    "Now what? What should I do?"
RI(message) WITHIN perspective: Request for
clarification of message either in RM or B perspective
                    "Which way is sideways?"
                    "Move what?"
RI(ME-), RI(B-) ACROSS perspective: Request for
instruction on means or buttons to achieve the goal.
                    "Then, which button is it?"
                    "How do I do that?"   "How?"

C: CONFIRMATION   (C+, C-, C)

C(A) by W: Confirmation of robot act
                    "Yes, you are doing it."
C(I) by W : Confirmation of Instruction expanded by the
Operator
                    "Yes, that's what I mean."
C(I) by O : Confirmation of understanding or hearing
Instruction
                    "I got it." "Okay."

RC: REQUEST FOR CONFIRMATION

RC·I : Request for confirmation of Instruction
                    "You mean, 'forward'?"
RC·A : Request for confirmation of robot act
                    "Is this it?" (pressing button)
RC·A+:   "Is this the right one?"
RC·D : Request for confirmation of Description
RC·D(A)   "Am I going forward?"
RC·D(ST)   "Am I near the tower?"

D: DESCRIPTION

D(A) : Description of robot act
                    "The robot is turning around."
D(ST): Description of the state or situation
                    "It's close to the tower."

RD: REQUEST FOR DESCRIPTION

RD(A) : Request for Description of robot act
                    " What am I doing?"
RD(ST): Request for Description of State
                    "Where am I?" "Where is the robot?"

INF: INF/Meta-statement

INF(A): Informing what the O is doing with the robot
"Forward? Okay,I am now doing forward."
INF(P) : Informing the plan.
by O :"Okay, I will try every button."
INF(K) : Informing the knowledge state, mostly in response to the W"s I(INF:BK).
"I don't think we can do forward."
INF(Ad): Informing the other of the past actions
"I did." "I pressed all the button."
"I was keeping on the same button."

<u>Robot Acts</u>.

A: LF, LB (LEFT WHEEL TURN FORWARD, TURN BACKWARD)
A: RF, RB (RIGHT WHEEL TURN FORWARD, TURN BACKWARD)
A: RF/LF (STRAIGHT FORWARD)
A: RB/LB (STRAIGHT BACKWARD)
A: Wc, Wcc (WAIST CLOCKWISE, WAIST COUNTERCLOCKWISE)
A: E1, E2, UP, DN (ELBOW UP, DOWN)
A: HO, HC (HAND CLOSE, OPEN)

/ : pressing 2 buttons at the same time.
> ; pressing the same button but the direction is changing.
    E1, UP>DN (Elbow is moving up and then continues to go
    down)
a : "away" from the tower
t : "toward" the tower

<u>Robot Parts</u>.

X : the top part of the robot (claw, arm)
R or WHEEL: the bottom part (robot, wheel)

C H A P T E R   IV
RESULTS OF ANALYSIS

Introduction

This chapter presents the analysis and the interpretation of the data. The transcripts from the videotapes of children playing the robot games are the source of information for this analysis. This chapter is divided into five main sections. First, overall performance of the dyads will be reported. That section will be followed by a discussion on the process of theme negotiation. Third, the message construction process will be examined and discussed with the focus on message repair mechanisms. Next, how the dyads come to share terms for the description of robot movements and parts will be explored. Finally, the strategies for describing spatial directions with a moving referent will be presented. In the last section, a summary of the salient points presented in the analysis will close the chapter.

The Overall Task Performance

In reporting the outcome of the task performance itself, it is worth noting that the task demands vary across three sessions. The first two sessions are almost identical in terms of the final criteria of "success," which is

"knocking over the tower." However, in the third session, children are asked to "pick up the can" which seems to require a great deal of coordination as well as advance planning to succeed in the task. For example, in order to pick up the can, the dyads need to make the HAND open first before putting it down to grab. Also, the amount of time the children spent on this game on each round varied greatly. For Session 1 and 2, the goal was "knocking over the tower." As long as the dyad knocks over at least one block of the tower with any part of the robot, they were categorized as successful. For Session 3, the criterion for success was whether the dyad could grab the target can, even though in the beginning instruction, they were asked to "pick up the can and drop it so that (name of the Operator) can hear it."

In all, each dyad played two rounds with role-reversal per session, and they repeated three times. Also there are six dyads for the older group and five dyads for the younger group. Therefore, there are 36 rounds in all for the older group and 33 rounds for the younger group. The dyads were listed with code names that were made up of the first two letters of each member's name. Therefore, JODA represents two names of the members, JO and DA.

Table 4.1 : Overall Task Success/Failure

AGE	SEX	DYAD	SESSION	ROUND1	ROUND2	TIME
5	M	JODA	1	−	+	27:00
			2	−	−	20:00
			3	−	−	27:30
5	M	TOJU	1	−	−	33:00
			2	−	−	21:20
			3	−	−	22:30
5	M	BLCL	1	−	−	31:00
			2	−	−	26:50
			3	−	−	20:50
5	F	LECH	1	+	+	27:00
			2	+	+	27:00
			3	−	−	28:00
5	F	AMNE	1	−	−	26:40
			2	−	−	21:18
			3	−	−	18:30
7	M	JADY	1	+	+	8:00
			2	+	+	14:20
			3	+	+	5:20
7	M	LUAD	1	+	+	19:00
			2	+	+	23:45
			3	+	+	28:40
7	M	TRJO	1	+	+	28:00
			2	+	−	29:30
			3	−	−	21:30
7	F	ANMA	1	+	+	15:00
			2	+	+	9:40
			3	−	−	23:40
7	F	TAWI	1	−	−	18:10
			2	−	+	12:40
			3	−	+	22:00
7	F	CATH	1	+	+	24:00
			2	−	−	25:40
			3	−	−	25:20

Key: + indicates success
     − indicates failure

Developmental Differences

Developmental differences were evident in the success rate of the overall performance. All the older dyads (7-year-olds) finished the task with success at least in two games while only two of the younger dyads (5-year-olds) ever succeeded in the game. Also, the success rate of games for the older group, 23 games out of 36 (63.8%), is far greater than that of the younger group, 5 games out of 33 (21.7%). Therefore, even with this small number of subjects, it can be concluded that there is a developmental difference in the success rate that is almost complete by age 7.

The most successful dyad, JADY, was also the one who spent the least amount of time on the task. Even in the third session, requiring an advanced level of precision, they finished the task in the shortest amount of time. Therefore, it seems reasonable to argue that this dyad learned how to play the game rather than succeeded by chance. On the contrary, the LUAD dyad, similarly successful according to the criterion of simple success or failure, spent increasingly more time in the later sessions. Therefore, even within an age group, it is likely that there are some differences in approaches each dyad employed to accomplish the task.

Gender Difference

This task is a communication task with an object that is typically associated with boys. Therefore, it can be generally assumed that the boys will be more successful in this task because they might have more expertise in this type of medium with lots of physical knowledge involved. On the other hand, some studies on pair collaboration showed no difference in terms of the outcome of the task. Therefore, it was hypothesized that there would be no difference in overall task performances. The result indicates that boys succeeded in the games slightly more often than girls did when both age groups are combined (44% vs 36%). However, one of the younger girl dyads succeeded in 4 out of 6 games and contributed to elevate the success rate when both age groups were combined. In the older group alone, boys were highly successful while girls were not when the number of successful games were counted (83% vs 44%, respectively). From this result, it appears that the older girls are either far less skilled communicators than their male counterpart or the girls' performances were hampered by the lack of relevant physical knowledge, or both. However, from this sample, it doesn't seem appropriate to speculate on this subject due to the small and unequal number of samples for each group.

Negotiation of Themes

If one conceives communication as a negotiating process, then children in this task are engaged in the process of negotiating what they will work on or discuss. Unlike most of the experimental studies, children in this game are not faced with a set of pictures that they must describe to each other in a fixed order. The sequence of action they take and communicate about is not predetermined. Therefore, the children in this task have to do more than simply map out their thoughts into words like most of the referential communication studies seem to assume communication to be. In fact, in everyday conversation, we often find ourselves in the process of negotiating what we are going to talk about. Successful communication seems to entail the step of joint negotiation of themes rather than one party deciding the theme without giving the other an opportunity to accept or reject. If two parties cannot agree on a common theme, either implicitly or explicitly, then they will not be able to genuinely communicate. Instead, they will be engaged in a parallel argument that will not result in an "intersubjectivity" (Rommetveit, 1985), therefore preventing them from achieving a common goal of the task.

According to Garvey (1986), young children exhibit the need to know what is going on during peer interaction. Identifying the objectives of interaction or "the purpose-

at-hand" is important because it influences the partner's decision on whether to join in or to assist in the on-going event. In the robot task, children need to make the robot perform a sequence of moves to succeed. If both members of a dyad jointly identify what the next robot move or the theme of an episode is going to be, then they can assist each other by proposing alternative strategies, reminding each other of the goal, relating the goal to the means, and so on. However, in the robot task, themes need not only be identified, but also verbalized for the following valuable reasons. First, two members in a dyad do not share the same visual field. Making the theme explicit will be desirable most of the time. Second, unlike other communication games in which the number of items in the array decrease as the game proceeds, the same repertoire of actions needs to be repeated until children achieve the task goal in the robot task. It is, therefore, crucial for the dyads to establish a certain degree of button knowledge in order to be effective. Since the Operator has the button control, one of his/her main responsibilities would be holding the information in working memory during the game. The main sources of information about the robot moves for acquiring button knowledge, from the Operator's position, are the instructions and/or the feedback following the robot action which the Witness provides. Therefore, jointly agreeing on a theme and making sure that their theme is mutually known or shared will be one of the crucial parts of the

communication process for this task. The theme that is jointly agreed-upon and also shared will be termed as "negotiated". Children in this task are expected to move toward negotiating themes of episodes. The null hypothesis to be tested here is that there will be no difference in the number of negotiated episodes between the old and the young groups.

In order to test this hypothesis, episodes were categorized as either **Negotiated** or **Non-Negotiated**. These two categories were defined according to: the absence or the presence of Instructions and Descriptions; and the perspectives of Instructions and Descriptions. Episodes were also categorized by whether the theme was mutually agreed upon or not. Examples for each category is as follows;

<u>Negotiated (N) episode</u>:
> As long as the Operator does not reject and goes on to the next relevant action, the episode is considered Negotiated. It can be initiated either by the Witness or the Operator. Also, the Instruction or the Description should be made in Robot Movement perspective in order to be shared.

> **(E.1)**
> W   "Go up with the arm."
> O   "Okay."
>   Elbow up
> W   "Good."

> **(E.2)**
> W   "Now... "
> O   "Turn the clipper?"
> W   "Yeah!"
> O   Elbow up
> W   "No, not that one... Turn it."
> O   "Oh*..Is this it?" (* falling intonation)
>   Waist c
> W   "Yes. Stop."

Non-Negotiated (NN) episode:
>   A Non-Negotiated episodes occurs when Instruction
>   and/or Description is made in either Button or Retro
>   Perspective, when Instruction or Description contain
>   only general information, or when there is neither
>   Instruction nor Description at all. Also when there is
>   a clear rejection of the Operator's theme by the
>   Witness. This has two subtypes.

(E.1) <u>Non-Negotiated/Not shared</u>:

```
O     (in the middle of an episode)
      RF, t (Right wheel Forward toward the tower)
W     "Yeah..do that.  Keep on doing it."
O     RF, t (cont'd)
W     "Good.  Now..."
```

(E.2) <u>Non-Negotiated/Not agreed-upon</u>:

```
O     "I am going to do forward!"
W     "No..you will fall through the crack!"
O     "I want to..I know it will get there.."
W     "Tzzz..." (chuckles)
O     RF/LF (both wheels Forward simultenously)
W     (silence)
O     "Now what?  Open the jaw?"
W     "Huh...."
```

The number of Non-Negotiated themes for each dyad and
for each group are reported below.

Table 4.2 : Number and Percentage of Non-Negotiated Episodes
for Each Dyad.

YOUNGER DYAD	TOTAL EP.	NON-NEG. EP.	OLDER DYAD	TOTAL EP.	NON-NEG. EP.
JODA	103	11 (10.7%)	JADY	108	0 (0.0%)
TOJU	83	4 (4.8%)	LUAD	158	16 (10.1%)
BLCL	130	12 (9.2%)	TRJO	82	5 (6.1%)
LECH	162	25 (15.4%)	TAWI	134	5 (3.7%)
AMNE	54	13 (24.1%)	ANMA	82	9 (11.0%)
			CATH	80	1 (1.3%)
TOTAL	532	65 (12.8%)	TOTAL	644	36 (5.4%)

Overall, the younger group shows a higher rate of episodes with Non-Negotiated themes than the older group ($t(9)$ = 2.07, $P < .1$), even though there is a great variance within each group. The young children in this task seem to be less sensitive to the needs for sharing themes compared to the older group. However, when we compare the most successful older dyad, JADY, and the most successful younger one, LECH, they show striking differences. (Henceforth, the success score will be the number of rounds in which the goal was accomplished.) JADY has no NN episodes while LECH has the highest number of NN episodes, although not the highest rate. Even within the older group, JADY and LUAD show the lowest rate and the highest rate respectively, while both are equally successful in the overall task performance. Therefore, it is likely that these dyads are engaged in NN episodes based on different reasons and strategies.

Knowing that the majority of episodes has negotiated themes, the natural next step would be to look at how children in this task collaborated in the process of negotiating and sharing themes. Also one needs to examine the situations in which the peers fail to, or choose not to, negotiate.

Negotiation of Roles/Responsibilities

The process of theme negotiation is intrinsically related to the negotiation of responsibilities for both dyad

members. According to the "communication game" approach, communication involves "interdependent social roles and purposeful social interaction that occurs within socially defined contexts" (Higgins, Fondacaro & McCann, 1981, p.289). Through prolonged interaction, children will come to share the definition of the roles and goals of a particular communication context. These changing perceptions of goals and roles will be manifested in the conversational strategies and the obligations children assume. In dyadic problem solving, understanding the interchangeability of roles, rather than sticking to the rigid perception of two separate roles, is said to be the key to the successful learning outcome. Effective dyads work toward the common goal rather than for the individual goal. Therefore, dyads in collaborative problem solving need to learn to coordinate and subordinate their independent roles and responsibilities for the sake of achieving the common goal. In the following, the manner by which dyads in this study change their roles and responsibilities will be examined from two viewpoints: the level of participation of both members and the referential perspectives both members employ during the interaction.

Optimal Level of Participation. Peer interaction studies have often demonstrated that the most crucial element to the successful outcome is active participation from both, whether it was the tutor-tutee relationship or

the speaker-listener relationship. However, there is a need to define the "active participation" more clearly. It gives the impression that the more participation from both sides, the better the outcome would be. As measures of participation, some looked at the amount of verbal outpouring while others studied the manner of sharing responsibilities. Medium levels of verbal interaction were related to success (Bearison, Magzamen & Filardo, 1986), and so was the sharing, but not the division of responsibilities in peer tutoring situations (Ellis & Rogoff, 1986). Miller (1987) found that the type of argumentation that dyads engage in is related to the outcome. Therefore, not only the participation itself, but in what manner the participants worked during the task, is crucial.

In the case of assigned roles or uneven distribution of the amount of knowledge, it is likely that there is an interaction effect for the outcome between the role assignment and the participation level defined in terms of responsibilities. To maximize the effectiveness, dyads need to define and redefine their roles and the possible range of contribution for the task based on their analysis of the task situation. In the robot task each role carries distinctive responsibilities. It should be mainly the Witness who decides on the theme of each episode and subsequently communicates the theme in the form of Instructions, since the game allows visual access only to the Witness. It should be the Operator, not the Witness,

who needs to memorize the buttons since s/he is the one with the button control panel. However, the role assignment is not symmetrical. The Witness is expected to take control of the interaction, especially for theme negotiation. Then, how much and what type of contribution from the Operator is conducive to the outcome? Part of the process of learning is coming to share the situation-specific but adaptive understanding of the task. Children will come to construct their own understanding of the task and responsibilities that accompany each role. Within the boundaries they are assigned to, the children need to find the way to contribute to the whole process for the common goal. Here, as a modified definition of the active participation used for this study, it is expected that a dyad will be successful when they collaborate <u>within</u> <u>the</u> <u>boundaries</u> of their assigned roles. In the context of this task, the Operators should not propose themes too often. If they do, they should do so with valid reasons which can contribute to the successful task outcome. Also, as the session progresses, the dyads will redefine their roles and responsibilities as their understanding toward the task changes. Therefore, in this section, the null hypothesis is that there will be no difference between two age groups of children and across sessions in the way the Witness and the Operator share the responsibility. If the older Operators propose themes, they would do so based on the need to achieve a common goal, while the younger Operators may try to push their own agenda

based on their own needs or wishes which are not related to achieving the common goal.

Gender differences in communication style are found in everyday conversation as well as in task-oriented communication settings. Girls tend to be more concerned with keeping the interpersonal dynamics intact while boys tend to treat the game situation as a ground for control. For example, girls mitigated their requests by using indirect forms and by giving goal-related accounts for their requests. Boys tend to use directives and often provide no explanation. If boys give reasons for requests, they are based on personal desires. One would expect, therefore, to see different interaction styles of theme negotiation for two gender groups. The literature on gender differences document that boys and girls use different conversational styles in interaction because of their differing perceptions or goals of the situation, not because of developmental differences. Even though one style is not developmentally advanced from the other, the dyads may gradually learn to assign priority to the common goal of the task over other interaction goals. Therefore, it is also expected that both gender groups move across sessions toward the mode of interaction which is more task-appropriate. The null hypothesis to be tested here is that there will be no difference across gender groups and across sessions in terms of negotiation strategies.

Each dyad will be examined separately to observe the different strategy of theme negotiation among dyads or across gender and age groups. To indicate the age group and gender for each dyad, OB and OG will be used to represent the "older boy" and the "older girl" respectively and YB and YG for the "younger boy" and the "younger girl" respectively. The following sample is included to illustrate the conventions for the actual discourse excerpts.

W[1] "Now, move up the pincher."[2]
O[3] HC[4]
W   "No, the PINCHER![5]"
O   "Okay....[6] This?"
      (looking at the partition expectantly)[7]
      Elbow 1, up
W   "Yeah!"

<LUAD[8] 1-2[9], 07:45-[10] >

(1) W :Witness
(2) " " :actual discourse
(3) O :Operator
(4) capital letters without quotation marks: Robot Move
(5) Capitalized words : Stressed words
(6) ..... : hesitation between utterances
(7) ( )   : the author's observations or descriptions
         of the on-going situation
(8) LUAD : Code name for dyads
(9) 1-2   : Identification of session and round
         (Session 1 Round 2)
(10) 07:45 : readings of digital timer in the video
               tape

For **JADY**(OB), a very successful dyad, the amount of verbal contribution from both Operators was minimal in the process of theme negotiation. In Session 1, both members as Operators did not actively participate in the process of

theme negotiation at all. In fact, there was not much verbal contribution of any nature from the Operators. In this dyad, the W did not seem to leave much room for the O to initiate the episode with theme proposals because both Witnesses, from the beginning, initiated episodes with Instructions. However, on a few occasions, both Operators proposed a change of themes <u>during</u> the episode, usually near the end of the game. They seemed to be checking, for example, if it was time to "knock over the tower" rather than "keeping moving forward." This indicated that they were actively monitoring the progress of the game. They had some expectations of the progress of the game as well as the functioning of the robot.

A very similar example of this type of monitoring is found in the following.

```
W      "Open it."
O      "Open it?"
       HC*
W      "No.  Open it."
O      HO
W      "Okay."
       "Close it."
O      "Why?"                                (1)
W      "Oh..Forward."                        (2)
```

<div align="center"><JADY 3-2. 11:28-></div>

In the above example, the O asks for the rationale for the seemingly unreasonable instruction with "Why?" **(1)** This, in turn, caused the W to reconsider his own instruction and change it into **(2)**. This simple question was very effective in preventing them from wasting their effort of engaging in a purposeless action of negating the previous movement.

This shows that the O is not blindly following the instruction. He plays the role of <u>more than a mere extension of the witness's hand</u> in this game.   The O is not a passive listener and he is **IN** this game along with the W.

The Operators in this dyad did not try to take total control of the other's responsibility. They contributed to the process by monitoring the progress of the game and providing the scaffold for the Witness.

Another dyad, **LUAD** (OB), shows a different approach to the task. In the beginning of each round, they usually start the episode by giving Descriptions rather than Instructions. These two categories are different in terms of the amount of responsibility the W assumes toward the task. For example, in Session 1, Round 1 started with a hidden theme:

```
O     RB
W     "You're going the wrong way."
O     RB/LB
W     "You are going the wrong way."
O     E1, down
W     "I think you are going pretty silly."
O     "Why is this silly?  It's funny."
W     "You are not going near the tower."         (1)
O     "I don't even see the robot 'cause I am     (2)
      looking at this stupid white curtain."
      (Robot churning)
W     "Make the pincher go up."                   (3)
                    <LUAD 1-1. 10:19>
```

The W here, LU, gives Descriptions in terms of what the robot is NOT doing **(1)**. If we put this description in the context of goal-oriented action, then, it is possible to infer the implicit goal from this statement. There is no other reason for the W to mention what the robot is not

doing, other than as an indirect expression of the gap between the desired goal state and the present state. Here, "going the right way," which means "going near the tower," seems to be the hidden agenda of this episode. Even though, the theme became clear eventually toward the end of this episode, the whole episode was not composed of focused interactions because there was no previous mention of what was to be the "right" way. By describing the movement as being "going the wrong way," the W here is presuming that the O knows the right way. The first episode with an implicit theme needs to give way to the episode with a more explicit theme as the W realizes the need to give instructions to the operator. In contrast to the rounds in Session 1, Session 2 and especially Session 3, one of the W, LU, started to give instructions early in the beginning of an episode. The O, AD, contributed to this change by reminding the W of the presence of the visual barrier in this case, or by asking for an Instruction, like "Well, which way am I supposed to go?" in another case. Overall, the O supported the process by directing the W's attention to not just <u>what was going on right now</u> (Description) but <u>what kind of information was needed and relevant</u> (Instruction) to this task.

The O, AD, proposed themes very actively early on, even though he gradually modified the manner of contribution so that he supported the process of executing themes rather than proposing themes. AD, in a later session, used the

form of INForming to propose a theme from a ground different
from that of previous proposals.

```
O       "Now I am gonna go straight."              (1)
        E2, down
W       "Your pincher is going up, I mean, down."
O       E1, up
W       "Now it's going up.  Stop!"
O       R stop.  Waist
W       "Go straight!"                             (2)
                        <LUAD 3-1. 08:36>
```

For this dyad, the theme of "going straight" has been, for
the past two sessions, the most important and the most
troublesome one. Therefore, it is not surprising to see the
O propose the theme of "going straight" at the early stage
of Session 3 (1). The initiation by the O in this case does
not seem to be from the O's belief that he can execute this
task without any guidance from the W. Rather, it was a
proposal from the operator saying "let's find out how to
make the robot go forward," since they didn't have that
particular button knowledge at the time. The surface form,
INForming, which the O chose for this proposal and the way
the W signals acceptance were rather unusual. The W does
not immediately accept the proposal by the O. Instead, the
W adopts it as his own and indirectly accepts it by later
issuing an instruction with the same content, "Go straight!"
(2) This way, the W can have the same degree of authorship
as the O has for this theme and the controlling power over
the ensuing interaction.

Overall, this dyad exchanged messages in a large
quantity, often trying to overextend their own

responsibilities for the assigned role. This tendency seems to stem from their perception of this task, and their interpersonal relationship in general, as a game of "control." Despite this initial attitude, which is not conducive to a successful outcome, both Operator, especially AD, gradually moved to collaborate within their own boundary of roles in their own way.

TRJO (OB), in Session 1, shared most of the themes that were originated by the W's Instructions. However, their games began to deteriorate when, in the beginning of Session 2 Round 2, one of the dyad members, JO, tried to take control of the game as an O and the other member, TR, wasn't willing to initiate episodes as a W. Since the O took control by way of asking for Descriptions, his theme proposals were not open for negotiation.

The interaction in this dyad was not focused around themes. The episodes were lengthy but often without clear marking of the ending. In one case, the W began to give Descriptions of the robot movement in relation to the overall task goal, not the current theme of the episode. When the description changed from "You're getting further, further and further" to "Getting closer, closer..," the O kept pressing the same button until the W gave an instruction to stop. This dyad's focus was on the underlined resulting state of robot move, "getting closer to the tower," rather than the means to achieve it, "moving the robot wheels." This strategy of aiming at the global level of goal

demonstrated flexibility and was used effectively by other dyads because they kept both the goal and the means to achieve it in mind. However, TRJO's strategy of relying on the resulting state only deprived them of the chance to accumulate button knowledge. This tendency seemed to have caused the deterioration of the game for TRJO because the task was viewed as a game of <u>random chance</u> rather than that of <u>planning and effort</u>.

In one of the older girl dyads, **ANMA** (OG), both Operators were not very active in terms of proposing themes. Only a few attempts were made when there was a gap between their expected plan and the witness's plan. In Session 1, after several episodes of moving the robot wheels, the O requested for confirmation of her idea; "Should I try to knock it over <u>now</u>?" Similarly, in Session 2, when W2 was struggling to give an instruction about moving the top part of the robot in the second episode, O2 suggested, "Straight?" From these examples, we can see that the O was actively following the progress of the game with her own idea about how to proceed in the game. Therefore she would propose alternatives based on reasonable grounds.

TAWI(OG), as Operators, also increasingly learned to propose the alternatives to the W's plan. Contrary to the absence of any attempt to do so in Session 1, the O, WI, proposed an alternative approach in problem solving on several occasions in Session 2. Despite the initial rejection of the theme, the O kept on proposing the same

theme from time to time which was eventually accepted, but
with different wordings in the new Instruction, by the W.

```
O    HC
W    "That's close."
O    "Now what?  Can I do it?  Can I swing it?"   (1)
W    "No----.  Make your clippers go a little      (2)
     sideways."
```
<div align="right"><TAWI 2-1. 11:30></div>

For this dyad, **(1)** and **(2)** represent the same action, Waist.
The W adopted the content of Instruction from the O's
attempt to propose **(1)**, but in a way still keeping her
authority as the W intact. Previously, the same phenomenon
was observed in the LUAD dyad in a slightly different way.
Despite the strong feeling about her plan as evidenced by
repeated attempts, the O, WI, did not impose her own idea on
the W. The O always used the form of Request for
Confirmation, rather than INForming as the O, LU in the LUAD
dyad. By Session 3, there was only 1 case out of 69
episodes of the O proposing a theme. It happened in the
last episode of Round 2 when the O requested confirmation
for the only possible action left to achieve the goal,
opening the hand to "drop the can." Overall, the attempt to
contribute themes by both Operators was minimal. The
members of this dyad seemed to be sensitive to the role
division. They showed an effort to respect and protect the
perceived boundaries of both roles, in contrast to the boy
dyad, LUAD.

Throughout Session 1, for **CATH** (OG), both Witnesses
were in firm control of defining and issuing Instructions in

general. But O2 (the Operator of Round 2) also attempted to propose themes in 3 episodes. One of them is related to the problem most of the dyads had in this task: finding the button for STRAIGHT FORWARD movement.

```
W       "Now go frontwards."
O       LF (about 3 seconds)
W       "It doesn't look like frontward.
        It looks like sideward."
O       "I know!  You did that to me!          (1)
        Now, I will go sideways, Okay?"        (2)
W       "Okay."
O       RF, toward  "That sideways?"
W       "Yep."
                            <CATH 1-2. 41:00>
```

What O2 did here is much more than just proposing and sharing the theme for negotiation. Since this was the second round after role reversal, O2 already experienced the same kind of puzzlement that W2 (the Witness in Round 2) was experiencing. She solved the same problem in Round 1 as W1, by labelling the WHEEL TURNING move "sideways." This experience helped O2 initiate a step of trying to work within the constraints. When the new W showed puzzlement and possibly frustration, because O2 was in the same situation when she was W1, she could first sympathize with W2 **(1)**, and could steer the process from being stuck in the fruitless repetition. Even though the movement was not what they intended, by proposing the theme of "going sideways," **(2)** the O highlighted the fact that it had the potential of moving the robot closer to the goal and defined the movement with the previously shared term, "sideways." The experience

resulting from role reversal helped the members to work for the common goal not only by sensitizing them to the needs of the other but also by providing the practical tool to contribute to the problem solving process.

JODA (YB) was successful in Session 1. After a near success with well coordinated communication in Round 1, they finally succeeded in knocking over the tower in Round 2. There were many attempts from the O to propose themes across three sessions. But Session 1 was tightly managed by both Witnesses, mostly with Instruction in Button Perspective in Round 1 and with Robot Movement Instruction in Round 2. As a result, both Os didn't have much need nor opportunity to contribute to the theme negotiation process. In one rare case, the O1, JO, was trying to initiate an episode with button pressing.

```
W       "Now...."
O       "Press this one?"  Waist c*                (1)
W       (looks at the robot)
        "Okay, you can do that. Yeah, do that." (2)
O       Waist c, toward
W       ".....cause that's the claw.."              (3)
O       Waist c, toward>away
W       "No! No.."
O       R stop.
                              <JODA 1-1. 12:25->
```

There was no evidence that the O had the knowledge of that particular button in (1), when the previous episodes were examined. The O, JO, here seemed to propose the button simply for the sake of participating, not as a way of collaborating on the theme based on his expectation or knowledge about the overall plan. Here the W, DA, accepted

the proposal **(2)** and also tried to share the information by Description **(3)**, maybe because he believed that the O did not know what he pressed. In fact, while 20 out of 28 episodes in Round 1 had some degree of Instructions in Button Perspective, only five episodes had NN themes. Given the high rate of N themes, DA seemed to be aware of the possible problem of communicating only with button information. Later when JO got anxious to move on with the task, he began to propose themes, as the O, mostly based on his own wishes and his own capability rather than based on the analysis of the game. For example, in Session 2 Round 2, 7 out of 16 episodes had at least one theme proposal from the O, either as an initiation or in the midst of working on another theme. Note that HAND OPEN move of the robot was so distinct that most of the dyads could remember that piece of button knowledge from freeplay sessions.

```
W       "Now, bring the arm like..."
        (gestures an arching forward movement)
O       RF*-LF*                                           (1)
W       "No, no, no, no.  Stop!  Stop! Stop!"
O       R.
W       "Bring the arm over."
O       HC
W       "No, that's the jaw."
O       HO
W       "No!  Can you...  Leave the jaw closed." (2)
O       "NO!  OPEN!!"                                      (3)
W       "Okay----- "
```
                         <JODA 2-2. 24:29>

Since the O, JO, knew from the beginning of the round that RF-LF was for the STRAIGHT FORWARD move, it was likely that he intentionally used those buttons **(1)** in this episode.

It could be that he didn't know which button to press in order to follow the presented Instruction or he simply wanted to get close to the tower regardless of the W's Instruction. Either way, JO didn't attempt to negotiate the theme. JO refused to follow the instruction, "leave the jaw closed" in **(2)** and **(3)**. In fact, he was repeatedly proposing the theme of "opening the jaw" even in the first episode. Later in the same round, the O again challenged the boundary of the W's role **(3)**. Insisting on his own idea without negotiating proved to be counterproductive, especially in the final stage of the game when precision was required.

```
W    "Put the jaw down and you will wreck it!"
O    "No...I want the JAW to wreck it."              (1)
W    "The JAW will wreck it."
O    "No, I mean the jaw to close and wreck it."
W    "Oh\  That won't happen now.  You're stuck!"
O    Waist c
W    "No, no, no! You still stuck.  Stuck!"
O    R.
W    "It's moving but you can't get the building   (2)
     down that way." (The arm is too high to knock down
     the tower)
                              <JODA 2-2.  34:04>
```

Eventually, they couldn't knock down the tower because they couldn't resolve the theme between them. The O advanced his own theme out of his personal desire **(1)**, rather than to support the team success in problem solving. In contrast with the O's assertion of his desire, the W attempted to persuade the O by giving, though not complete, the rationale that's related to the task success **(2)**. So far, JO, as the

O, reduced the role of the W into an "mindlessly extended eye" for him. In Session 3, the situation got worse, and JO didn't even trust the descriptions provided by DA, the W and his description.

```
     (In the middle of the first episode)
     O     "Open the jaw?"
     W     "No, it's already open."
     O     "No, it's not."   HC                          (1)
     W     "Yeap.  That's closed."
     O     HO                                            (2)
     W     (looks at the robot and turns away)
           "Good night!" (lying down on the floor)  (3)

                    <JODA 3-1. 10:32->
```

Since the O trusted his own limited knowledge rather than the W's description (1), and went on pursuing his own agenda (2) despite the rejection by the W, the W shut down the communication channel saying, "Good night!" (3). From then on, the O began announcing his themes in the form of INForming which didn't get much cooperative response from the W in the process.

By being overly eager to participate in the theme negotiation process, even across the assigned boundary, JO's active participation as the O hampered the progress in this task. He couldn't negotiate themes successfully because he couldn't put the success of the dyad as a team before his individualistic "wants" and "needs."

The majority of NN episodes for **BLCL** (YB) were initiated with Instructions in Button Perspective. Even when the O proposed a move, it was often in terms of buttons.

```
W     "Now.... (pause)"
O     "Do the left?"                              (1)
W     "Yeah."
O     LB
W     "Yeah, keep on going..."
                              <BLCL 1-1. 20:25>
```

(Before this episode, they had been exchanging in terms
of buttons. The word LEFT seemed to refer to the left
side of the control panel. The left wheel button which
the O pressed was the left most one for that session.)

Without the O's knowledge of what the "left" button did, the

theme couldn't be shared. This was also found in session 2

as well. Because of the overall tendency to rely on button

information, the O in this dyad even invited the instruction

with "Now which button?" instead of "Now what should I do?"

as an episode opening device. As the game went on without

progress, the only theme the O seemed to have in mind is

"going near the tower." Therefore, he kept asking "Am I

getting anywhere?" regardless of the proposed theme. The

focus of the discourse was on the resulting state without

considering the means to achieve it, as was previously

observed in the TRJO dyad. However, unlike TRJO, BLCL

sometimes switched their focus of the discourse to the

concrete means only ("Now, which button?") without even

mentioning the goal or the outcome. The older dyad TRJO

seemed to understand the impracticality or impossibility of

exchanging in Button perspective only.

For **TOJU** (YB), most of the episodes were initiated by

the W. In session 1, O2, TO, after the role reversal, was

much more actively engaged than O1, JU, in proposing themes;

1 episode out of 29 vs 7 episodes out of 32, respectively

for Round 1 and Round 2. When the circumstances and the theme contents were examined, O2 proposed the FORWARD move most of the time. To O2, when he was W1, the FORWARD move was a much needed but most unsuccessful one. Despite the frustrating previous experience, O2 wanted to try it, probably because he believed that HE, not O1, could find it since he had the control for buttons at the moment. In fact, O2 blamed O1 for being incompetent of doing the task. He even flatly announced his plan in the form of INF(P), "Okay, forward," ignoring the W's Instruction. In other remaining cases, he proposed the BACKWARD move as a way of correcting the overshot situation of the presumably FORWARD move. Those "Backward" proposals were always made when the W yelled, "Stop!" In this sense, O2 learned from the experience of being a witness that it was often possible to overdo robot movements. Unfortunately, for TOJU, this sensitivity was not developed into a communication strategy to prevent overshot cases, as it often did for other dyads. Instead, in the later sessions, they became less coordinated and less responsive to each other.

For LECH (YG), more than half of the NN episodes were the result of issuing instructions in terms of buttons, mostly with the instruction to TEST BUTTONS (TB). This was one of the ways this dyad invented to get the WHEEL TURNING moves.

```
W       "Now press all the buttons."              (1)
O       LF
W       "Nope"
O       Wcc
W       "Nope"
O       RF, toward
W       "Yeah."                                   (2)
O       "Oh, that's the number 3."                (3)
        RF   R.
W       "Keep on doing that."
O       RF
W       "Now stop."
```

<div align="right"><LECH 3-1.   1:36></div>

This is one of many cases of similar situation. The episode

started with a usual framing device, "Now," (1) signaling

the beginning of a new episode rather than a subroutine of

button exploration for the previous episode. When the W

confirmed the intended move (2), which was the RIGHT WHEEL

FORWARD TURNING, the O provided the button information to

the W (3). It was an interesting and unusual way of sharing

information because sharing was attempted within the realm

of the O's responsibility. Instead of requesting for

Description of what the robot was doing from the W, she

provided the button information. It could be an effort on

the part of the O to share the burden of memorizing the

buttons with the W as well as an effort to ease the problem

of describing the turning movement for the W.   Even though

the W didn't utilize this particular piece of information in

giving Instructions in the same round, O1 as W2 gave

instructions in buttons after the role reversal; "Now, press

the number 3." Judging from this, O1 seemed to know the

type of move for the Button 3 in that session. Then, this

speech act was an attempt to create a piece of common

knowledge to ensure the success and efficiency of future communication. Many dyads tried to instruct each other in terms of buttons. However, they provided information only when they were asked after role exchanges. What was unique about this dyad is that the O expected beforehand the utility of sharing button knowledge, and even once reminded the W as in "Remember, it's Button 3." Therefore, it shows a planful and deliberate act on the part of the O and involves a high level of metacognition compared to other Operators trying to regurgitate the information at the partner's request. This was also different from other younger dyads whose Operators often initiated episodes in Button perspective without the button knowledge.

AMNE (YG) started each round almost invariably with an episode with no explicit theme.

```
O       "Is that the wrong way or the right way?"    (1)
        HO,  LB (left wheel backward)
W       "No, AM!  Not that way."
O       LF (left wheel forward)  "Is that it?"       (2)
W       "And it's not that way either."
O       "Oh well..This way?"   RB (right wheel backward)
W       "Not that way either!!" (tone of disbelief)
O       "That way?"  RF (right wheel forward)
W       "You are close to it.  Stop!"
O       R.
                            <AMNE 1-1. 15:08>
```

During this rather lengthy Episode 1, there was no explicit discussion on "it" **(2)** or "the right way." **(1)** It was assumed to be known by the W, and the O didn't ask either. It was almost as if the O was asking, "Is this the one that you had in mind?" at every turn. Instructions from the

Witnesses were slow to come and the Operators never explicitly contributed to theme negotiation. In a rare occasion, the O initiated an episode without checking with or telling to the W. This dyad implicitly negotiated the theme.

In all, the dyads in this task shared responsibilities in different ways. First of all, for both age groups, most of the themes were proposed by the Witnesses. But the older Operators in most of the dyads were less active than the younger Operators in contributing to the theme negotiation process in terms of amount. When the older Operators contributed, they did in a way that served the common goal while the younger Operators tended to contribute based on their own individual desires. For many very successful dyads, the Witnesses issued themes, while the Operators monitored the progress of the task and proposed themes only when it was necessary. Across sessions, the Operators in successful dyads gradually moved away from directly proposing themes toward supporting the W indirectly.

Changes in Referential Perspectives. Another way of looking at how the dyads negotiate and share the responsibilities is examining the changes in the referential perspectives. While the dyads are proposing or negotiating themes, they are also negotiating which perspective will be adopted for the current episode. In this task, three different ways of giving and requesting Instructions were

identified. They are <u>Robot Movement Perspective</u> (RM P), <u>Button perspective</u> (B P) and <u>Retro Perspective</u> (R P), depending on the referent in Instructions. RM perspective Instruction is about how the robot should move. B perspective Instruction is made in terms of which button(s) to press. Instructions from Retro perspective are anchored to the previous actions of either robot moves or button pressing. Out of three, only two, RM perspective and B perspective, are relevant to the process of negotiating themes because the use of Retro perspective alone will not provide the dyads a chance to negotiate themes.

The choice of referential perspective reflects how the responsibility toward the task is shared between members. In general, Instructions in RM perspective focus on the subgoals a dyad needs to work on to achieve the task goal, while Instructions in B perspective focus on the concrete means to achieve subgoals. When the W gives an Instruction in RM perspective, she/he presupposes that the O knows the means to achieve the subgoal or at least expects the O to assume the responsibility of figuring it out. On the other hand, executing an Instruction in B perspective does not require the O to have the relevant button knowledge. Therefore, depending on the understanding of the task and the definition of their roles in it, dyad members will choose a perspective or perspectives that carry different levels of responsibility toward the task. Considering the

task setting, it is expected that dyads, across time, will move toward using RM perspective in giving Instructions.

In an effort to visualize the changes in terms of the perspective choice across sessions and the amount of efforts dispensed by the dyad members, graphs were constructed using the Instructional messages in two perspectives, B perspective and RM perspective. Analyzing the graphs for all eleven dyads reveals a pattern. While most of the younger dyads gave Instructions in only B perspective or B and RM perspective, the older dyads relied solely on RM perspective in their Instructions most of the time, except one girl dyad who heavily exchange instructions in B and RM perspective. The older girl dyad, TAWI, gradually moved toward RM perspective across sessions.

In order to illustrate this point, one set of graphs from each age group is presented as representative examples in Figure 4.1 (see pages 85-87). The graphs of other dyads will be attached in Appendix. JODA is the code name for one of the younger boy dyads and TAWI is the code name for one of the older girl dyads. The numbers following the code name show the session and the round. For example, "1-2" indicates "Session 1 Round 1". The roles assigned to each dyad member are found in parenthesis. For example, (O:JO, W:DA) indicates that JO serves as the Operator and DA as the Witness for that round.

Some comments on the elements of graph are necessary. The left column shows the levels of instructional message in
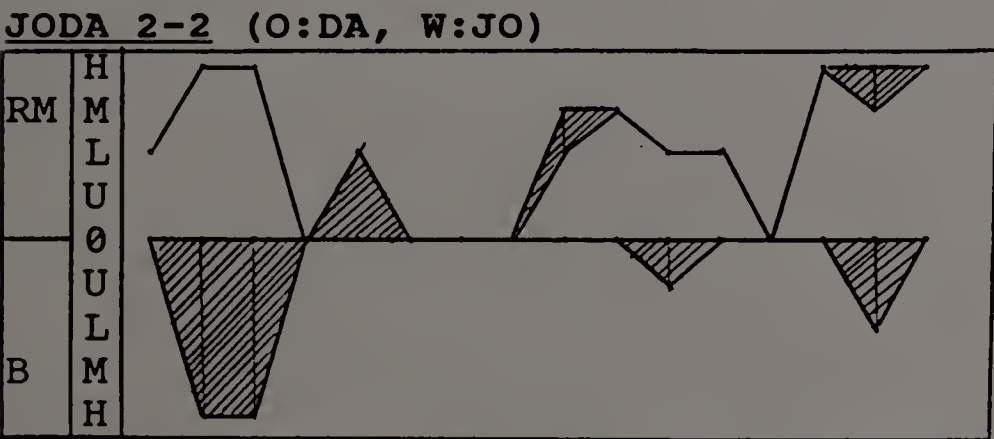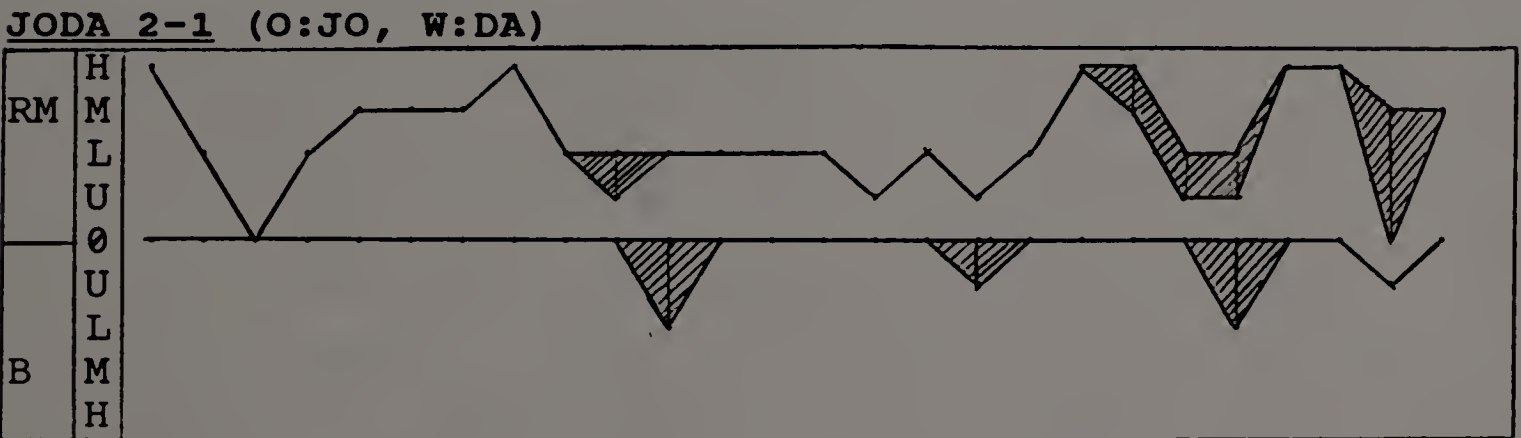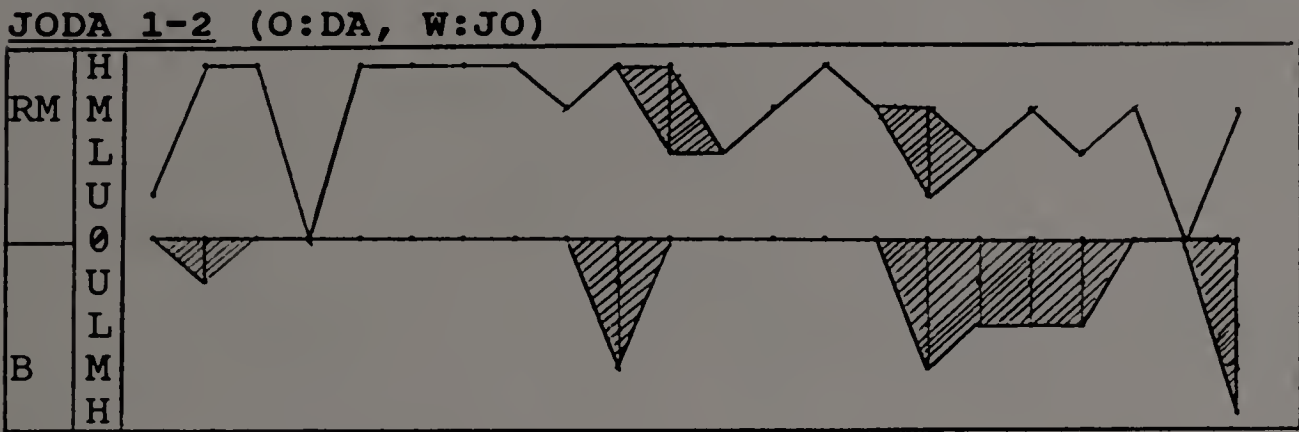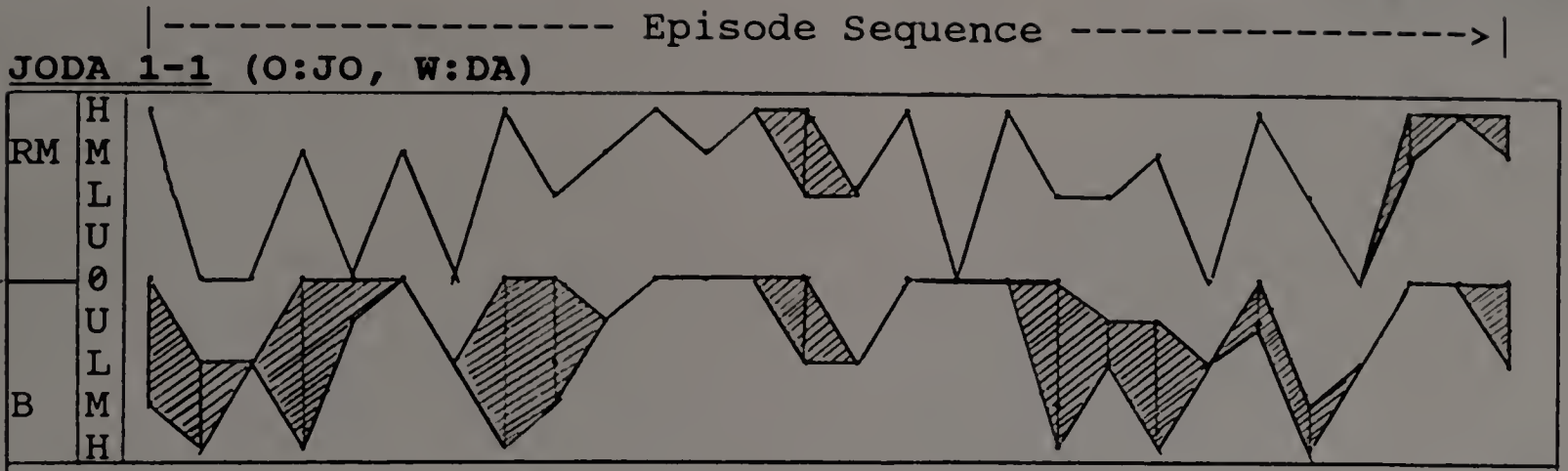
1. Younger Dyad
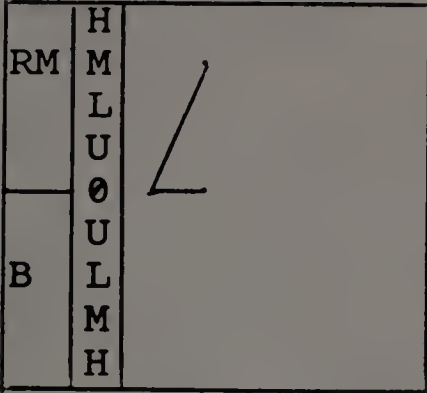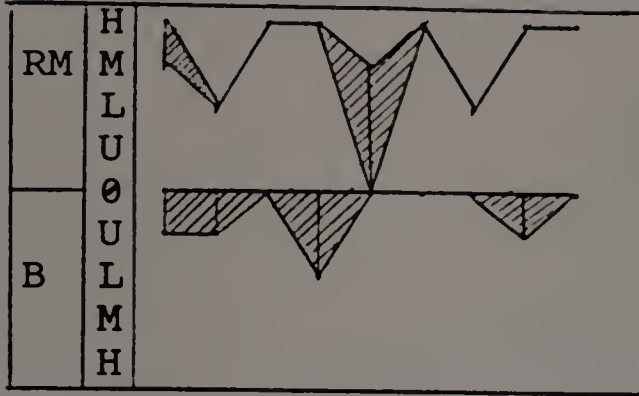

Figure 4.1   Graph Sets: Changes in Referential Perspectives
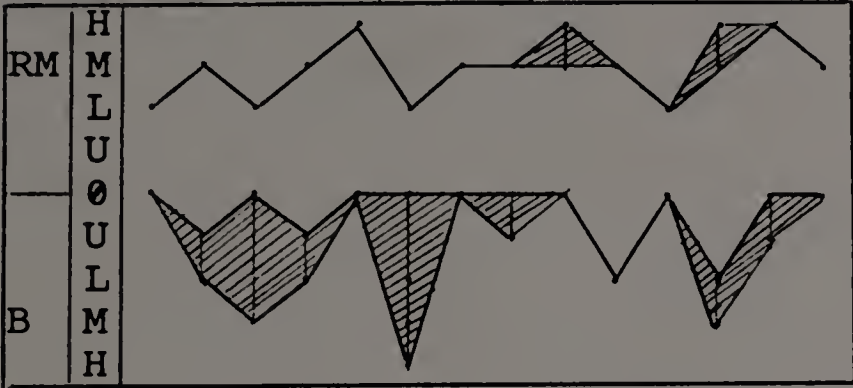
JODA 3-1 (O:JO)

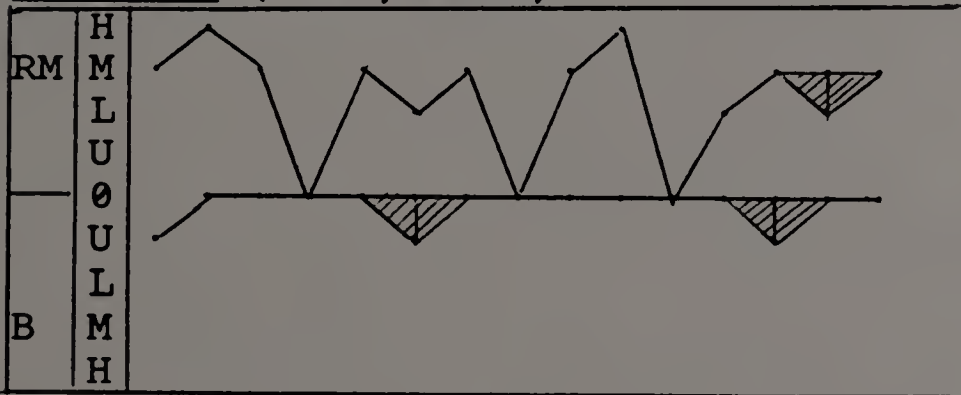**JODA 3-2 (O:DA)**

2. Older Dyad

|--- Episode Sequence ----->|

TAWI 1-1 (O:TA, W:WI)

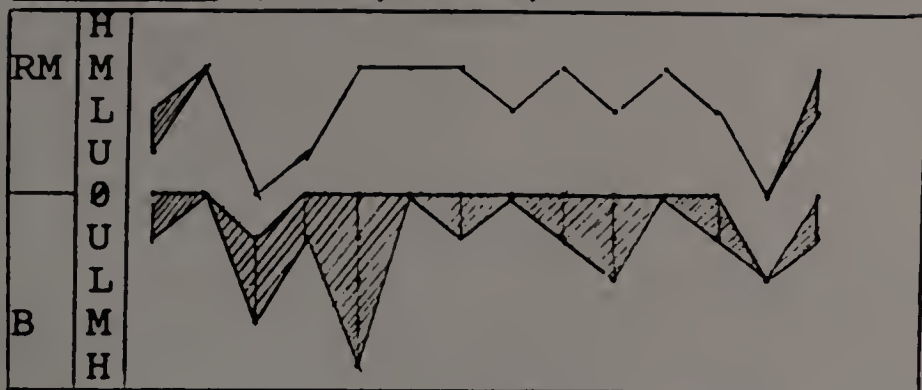**TAWI 1-2 (O:WI, W:TA)**

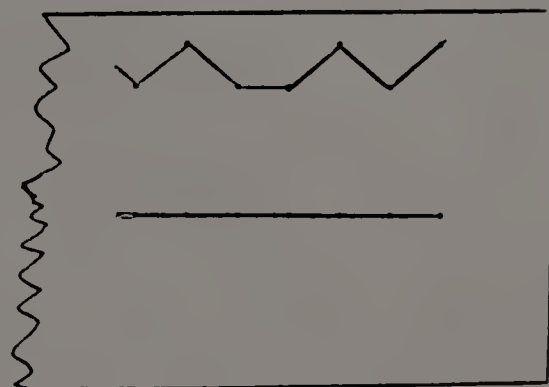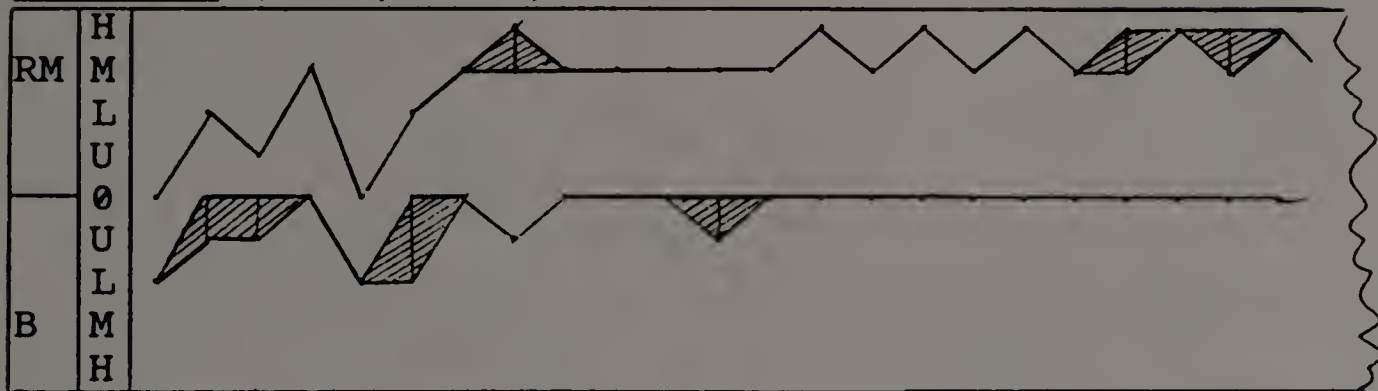**TAWI 2-1 (O:TA, W:WI)**

Figure 4.1   Continued

TAWI 2-2 (O:WI, W:TA)

TAWI 3-1 (O:TA, W:WI)
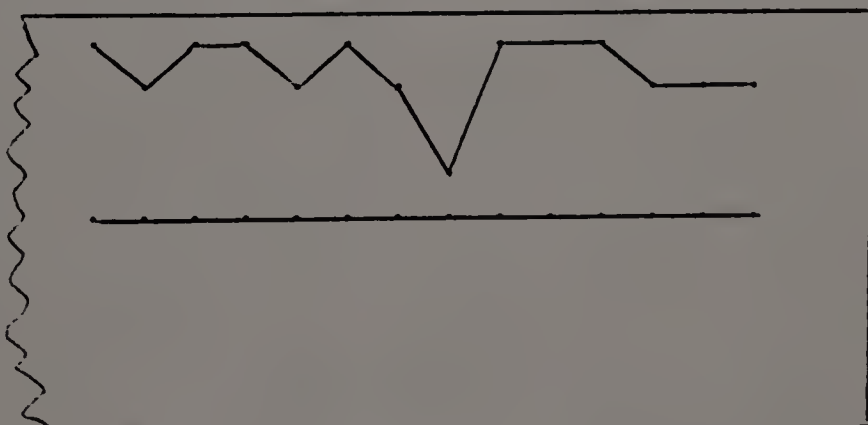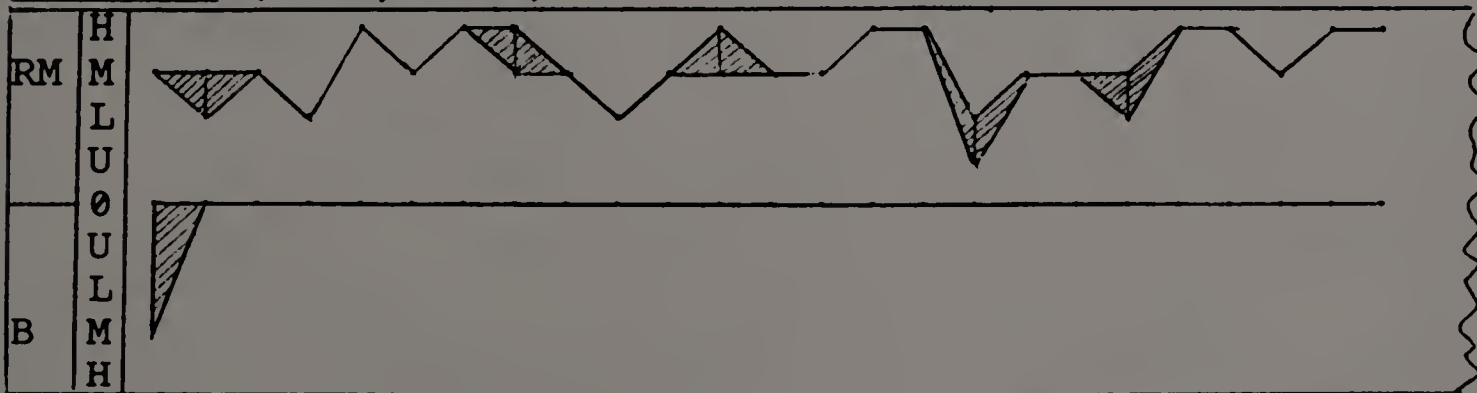

TAWI 3-2 (O:WI, W:TA)

Figure 4.1   Continued

two perspectives, RM perspective and B perspective. The levels of message in B perspective were _inverted_. "0" in the second column from the left indicates that there was no explicitly verbalized Instruction for the episode. The area above 0 is for messages in RM perspective and the area below 0 is for messages in B perspective. Within each perspective, there are four message levels depending on the amount of information: _High_, _Medium_, _Low_, and _Unspecified_. When the message contains only general information, it was coded as _U_. "Go" and "Press buttons" will be examples of _Unspecified level of messages for RM and B perspectives respectively. When the Instruction contains one piece of component information out of a possible three (PART, AXIS, DIRECTION for RM perspective and BUTTON POSITION, ANCHOR POINT, BUTTON HALF for Button perspective), the message was coded as _Low_. When the Instructions contain two or three pieces of information, they were coded as _Medium_ or _High_, respectively. Some episodes have Instructions in both RM and B perspectives. Therefore, the data points indicate the levels of information for Instructional messages for each episode. Some of them also have more than one data point for each perspective. The data points that are close to the center 0 line represent the level of _initial_ messages while the data points away from the center 0 line represent the level of _final_ messages. (Detailed discussion on the level of information can also be found in the section on Message Adequacy.) Initial messages are issued by the Witness alone

within the first turn, while final messages represent the
accumulated amount of information, not the last messages,
jointly produced by both the Witness and the Operator.

Based on the definitions of the elements, one may draw
the following information from the graphs: The top and the
bottom lines represent fluctuations of the information level
for the instructional message. The shaded area in the graph
represents the amount of contribution by the Operator in the
final message production. The distance between the top and
the bottom lines indicates the collective amount of effort
dispensed by the dyad. One can also observe the dyads'
movement toward one perspective, either RM or B Perspective.

From the first set of graphs, it is evident that both
Operators of the JODA dyad actively contributed to the
problem solving process, judging from the overall amount of
shaded area. However, shaded areas are more prominent
proportionally in B perspective than in RM perspective.
This indicates that the Witnesses do not spontaneously
volunteer the information in B perspective. Rather, the
Witnesses are prompted by the Operators to provide button
knowledge which is usually the responsibility of the
Operators. In Round 1-1, many episodes including some
earlier ones have initial instructions in B perspective.
This was possible initially because the Witness, DA, learned
much of button knowledge during the freeplay period. This
knowledge, as well as the constant prompt by the Operator,
seemed to reinforce the Witness to give initial instructions

in B perspective in some of the episodes. The Witness'
willingness, and capacity to do so, in turn prompted the
Operator to be dependent on the Witness. They sometimes
shifted the perspective from one to the other and, at times,
worked from both. In terms of relying on both B and RM
perspective for Instructions, there was no dramatic change
in the pattern across sessions, except Round 1-3. Like many
other dyads, they were not responsive to each other due to
frustration.

The pattern in Round 1-1 of the TAWI dyad is similar to
that of JODA. The O, TA, requested for button knowledge to
the W, WI, even in Round 1. This could be a reflection of
their relative status in the classroom. The W, WI, maybe
out of desire to succeed in the task, accepted the extra
amount of responsibility that was imposed on her by her
partner. In Sessions 1 and 2, interestingly, individual
differences were noted. This pattern of heavily relying on
Button perspective was only witnessed when TA was in the
Operator's role. For instance, while TA as O1 in Session 1
she demanded button information from W1, yet she did not
provide button information when she was W2. Therefore, the
pattern of interaction was the function of having a
particular dyad member in a specific role. It is not
constant and easily transferrable across situations. By
Session 3, however, the use of B perspective decreased
remarkably. Even though the dyad in 3-1 worked from B

perspective more often than they did in 3-2, the difference
was remarkably reduced from Sessions 1 and 2.

In an effort to succeed in the task, both dyads
adjusted their perspectives and strategies to each other.
For instance, the younger dyad, JODA, exchanged in B
perspective a lot in Round 1 Session 1, not by chance but as
a result of trying to accommodate to the perceived ability
of the O.

```
    (They have been working on the theme of robot TURNING.)
W      "No."
O      Waist c*
W      "Yes, but press the other..press up or down
        whichever opposite side it's on."                    (1)
O      Waist c
W      "No..press the other.  Press the .."
O      Waist cc
W      "Yup.  Keep going that, Keep doing that.  Stop!"
O      R stop.
        (The robot arm seems to be pointing to the tower.)
                        <JODA 1-1. -23:03>
```

The W was basically trying to maximize the chance of getting
some things done, and chose to give Instructions in terms of
buttons. First, this was possible because, during the
freeplay period, he "learned" the top-bottom relationship of
button halves. But also it was an attempt on the W's part
to ensure the success of this episode by tailoring the
Instruction to be easily executable by the O. He was
eventually forced to take over the responsibility of
supplying the button knowledge when the O kept asking for
the button information. He seemed to find it easier to give
Instructions in buttons, for example, as in, "Press the
second button," which was correct, rather than dealing with

the difficult task of describing movements in appropriate
spatial terms. With repeated requests from the O for button
information, the W, DA, was trying to communicate in a way
the O was willing to and able to follow, Button perspective
Instructions. For the older dyad, there was a sense of
direction in the changes. They moved toward the more task-
appropriate perspective, RM perspective, while the younger
dyad stayed in the B and RM perspectives. WI as the W often
supplied or even volunteered the necessary button knowledge,
thereby temporarily accommodating her partner's requests.
However, WI always switched gears to RM perspective for the
initial Instructions of new episodes.

These differences in the manner they share the task
responsibilities across sessions and across age groups seem
to stem from the different perceptions of their roles in the
task. All the sessions of JODA and the earlier sessions of
TAWI showed that the Witnesses often provided Instructions
in B perspective when the Operator chose wrong buttons, as
in, "Press the top of that button." The Operators often
verbally requested Instructions in B perspective, as in
"Which button is it?" when the Witnesses gave Instructions
in RM perspective. In addition to being ineffective, these
showed the tendency of the O to assume the role of a
"mindlessly extended hand" of the W by delegating his/her
responsibility to the Witness. The W was trying more than
s/he was capable of by trying to tell the O which button to
press. On the other hand, both members of successful dyads

worked together to find the correct buttons by doing what they do best; the Operator by trying to hold the button information in working memory and the Witness by describing what the robot is doing. Apparently, both JODA and TAWI thought their roles are separate but interchangeable. However, they did not view their roles and responsibilities as inherently interconnected toward a common goal which extended beyond the immediate success. Their idea of active contribution to the problem solving process, therefore, was temporarily assuming the partner's role as well as their own. This tendency of reducing the Operator's role as a "mindless hand" of the Witness is of the same nature as the tendency of reducing the Witness's role as a mere "mindless eye" by the dominant Operator who decides themes of episodes. Both examples of assigning too much responsibility to one member represent the lack of understanding of the functions of social coordination. Dyad members of this task need to contribute in a way that serves the long-term common goal.

Another observation is possible on the relationship between the amount of effort and the outcome. In this case, the amount of information carried in Instructions will represent the amount of effort. If the only clue to success is the amount of effort or contribution from both sides, then JODA should be more successful than TAWI because the distance between two lines tends to be bigger, especially if we compare two dyads in Session 3-2. In reality, JODA

couldn't even move the robot away from the starting position in 3-2 while TAWI successfully picked up the can and dropped it in 3-2. From this, it can be argued that the amount of effort per se does not explain success. If the concentrated or focused effort is the key to success or effectiveness, then, we should be able to find both B and RM perspective users in successful cases. There was no such case. Therefore, it was focused effort with role-appropriate perspective that produced a positive outcome.

Gender Differences. Throughout the sessions, both the older boys dyads and the older girls dyads were sensitive to the role boundary in general. Both girls and boys became upset when the Operator in any manner tried to take away the opportunity of giving Instructions. For instance, during button exploration, the Operator of LECH verbalized the expected response from the Witness after each button pressing without giving the W chance to respond. The W, CH, explicitly told the O, "You're not supposed to do that!" showing a clear sign of discontent.

In terms of attitude toward sharing responsibilities within each role, for the majority of dyads there wasn't much difference between the two gender groups for the two domains. However, there were more boy dyads whose Operators showed eagerness and assertiveness in proposing themes. One older girl dyad relied on button information, while no dyad from the older boy group did. Combining the observation in

two areas, some gender differences were noted. When either of the older boys in the LUAD dyad wanted to "control" the other, he did it through directly proposing themes. On the other hand, one of the older girl dyads, TAWI, subtly engaged in a tug-of-war with the partner in the knowledge domain, here button knowledge, rather than trying to get the floor for issuing commands or instructions. Eventually, in those two cases, they both moved toward the task-appropriate pattern in Session 3.

Girls and boys were found to pursue different goals and show different orientations in their interaction. Girls especially put the social relationship goal or interpersonal goal before other goals. In a task setting like this study, both groups need to learn to put the task goal before any other goal. Again, the two older dyads, LUAD and TAWI demonstrated the examples of these different goals in their interaction.

Both dyads struggled to find the correct buttons for robot moves. However, they dealt with the problem in different ways. When the Operator asked for button information, both members in LUAD as Witnesses responded with an air of command as in, "You find out!..That's what you will do!" Often W2 withheld the button information even though O2 demanded it constantly. This dyad viewed the role of the Witness as a controller of the game. Therefore, their rounds ran usually long with unfruitful exchanges because they put the individualistic goal of "control"

before the team goal for a while. This dyad gradually moved toward cooperating rather than controlling each other.

The girl dyad, TAWI, also had problems of identifying buttons. Later, TA, as an Operator, relied heavily on the test button routine. However, she adopted the routine mechanically by pressing all the possible 10 button halves everytime without eliminating buttons that she already knew the functions of. This blind application of routine obviously frustrated the W, WI, judging from her tone of voice in "TA!!!" and many sighs. However, she did not challenge the TA's inefficient problem solving strategy. Here, WI put the interpersonal goal of keeping harmony before the task goal. Therefore, WI's pattern of interaction somewhat hampered the progress of the task.

Another difference between some of the boy and the girl dyads was found in their comments when they faced difficulties in problem solving. Often boys, not girls, used heavy handed strategies of persuasion, like threats, to get out of the block in problem solving. Only girls, not boys used encouragement like "Come on! You can do it!" or "Why don't we try .." implying that both were responsible for the trouble.

Negotiation of Themes as a Source of Button Knowledge

The children in this task rarely set aside time to learn the buttons, while some of the adults were found to go

through a separate routine of <u>finding the button-robot movement connection</u>. Rather, they acquire the button knowledge itself as well as the fact that they do not have the button knowledge <u>while</u> they are trying to solve the problem. Without that accumulated knowledge, for every new move, they have to repeat the process of trial and error often undoing the previous moves. This violates the rule of protecting their gains in problem solving (Cohen & Feigenbaum, 1982).

The episode that does not have an explicit beginning Instruction deprives the Operator of the chance to request for sharing information. This type of NN episode is related to the young children's belief that direct access to the information, like seeing or hearing, is the only source of knowledge. Even though they are skilled at making inferences from a context, they are not aware that the context can also be a source of knowledge (Ackerman, 1989). The Witness in this task would easily realize that the Operator <u>doesn't know</u> what is going on without being told. However, the Witness would not be able to realize that the Operator might acquire the <u>wrong</u> button knowledge from the context when there is no explicit Instruction or Description. Therefore, not sharing the theme is more than just losing the chance to accumulate the button knowledge. Since the action at issue does not happen without any preceding interaction or context, the result of not sharing the theme will be the accumulation of wrong button

knowledge, rather than the lack of button knowledge for that particular robot movement. In the following, the relationship between the process of theme negotiation and the accumulation of button knowledge will be examined.

   <u>Sources of Wrong Button Knowledge: Compensation Episode</u> <u>and Incidental Episode</u>.   One common type of not sharing the theme happens when the Witness is faced with an unexpected but equally valuable robot move that does not correspond to the current theme. The type of episode resulting from accepting the robot action while working on another theme will be called **"Incidental episode."** The following shows a typical example of an Incidental episode.

```
W       "Now try to roll over the wheel..
        try every button."
O       "What?"
W       "Try every button."
O       Waist c
W       "Nope/"*
O       Waist cc                                      (1)
W       "Yes.." (Waist cc continued)
        "That's enough!"
        "Now, roll the wheel."
O       Waist cc                                      (2)
W       "Nope!.."
```

   (* ".../" indicates the upward inflection.)
                            <BLCL 2-1. 13:22>

In this example, the WAIST move was accepted **(1)** because it makes the top part of the robot point toward the target. Even though the W was flexible enough to seize the opportunity, the result of accepting the robot action without informing the O of the theme change is the O's wrong

belief that the WAIST clockwise button was for the movement of WHEELS (2). Even though the W didn't tell the O that the O was doing the WHEEL move, the O made the inference from the context because there was no signal from the O that the theme had been changed. This happened because the W gave feedback, a positive Confirmation, to the particular move as an isolated one, not as related to the on-going theme of the episode.

This strategy itself is not always counterproductive. Instead it represents the flexibility in problem solving on the part of the W. In fact, the most common problem for some dyads was failing to recognize the potentially useful moves while they were working on some other goal. However, there is a trade-off between the flexibility and the long term effectiveness derived from the accuracy of information. Therefore, it is not the presence of the incidental episode itself, but rather the way the dyads deal with the information in the case of Incidental episode that is worth noting. The following case provides an example of effective use of this type of episode:

```
(The situation demands the RIGHT WHEEL FORWARD move.)
W    "Now, go..(looks at the tower).. the other way."
O    "What other way?"
W    "Towards the little..."
O    LB, t (left wheel backward, toward the goal)
W    "Yeah, do that!  You're backing it up.      (1)
     But that's really good.  You're going
     the way I want you to go."
```

<LECH 3-1. 1:34>

In this case and many others, the W <u>shared</u> the information in the form of Description **(1)** in addition to the Confirmation of robot action, thus ensuring the O the knowledge of what is being done as well as maximizing the chance of getting done something equally valuable at the moment.

There is another potential case of Non-Negotiated theme episode which is very similar to the Incidental episode. The dyads in this task often have to deal with wrong guesses by the O during the button exploration process because the accumulation of button knowledge is the result of a lengthy process. It is quite common for the O to test buttons still at the end of games, even in successful dyads. Therefore, the W has to decide what to do with the wrong movement that was produced during the button testing process. If it was in the way of achieving the goal, then they may have tried to negate the effect of wrong robot moves. This led them to be engaged in a new episode which is termed **"Compensation episode"**. The purpose of Compensation episode is to compensate for the effect of the previous wrong move.

Compensation episodes and incidental episodes are similar in that they are both <u>unintended</u> and <u>unplanned</u>. However, Compensation episodes happen when the previous robot move is not desirable in terms of overall plan, while Incidental episodes happen when the previous robot move is judged to be desirable and useful.

```
W      "LE, try to press other button that
       makes it go forwards."
O      E1, up
W      "No! (1)  That was making the thing go up. (2)
       "Press it down." (gesture)                    (3)
O      E2, down*
```
                              <LECH 1-2. 2:00>

In this case, the ELBOW 1, UP move is an unintended one, of which the W decided to negate the effect. Therefore, she did, in one turn, disConfirm the Action **(1)**, Describe it **(2)**, and give a new Instruction **(3)** in order to rectify the situation. Often the W signals the intention by giving Instructions as in "put it <u>back</u>." From the discourse, the O knows what purpose will be achieved, but has no knowledge of what move is involved. If the witness chooses to say, "the other way," in response to an undesirable action because changing the button half will automatically negate the previous move, then the operator can be led to believe that she pressed the correct button but only in the wrong direction. Therefore, the compensation episode can also be a possible cause for the accumulation of wrong button knowledge as well as loss of chance to learn the buttons.

<u>Accumulation of Button Knowledge</u>. In this section, the manner in which the dyads accumulate button knowledge during the process of theme negotiation will be examined. Most of the button knowledge can be accumulated during the process of making the robot move. However, the author has noticed some occasions that cause the dyads difficulty. The

following is an examination of these occasions and how the
children acquire the button knowledge.

In the LUAD(OB) dyad, the W, AD, often gave impressions
of <u>withholding</u> necessary information, despite the O's
persistent requests for descriptions of robot actions in the
earlier sessions. This seeming <u>unwillingness to provide
information</u> was especially evident in Incidental episodes.

```
W      "Go.  G.O. please."
O      LB, t (left wheel backward, toward the goal)
       "Where am I going?"
W      "Keep going the way you're going!"
O      "Okay.."
W      "That's the way you're going.
       I'll tell you when to stop."
                          <LUAD 1-2. 24:45>
```

In another example, the W responded to the O's question by
repeating the Instruction with the self-quotation device.

```
O      LB, away (left wheel backward, away from the goal)
W      Keep going.
O      Where am I going?
W      I SAID, keep going!                              (1)
O      Okay/\  I am holding on to the same button.
```

<center><LUAD 1-2. 23:50></center>

In addition to repeating the Instruction, the loud and
aggressive tone of the W's voice in (1) seemed to give the O
a hidden message that he was not supposed to ask where the
robot was going. The W's attitude seemed to have caused the
O, LU, to stop requesting for information of what the robot
was doing during subsequent sessions. It is interesting,
though, to note that all NN incidental episodes involve the
WHEEL TURNING move. Usually, describing the robot WHEEL

TURNING move was one of the hardest for all the dyads in this task. The findings from spatial terms research show that, developmentally, the directional terms for horizontal-lateral movement, in other words, "left" or "right," is the last one to appear (Cox & Richardson, 1986). It is possible, then, that this dyads' tendency to get the WHEEL TURN move done in the context of incidental episodes may stem from their lack of grasp of using those terms. The W's aggressive tone and ignoring the request for description in the incidental episodes for this dyad are attempts to disguise his inability to describe those movements in appropriate spatial terms. Considering all this, for this dyad, there seems another type of negotiation going on which is not directly related to this task. This dyad is trying to negotiate their relative status on the interpersonal level. Incidental episodes seem to suit their purpose: to get the sense of control while not losing face.

A similar pattern was found in one of the younger dyads, LECH (YG). The context for Incidental episodes invariably include TURNING moves. This is not surprising considering the statement from one member, CH,: "I don't know those things, left or right!" It seemed this dyad tried to circumvent the problem of describing the TURNING move by seizing the unexpected opportunity for getting it done whenever they could. Judging from the fact that they do not use this strategy with other types of robot moves, it

is very likely that they are aware of the problem associated
with the advantage of getting things done.

Not all the Incidental episodes have NN themes.
When the dyads are engaged in either Compensation episode or
Incidental episode, they have different ways of signaling
their partners about the change of themes.

```
W       "Go straight."
O       HO, HC                                       (1)
W       "You're opening up the pincher.
         You're closing the pincher.
         Do that again.  Open it."                   (2)
O       RF/LF (straight)                             (3)
W       "Go.  Go straight.  Stop."                   (4)
O       R stop. "Now what?"
                              <LUAD 3-2.  -35:26>
```

In the above example, the W tried to share the theme by
giving the Instruction retroactively in Robot Movement
perspective in (2) and (4) by matching the content with the
ongoing robot action (1) and (3).

Another dyad employed a variety of devices in
preventing the accumulation of wrong button knowledge.   As
a result, for this dyad, ANMA (OG), 2 out of 3 incidental
episodes had shared themes by session 3.

```
(They have been working on "going forward")
O       LF, t
W       "No,...wait!  Keep doing that way."      (1)
O       LB, LF, t.
W       "Stop.  Forwards."
                              <ANMA 3-2. 23:24>
```

With the subtle cue from the W, "wait!" along with "No" (1),
it was more likely to be considered by the O as a side step

rather than a continuation of the original theme, "Forward".
In another occasion,

```
O    RB, toward
W    "Yeah.  Keep it going.  It's backwards.
     You're turning (not intelligible) and sideward."
                    <ANMA 3-2. 24:17>
```

Any movement that makes the robot closer to the tower is attractive to the dyads. Here, the W managed to sacrifice neither the efficiency from being flexible nor the accuracy from being informative. Therefore, this formula of D+I (Description and Instruction) is the one pattern that many effective dyads used.

On the other hand, in the following case, the purpose was not easily detectable.

```
W    "Now, go down a tiny bit."
O    Waist cc
W    "No,(1) go the other way.(2)"
O    Waist c
W    "Now go down."
O    Waist cc
W    "No."
O    Waist c
                    <TAWI 3-2. 26:11>
```

Here, "No" (1) could mean either a "correct move but wrong direction" or a "wrong move". Also the instruction "go the other way" (2) itself didn't communicate the purpose of the instruction. Therefore, the O ended up having a piece of wrong button knowledge that the WAIST button was for the ELBOW up or down movement.

Often the O, not the W, intentionally or unwittingly creates the situation for Incidental episodes. CATH (OG), had only one NN episode during all three sessions, despite

ten Compensation and three Incidental episodes. The only NN

theme episode was the Incidental episode.

```
    W       "Now go frontward."
    O       LB (left wheel backward)
    W       "Frontwards, CA!"
    O       LF, toward>away
            R stop
            Waist C     "Is that good?"            (1)
    W       "Yes."
    O       Waist C (continued)
                                    <CATH 1-2. 46:50>
```

In this case, it is not clear whether the O believed that

the WAIST clockwise move was for "frontwards"(1). When the

previous episodes were examined, this O always pressed the

LF button for "frontwards." Therefore, the O's RC·A+, "Is

that good?" might have meant "Is that good for any purpose?"

rather than "Is that good for frontward?". Both the W and

the O seemed to know implicitly that they were working on a

different theme other than "frontward." On the other hand,

in the case of the younger dyad, AMNE (YG), the O's

unspecified question, "Is this good?" often caused the

Incidental episode. This type of question gives the W a

legitimate reason to accept the presented move other than

the proposed one. Therefore, the O unwittingly prompted the

W to create a NN episode. The Operators from both age

groups sometimes initiated the Incidental episode. However,

the older O used the unspecified question in a way that at

least prevents accumulation of wrong button knowledge while

the younger O didn't. This is due to their tendency to

focus on the undifferentiated task goal, like "doing it

right" (A+), without thinking about the means to achieve
the goal.

The Compensation episode, too, is commonly initiated by
the O. As a result of having jointly worked on Compensation
episodes several times previously, the O proposes a theme
for initiating a Compensation episode without any prompt
from the W. AMNE (YG) had almost 25% of NN episodes, the
highest rate among all the dyads. Like other dyads,
Compensation and Incidental episodes, as well as an
unspecified instruction like "Go," were the sources of NN
themes. However, in the following case, they successfully
compensated and shared the theme.

```
W       "Now, bring the handle down."
O       "Down?"
W       "Ya."
O       "Which button?"
W       "I don't know."
O       RB, away
W       "Hey!  You're moving it back!"              (1)
O       "Whoops!"  RF                                (2)
W       "Ya, ya, ya, ya."
O       "That's all?"
W       "Ya."
O       E1, down, away                               (3)
W       "No, not that way down."
        (gesturing toward tower)
                      <AMNE 1-2. 40:56>
```

While working on the theme "handle down", the O initiated a
compensation theme (2). Here, Descriptions by the W (1) and
a subtle cue like "whoops!" (2) were the means to signal to
each other their intentions. As soon as the episode was
over, the O again went back to the original theme without
any prompt from the W (3).

Another young dyad, JODA, also had Compensation episodes without the explicit prompt from the W. For this dyad, just like AMNE, the source of the O's themes was the preceding statements by the W. In Session 2, O1, DA, proposed the Compensation theme twice, both times prompted by the Descriptions of robot move.

```
W       "Now move it...umm..forwards."
O       HC/E2, down   (two buttons at a time)
W       "That's putting the head down."           (1)
O       "Okay, I'll move it up."                   (2)
        HO/E1, up
W       "No, that's the jaw!"
O       R stop  HO/E1, up
W       "The jaw's going out, too."
O       R stop.   E2, down
W       "Stop."
O       R stop.
                              <JODA 2-1. 09:40>
```

The O interpreted Description in the context of the theme of the episode. Therefore, the description of an unintended move **(1)**, for this O, at that moment, functioned as an indirect request for compensation. This O, unlike AMNE, explicitly informed his intention **(2)**. This gave the O a chance to reject the theme if it was deemed unworthy to pursue. And often this was the case.

In most of the cases of Incidental and Compensation episodes, Descriptions of on-going robot actions were the means for sharing themes.

```
W       "Now, go frontwards."
O       LF*  "Okay, I need to just.."   LF
W       "You're making it go sidewards."
O       "Is that right?"  RF, toward
W       (silence)
O       "Is it?"  R stop.
```

W   "<u>No</u>.(1) <u>That's frontway</u>.(2) <u>You can go that</u>
         <u>way</u>.(3)   That's better."
                         <CATH 1-2.   40:03>

The W, in the last turn, gave <u>Confirmation</u> of the action **(1)**
in terms of the proposed theme, informed the O of what she
did with <u>Description</u> **(2)**, and signaled the beginning of a
new episode with <u>Instruction</u> **(3)**.

In session 3, the O of the same dyad initiated a
Compensation episode when the W provided the description of
robot action. However, instead of just assuming the
intention of the W, the O requested confirmation of her
compensating action. Therefore, the O internalized co-
constructed strategy of compensation, but still <u>shared</u> her
intention.

The patterns of C+D+I or D+I for the case of Incidental
episode and Compensation episode, seemed to suit both the
problem solving efficiency and the communication accuracy.
However, some dyads found a creative way of getting all done
in a more condensed way. The W often showed the capability
and the inclination of packing a great deal of information
in one speech act, just like in the case of "Turn the
clipper **<u>back</u>**" for Compensation episodes and "**<u>Keep</u>** moving the
clipper around" for Incidental episodes. In the above
mentioned ways, the O can share the knowledge of what she is
doing. She can also get clues of which button to press
right at the moment from words like "back" or "keep -ing,"
which respectively can be translated into the strategy of

"change the button half" and "keep pressing the same button."

In later sessions, the dyads learned to be more sensitive to the knowledge state of the O. They often tried to adjust the theme to fit the O's capability. AD, as the W in LUAD, became sensitive to the O's ability to perform robot moves and learned to take this into account during the theme negotiation process. In Sessions 1 and 2 the Witnesses often repeated the Instruction when the Operators signaled their lack of knowledge for execution of the proposed robot action. In Session 3, towards the end of Round 1, however, the W tried to adapt to the O's button knowledge state.

```
W     "Okay, go backwards."
O     "With what?  The vehicle?"
W     "Yup."
O     "Ummmm...  How do I do that?"
W     "You can do it with the pincher or vehicle."
O     "Umm.."
W     "Pincher would be easiest.."              (1)
O     "Alright.  I'll do it with the pincher."
W     E1, up  R.
                    <LUAD 3-1. 25:22>
```

In this example, the W showed flexibility and willingness to negotiate the theme in response to the O's reference to his inability to perform the action, "How do I do that?" The request for means, RI(ME), as well as some hesitation by the O, prompted the W to find an alternative theme which the W believed the O could handle (1). They had been working with the "pincher" around the time when this episode happened.

Therefore, it was more likely for the O to remember which button was for the pincher rather than for the wheels.

Even though accommodating each other seems to be necessary as seen in the above mentioned case, sometimes, too much accommodation can hamper the progress in the task. TRJO(OB) had a tendency not to question each other whether it was the O's knowledge state or the W's message. Mostly, the W tended to accommodate to the O's belief even during the theme negotiation process.

```
W     "Move it a little bit to...(thinking)"
O     "To the right or left?"
W     "Right."
O     "Uhuh\  You can't move it to the right.
      It only can go straight."              (1)
W     "Go to the left."
O     "Can't go to the left."
W     "Then back up!"                         (2)
O     RB (right wheel backward)
                        <TRJO  1-1. 16:43>
```

Without questioning whether the O's claims were valid or not, the W gave in and chose the theme based on the options available **(2)**. At this point in the game, there seemed to be no need to do "back up." Still, the W overaccommodated to the O's belief even though the W himself had a chance to observe the robot moves. In fact, they never succeeded in making the robot go straight. The O wrongly believed that he was doing STRAIGHT because the W didn't correct the O's wrong belief. Without confronting the O's wrong belief or wrong button knowledge, they cannot genuinely negotiate themes or accumulate the button knowledge. The tendency to

overaccommodate to the other's opinion seems to be a barrier
to progress.

Similarly, for the TOJU (YB) dyad, the O's running
narration of the robot action was perceived as a solid fact
and never challenged by the W. Because of the W's general
attitude toward the O that "you are supposed to know," the
O, JU, was trying hard to contribute beyond his capability.
He never openly informed the W of his ignorance of button
knowledge, which was usually the first step for most of the
dyads for the co-construction of button knowledge. When the
W showed frustration at wrong robot moves, the O, JU, even
apologized: "I didn't hear that well."   This attitude of
<u>NOT challenging the other's assumption</u> deepened the W's
conviction that the O knew what he was doing. Therefore,
they later concluded that it was the robot that was at
fault. In their own words, the robot couldn't go forward,
and therefore, they needed to exchange the current robot for
a new one.

On the other hand, the following episode by ANMA(OG)
displays a sharp contrast to TRJO's overaccommodation.

W	"Turn the whole robot towards me."	
O	Wcc	
W	"N-----o. The whole robot!!"	
O	(pause) "<u>I can't</u>!"	**(1)**
W	"<u>Yes, you can</u>!"	**(2)**
O	Wcc	
W	"Remember the ones we used...."	**(3)**
O	Wc " <u>I'll get the thing first</u>..	**(4)**
	(not intelligible)"	
W	"Alright."	
O	Wc R stop " <u>There</u>!"	**(5)**
W	"Remember the ones...	

how we used to go straight?"

The W countered the O's wrong belief "I can't!" (1) with "Yes, you can!" (2), and tried to provide the clue on where the O might be able to find the means to do it. It is also very illuminating that the W attempted to call the O's attention to their past shared experience with "Remember..." (3). Therefore, accommodating the O's knowledge state is adaptive to the situation and often necessary. However, overaccommodation is not conducive to learning the button knowledge as well as to establishing effective problem solving strategies. Sometimes good spirited confrontation is necessary.

Noteworthy, too, in this episode is the manner in which the W signals her intention for the new episode, a Compensation move. Using the form of INForming her Plan (4), she shared with the W the theme. The W accepted it and resumed the original episode as soon as the O signaled the completion of the theme with "There!" (5). By informing the W of her plan, the O could avoid being blamed for not responding to the W and could check if it was worth doing. This was the result of the W and the O collaborating on the Compensation episode repeatedly. The O showed that she internalized the strategy by Session 2 and was able to initiate the sequence without being prompted by the Witness. It is different from the younger O's approach to the Compensation episode in that the O shared her plan and made it available for negotiation and approval from the W.

In summary, Compensation and Incidental episodes are found in both the younger and the older dayds. The way both groups deal with these occasions differ. If utilized effectively, these episodes can provide valuable tools for efficient communication and problem solving. Focusing on the immediate outcome in these types of episodes, the younger dyads often acquired a piece of wrong button knowledge and subsequent confusion. However, this seems to be a potential case of "one-step back then two-steps forward." The older dyads effectively overcame the problem and could even capitalize on the occasions by sharing the information and checking each other's intentions.

Pattern of Contribution for Theme Negotiation

Most commonly, themes were proposed by the W in the form of Instruction and, in turn, accepted by the O by pressing buttons. However, there was more than one way of introducing a theme by the W and signaling the acceptance of the theme by the O. This process became more elaborated when the O, not the W, introduced a theme. Other than providing the content or the slot for the theme, Operators contribute to the theme execution process by keeping the theme in focus. How did the dyads insure that themes were shared? The contribution process of theme negotiation will be examined through examples in an effort to identify some patterns.

First, how did the dyads contribute to the grounding process during theme negotiation? Especially when the W introduced a theme, what device did the O employ to make sure that both share the theme? One of the most common devices is **specific Request for Confirmation of Instruction (RC·I-specific)** which involves repeating a part of or the whole Instruction in the question format. Across three sessions, both members of the JADY (OB) dyad increasingly used this device. For most of the cases, their intentions were not simply confirming whether the Os had heard correctly, as is the standard assumed function of this device. Every time the O produced it, the original instruction was very clear and unambiguous. Therefore, it seemed to function as a sounding board for the W to think about the theme and, for the O, as an aid to remember the instruction. ANMA(OG) also increased its use by Session 3. This sometimes functioned as a prompt to change Instructions. Other times it functioned as a way of simply keeping the theme in sight for the O and available for reexamination for the W. Even though there were differences in terms of how often each dyad used this particular type, all of the older dyads could use this device. The younger dyads also used this form, and sometimes it prompted a change of theme.

```
W     "Now back up a little.  Backing up."
O     "Backing up?"                                      (1)
W     "No, no backing up. I want you pull up..."
O     "What?"                                            (2)
```

W   "Now open, open the handle thing."
<BLCL 1-2. -37:43>

The reason why the O requested the Confirmation is not

clear. Maybe he was confused by the W's "Backing up" which

could be either an Instruction or a Description of current

robot action. However, with the O's **specific RC·I (1)** along

with **nonspecific Request for Repetition (N-R) (2)** as

prompts, the W had a chance to think about his plan and

readjust it. In the above cited example, he must have

thought, "In order to pull a block, I'd better open the

handle thing first." Other younger dyads, TOJU, LECH, and

AMNE were all habitual users of this device.

A similar effect is produced by the W repeating the

Instruction itself without the upward inflection. By

Session 3, both Operators of JADY began giving positive

evidence of understanding to the Witnesses. This was not to

indicate lack of understanding. This <u>neutral repetition</u> is

an effort to avoid trouble before it happens by making

certain they understand each other through the process of

"grounding" (Clark and Schaeffer, 1989). This dyad was

successful in the first and second sessions. However, they

adopted a new step of signaling their understanding in the

third session. This tells us that they are not working in

reaction to the failure of physical success, but rather

working against <u>the possibility of failure</u> in communication.

This change can only be explained by their increased

understanding of the communication process particular to

this task. When they gave signals of understanding, they

repeated verbatim all of the Instruction, and thereby
provided the strongest evidence of understanding (Clark and
Schaeffer, 1989).

```
W     "Put the hand down."
O     "Put the hand down."          RC·I-specific
      E1, up
      "Down?"
W     "No."
O     E2, down* (*-brief stroke)
      "That one?"
W     "Yeah."
                              <JADY 3-1. -09:25>
```

In this task situation, it is more than just providing
the evidence. It also serves as a reminder of the theme for
both. Along the same line, informing what the O is working
on, **INF(A:content)**, as in "I am turning the pipe" and
requesting Confirmation of Robot Action, **RC·A(content)**, as
in "Is this closing it?" were commonly used, especially for
the younger dyads. Often the sequence of specific RC·I
along with Request for Instruction of Means, **RI(ME-content)**,
was commonly found, as in the following example:

```
W     "Open it."                    I(A: HP)
O     "Open it?"                    RC·I-spec.
      "How do you open it?"         RI(ME-HP)
```

The younger dyads are not the only ones to use this
approach. LUAD(OB), in the earlier sessions, used
RC·A(content) along with specific RC·I, in order to keep the
theme in focus.

```
W     "Lift your pincher up."        I(A:E UP)
O     "What?"                              N-R
W     "Go up!"                                   I
      "Make the pincher go up!"      I(A:E·UP)
O     E1, down. "Is it going up?"    RC·A(UP) (1)
W     "No."                                C-(A)
                              <LUAD 1-2. -21:26>
```

Instead of just pressing buttons, often children in this game tried to confirm whether they had the correct robot action in terms of the goal or the theme. This dyad, instead of just asking "Is this _it_?" (RC·A), added to this device the content description of what they wanted to confirm by repeating the whole or the part of instruction, as in "Is it _going up_?" (1). Similarly, when they requested further information on the means to execute the theme, they incorporated the content into this speech act. Therefore, instead of asking "How do I do that?", they would often ask the W, "How do I _go straight_?" While RI(ME-) with instruction content and specific RC·I were found steadily throughout the three sessions, RC·A with content was found considerably less in later sessions. They can all achieve the same effect of keeping the theme in focus by repeating the instruction. However, in the case of repeated **RC·A with content**, it is a very laborious process. Therefore, the trend of fewer cases of RC·A with content in later sessions shows us that this dyad worked toward efficiency in communication. Under usual circumstances, failing to presuppose and repeating what is already given to both is actually against the conversational rule that has developmental implications (Hickman, 1987). Considering that the older dyads put stress on each word when they repeat the content and also that they do presuppose at other times using RC·A without content in the same session, the practice of including the content in these monitoring

devices seem to be motivated by their effort to keep the theme visible. However, for the younger dyads, it could be developmental trends as reported in other studies.

Request for Instruction of Action, **RI(A),** as in "Now what?" or "What should I do?", is one of the most preferred modes of participation by the O in LUAD. This device does not include any content of the theme. It simply signals the W that the O is ready to receive a new Instruction. In Session 2 Round 1, it reached the peak with about 27 percent of the episodes including RI(A) by the O, sometimes functioning as a marker of episode, sometimes as a proposal for a change from the on-going theme. The frequent use of RI(A) shows active participation on the part of the O to support the transition among episodes as well as to have some sense of control over the flow of the game. The fact that episodes with RI(A) increased and then decreased for this dyad shows that, despite the eagerness and the ability to participate from the O, the W also internalized the co-constructed structure of an episode and learned to give in advance of possible RI(A) from the O. Even though it is not as intrusive as directly proposing themes, it can, in some cases, disturb the W's thinking by controlling the pace of the game. JO in the TRJO(OB) dyad issued RI(A) for about a third of all the episodes in Round 1 of Session 1. By issuing these, JO as the O could control the timing of the initiation as well as termination of an episode. When the timings between two members are not in synchrony, as was the

case of TRJO, the constant push from one partner seems to
disrupt the flow and the effectiveness of the game.   This
device was also found in many of the younger dyads.

What kind of device do the Operators use to contribute
themes? The pattern seems to depend on the circumstances of
proposal. In the case of older dyads, when the O has a good
ground or reason for proposing a theme, they often use a
very direct device. In the following example, the O
proposed to "move backward" using the form of **INF(Plan)**.
Nearing the end of the game, the W gave the description of
what was going on so that the O had a mental image of the
situation.

```
W       (nervous laughs)
O       "What am I doing?"
W       "You are pinching the block          (1)
        but it didn't fall down.
        Now move the truck."
O       HO
W       "No, you moved the pincher.
        Close the pincher again."
O       "Okay."   HC
        "Now I will back up."    RF/LF         INF(P)
W       "More. Just keep going the same
        way you were going before."
                        <LUAD 1-1.28:30>
```

The description from the W and the O's knowledge of the goal
may have made the O sure of what he can do to achieve the
goal. Right after closing the pincher to secure the block,
the O right away proposed a plan, which is pulling out the
block to knock over the tower by moving the "truck"
backward.   Therefore, the W is proposing in this case a
reasonable option based on enough information he has at

hand. This device of INF(P) is not exclusively used by the boys, even though there were more boy dayds who used this form. The girls, in the context of compensation moves, sometimes simply announced the plan to compensate the wrong move: "I'll put it back first." On the other hand, young boys tend to announce more often than the older dyads. One young girl dyad sometimes demonstrated the same pattern. It is possible that the younger group used this form out of frustration because they were not very successful in the task. However, in some cases, they used this form at earlier stages of the game while the older dyads used it at later stages of the game on reasonable grounds.

The most common device for theme proposal by the O is **RC·I-potential**. The following episode involved the theme of "turning the arm", possibly to knock over the tower.

```
W       "Now make it go around."
O       Elbow 2, down*
W       "No."
O       Waist c
W       "Yes."
O       Waist c (continued).  LF
W       "Now move frontwards.  Move a little more."
O       LF (still pressing)
        "Should I move the clip thing around?" RC·I-pot
W       "No... Could you move that down?"
                            <CATH 1-2.  49:49>
```

Here, the O seemed to have a certain idea of what to do next because the W previously gave the Instruction to "move the clip thing around". However, the O requested for confirmation of her proposal. This form was the most sensible considering that the O did not have access to the

robot and the target. And successful dyads, like JADY,
mostly relied on this device. Other successful dyads also
moved toward this device across sessions.

Often, theme proposals were made by more than one move.
The following example demonstrates a unique sequence the
LUAD dyad used in negotiating themes.

```
(They're working on "Turn.")
O     RF/LF away
W     "Going backwards, going backwards,
      going backwards."                          D/[I]
O     RB/LB toward                                  A
      "Now, I am going frontwards?"              RC·D
W     "Yes."                                     C+·D
O     "Am I going good?"                         RC·A+ (1)
W     "Yes, you're going good....Now.."
                          <LUAD 1-2. 26:38>
```

For negotiating themes, this dyad used a sequence of D =
RC·D = C+·D = RC·A+ instead of using RC·I. This O took a
much more active role in defining the theme compared to
other Operators. Even though the O sought the acceptance of
the theme from the W by way of Request of Confirmation of
Action, **RC·A+ (1)**, it is the O who initiated the theme
negotiation. In this type of sequence, the O had to wait
until he encountered an intended or desired movement. This
tendency seemed to contribute to having the highest number
of episodes all together out of 11 dyads. However, they
still made sure that both understood the theme at hand.
This pattern of theme negotiation faded away as they moved
across sessions. By Session 3, this dyad moved from using
Request for Description, **RD** or Request for Confirmation of
Description, **RC.D** to **RC·I-potential**. Therefore, they seem

to have learned to propose a theme in a way which is more efficient and makes more sense in terms of this particular task situation, even though less frequent. The Operators in this dyad gradually moved toward supporting the Witnesses in theme negotiation by providing the frame or simply the slot only, instead of the content. If they did provide the content, for good reasons, they began to use the form of Request for Confirmation of Instruction, RC·I, which was more open to negotiation, rather than INForming the theme of his own choice. Therefore, their seeming lack of coordination appears to be the result of their attempt to take control of the interaction in general, rather than being the function of their inability to take into account the other's viewpoint or the task situation.

JO, in TRJO(OB), as the O, by session 2, became more directly involved in theme negotiation by often requesting Descriptions of what the robot was doing, **RD(A)**, even though the W already gave instructions. This constant request distracted the W and made him a passive supplier of description, rather than giving Confirmations in terms of the Witness's own proposed goals. Later, the W gave descriptions even to the robot move that he sought after, because the interaction pattern of **RD(A)** and **D(A)** was established between them. This resulted in a game in Session 3 without a single theme, but just parallel exchanges of what was happening. The difference between this dyad and the LUAD dyad, another habitual user of RD(A)

and D(A), is that LUAD <u>elevated the act into a theme</u> by

adding RC·A+ to attain acceptance from the W. Another dyad

from the younger group showed the same pattern and result.

In the beginning of each game, the Operators in BLCL(YB)

sometimes used Request for Confirmation of Description,

RC·D, as in "Is this going toward the tower?" or "Is it

close to it?", maybe in an effort to propose a theme.

They didn't fully develop their potential ideas into

negotiated themes by seeking the acceptance from the

Witnesses. As a result, many exchanges of RC·D(A) and C·D

or RC·D(A) and D(A) were made without an apparent goal and

efforts were often wasted.

The same pattern was found in a slightly but

significantly different way with an older girl dyad, CATH.

```
W     "Now go frontwards."
O     LF (robot movement obstructed, churning)
W     "It's not going-\"
O     "Did I push the clip over?"                    RC·D(Ad)
W     "No \/"                                            C-·D
O     Waist c*  Waist cc*                                   A
W     "Hey, you're moving it around now."              D(A)
O     "I am?"  Waist c                        specific RC·D(A)
W     "Yes"                                           C+·D
O     "Should I?"                                    RC·I(A)
W     "No way!  Move it back."              C-(I/A),I(A)
O     R stop.  LF   R stop.  "You mean,
      the clip, clip..?"
W     "Move it backwards."
O     LB
W     " (unintelligible), CA!"
                        <CATH 1-2. 44:07>
```

Before this episode, they had been working on wheels for a

while. In order to introduce her own plan of knocking over

the tower, this O went through a series of carefully

sequenced steps of advancing her theme. She could have

easily done the same thing by simply using RC·I. This

example showed the O's sensitivity toward the boundaries of

each role.

If we look at the sequences together, we can see some

progression in the pattern of theme proposal.

```
LUAD             D = RC·D = C+·D = RC·(A+)
TAWI    RC·D...D = RC·D = C+·D = RC·I(A)
TRJO               R·D = D(A)
BLCL             RC·D = C+·D
```

(= indicates a change of conversational turns.)

What's missing from the last two dyads is <u>D</u>escription of a

<u>potentially</u> <u>relevant</u> **Act**, right before this exchange, and

the <u>confirmation</u> <u>seeking</u> step done with RC.A+ by LUAD and

with RC·I(A) by TAWI, right after the exchange. The first

two sought to elevate the preceding lengthy exchange into a

theme while the last two didn't. It doesn't seem accidental

to witness the last two dyads as unsuccessful in this task

even though this is only a fraction of the whole process.

The younger dyads showed remarkable sensitivity to the

possible hidden intentions. For them, one of the common

sources of the O's proposal was often the descriptions by

the W.

```
O      E1, up  "Is this backwards?"  Waist c
W      "You moved the clippers."
O      "Okay, okay.  Here!"  Waist cc
W      "You keep..you moved the clipper button."
O      "The clipper!  Okay."  E2, down
W      "No, no! Those are the clippers.  I didn't say
       clippers.  Backwards.  Push backwards."
                        <TOJU 1-2. 44:57->
```

They often adopted only a part of a statement and transformed that part into an indirect request. They often focused on parts or words, not considering the whole statement or the context.

For one of the younger girl dyads, AMNE, Descriptions, especially describing what the robot was NOT doing, was a preferred mode of indirect request instead of explicit Instructions. For example, "You are <u>not</u> moving the wheels," right after the completion of an episode or "You are <u>not</u> doing <u>anything</u>!" after a long pause were interpreted by the O as instructions for "Move the wheels" and "Test buttons" respectively.

The Operators in the LECH dyad seldom contributed theme contents. When they initiated episodes, they were mostly compensation attempts which originated from the W's descriptions of unintended moves.

```
W       "Open the thing up."
O       Waist cc, toward>away
W       "Stop."
O       R stop
W       "It's gonna get my nose in a little bit."      (1)
O       Waist c, toward                                (2)
W       "Yeah."
O       Waist c*
W       "Open the thing."
O       Waist, c
W       "Open the thing!  You're not!"
                              <LECH  3-2. 2:00>
```
(They played the game at a table, and the robot was
right in front of the witness. At this particular
moment, the robot Arm was turned toward the witness and
the Hand was right in front of the witness's nose.)

When the W gave the description which was not directly relevant and was implying disConfirmation (1), the O

initiated a compensation move (2), even though she didn't have the right idea on what she was doing. As evidenced later, she seemed to have thought that she had the HAND move.

The tendency to use Description as an indirect request and to interpret Description as a possible request was reported in other studies, too. Young children often use statements instead of Directives in a peer learning situation (Cooper et al, 1986). Using Description is helpful to the O to know what is being done. At the same time, however, as an alternative to an Instruction, it can be easily ignored by the O. It can even distract the O from the on-going theme. Also, young children tend to focus on the intended meaning without differentiating it from the literal meaning (Beal, 1989). Similarly, the young children in this task tend to assume the discourse function of Description as an indirect Instruction without verification from the W. Even though the skill of figuring out the speaker's intention from the context is remarkable and valuable in every day situations, this tendency does not work effectively in a task-oriented interaction. If communication skill development means learning to use the task-appropriate form of discourse, then Instruction is best suited and necessary for theme negotiation process because it clearly communicates the theme and promotes goal-oriented, not parallel, discourse exchange. On the other hand, Description is necessary in the cases of Incidental

and Compensation episodes because it ensures accumulation of button knowledge and sharing of themes.

In the earlier session(s), there were differences in the way the O proposed themes between two genders for the older group. Later, however, they converged into the form that was more task-appropriate, **Potential-RC·I**, the most economical, yet still open for negotiation.

Construction of Message

One of the W's prime responsibilities in this task was giving clear and unambiguous messages to the O. The O's role was to ascertain that s/he understood what the W means with the message, sometimes by asking questions if the situation demanded it. In this section, the manners in which the dyads improved their messages in Instructions will be examined.

According to the research on children's communication skills, young speakers are not good at producing messages that can uniquely define the referent (Asher, 1979). Also young listeners don't ask questions even though they do not have enough information (Robinson, 1983). That skill develops rather gradually and continues to develop well into the school years (Beal, 1989). However, in a peer communication setting, children were found to produce better messages and learned to ask questions when they were engaged in collaborative problem solving (Beaudichon, 1981).

Similar findings are reported in peer interaction research. Children in peer interaction settings advanced their skills in Piagetian tasks as well as in other problem solving tasks. They especially showed progress when they were required to reach a common conclusion. This indicates the crucial role of genuine collaboration in learning. Considering communication itself as a collaborative process, it was expected that the dyads would increasingly improve their messages across three sessions as a result of trying to solve the problem through communication. Also, as found in many other studies, the older group was expected to produce more adequate messages than the younger group.

Message Adequacy

Since this task allowed the dyads to interact freely within a defined goal, unlike the standard referential communication task, the Witness was not solely responsible for the message quality. The message was a joint production of both the Witness and the Operator. Furthermore, in this task, the Operator often initiated the construction process of instructional messages. Therefore, the "final message" that a dyad jointly produced during one episode will be the unit of analysis rather than only the "initial message" that the Witness produced in his/her first turn. The final message does not refer to any one particular message like the last message in an episode. Rather, it is the

accumulation of all the information provided by either the Witness alone or by the Witness and the Operator. The message produced by the Witness after the prompt from the Operator does not qualify as the initial message. Later, in order to analyze the Operator's contribution in message improvement, the initial message, the final message and the mechanism of repair linking the two will be examined.

Before examining the message adequacy, it should be noted that the instructions were made in this task in two ways, depending on what the referent was. One way was giving instructions in terms of robot movement (Robot Movement perspective) and the other in terms of buttons (Button perspective), as mentioned previously. Since almost all of the episodes contained the instructions in robot moves either alone or sometimes with the instructions in buttons, the message adequacy will be examined in the instructions in robot moves. There were cases, rarely though, when the instructions were made only from B perspective. Those episodes were not counted when the adequacy was calculated.

The robot consisted of 5 motors controlled by 5 individual buttons. However, it did not have 5 individual sets of parts. Various types of moves shared the same parts. One obvious example is that one wheel/motor alone made a turning move while the same wheel/motor with the other wheel/motor produced a straight move. From the sample transcripts, 3 components of information were

identified in the children's description of robot moves:
PART, **AXIS** and **DIRECTION**. Depending on the number of
components included, messages were categorized into 3
levels: High, Medium and Low. For example, the Instruction
"Turn the arm left" contains all 3 components (high level),
Axis, Part, Direction, while "Move the arm" has only 1
component (low level), Part, since "move" alone doesn't
specify the Axis. Information on 2 components makes a
medium level message.

Instructions could be made in terms of the above
mentioned 3 components. But the dyads did not always
include all 3 kinds of information. In many cases,
information on 2 components enabled them to refer to and
identify a particular robot move. However, which component
information can be safely or effectively presupposed as
given varies according to the type of move and the
particular "history" of dyads and other contextual
variables. For example, for the ELBOW UP move, either "move
the pincher up," or simply "up" worked the same because both
the O and the W had the basic information on the task goal
and the material from the free play session and the
Experimenter's directions. Therefore, the following fact
can be shared and used as such: The ELBOW moves and may need
to be moved "Up" to achieve the task goal, even though from
time to time, the robot itself can also be lifted up due to
some obstruction. Therefore, the message "Up" could
explicitly give the dyads information on AXIS/DIRECTION, and

imply which PART to move at the same time. Another example would be "close," which means "close the HAND." Whether the information was shared and utilized as such depends on each dyad. The above examples simply present the possibilities. The maxim of relevance (Grice, 1975) often plays a crucial role in the formulation of the message. The instruction, "turn _it_ to the tower," issued right after the episode of "going straight" could carry enough information, due to the context, for the listener to interpret "it" as the robot or the wheel rather than the top part. This may not always work because young dyads have a tendency to use pronouns to refer to objects in the physical context not necessarily the things that were previously mentioned in discourse. In addition to the above mentioned reasons, a message with two components seems to provide a reasonably sound starting point.   Therefore, any message with information on 2 or more components was defined as **"adequate"**. It was decided to look at how many episodes have adequate final messages for both age groups. The results are presented in Table 4.3. According to this definition, one cannot tell whether the 2-component, or Medium-level messages are from lack of awareness toward the message ambiguity or from the use of other adequate conversational strategies. This is an attempt not to penalize the dyads who might rely appropriately on conversational strategies.

Table 4.3 : Rate of Episode with Inadequate Final Message

	YOUNGER				OLDER		
	A/C	(A-B)/C	B/A		A/C	(A-B)/C	B/A
JODA	32.8	31.8	21.5	JADY	20.7	8.2	21.5
BLCL	49.0	43.2	11.5	LUAD	16.3	10.8	45.4
TOJU	71.6	44.5	35.4	TRJO	42.9	34.2	35.5
LECH	53.0	47.7	9.5	ANMA	22.7	13.7	54.2
AMNE	47.7	38.5	19.4	TAWI	26.7	20.3	27.2
				CATH	54.5	51.5	6.7
M	50.8	41.1	19.5	M	30.6	23.1	39.0

*A: N. of Episodes with inadequate initial message
 B: N. of Episodes with adequately repaired final message
 C: total N. of Episodes per round

For the younger group, an average of 41.1% of the episodes
per round had inadequate final messages, while an average of
23.1% of the episodes per round showed inadequate messages
for the older group. The older group in this task produced
significantly more adequate final messages than the younger
group did, t(9) = 2.26, P < .05.

Then, how can one explain this developmental difference
in terms of this task? If the young children do not realize
the inadequate message as a possible source of communication
failure as found in many studies, then the younger children
who produce inadequate messages in the first place will also
be poor at repairing messages by rephrasing or suggesting
new components. When the first and the third columns of the
table are examined, the younger group, compared to their

older counterpart, showed a higher rate of episodes with **inadequate initial message** (A/C), and a lower rate of **repair** (B/A). Then, the younger group, compared to the older group, seemed to start with inadequate messages more often but engaged themselves less frequently in the message repair process even though they needed to. The similar finding was recently reported in the studies by Lloyd (1990) and his colleagues. In the next section, the repair mechanisms will be examined to see how each age group employs different types of repair strategies to improve messages.

Mechanisms of Repair

Even though they do have an increased level of message, what is the source of improvement? Is it because the Witness's initial message has improved or because the Operator contributed more? In order to find out in what way the Operator helps the Witness improve the message, the types of the Operator's contribution to the repair process were examined. Many studies of repair mechanism focused on finding out types of devices children commonly use and the developmental differences in the type of repair mechanism. In this study, the relationship between the repair and its fulfilled function was examined. The number of repair instances itself may increase as the Operator learns to request for clarification and then decrease as the Witness learns to give better Instruction, as McTear notes (1985).

However, the number of repair cases for the inadequate message, as defined in this task, should increase.

There are many ways to categorize the phenomenon of repair or reinitiation as well if one broadens the concept of repair. In this study, message repair cases were categorized into two types according to their fulfilled functions: **"Component Addition"** or **"Replacement"**. In this section, only the component addition type of repair will be examined to see how the dyads collaborated to produce final messages.

One of the major sources of message improvement will be the Operator's question when the Operator realizes that s/he does not have enough information. This device, often called the **"Clarification Request"** **(CR)** sequence (Garvey, 1975, 1984; McTear 1985) is well researched, even though there are differences in terms of how broad the definition might be. Usually it does not include the cases of defining the topic of episodes. This section discusses how the CR sequence improves the message production. It is expected that the children will learn to request clarification when they do not have enough information.

Another strategy of clarifying the message for young children is guessing through action. This is a non-verbal means of message clarification. Young listeners guess when they cannot find any situational clues to clear the ambiguity or the uncertainty. Even though they often choose to guess rather than ask questions, they seem to expect the

feedback from the speaker (Speer, 1986). Therefore, their action qualifies as a clarification attempt. Here, it will be called a **"Non-Verbal Guessing"** strategy. If children use this strategy in everyday situations, they may utilize this strategy in this task also because it provides the channel for this type of clarification: button pressing by the Operator. If interpreted by the Witness as a request for clarification, then it can function as a prompt for the Witness to improve messages through reinitiation.

The categorization system for the CR sequence in this study is based on McTear(1985)'s version. By definition, the <u>potential</u> request type is the one most likely to achieve the goal of improving the message, as assumed in other studies (Lloyd, 1990), because it highlights missing components. There is no one-to-one correspondence between the form of repair and the function, as noted by many discourse analysts (Corsaro, 1979; McTear, 1985). This task gives the O an access for clarification through non-verbal means, pressing buttons. One cannot assume that all the successful repairs were the potential type. Then, what types of devices are both used and successful at adding more component information? First, some examples of these devices will be analyzed to study the types used and how they functioned for each dyad in ensuring message adequacy.

<u>Repair Device : What works</u>? The following type of repair is, regardless of who the initiator is, a

collaborative effort to establish a <u>routine</u> for
instructions. The dyads work toward adding a presently
missing but potentially available component to the
instructions.

```
W     "Now move."                         (1)
O     "Move what?"                        (2)
W     "Move the robot."                   (3)
O     "What part of the robot?"           (4)
W     "Move the wheels. That's what"      (5)
O     "But what direction?"               (6)
W     "Forward."                          (7)
                        <TOJU 1-1. 13:27>
```

The initial instruction **(1)** has no component. However, the
O's request for more information on missing elements in **(2)**,
(4) and **(6)** were all responded to by the W with additional
information. As a result, the initial message with only a
general action verb, "move," turned into the final message
that could be summed up as "Move the wheels forward" at the
end of these exchanges. The type of clarification request
here is **"potential Request for Elaboration"** even though
there is a side sequence of **"specific Request for
Specification"** between the lines **(3)** and **(5)**. What is
noteworthy here is that this potential type of request is
demanding on the O, but also very time consuming.
Therefore, as soon as the routine is established, the dyads
may move toward less costly devices unless the situation
demands otherwise. If the routine is not internalized by
the W, then explicit forms of support from the O will be
necessary. If the routine is internalized, then minimal

forms of prompt will be enough to have as much effect as the maximal prompts.

In other times, the O contributes the content, too, in the structure.

```
W     "Okay, now..bring it to the sides."      (1)
O     "The side toward the wall?"              (2)
W     "No..."                                  (3)
O     "To the clock?"                          (4)
W     "No, not to the clock."                  (5)
                           <LECH  2-1.  1:36>
```

In line **(1)**, the Instruction does not have the information on the DIRECTION. Before pressing buttons, the O made a verbal guess, "to the clock?" Even though it was a wrong guess, it primed the W to think about the DIRECTION that's missing from the initial message. This CR sequence is "**potential Request for Confirmation.**" To the O, both of the potential type of CR are much more demanding than the specific type of CR. The potential type requires the O to find out the element "which is missing from the surface but potentially available" (McTear, 1985).

Somewhat less demanding to the O is the repair process of using "**specific Request for Confirmation.**" At the same time, this request could prove less effective in eliciting the information from the W because it doesn't specify what needs to be filled in. This could simply signal to the O that more information is needed.

```
W     "Drive it."                              (1)
O     "Drive it?"                              (2)
W     "Uhmmm/ (meaning yes)  Straight!"   (3)
                           <JODA 1-1.  17:29>
```

In this example, the specific Request for Confirmation (S-C) (2) fulfilled the function far exceeding its originally assumed one. It is not clear what the intention of the O was in using that specific form. However, what is clear is that the low level of prompt functioned in this case as strongly as the high level of support.

Sometimes, repairing happens without any verbal request from the O. The repair process begins when the O presses a wrong button. The O doesn't initiate a request for clarification sequence. Instead, the O makes a **"Non-Verbal Wrong Guess"** (or simply, **Wrong Guess**) which in turn functions as a request for clarification to which the W might respond.

```
W      "First...turn.  First turn."                (1)
O      Waist cc                                     (2)
W      "Oh, not with the arm.  With the wheel."(3)
                   <JADY 1-2.  12:24>
```

It is an example of "reinitiation" of how the W rephrases his Instruction after an unsatisfactory response from the O. In **(1)** there is information only on AXIS. Judging from the O's many failed attempts to get it right after this initial attempt, the robot move of WAIST here is not meant by the O to be a request for confirmation of TURN THE WAIST. He was simply trying to find the correct button. However, the W acted as if the O put out the potential request for confirmation, "You mean, turn the arm?" The W's rephrasing was a retrospective repair prompt to the O's WAIST move. In this example, the O played a minimal role while the W showed

the capacity to reexamine his own initial Instruction and to modify the instruction in relation to the presented move.

Even a **pause** is more than a device for slowing down the pace of conversation. A pause in the place that <u>predicts</u> a response functioned as a repair prompt here.

```
W     Bring it towards me.  (gesture)     (1)
O     (pause)                             (2)
W     Move the tire that has..            (3)
```

In line **(1)** the pronoun "it" is not clearly defined. Whatever the reason might be, the O didn't respond, and then the W interpreted it as a prompt to repair the message. In **(3)** rather than blaming the O for not responding or repeating the same instruction, the W replaced "it" with "the tire" to make the message more informative. Other than the above mentioned, a few cases of **"Nonspecific Request for Repetition"** as in "Huh?" or "What?", and **INF**orming what the O did as in the case of "I moved the arm," were also found to function as prompts for repair.

Many devices were found to be used in adding more component information. Even though the potential type is the one that directly addresses the problem, many other lower level prompts also served to add more information in terms of component. The variety itself does not guarantee that these devices will work all the time.   It means that they have the potential to function that way.   Also, these devices will not be used at the same rate. Then which ones are preferred by each age group?

<u>Developmental Difference</u>. Among different types of repair mechanisms, the potential type of explicit request is most demanding to the Operator but most supportive to the Witness. Children's communication skills as both speakers and listeners are limited but developing at the age range of this study. Considering their lack of the metacommunicative knowledge that poor messages can be a cause of communication failure, the younger dyads will favor the non-verbal guessing strategy more frequently than their older counterparts. This may explain the low rate of repair for the younger dyads. Then, are the non-verbal guessing strategies as successful as they are favored in adding component information? What kind of devices are involved in successful repairs? The dilemma is that the younger group may need explicit verbal requests including potential types, as a repair mechanism while the very same group of children are not equipped to do just that.

In order to see if there is any difference in the type of successful repair mechanism between two age groups, the number of episodes that employed each type of device was tallied. They were grouped into 5 categories: Self-Repair, Pause, Non-Verbal Wrong Guess (WG), Nonspecific and Specific Requests (NS & S), Potential Requests. **"Self-Repair"** includes the repair work initiated and made by the Witness within the first turn. **"Pause"** is defined as time lapse of at least 3 seconds while both members are engaged in the task. **"Non-Verbal Wrong Guess"** (WG) is an act of pressing

buttons that resulted in message repair by the Witness. **"Non-Specific"** and **"Specific"** requests **(NS & S)** are the general type of CR as in "What?" or "Pardon?" (Non-specific requests) and the type that refers to the specific component of the preceding message as in "Move the arm" - "What arm?" (Specific requests). **"Potential"** requests focus on the component that is missing but potentially available from the prior message. The example might be: "Move the arm" - "Which way?" - "Up."

The following Table 4.4 presents the dominant type of repair mechanisms for each dyad. If one type was found in more than 50% of the total number of repair episodes, it was marked **. If it was found between 25-50% of the total number of repair episodes, it was marked *. There was often more than one device used in an episode. In this tally all the repair cases, not just the ones that contributed in producing the "adequate" message, were included.

While the older group tended to have one or two dominant devices, the younger group showed a wider variety of devices. However, for both age groups, the W added more information mostly after the O's wrong guess. One out of six dyads from the older group, LUAD, and two out of five dyads from the younger group, TOJU and LECH, employed both the WG and the Potential type to succeed in repairing messages. Therefore, the W first seems to need the explicit CR sequence to successfully repair messages and later can repair messages without the scaffold from the O once the

Table 4.4 : Dominant Repair Devices for Each Dyad

Age	Dyad	SELF	PAUSE	WG	NS & S	POTENTIAL
5	TOJU			**		**
5	JODA			**		
5	BLCL			**		
5	LECH	*		*		*
5	AMNE	*		**		
7	JADY			**		
7	LUAD			**		**
7	TRJO			**		
7	ANMA			**		
7	TAWI			**		
7	CATH			*		**

routine of message clarification is internalized. In order
to succeed, therefore, it seems to be a matter of who is
going to stretch their ability at the moment. One dyad from
the older group, CATH, shows only 3 cases of successful
repair (one of which is followed by the WG and two followed
by the potential requests). From the younger group, the
remaining 3 had not many cases of potential requests and
AMNE had no repair case of the potential type at all. In
order to say that the younger group needed to rely on
explicit forms of support in repair more than the older
group, the presence of 3 dyads that demonstrated the pattern
similar to the older group needs to be explained. Those
three younger dyads' inadequate message rates are not much

different from the rest of the young group. This seems to

indicate that this dyad is not developmentally advanced in

terms of message evaluation. In fact, they rarely succeed

in the game. There must be some differences even though the

older group and the younger group exhibited the same

pattern.

In order to find out possible differences in the role

of WG, the relationship among the initial message, WG, and

the reinitiation were examined. WG is not an explicit

prompt for the W to repair, rather it is a signal to the W

that the communication failed. The source of failure is not

known. The failure could be a result of the message

ambiguity or a lack of button knowledge. However, when the

W repairs the message after the O's wrong guess, it means

that the W believes the inadequate message to be the cause

of failure. When the older and the younger dyads are

compared, there were some differences in terms of how WG

functioned as a prompt.

W	"Okay, shut it now and <u>bring the arm</u>.."	(1)
O	E1, up	(2)
W	"<u>Bring the arm that's holding the jaw</u> <u>down</u>."	(3)

<div align="center"><JODA 1-2. 29:06></div>

W	"Now turn it a little more."	(1)
O	LF (left <u>wheel</u> forward <u>turning</u>)	(2)
W	"No, the <u>arm</u>."	(3)
O	Oh\ Waist c	(4)
W	"That's good. Oh, turn it a little more."	(5)
O	Waist c	(6)
W	|"No, the other way...one notch."	(7)
O	Waist cc*	(8)

<div align="center"><JADY 1-2. 14:24></div>

In the first example by a younger dyad, even though the W provided an additional component information, he didn't do it in a way that differentiates the <u>new and critical</u> information ("down") from the <u>old and not-so-relevant-at-the moment</u> information ("the arm that's holding the jaw"). On the contrary, in the second example, this older dyad added the information only on the component that needs to be <u>contrasted</u> (PART).   The older W provided the new piece of information based on the comparison between the initial message and the proposed move. In presenting this information, he, both in **(3)** and **(7)**, <u>highlighted</u> <u>the new</u> by using only the new while the younger W did not. The younger W even elaborated on the already available component ("arm that's holding the jaw"). The Os in this dyad often get confused by this type of repair, and move onto a new button. When new information was presented in two components, PART and DIRECTION, the O could not decide which one of the components (or maybe both) needs to be focused and fixed. It seems that, for the younger dyads, wrong guesses by the O seem to function only as a <u>signal for failure</u> to communicate. When they repair the message they do not help the O by highlighting the new from the old, maybe because they do not know which one is needed by the O and thus needs to be highlighted. Even though the same type of prompt was used successfully by both age groups, it functioned differently because the dyads used it differently. The older dyads used it in a listener-sensitive way to fully

maximize the utility of new information while the younger dyads did not.

Optimal Level of Message. Judging from behaviors of young children, they seem to operate on the assumption that more information is better. Sonnenschein (1984) argued that children succeed in communication, first as a result of being redundant and later by producing contrastive messages. Using adult subjects in the referential communication setting, Clark and Wilkes-Gibbs (1986) demonstrate that communication proceeds toward reducing the collaborative efforts. Then, one of the areas in children's communication development would be moving toward reducing the collaborative effort rather than focusing on individuals. Do children in this task learn to collaborate to reduce efforts? If they do, what are the sources? There can be many ways to minimize the collaborative efforts, and the pattern will depend on the particular task situation. Earlier in the section on "message adequacy", it was speculated that the dyads might work under the collaborative principle, maybe by utilizing the shared terms or the principle of relevance. If they do, then it will be most evident for the effective pairs, especially in the last session, because any dyad first had to construct the shared terms or other devices for efficiency through elaborate efforts. Among all the dyads, JADY is the most likely candidate in many ways: they succeeded in all six rounds

with the shortest amount of time; the rate of episode with
inadequate final messages was the lowest reaching the level
of 0% in Session 3; the repair rate was the highest
throughout, steadily increasing up to the level of 100% in
Session 3. If the dyad is not working toward the
collaborative principle, their adequate final messages would
be as explicit as possible and would contain the highest
level of information for the most episodes.

As seen in Figure 4.2, messages are mostly at the
medium level, not at the highest level. However, one cannot
say conclusively that this dyad are working under the
collaborative principle. One should analyze the source of
reduction to find out if the children are working under the
collaborative principle.

One of the ways of reducing efforts collaboratively
would be relying on shared knowledge. If the dyad is
working on this principle, they would utilize the shared
knowledge as much as possible. From the table, the
component that was most often omitted was PART. By Session
3, they seemed to make it a piece of shared knowledge that
"straight" is "wheel straight" and "up" is "arm up". When
they included the PART information, it usually happened
after they worked on "the other kind of PART", WHEELS, as in

JADY 3-1

Episode #		1	2	3	4	5	6	7	8	9	10	11	12	13
High														
Medium														
Low														
$\emptyset$														
Content		RT	Y_1	RT	Y_1	RT	Y_1	E	RT	H	E	Y_1	H	Y_2
Component	D	x	x	x	x	o	x	x		x	x	x	x	x
	A	o	x	x	x	x	x	x	x	x	x	x	x	x
	P							x	x	x	x			

JADY 3-2

Episode #		1	2	3	4	5	6	7	8	9	10	11	12	13	14
High															
Medium															
Low															
$\emptyset$															
Content		Y_1	RT	Y_1	RT	Y_1	E	Y_1	H	Y_1	RT	Y_1	H	Y_2	H
Component	D	o		x		x	x	x	x	x	o	x	x	x	x
	A	o	x	x	x	x	x	x	x	x	x	x	x	x	x
	P		x		x		x				x				x

KEYS: RT: TURN WHEEL   x: initial component
       Y_1: STRAIGHT   o: added component
       Y_2: BACKWARD
       H: HAND
       E: ELBOW

Figure 4.2 : Condensation of Message

the cases of Episode 6-7, 7-8, 8-9 in Round 1 and in Episode 5-6, 9-10 and 13-14.

Another source could be from the development of the communication strategy specific to this task. The DIRECTION information was also often missing in initial instructions. This seems to be due to the features of this task: the robot is constantly moving and it is not optimal to try to memorize all 10 different button halves. Instead, the children often focus on 5 different buttons, and work on the directions by pressing buttons. It makes the task manageable for both and also saves the effort. (More detailed discussion of this case is in the section on Strategies.) Opening up the chance for the O to fill in by testing buttons seems to be a strategic decision. In this task, therefore, the dyads learned to work toward reducing the collaborative efforts.

Shared Terms

Studies of peer learning discourse report that effective dyads use idiosyncratic but shared terms in referring to objects during the task (Cook-Gumperz, 1979; Cooper, 1980; Dickson, 1982). The use of shared terms is also predicted by the least collaborative effort principle of communication (Clark & Schaeffer, 1989). The robot in this study has several parts and makes a variety of movements. Since the robot is not a common object, there

are no readily available names for parts or types of movements. Therefore, each dyad in this task needs to create referential labels for the robot parts and movements in an effort to communicate efficiently.

How does this process of defining names work? As an effort to establish a common perspective toward referents, adults always describe the referent first (Clark & Wilkes-Gibbs, 1986) and later develop names by shortening the lengthy descriptions (Carroll, 1980). In computational linguistics, studies of task-oriented discourse analysis with adults (Cohen, 1985) reported two different modes of securing referents: separate or embedded. Quite different from adults, young children were found to introduce the idiosyncratic names without first describing them (Krauss & Glucksberg, 1977). If the dyads in the robot task are aware of the possibility of discrepant perspectives toward referents, they will make an extra step of referent identification before issuing Instructions. Older children are always more sensitive to the listener's needs in communication. Therefore, the older dyads are typically expected to engage themselves in referent-identification steps while the younger dyads are typically expected to introduce names without referent-identification steps.

All the dyads in this task struggled to verbally share the referents because they were not identifiable deictically. The children had to refer to objects (robot parts) as well as events (robot movements). In the

following, the process of co-constructing the shared terms for the top part of the robot will be examined.

Top Part as Referent X

The robot was controlled by five separate motors. For the dyads in this task, the robot seemed to be divided perceptually into two parts: the top part that had three motors (ELBOW, WAIST, HAND) and the bottom part that had two motors (2 WHEELS). The bottom part with wheels did not seem to pose any problem for the dyads to "name". They often used the term "car", "constructure", "the whole robot", "robot" or simply "wheels". These terms respectively did not seem to require any further elaboration for the dyads to understand what was being referred to. They were based on the physical features of the referent. However, the top part had three distinctive motors that produced different moves even though they all shared the same part.

Since the same robot was used for all 3 sessions, only the first session will be analyzed. The variations on "X" in terms of names were coded as X_1, X_2, ..X_n. Any deictic or pronominalized reference ("it" or "this") was coded as "x." The proword like "the thing" was coded as "(X)." However, sometimes, "the thing" was used consistently for X. In that case, if it was used more than twice consecutively, then at the third time, it was considered as a shared term and coded as X. The subscript simply indicates the order

of introduction of these names. Therefore, Xn signifies
different names for different dyads.

Referent-Identification of X

The <u>first</u> <u>effective</u> <u>explicit</u> references of X for each
dyad was examined to see how each dyad proposed and accepted
the names of X for the first time. From the sample
transcript it became clear that the dyads introduced more
than one name. Therefore, for each new name, each dyad will
be assigned to one of 3 categories according to their
strategy of securing the referent:

1. **No Referent-Identification:**
   The first reference to   the name occurred without
   further elaboration: e.g.) "Make the <u>pincher</u> go
   down." -- I(A: X_1 DN)

2. **Embedded:**
   The first referent-identification was attempted
   during the process of predicating: e.g.) "Make <u>the
   thing that smooshed our fingers</u> turn."   --
   I(A: X_1[Ref-Id]T)

3. **Separate:**
   As the first reference, the dyad was engaged in a
   referent-identification process before predicating
   : e.g.) "Do you remember <u>the blue clip thing</u>?"
   "Yeah/"   "Make it go up." -- I·INF(Ref-Id:X_1) =
   INF(Ref-Id) = I(A:xUP)

Based on the codings of the first reference of X, each dyad
was categorized in Table 4.4.

Table 4.5 : Shared Terms for X

AGE	DYAD	ROUND	NAMES	CATEGORIES
5	JODA	R1	X_1: arm	1
			X_2: claw	1
			X_3: jaw	1
			(X1: arm)	1 [?] 3
		R2	X_3:	1
			X_4: X1[X3]	1
			X_1:	1
5	BLCL	R1	X_1: thing that hooks	0 [2]
			X_2: hand	1 [?] 3
		R2	X_3: the thing	1, 2
			X_4: pipe	1
			X_5: white wood	1
			(x3: the thing)	2 [?] 3 [1]
			X_6: handle thing	1
5	TOJU	R1	X_1: hook	1
			X_2: clipper	0 [1]
		R2	X_2	1
5	LECH	R1	X_1: gray thing	3
			(X)	2
		R2	X_2: the thing	1
			X_3: the thing that smooshed our fingers	1*
5	AMNE	R1	X_1: hand	1, 2
		R2	X_2: handle	1
			X_3: claws	1
7	JADY	R1	-	
		R2	X_1: arm	1
7	TRJO	R1	X_1: claw	1
			X_2: arm	1
		R2	X_1: "	1
			X_2: "	1
7	LUAD	R1	X_1: pincher	1
		R2	X_1: "	1
7	ANMA	R1	X_1: plastic bar	1
		R2	X_2: the thing	1
7	TAWI	R1	X_1: tweezer	1 [?] 2
		R2	X_2: clipper	1
7	CATH	R1	X_1: top	1, 2, 3
			X_2: top that clips	1*
			X_3: clip thing, clipper	1
		R2	X_3': clip thing	1

[n]   First reference of X by the <u>Operator</u>
[?]   Requests for clarification of terms by the <u>Operator</u>
0   Absence of proposal. "Make <u>it</u> up."
*   These relative clauses are originally used to elaborate the name. However, they are categorized as type 1 because the whole clause functions as <u>a name</u> in these two cases.

Contrary to the expectation, it is the younger group, not the older groups, who showed more cases of requests for referent identification. And it was only the younger group who ever first introduced the names with some elaboration, either in a separate sequence or in a relative clause embedded in Instructions or Descriptions. Consequently, a few possible explanations need to be explored.

One of the most likely explanations is that the names proposed by the older Witnesses could be better for recognition by the Os in the first place. If this is the case, then both the W and the O would not desire any extra steps for grounding. Upon examination the names from the older group tend to be short, single and unique nouns ("tweezers") while those for the young groups are long, compound nouns made up of general terms ("the thing that hooks"). While a lengthy compound noun description looks more informative, it doesn't seem to capture the essence of the intended referent. The feeling of unsureness and dissatisfaction toward the name by both the W and the O may have prompted the younger dyads to get engaged in the grounding process.

Another possible explanation could be the sheer number of names the younger dyads created during their sessions. Maybe a result of dissatisfaction toward their names for X, the younger dyads switched to different names more often than the older dyads. Or perhaps the older dyads may have realized that any name would do, as long as both the O and

the W agreed. Whatever the reason might be, the younger

dyads needed to deal with many names while the older dyads

have one or two names they used for both rounds. Therefore,

the younger dyads had more names to commit to memory, thus

less time for each name. This may have prompted the O to

request information for referent identification. In fact,

two of the younger dyads, JODA and BLCL, got into the

referent identification process with previously introduced

names. Having many names to deal with, they may have easily

forgotten the name they previously used with success.

Finally, even though the robot itself is not a common

one, the referents can be described in terms analogous to

real objects. Many other studies used abstract pictures

that can be communicated properly only on the basis of

mutual agreement. Clark and Schaeffer (1989) argue that the

pattern of contribution vary depending on the task situation

that includes the communication mode, material and setting.

Here, in this task, the material (robot) is different from

abstract drawings that do not have counterparts in reality.

The older dyads in this task spent little effort

establishing mutual agreement on the names because they

chose the names that could be recognized easily through

analogies to common objects.

Even though the younger dyads worked harder than the

older dyads to identify referents by adding and replacing

descriptions, both groups generally introduced a new name

without the separate referent-identification process. Only

when faced with a communication problem did and could they initiate the extra step. Therefore, the motivation behind this "sequential construction" (Ochs, 1979) of separate <u>referent-identification step</u> + <u>predicating step</u> seems to be an effort to establish mutual understanding. Using this construction sequence is not the evidence of children's mature ability to plan discourse ahead of time, as others claimed (Ochs, 1979).

Naming Process

This section will discuss how names evolve and what types of base the dyads adopt to describe referents

<u>Source of Names</u>. A closer look at the way both age groups tried to secure the reference reveals very interesting differences. The older dyads usually shared names across rounds. Usually they were single nouns like the "pincher". One of the older dyads, CATH, used 4 names, while others used either only one or two names. From this dyad, one can see the <u>predictability</u> of the naming process. The four names are:

    (1) "the top"
    (2) "the top where it clips"
        (or "the top thing that clips")
    (3) "clip thing"
    (4) "clipper"

These are not just four randomly selected names. The first introduced name, "<u>the top</u>" **(1)**, was elaborated with a

relative clause into **(2)**, "<u>the top where (or that) clips</u>."
Since "the top" was not a successful name, which is why the
W got into the repair process in the first place, "clips" is
the only one eligible core element left out of 2 (Carroll,
1980) in the phase **(2)**. In **(3)**, while dropping "the top",
the W retained "thing...clips", which in turn was
transformed into the "<u>clip thing</u>."   Since the single noun
is a minimal unit, it was preferred for the sake of the
least effort. Therefore, this compound noun of "clip thing"
became the "<u>clipper</u>" in **(4)**. One young dyad, LECH showed
the same type of underlying principle when they moved from
"<u>the gray thing</u>" to "<u>the gray thing that smooshed our</u>
<u>fingers</u>" in Round 1 to "<u>the thing</u>" and "<u>the thing that</u>
<u>smooshed our fingers</u>" in Round 2.   In Round 2, they only
moved back to the lengthier one, "the thing that ..." only
after they had a miscommunication with "the thing".
Therefore, the naming process or the name repair process for
the older dyads and some younger ones seems to be driven by
the principles of <u>efficiency</u> through minimizing the effort
and <u>recognizability</u>, in other words, "recipient design"
(Sacks & Schegloff, 1979). With the O's help through
feedbacks, the W could create a name that satisfies both
principles. The naming process for the older dyads is
predictable rather than random. They propose, expand, and
then condense. Even though they use the same name in the
beginning and the last phase often, the same name in two
different phases is different in terms of the status.

Contrary to the older dyads' predictable nature of the naming process, the young dyads do not seem to follow the same principle. They tend to <u>exchange</u> names rather than creating the new one out of the old one through <u>transformation</u>. For example, BLCL's Xs range from "the thing", "the handle thing", "pipe", "white wood" and so on. Even though we can derive some commonalities from the features of those named objects, there is no structural progression across name changes.

<u>Bases for Descriptions</u>. There is another characteristic of the content of the description that is unique to the young dyads' way of referent-identification. Since young children tend to rely on the immediate physical context to refer, like deictic expressions ("that way" or "this one"), it is likely that they try to secure the referent by relying on what they can see at the moment rather than relying on what both the W and the O can locate from the shared experience. As expected, the younger dyads relied on the immediate context to refer to the part.

(1) "Put the thing that is up...put it down!"
(2) "I mean, turn the thing that's open."
                              <BLCL 1-2>

In both **(1)** and **(2)**, the descriptions "that is up" and "that is open" are based on the current state of affairs. Even though "that's open" in **(2)** may give the O a clue about the referent, they are <u>temporary</u> and only accessible to W but

<u>inaccessible</u> to the O. Especially, in **(1)**, the supposedly new information "that is up" does not help the O identify the referent because it is locked in a circularity of "up-down". This phenomenon is not unique to the description of X. One of the older dyads, TRJO, tried to help the O identify the side on which the "claws" should go.

```
     W      "No, it's not that side."
     O      "Which side?"
            (pause)
            "Which side?"
     W       "It's where one of the two wheels
            nearest where the claws is."
                    <TRJO 1-1. 12:20>
```

On the other hand, the older dyads in the same situation mostly used,

"Remember the <u>blue</u> thing <u>that closes and opens</u>?"
<TAWI, 1-1>

referring back to the free play session when both share the referent. By starting with "Remember..", the W signals the O where to search (shared memory). Also, the information is composed of and presented in terms of the constant physical characteristics (blue, that closes and opens).   Another dyad, ANMA tried to help the O identify X as follows; "the one that makes <u>sound</u> ...." (The robot arm was making clicking sound whenever it moved for that particular session.)   In this case, the information, sound, is currently identifiable to both, despite the visual barrier. One younger dyad who succeeded in solving the problem 4

times, LECH, also used the shared experience as the source of a name, "the thing that **we** smoosh**ed** our fingers with."

X-in-Use

Even though identifying the referent and giving names are very important, "what to do with it" or predicating is a central part of Instruction. Any referential label or name is a part of another type of referent, movement, that needs to be repeated many times during each round as either Instructions or Descriptions. The need to share concepts, according to Freyd (1983), causes changes in the knowledge structure. Then, the need to share the description many times with the O may cause the W to gain a better understanding of how the robot works, as much as the newly gained understanding changes the descriptions of robot movements and parts. Then it is expected that the description of robot movements or the names will change toward the direction of better understanding of the robot functioning.

For the children who do not understand that each motor has a different function, it is quite a challenge to differentiate 3 moves based on intangible momentary paths of movement. Therefore, naming the top part, coded as X, involves identifying the part in a way that also enables the O to identify a certain move. Naming X seems to be influenced by what type of move is asked for. For this

reason, the unit of analysis will be the Name for X and the

Predicate as a whole. In other words, "X-in-use" will be

examined to see whether and how the dyads change the name

for the top part as they progress in this task.

The function of the name seems to change from one

context to another.

```
W     "No, move it that way." (gestures)
O     HO
W     "No, don't move the clippers. Just move it."   (1)
      (gestures toward the tower)
O     "This ?"  Waist cc
W     "Ya, ya, that's it."
                         <CATH  1-1.   35:24>
```

In (1), the name "clippers" denotes the PART as well the

movement, specifically, the HAND move. In the same way,

"it" means WAIST move, if used deictically. If it was used

anaphorically, then "move the clippers" means both the WAIST

and the HAND moves. In both cases, the name "clippers"

carries more than the "part" information.   On the other

hand, in "Move the clipper up", the clipper is just a name

to be combined with other elements. While the same top part

is involved in 3 types of moves, they do not share the same

button. All three moves are controlled by different

buttons. In general, children, initially, seem to think

that once they identify the referent, X, then the O can

identify the button for any of the three moves. Therefore,

they need to move toward differentiating the moves despite

their initial perception. After all, it is their own

construction or model of robot functioning that all three

moves are controlled by the same button. They are not sure
about the one-to-one correspondence between the button and
the robot move. By tracing the use of X in the context, one
is able to see the process of the changing understanding of
the task and the material (robot).

Roughly, the dyads can be divided into two groups in
terms of the number of names they employed. Most of the
older dyads and some younger dyads have a minimal number of
names and use usually one or two names for all three moves
(ELBOW, WAIST, HAND) throughout sessions. For them, these 3
moves are differentiated by the predicate, not by the name.
The following is one such example:

ELBOW: "Move up the pincher."
WAIST: "Turn the pincher toward the tower."
HAND: "Open the pincher."

Therefore, one name, **the pincher**, was used to differentiate
all three moves.

For the dyads with multiple names for X, they seem to
go through a few phases before they finally settle with one
name. The following example is from Session 1 of TRJO, one
of the older dyads. In order to see the changes in the way
they use the names, names with predicates were listed in the
temporal order, and then divided into chunks along the line
of change in terms of patterns. Therefore, chunks are
psychological not temporal. Also ," => " means there is an
external conflict situation involved for the change, while
" = " between phases means no overt conflict is present.

	R1 (W1)		R2 (W2)	
ELBOW	Move X1		X2 Down	X1 Up
WAIST	Move X1 =>	Move X2	(X3->X2)Turn =	X1 T Right
HAND	Close X1	Close X1	X1 Close	X1 Open
	[A]	[B]	[C]	[D]

In Round 1, the W1 first seemed to have an <u>undifferentiated</u> concept for the movement of the top part **[A]**, even though the HAND move was differentiated from the other two, very early on. When they had a miscommunication (A=>B), the W1 tried to <u>differentiate</u> moves by using different names for the WAIST (X2) and the HAND (X1) moves **[B]**. Therefore, instead of trying to repair the message structurally, by adding missing components, the W1 tried to fix it lexically by replacing the names (X1 -> X2). In Round 2, the W2 <u>overdifferentiated</u> the moves by using three different names (X1, X2, X3) along with 3 different types of predicates (Down, Turn, Close) in **[C]**. Varying the names or descriptions only in one component, either X or the predicate would fulfil the goal of differentiating 3 moves. Therefore, it is a case of overdoing. These strategies of overdoing seen in **[B]** and **[C]** may have come from the realization that all three moves are controlled by 3 different motors or buttons. Later, the W2 went back to using the term that's the <u>same</u> as the first one, X1, <u>but</u> <u>differentiates</u> 3 moves varying only the predicates [D].

This strategy of description seemed to work well because it is compatible with the way the robot is structured.

It is very interesting to note that from C to D there was no explicit conflict. It is a change that the W initiated spontaneously. In fact, this is not unique to this dyad. Therefore, the change from [C] to [D] seems to be driven by the W's internal desire to be efficient rather than due to the need caused from the outside. It could be the result of internal reorganization of the way one describes these moves despite the success as Kamiloff-Smith argues (1984). Also, at [B], assigning different names will achieve the same goal as the strategy [D]. However, this strategy will burden the W because s/he has to memorize all 3 different names. On the other hand, predicates do not demand any rote memorization. Some dyads similarly tried to differentiate 3 moves by varying the predicates. For example, they would say, "open", "turn", "up". This approach may become problematic because, without the name for X, the WAIST (turning X) move cannot be uniquely identified separate from the TURNING THE WHEEL move.

Surprisingly, both age groups are not much different in that they mostly resulted with strategy [D]. However, the younger dyads tended to switch around names often relying on strategy C. Comparing the names that the older dyads used consistently and the ones that the younger dyads used, the older dyads' names show some advantages. The three moves that involve X are not all equal in terms of control. The

HAND part is the most salient part for children. However, it also moves along with any other moves, WAIST or ELBOW, because HAND is at the tip of the whole top part. Therefore, the hand is the ultimate patient in terms of movement control, and also the common element in all three moves. If the names for X are "the pincher" or "the tweezer", the W do not need to look for other terms for ELBOW or WAIST moves. However, if the name for X is "the pipe thing" or "the arm" because it was shared <u>in the context of</u> the ELBOW move, then children tend not to use it for the HAND move because "closing the arm" may not sound right. Therefore, the W needs to devise a new name for every new move.

Sharing the name and information is crucial for a sustained or repeated interaction. When a name is introduced, it should be shared between conversants or interactants. But shared names are more likely to survive and be helpful for future communication if they are compatible to the task at hand or can easily be shared. The value of idiosyncratic but shared names are immense in short interactions, as found in many studies. However, for a long sustained interaction, dyads may need to find and settle for a more "user-friendly" name so that they can easily recollect it whenever needed in the future. Even though a name is shared, it won't be used if it is not remembered. The dyad, therefore, needs to engage a naming process repeatedly. This seems to explain the high number

of names for some young dyads and the developmental shift
toward the easily share-able names.

Instruction-Giving Strategies for Spatial Directions

Children often try to resolve ambiguity through lexical
repair, as witnessed in the construction of shared terms.
When the W cannot get a satisfactory response from the
operator, the W changes the way of giving instructions
through replacement, especially in the component of
DIRECTION.

```
W     "Move the arm left."              (1)
O     "Which way is that?"              (2)
W     "Ummm..  toward the camera."      (3)
```

In line (1), the Instruction consists of two components,
PART and DIRECTION. In an effort to assist the Operator,
the Witness replaced "left" with "toward the camera". Even
though this repair does not increase the number of
components in the message, it certainly could help the
Operator understand the Instruction better. Therefore, it
is redundant in terms of component, but possibly useful. As
seen above, the dyads use various ways of describing
directions and shift them to adjust to each other's
strategies.

According to the studies on children's development of
spatial relations (e.g. Cox & Richardson, 1985), there is a
developmental shift from nonspecific ("here") to
environmental terms ("to the wall") to spatial terms

("left"). The acquisition of appropriate spatial terms follows the order of (1) vertical dimension (up/down), (2) horizontal-frontal(front/back), (3)horizontal-lateral (left/right) in the early years, up to 6 years old. In these studies, the referents are invariably stationary objects. The robot task has a constantly moving referent. How do children describe spatial relations for a moving referent?

Depending on the referential anchor point, the following 6 types of describing directions were identified. They are termed as strategies.

		MOVE +
1.	GESTURES only	"(hand gesture)"
2.	DEICTIC + GESTURES (phys. context)	"this way"
3.	OUTCOME (outcome of action)	"right way"
4.	EXTERNAL (landmark)	"toward the tower"
5.	INTERNAL (robot path)	"to the left"
6.	RETRO (previous action)	"the other way"

For this analysis, Instructions only in Robot Movement perspective were included. The robot in this task makes movements in all 3 above mentioned dimensions (vertical, horizontal-frontal, horizontal-lateral). In addition, it has the HAND movement that does not belong to any of the three categories. During the process of problem solving, each dyad attempted different types of movement at varying rates. Some worked mostly on the HAND while others were obsessed with figuring out how to make the FORWARD movement. Unlike the case of describing a stationary object, these different strategies are not equally valuable in this task.

In the following segment, these 6 strategies will be grouped into 3; Non-Adaptive (GESTURES, DEICTIC, and OUTCOME), Adaptive (EXTERNAL and INTERNAL), and RETRO. Based on the examples from the transcripts, the manner by which the dyads utilized these strategies and solved problems inspired by each strategy will be examined.

Non-Adaptive Strategies: GESTURE, DEICTIC, and OUTCOME

Due to the visual barrier, the first two types, GESTURE and DEICTIC, would be inappropriate. The OUTCOME strategy assumes that the O knows which way is the "right" or correct way. Therefore, these three strategies are not adaptive to this situation unless they are used in conjunction with other types. Not surprisingly, this group of spatial terms was found often in the younger group and found occasionally in the older dyads. For one young dyad, LECH, for example, this group of spatial descriptions decreased across sessions (11 episodes out of 53 episodes with the DIRECTION component in Session 1, 2 out of 39 in Session 2, and 0 in Session 3). They were repaired most of the time (8 out of 11 in Session 1, and 2 out of 2 in Session 2). This is often done with the help of the O's Specific request for Specification (1) or Potential request for Confirmation (3) as seen in the case below.

```
W    "I can't see..Which way is that way?"    (1)
O    "That way!" (pointing toward the O)      (2)
W    "Towards the door?"                       (3)
```

```
O     "Yeah! Towards the door!"                    (4)
                            <LECH 1-2. 1:51>
```

Another interesting thing many of the younger dyads did can be found in the following example.

```
W     "Which side?"
O     "I don't know...left.  No, right!"
W     "Right?  Is that way right?"  (asks Experimenter)
O     Left wheel backward
W     "Which side is the right?"                    (1)
O     "This side..(pointing)"                       (2)
                            <BLCL 1-1.  -13:31>
```

Knowing which side is "right" won't help them much because they do not have the button knowledge at that specific level. They often go on requesting information exhaustively only to find out that they do not know which button to press. (Since the buttons have binary controls for two opposite directions, changing directions can be made by changing the button halves. Therefore, information on the DIRECTION is not very useful when you don't know which button set is the right one.)   After having exchanged information at a highly informative level, in (1) and (2), they went back to the DEICTIC strategy to "clarify" the message. Considering that the principle of repair is toward strengthening the evidence, this repair is unusual and against the rule of conversation. This type of <u>downward</u> repair was commonly found in younger dyads, maybe because they do not see any difference in terms of functional value of both types of information. For some dyads whose game deteriorated toward the third session, the deictic terms and gestures reappeared. This seems to indicate that the young

dyad realized that the message clarification was not the only problem in this task. For them, frustration may have caused them to give up on the laborious job of repairing and formulating messages because it wouldn't make any difference after all.

The older dyads also used the DEICTIC strategy even though they were mostly found in the first session. Their tone of voice and facial expression suggested that they were not satisfied with their own description. They seemed to use the deictic strategies for lack of better terms, not because the W believes that the O can see the gesture or understand those terms. In that sense, those terms or gestures functioned as a "place holder" for the DIRECTION information. They knew that more information was necessary, but did not know how to supply it. In some cases, the dyad seemed to use gestures to test the limits of the rule with regard to the visual barrier. One older girl dyad jokingly ran their fingers across the curtain saying "this way..." at the same time looking at the experimenter. This can be a flaw in the experimental setting. However, it considerably helped them ease into the game in the beginning.

In contrast to the other-initiated type of repair for the younger dyads, the Witness of the older dyad repaired most of the deictic terms in two ways: either after the Operator made a wrong guess or within his/her turn as a "self-initiated self-repair". The Os of the older dyads usually tested buttons instead of requesting clarification

of deictic terms. This strategy seems to stem from the O's awareness that testing button halves is more cost effective than trying to clarify the message verbally. There are only two choices in button halves. The W uses the deictic terms for the DIRECTION often because of the difficulty of finding the appropriate terms in the first place. Testing button halves is a more efficient way of solving the problem. Many older Operators seem to treat the deictic terms as a request for help from the Witnesses rather than as a "bad" message to be fixed. Judging from the contextual information and from the way the W treated them, the deictic terms or gestures for the DIRECTION seem to function differently from those of the younger dyads.

Adaptive Strategies: EXTERNAL and INTERNAL

The other three types, EXTERNAL, INTERNAL and RETRO, cannot be defined as inappropriate or appropriate because there are different advantages and disadvantages in relation to this particular task setting. Both the EXTERNAL and the INTERNAL strategies can be used in describing the robot movement _correctly_ and _informatively_ if one only looks from the W's point of view. Of the two, the INTERNAL is more adaptive and functionally valuable to the O who needs descriptions from a permanent frame of anchor, the robot. Despite this advantage, the O still needs to have the button knowledge of 10 button halves in order to work effectively

with the INTERNAL strategy. At the same time, the W has to
master the skill of using INTERNAL TERMS like "left" or
"forward" correctly.

The EXTERNAL strategy is easier than the INTERNAL one
for the W to produce because s/he does not need to put
himself or herself into the position of robot and choose
correct directional terms. The W needs only to identify the
landmark which is concrete and then relate it to the target
referent. The use of this strategy is appropriate with the
stationary referent, and according to the studies, is
acquired earlier than the INTERNAL terms. However, it does
not always work with a moving referent. Even though the O
understands where to go, for example, "turn the arm toward
the tower", he/she does not know which button half to
press. Since there is a visual barrier and the spatial
relationship between the robot and the landmark changes
across time, the O still doesn't know which direction the
robot should move. The older dyads notice the problem of
this EXTERNAL strategy as witnessed in the following
statement:

>"I don't know where the tower is. Oka--y?/ So how can
>I turn it toward the tower?"
>   <LUAD 1-1>

While the horizontal-lateral dimension(left/right) is
the hardest one to describe for the dyads, the horizontal-
frontal dimension (forward/backward) seems to be the one
that causes miscommunication most often. By definition,
the EXTERNAL terms in this dimension do not allow much room

for ambiguity. In fact, as long as the O can recollect or
identify the landmark in focus, the message itself is not
going to be ambiguous, even though what the next action is
flexible and not well defined. The INTERNAL terms that the
dyads used in describing the spatial relations in the
horizontal-frontal dimension are "Straight", "Forward",
"Frontward", "Frontways", "Backward"' and "Back up".
Compared to the INTERNAL terms in other dimensions ("up" or
"left"), these terms are rather open to many alternative
meanings. In the above mentioned study by Cox and
Richardson (1985), they report that even adults do not agree
on meanings of these terms all the time. Even though
different dyads use different terms for the horizontal-
frontal movement, there is one thing common to most of the
dyads. They do not use the term in a way that uniquely
defines the frontal movement. For example, "straight" often
means both "straight forward" and "straight to the tower".
If they do not construct the shared meaning for a specific
term, it is hard for them to solve the task because the task
demands the differentiation between the straight two-wheel
movement and the movement that simply brings the robot to
the tower. In the robot task, both age groups often use the
INTERNAL terms in reference to the frontal movement.
However, the older groups use the same frontal terms in the
INTERNAL framework, while the younger dyads use the same
term in the EXTERNAL framework. Therefore, for the younger
dyads, any movement that brings the robot to the tower is

termed "straight" whether it is a two-wheel movement or a one-wheel circular movement. Even for the older dyads, this differentiation was not present at the beginning. Rather, during the process of trying to communicate what they have at the moment, they come to understand the differences or the importance of differentiating these two moves.

```
W    "Now go straight."
O    RB
W    "You're going backwards."
O    RF (right wheel forward), toward.              (1)
W    "Now you're going straight."                    (2)
O    "Yeah!"
     RF
     "Go straight!" (the O, speaking to the Robot)
W    "You're going."
O    "Now what am I doing?  Nothing?
     Keep this stupid thing on straight?"
     RF, away                                         (3)
W    "You're turning it!"                             (4)
O    "No, I am not!  I am keeping it on straight!"(5)
     R.
W    "Looked like you're turning it.
     (with a renewed vigor)
     Okay, now go straight, right for the tower." (6)
                              <LUAD 1-1.  13:09>
```

For the first 3 minutes into this round, this dyad has been looking for the STRAIGHT movement. When the W noticed that the robot was moving toward the tower in (1), he accepts and labels it as "straight" (2). Since only the right wheel was pressed forward, the robot was moving closer to and heading toward the tower, but turning. Therefore, as time went by, the robot began to turn away (3) from the tower. The tone of voice in (4) was that of a puzzlement and blaming. For younger children, it is usually a tone of anger and disbelief. In (5), the O disputed against the statement by

the W because the O was pressing the same button. At least
the O seemed to know that one button produced one type of
movement and the robot does not change its course during a
continuous button pressing. Then, at **(6)**, the W again gave
the Instruction of "straight" with an addition, "right for
the tower." From this, it seems that the W's meaning of
"straight" is loosely equivalent to "right for the tower."
(It is not clear in this case whether this interpretation is
correct or not. However, for some other, especially the
younger dyads, it is much clearer that "straight" or
"forward" means "to the tower".)

In this episode the W could have mistakenly thought the
turning forward movement was going straight. Or the W could
have the EXTERNAL framework for the spatial terms. Whatever
the source of this problem, the dyad could successfully find
the frontal movement, and used the term "straight"
consistently in the INTERNAL framework. In this case, the O
made a strong contribution by sharing the information and
making a very effective argument. Instead of just saying,
"No, I am not", he supported his argument by stating the
rationale. This is in contrast to the way the dyad in the
following example dealt with the same problem.

```
O      LF (Left wheel Forward), toward        (1)
       "Is this frontward?"                   (2)
W      "Yes."
O      LF, toward>away                        (3)
W      "That's funny!                         (4)
       It's going somewhere else!"
O      "I know. You did that to me (unintelligible)"
                         <CATH.  3-1. -19:56>
```

When the robot began to turn <u>toward</u> the tower **(1)**, the W accepted it as "frontward" **(2)**. However, when the robot started to turn <u>away</u> from the tower in terms of distance and also orientation, the W described the phenomenon as being "funny" **(4)**. This tells us that the W wasn't expecting the robot to turn away as predetermined. In other words, she did not focus on the constant feature, the path of the robot movement as she should. Instead, she seems focused on the distance between the desired point and the current position of the robot and connects these two positions with straight lines. In fact, quite commonly, the dyads drew lines between the robot and the tower. The reason why she <u>didn't</u> <u>focus</u> on or <u>didn't</u> "<u>catch</u>" the pattern of movement is another issue to explore. However, the comment "funny" gives us a hint that it is the framework of her thinking, rather than a lapse of attention at that moment, that explains her behavior. It seems that she didn't realize the constraints of the robot which shows the "conservation" of movement. One young dyad even commented on this type of occasion in that line of thinking; "Press it <u>hard</u>, <u>all the</u> <u>way down</u>!" The same line of thinking is evident in the O's comment, "You did that to me.." In the LUAD example, the O's comment directly challenged the W's premise (or the W's line of thinking) by indirectly saying, "How can it be a different move now when I am pressing the same button all the way?" In the CATH case, the O concurs and sympathizes

with the W's trouble, therefore, not providing the alternative as antithesis to the W's current framework, the EXTERNAL perspective or strategy.

From the above examples and many others, it appears that the dyads, especially the younger groups, learn to use the INTERNAL terms for describing movement but use the INTERNAL <u>form</u> within the EXTERNAL <u>framework</u>. From the above example, one can also see how the transition between the two types can happen. At first, by transferring the strategy that they can comfortably use in describing the stationary referent to describing the moving referent, they seem to gradually develop the true INTERNAL description. This transitional nature of their strategy was spotted in the next example.

In an attempt to describe the ELBOW arch forward movement, LECH tried to combine two strategies;

" ..(not intelligible)..<u>forwards</u>, <u>up</u> and then
<u>forwards</u>." (gestures for each underlined segment)
<LECH 1-2. 1:54>

The W segmented the path of the movement into three sections accompanied by gestures, even though that move is produced by pressing one button continuously. Segmenting the path and updating the directional instruction at each point shows the vestige of the EXTERNAL strategy while the terms themselves have INTERNAL forms. It is common to find the awkward combination of a stationary and a motion-

oriented element for the younger dyads in the term itself, as in "side-ward" or "front-ward".

Another problem related to using this strategy is that the EXTERNAL strategy tends to distract the W from the valuable button knowledge. After a long search for the button for STRAIGHT FORWARD movement, one dyad encountered it during the next episode. However, they couldn't utilize the readily available information because the W was giving Descriptions with the EXTERNAL strategy. Therefore, the long-sought-after move was followed by the W's description, "It's coming <u>toward me</u>! So turn it."

This entanglement of two strategies is not only found in the horizontal-frontal dimension but also in the vertical dimension. Since the robot ELBOW move follows an arc, it is not, in a strict sense, a vertical movement. The term "straight" is often found in both cases of ELBOW and WAIST moves. For example, by saying "Adjust the claws <u>straight</u>", the W wants X to point to the tower. This alignment of X to the tower requires either the WAIST or the ELBOW move, depending on the situation. This implies that the dyads in the task with a moving referent use the INTERNAL surface form within the EXTERNAL framework. Children acquire the spatial terms, which are compatible with the INTERNAL terms, in the vertical dimension earlier than in the horizontal-lateral and the horizontal-frontal dimensions with <u>stationary</u> referents. Then, the fact that one can observe the half-baked INTERNAL/EXTERNAL strategy in all three

dimensions seems to reflect the more demanding nature of describing spatial relationships with _moving_ referents.

RETRO Strategy

Lastly, the RETRO strategy is most functional in the immediate context but least informative because it does not provide information on which direction the robot moves.

The value of the RETRO strategy is well appreciated by the older dyads. They often intentionally omit the component of direction in their instruction. In the LUAD dyad, when the O insisted on getting the complete instruction by asking "which way?", the W replied "Just turn." Especially in the case of the turning movement, which proved to be the most difficult directional descriptions for the dyads, the use of RETRO strategy is a very effective way of getting around the problem. The JADY dyad, who succeeded in all 6 rounds with the shortest amount of time, often omitted the DIRECTION information in their instructions of turning movement, and later completed the episode with RETRO strategy. The intentional use of this, therefore, indicates that the dyad is very aware of the level of information that is optimal for this task.

The most common and valuable use of the RETRO strategy was found in the case of **"overshot."** One of the skills the dyads muster is _timing_. They often overdo a movement because their communication is not well coordinated in terms

of timing. This is especially common when they are near the tower and require precision. At the final stage, most of the children in this task achieve the goal by using the WAIST move while keeping the robot wheel immobile. When the WAIST passes the nearest point to the tower they consider it the case of **"overshot"**. This was a problem that all the dyads encountered at some point during the game.

In fixing this problem, the older and younger groups used different strategies. In general, the older dyads often quickly learned to use the RETRO strategy while the younger dyads used strategies other than the RETRO.

```
O      Waist C
W      "That's good." (the arm, gone too far)
       "Oh, turn it a little more."                (1)
O      Waist C
W      |"No, the other way...one notch."           (2)
O      Waist CC*                                    (3)
W      "Another notch."
                        <JADY 1-2. 14:24->
```

"|" in (2) shows that the W started to talk at the same time when the O pressed the Waist c button.
"*" shows that the pressing was very brief.

In **(2)**, the W gave the correct Instruction for negating the overdone portion of movement using the RETRO strategy. However, in **(1)**, he incorrectly gave an instruction for **continuation** by saying "a little more." This dyad, as well as other dyads, often used the correct strategy but the wrong message. This problem of confusing <u>more action</u> with <u>more action in the opposite direction</u> was consistently found in Session 1 for this dyad, and often self-corrected **(2)**. By

Session 3, this dyad no longer experienced this confusion.

Another noteworthy feature is the use of "one notch" and the

brief pressing action by the O (3). In an effort to avoid

overshot cases, the O often developed a strategy of tapping

on the button briefly as a request for confirmation from the

W rather than continuous pressing.

The seriousness of the problem caused by overshot, and

the tremendous potential value of the RETRO strategy, is

most striking in the ELBOW move case. The ELBOW move is an

arching movement often described and initially perceived as

UP/DOWN movement by the dyads. The problem arises when the

O presses the button too long; the elbow begins to pass the

apex and arch backward away from the tower.

```
W      "Open the pincher."                                (1)
O      E2, down                                           (2)
W      "You're putting the pincher down.                  (3)
       Put up the pincher..Up."                           (4)
O      E1, up                                             (5)
W      "Thank you..Stop!!"  ( elbow, 45 degree up)        (6)
O      R.                                                 (7)
W      "Put the pincher down."                            (8)
O      E1, up  (arches backward)                          (9)
W      "You're putting up, Oh..stop-----!!"              (10)
O      R.  (elbow moved 135 degree)                      (11)
W      "Put it down.  I mean, up."                       (12)
O                      |E2, up>down (arches forward)     (13)
       E1, up (arches backward)                          (14)
W      "You're going down.  Put it up."                  (15)
O      E2, down (arches forward)                         (16)
W      "Good......Stop!"                                 (17)
O      R.                                                (18)
                    <LUAD 2-1.   15:14>
```

The case of **overshot** started at **(6)**, when the W thought the

elbow was too high. At **(8)**, the DIRECTION was given with

the INTERNAL type, "UP." Since the O cannot always remember

which button half is for UP or DOWN, the O made a common
mistake of pressing the wrong half. By the time the W
instructed the O to stop at **(10)**, the elbow arched backward
(11). In order to bring it back, the W had to focus on the
previous move and give Instructions accordingly. At **(12)**,
he should have stuck with his original Instruction which was
probably made in relation to his previous statement **(10)** in
mind. However, he quickly "corrected" himself with the
instruction that was based on his immediate perceptual
information. For him, the elbow is now over the apex.
Therefore, it should be brought UP toward the tower first to
get back to the original position. Due to the timing, the O
changes its direction twice to be truthful to the latest
Instruction. At **(15)**, even though he was told that he was
wrong again, while in fact, he was correct, he didn't
protest. By this time, the O seemed to have changed his
style: Rather than sticking to his shaky button knowledge,
he simply followed the pragmatic clue and did the opposite
of his previous action whenever he heard a new Instruction.
For the purpose of adjusting the height of the elbow, this
dyad engaged themselves in an unusually long stretch of
interchange. The effort could have been saved if the W used
the RETRO strategy possibly at (8) and definitely at (12).

     When this type of strategy was used, some young
Operators wandered into a new button because the complete
Instruction like **(8)** was often interpreted as a signal for a
new episode. They often focused on the pragmatic clues

rather than the content of the message. By using the RETRO strategy, as in "the other way" or "you went too far", they could succeed without spending too much time and effort to fix the problem. In this case, the RETRO strategy worked as a cohesive device by the nature of its definition.

Using their limited vocabulary, the dyads in this task try to solve the problem of describing the spatial relation of a moving referent, the robot. In order to solve the problem, they seem to borrow some strategies from the more comfortable domain, describing the spatial relations with stationary referents. Even though there is a problem of lack of consensus on the definition of meaning, the dyads sometimes successfully work toward constructing the shared meaning while trying to communicate. However, there seems to be a sense of direction in this process. The dyads are not just content in their present framework, EXTERNAL. They work toward the INTERNAL framework which is more adaptive to the task of describing the movement. For this transition, the need to communicate first and the role of the partner as an active participant are the crucial elements. The meanings shared between dyad members are not solid at first. But this seems to be the first step toward learning the conventional meanings which are common to the broader community.

Even though there seems to be a developmental progression between the presence of EXTERNAL and INTERNAL strategies, all the strategies seem to be present for both

age groups. What differentiates the older from the younger groups is knowing when and in what situation they call upon those strategies. This ability seems to be related to their awareness toward the collaborative nature of the task.

Summary

In this chapter, the analysis and interpretation of the data were presented. According to the framework that communication is a negotiating process, first, how children negotiated themes was examined. The focus was on discovering how children shared themes and how they failed to share them. Compared to the older group, the younger children failed to share themes in their episodes more often. Upon examining how much the Operator contributed to the theme negotiation process, the older dyads didn't contribute much in general. When they did, they did it mostly for the common goal while the younger dyads contributed based on their own desire to take the control of the game. The lack of metacognitive knowledge is the cause for failing to share themes for the younger group. There was no gender difference in terms of the sensitivity toward sharing the theme. In general, the older group contributed to the process by scaffolding the process for the W while the younger dyads wanted to directly contribute by proposing themes.

The older group exchanged information from the task-appropriate perspective while the younger dyads focused on the immediate need to get things done. In order to see some trend in how the dyads change their perspectives toward the task and their roles, graphs were constructed. The older children moved toward establishing a common and more appropriate perspective while the younger dyads did not.

During the process, the older dyads could learn how to, maximize both the problem solving efficiency and the communicative informativeness. Adjusting to each other's style and being sensitive to each other's roles and needs were important in achieving the communication goal, but overaccommodating to the partner's knowledge state or to the immediate situation only were not productive. Task related confrontations were sometimes necessary in effectively solving problems.

Patterns of contribution to the theme negotiation process were examined. The older dyads employed discourse strategies that respected the role assignments. Gender difference was noted in terms of preferred devices. However, both gender groups, especially for the older dyads, moved toward the task relevant discourse pattern.

One of the central components in this task, message, was examined. Message adequacy was defined and measured. The younger dyads produced less informative final messages. When the operator's contribution in message improvement was examined both age groups were found to rely on the non-

verbal clarification strategy. While the older children used and benefited from the non-verbal strategy, the younger children seemed to benefit from an explicit type of support, potential CR sequence type. Non-verbal strategy was not always effectively used for the younger Operators. The highest level of informativeness in message was not always functionally useful for the younger dyads because they do not use nor present them in a useful way.

In constructing shared names the older dyads engaged in a separate referent-identification process only when there was a trouble communicating. On the other hand, the younger dyads switched frequently and spent a lot of effort in securing the referent without obvious benefit.

Finally, the children's strategies of describing a moving referent were examined and compared to those of stationary referent. The developmental progression of spatial terms for a moving referent lags behind that of a static referent.

C H A P T E R   V
SUMMARY AND DISCUSSION

Summary

In this work, some attempts have been made to identify
relevant and meaningful issues related to peer learning
discourse. Using a small battery operated robot, 5- and 7-
year-old children were asked to play a game three times with
role reversals. The setting was semi-structured in the
sense that they were asked to play the game that an
Experimenter presented, but that they were allowed to
interact freely with a minimal level of interference. In an
effort to understand how children communicate to exchange
information and how they learn to communicate better in the
peer problem solving process, several areas of interest were
identified. Within those areas, developmental differences
as well as changes across sessions were focused upon.
Additionally, speculations about the mechanisms of change
were made.

Several developmental trends were introduced. First of
all, the older children were more successful in this
instructional communication task for the overall
performance. Both age groups negotiated the themes of their
interaction most of the time. However, the older children
shared themes more actively using explicit means of
communication compared to the younger children. The

children gradually learned, across ages and sessions, to participate in the task within the boundaries assigned to them so that they could maximize the effectiveness of the team communication. The older children's instructional messages were more informative and were made in the task-appropriate referential perspective more often. For establishing shared names the older children engaged themselves in the naming process less often. They used names that can be easily shared. At the same time, they used fewer names. As a result, they were more efficient in the amount of collective effort needed to exchange information.

As problem solvers, the children learned to balance the advantages and the disadvantages of problem solving strategies with a long-term goal in their mind. In the cases of Incidental or Compensation episodes, for example, they increasingly coordinated the flexibility of accepting unexpected themes with the informativeness derived from sharing themes. Be it the message clarification sequence or the button exploration sequence, the children moved from first blindly adopting and employing the surface form of strategies toward knowing their full implications and integrating them into the whole process to produce positive results in this task.

Discussion

Many studies of children's communication skills try to answer the question, "What is it that develops?" including the case of the peer learning discourse (Cooper & Cooper, 1984). This study shows that one elements of <u>what develops</u> in the children's communication skill is how to use whatever skills they have in a way that is appropriate to the situation at hand, as many argued and demonstrated through observations (Beaudichon, 1981; Garvey, 1984). The older dyads were successful or effective not as a result of the amount of information they exchanged through messages, even though they produced more adequate messages. Young dyads did not require the most informative messages to succeed in this communication setting. They knew how to utilize their already existing skills.

One of the most commonly cited young children's communication strategies is their tendency to rely on the physical context in conveying and clarifying intentions (Hickman, 1987; Speer, 1984). Few studies, however, allowed this channel of communication in the tasks. They focused, instead, on the development of communication skills through the verbal channel only (Evans & Carr, 1984), especially around the age group in this study. One of the many assumptions behind this approach is that there is nothing to be elaborated or developed in the non-verbal mode of communication. Communication development does not proceed

by replacing one mode of communication with another,
Ochs(1979) argued. In this study, by allowing the
interaction between two participants and also giving them
access to the non-verbal channel (like button presses),
young children were allowed to communicate without unnatural
breaks in the flow of exchange. However, the children,
especially young children could not apply their preferred
strategy appropriately in the beginning. Gradually they
learned to effectively coordinate the verbal means, asking
for confirmation of their act, with the nonverbal means,
button presses, using the appropriate timing. Often the
dyads could upgrade the value of a button press from an
instrumental act into a metacommunicative act of testing.
Therefore, there is a need to study how children refine and
effectively utilize their already existing skills during the
transitional phase of communication development.

　　Development of instructional communication skills also
includes finding out the optimal level of information in the
message. Since the message is a tool for solving a problem,
the children need to decide how much information is
necessary as well as sufficient to carry on with the task.
There is no need to create an absolute match between the
intended referent and the O's identification, as in any real
life referring act (Bruner, 1983).   The children in this
study learned to question each other when they did not
understand the message. The older children also learned to
stop asking questions in favor of button testing while the

younger children tried to clarify the message to the utmost detail without any obvious gain. They need to move toward "<u>knowing when you have enough</u>" in addition to "<u>knowing when you don't know or don't have enough</u>" as many referential communication studies proposed (Markman, 1979). Relying on the optimal level of information is shown not only in the message level of individual Instruction, but also in the type of feedback given and requested. For example, Description is not always needed every time a button is pressed. It often distracts the listener away from the crucial and goal-oriented information. Then, what is the principle regulating the optimal level of information? The driving force seems to be reducing the overall effort level of collaboration as opposed to the individual effort, as reported in the adult referential communication study by Clark and Wilkes-Gibbes (1986). The Witness in the robot task often intentionally and effectively solicited the help from the Operator. There is a developmental trend toward collaborative efficiency in communication. This finding highlights the need to conceive the communication development as a collaborative venture.

This leads to the idea of the "optimal level of participation" in peer collaboration. Even though active participation from both is essential, it should be done within the proper boundaries of each role for the common good. Based on informal observations, changes in the children's perceptions of the task were noted. Many younger

dyads seem to view the task as having two separate roles and focus only on success in the immediate action. As a way of active participation, some of the dyads tried to take over the other's role or too easily get a free ride to success. There were changes toward working for the common goal across age groups and sessions. Forman(1987) and Rubtov(1981) reported the developmental progression in cognitive as well as socio-cognitive functionings in peer problem solving. At the earliest stage, children in peer problem solving do not realize the interrelatedness of roles. They simply take turns in performing tasks as if the tasks are individual. In the next stage, they acknowledge the interchangeability of roles. Even later, they finally realize the interchangeability of roles in relation to the goal. Therefore, they come to coordinate and share their responsibilities to maximize the group goal. In fact, in a pilot study of this robot task, children ages 3 and 4 years, in the role of the Witness, were found to wait behind the screen to have his or her own turn to press buttons without any visible attempt to help the partner. Therefore, children seem to move from the definition of the task as a zero-sum game to that of a positive-sum game, as labelled by Higgins and his collegues (1981). They view communication as a game with various goals. Decision making ability to choose the most appropriate goal is related to the developmental level. This argument presupposes the capability of the interactants to employ any goal, if they

choose or are asked to. It is not clear that in this population working on this task, that the younger group can perceive the task as having a common goal. However, for the older group, changes in their perception of the task toward the task with a common goal seemed to happen across sessions. This change, in turn, influenced their strategy.

Does peer interaction promote development of communication skills? Young children seemed to need a lot of support to succeed in communication. Younger children who do not have strong communication skills cannot be effective in scaffolding others during the communication process. As children get older, however, they can scaffold each other in the communication process much more effectively, as described by others as a "bootstrapping" phenomenon (Cooper et al, 1986). Working with a novice while being a novice may have caused the deterioration of the younger dyads' games in later sessions. However, this downward spiraling is not due to their decreased competence. Despite the disappointing performance, being exposed to contradictions has its advantages. This long process needs to begin somewhere. Miller (1987) argues that the way children engage in argumentation differs according to their developmental stages. In terms of the manner of argumentation, children gradually move from reiterating his/her own statement to questionning the tenability of the partner's statement. Bos (1937, cited in Rogoff, 1990) also reported the benefit of simply being exposed to the

different ideas of peers in problem solving. In
communication development, many studies (Beal, 1988) have
shown that children often were aware of the uncertainty in
communication before they learned how to effectively deal
with communication failure. Also consider that the benefit
might not be represented in the final outcome if the gain
from experience is largely a procedural one as opposed to a
piece of declarative knowledge (Forman, 1990). In the robot
study, the younger children's game deteriorated in later
sessions due to frustration. The main source of frustration
often stemmed from the awareness that the message
clarification was not the only source of communication
failure. They began to realize that there was another
source: lack of button knowledge. The awareness of the
"ignorance" of relevant facts in addition to the
"nonunderstanding" of messages as sources of communication
failure, according to Robinson (1986), is an advance. Their
poor performance should not be considered as "no gain".
This study also points to the need to look at the procedural
aspect of learning such as the instruction-giving
strategies, let alone the product scores based on the number
of correctly identified itmes, for example, in the
communication task when we examine the benefits of peer
interaction. Still, the benefits of peer interaction for
achieving specific goals would be much greater and more
evident with older children.

What are the elements that are involved in effective peer learning in this task? In order to benefit from peer interaction, <u>overaccommodations</u> should be avoided. Establishing intersubjectivity is the core of peer interaction (Rogoff, 1990). However, establishing intersubjectivity by adopting anothers' viewpoint without discussion seems to be unproductive. Posing contradictions seems very effective when they were made within the specific context, right at the point where the wrong strategy is applied rather than accusing globally the other of incompetence later. This is similar to the findings by Damon and Phelps (1987). Conflicts over roles and behaviors are not fruitful while those over strategies are. Also, some elements of tutoring are involved so that both, not just one member, can move forward.

To be more ecologically valid, the sustained interactive aspect of peer collaboration should be considered in research design as well as in educational implementation. Interactions in the classroom or learning sessions do not happen with unfamiliar persons on a random schedule. Interactions are influenced by the existing relationship and develop into a relationship across time (Garvey, 1986). Even within this task, certain interaction patterns developed across sessions. Therefore, suppression of undesirable patterns of interaction is crucial for the benefit of peer interaction. Learning involves coming to know what the task is about. Without the sustained

engagement, the children will not come to understand the
task fully. This is crucial not only in terms of measuring
the representative samples of their developmental levels,
but also in giving them opportunities to construct the
understanding of the task through redefining the task
situation.

There was a gender difference in terms of task
performance. Observations revealed that girls had more
trouble with the physical knowledge aspect of the task than
boys. For example, the physical knowledge that two wheels
make the robot go straight forward was not evident from the
girls' performances. If the intention of the study is to
learn about children's communication skills, a brief session
on the functioning of robot parts might free the girls as
well as some boys from the burden of figuring out that piece
of knowledge with their limited conversational skills.
Similarly, we can design a task that girls have advantages
in terms of domain knowledge. Communication skills can be
exercised freely and also can flourish with the help of the
domain specific knowledge. It will be worthwhile to figure
out the type of task that is suitable for teaching/learning
instructional communication skills. This procedure might
help us see whether there is a gender gap in communication
skills or not. Similar modification might be necessary for
the studies in other culture with different rules of
discourse. Therefore, for a possible cross-cultural study,
it is important to find the situation that preserves the

nature of the task but promotes uninhibited exchanges of information within that specific culture.

Another possible source of the gender difference is the girls' conversational strategy that gives the higher priority to keep the interpersonal harmony intact. What they might need is an excuse or a rationale that can protect them from getting criticised for being too task-oriented. Instead of trying to change the features of the task to obtain a certain expected outcome, changing the measure of success might be a fruitful and valuable approach to the development of communication skill. The girls in our study often seemed to be very satisfied with the way they performed as long as they shared the experience with her partner in good terms during the task. Therefore, how successfully girls can manage the task in their own terms can be another good measure of communication skill.

Still, many more components and issues need to be identified and explored in order to understand the children's communication process in the peer learning context. However, the observations from this study and others highlights the importance of the knowledge about the specific task of the study itself because development of communication skills involves learning to use skills appropriately in a given situation.

<u>Educational Implications</u>

Rather than leaving children with loosely structured peer learning situations, it would be more effective if we design a task in which collaboration is necessary. Children will try to solve the problem first by the desire to succeed. During the process, as we have seen in this study, they will learn the implication of settings through a newly emerging definition of the task.

The robot task has the potential for both teaching and learning communication skills. It has a clearly defined goal for the children, and the children seemed to be motivated to work on it. Embedded in this task is an inherent need for collaboration. Unlike the other cooperative learning techniques which are based on the concept of extrinsic rewards, this task promotes intrinsic motivation to collaborate. It requires the participants to cooperate in a way that promotes greater understanding of communication, if they ever want to succeed. There is always the issue of the ecological validity of importing an experimental task into the classroom. However, left alone, children have much less opportunity to engage in this type of communication in natural settings (Dickson, 1982). As long as the task provokes some interest from children, which it did with the sample in this study, it will have a tremendous value in helping children learn how to communicate with each other in peer or group learning

settings. Children who are inhibited in natural settings might feel especially motivated and relieved because they do not have to initiate the whole interaction by themselves.

Another implication for teachers is derived from the observation that when a child is frustrated and knows that the effort does not make a big difference, they often give up. But this does not mean that they do not benefit from the experience. The long-term view toward this learning situation is necessary. Teachers should be sensitive to the interpersonal dynamics of each pair or group. Interaction patterns are developed between members and tend to show an impact on the learning outcome.

The experience in the peer setting is not meant to replace the role of the adult-child interaction. It is a complementary process to other means of learning/teaching. However, it has a very important value, as many argued (Corsaro, 1979), in that children have an apportunity to exercise their skills within a non-tnreatening environment. For example, the children in our study seem to know the social meaning of giving instructions and demonstrate it in their speech style, intonation, etc. They first adopt the surface form of this social language use. During the process of peer exchange, they come to understand better. Their own perception of what it means to tell other people what to do comes to life by actually using it in a real situation.

Some observations on Methodology

Peer interaction studies need to be conducted within a broad framework. From the observations in this study and others, it becomes clear that children do bring their patterns of interaction or relationship to the learning situation. Therefore, a more complete understanding of peer learning discourse requires an observation on two fronts: in the classroom situation and in the peer learning situation. From that point of view, one limitation of this study is that there is no data from the natural setting. These combined observations could have provided insight for better understanding of what is involved in peer learning.

In this study, graphic representations were used to present and analyze the data. This was especially useful in to capturing the dynamic changes of children's behavior across time. Graphs proved to be very helpful not only in finding answers but also in formulating questions. This seems to be a promising way of approaching data when analyzing dynamic interactions.

Most of the studies in peer learning discourse has focused on the level of either the speech act, such as the directive, or the speech exchange, composed of an act and the response to that act such as the request-explanation sequence (Webb, 1989). However, it is crucial to the outcome in the problem solving discourse whether the individual speech act or the speech exchange is goal-related

or not. A comprehensive understanding of the peer learning discourse and its impact on the outcome seems to require an analysis of how speech acts or exchanges are related to the goal of the task.

Coding is an attempt to define someone's intentions. Unlike the field of syntax, there is no known formula or rules for translating the surface form into the speakers' intentions. Just like the children in the study, analysts need to discover the appropriate level of interpretation from which to work. Even though general frameworks or theories are helpful, they need to be reinvented in each specific context to be used meaningfully. In conducting this study, the process of coding was, itself, an experience that was more illuminating than the examination of the coded data. Better understanding of the children's communication issues occurred during the process of solving the problem of the study, coding, just like the children in this study .

APPENDIX

<u>FIGURES : CHANGES IN REFERENTIAL PERSPECTIVES</u>

This section includes the graphs of 9 dyads that mapped
out the changes in referential perspectives from Session 1
to Session 3. The discussion on these graphs can be found
in Chapter Four, along with the graphs of the other two
dyads. Sets of graphs for the younger boys (YB) and the
younger girls (YG) will be presented first and those for the
older boys (OB) and the older girls (OG) will follow.

<u>Younger Dyads</u>

|------------- Episode Sequence --------------->|

<u>LECH (YG): 1-1</u>
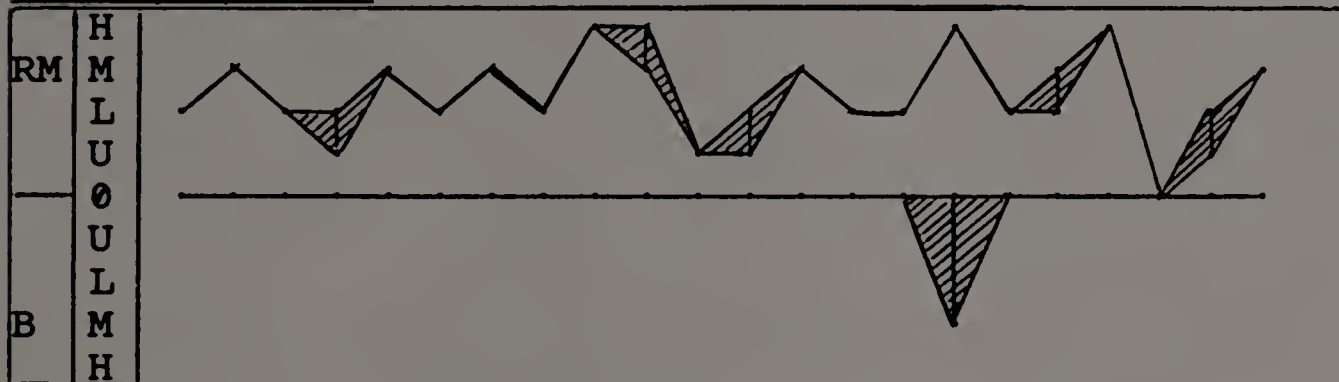
<u>LECH (YG): 1-2</u>
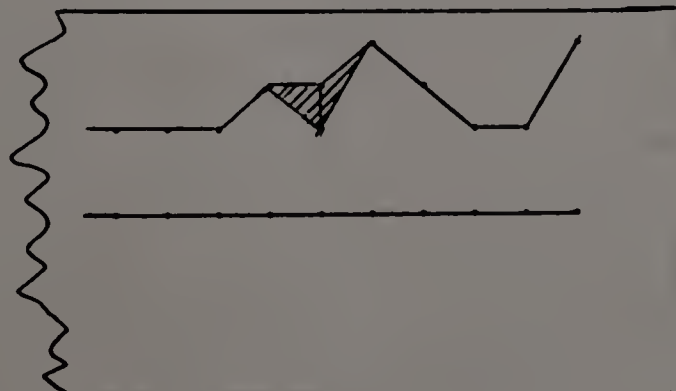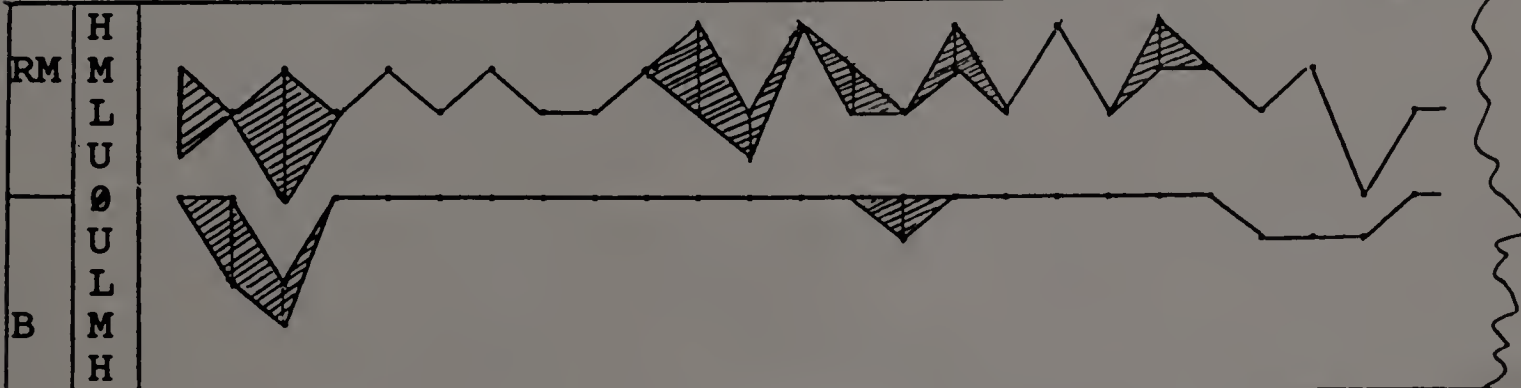
LECH (YG); 2-1
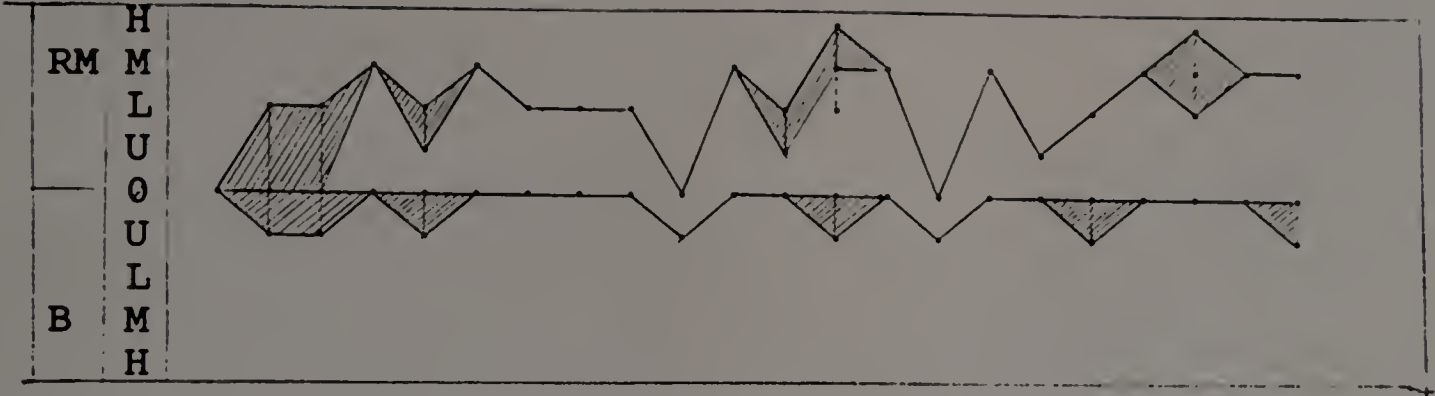
LECH (YG): 2-2
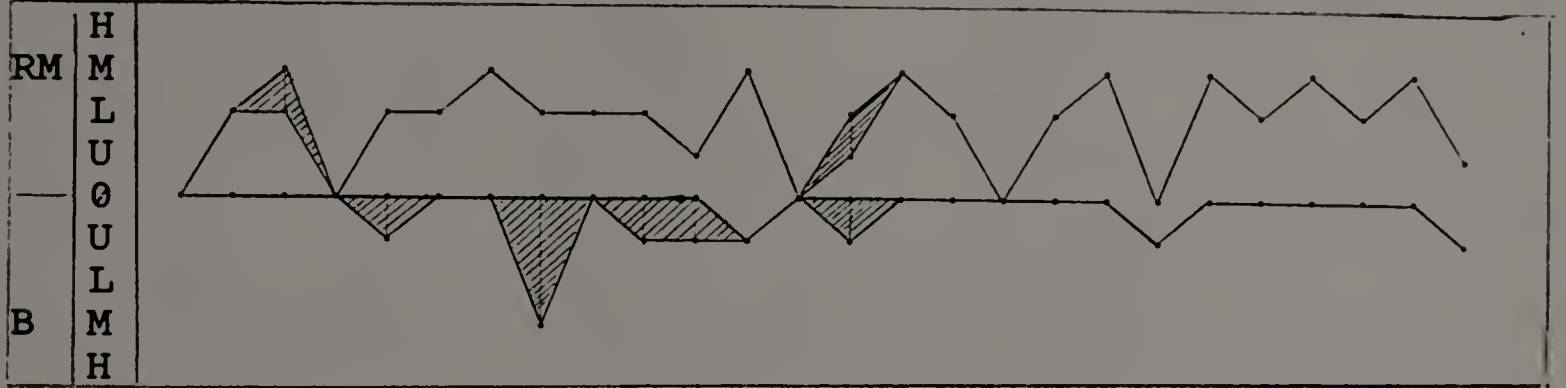
LECH (YG): 3-1
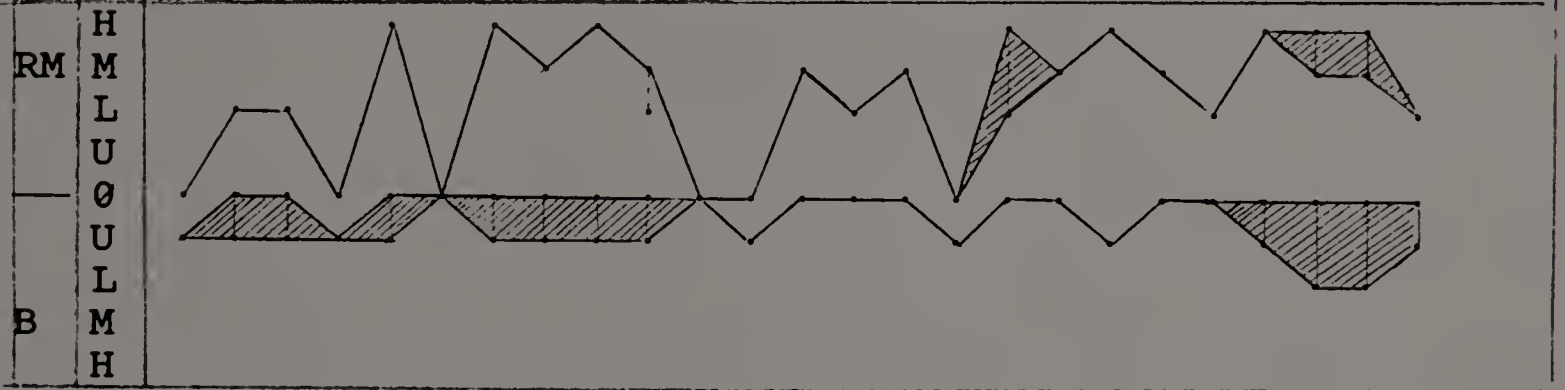
LECH (YG): 3-2
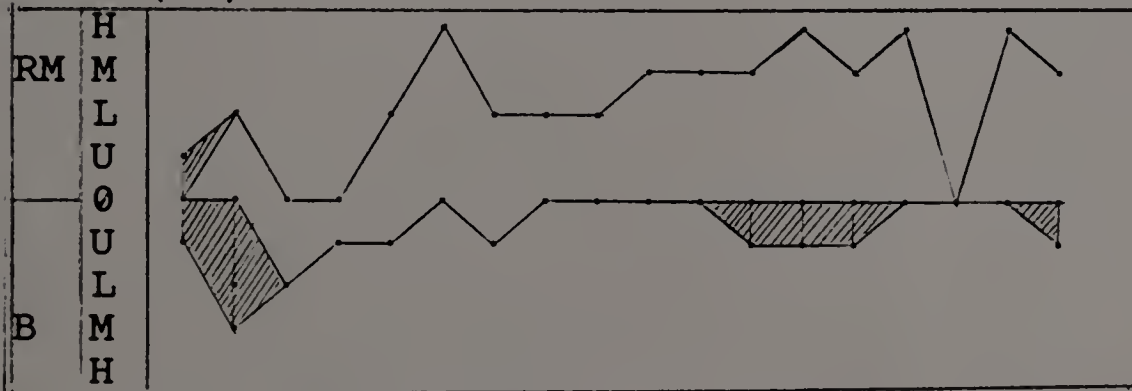
AMNE (YG): 1-1
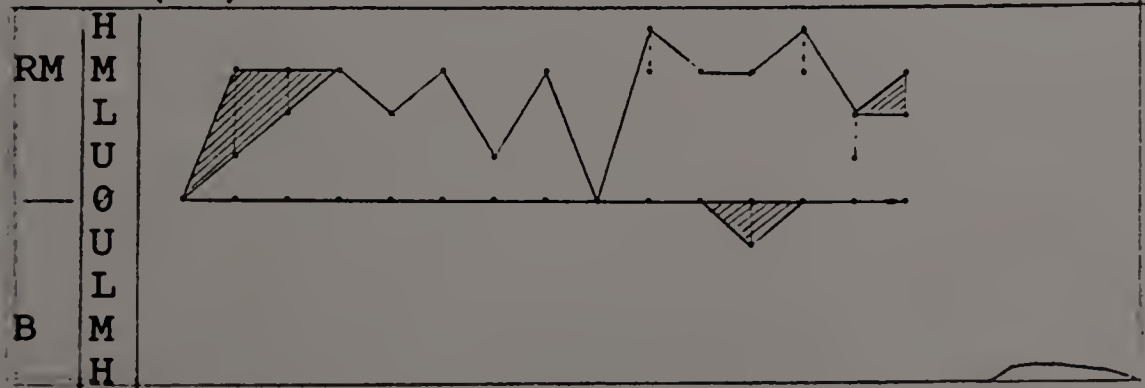
AMNE (YG): 1-2
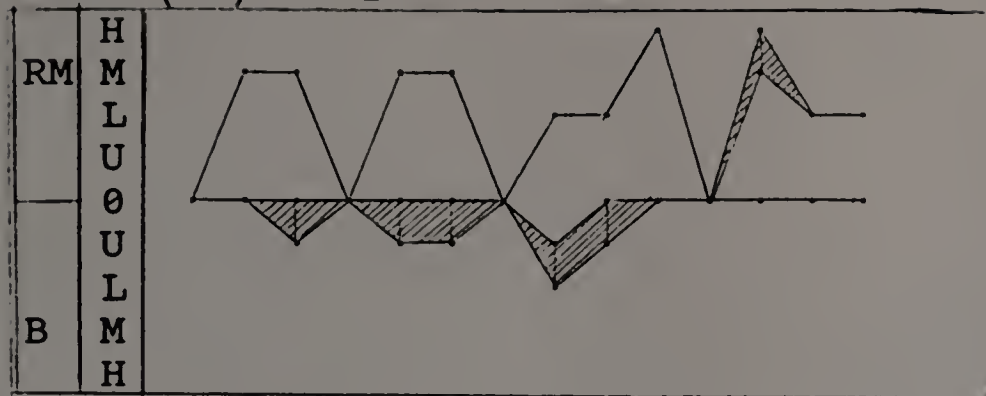
AMNE (YG): 2-1
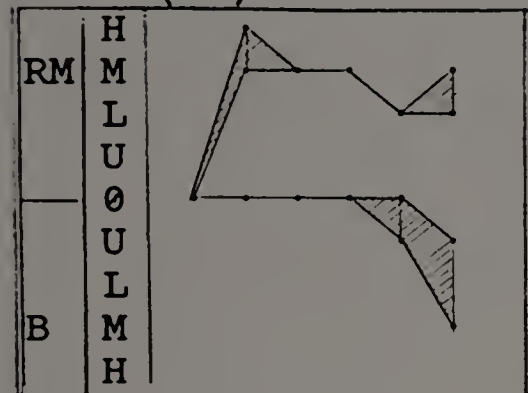
AMNE : 2-2
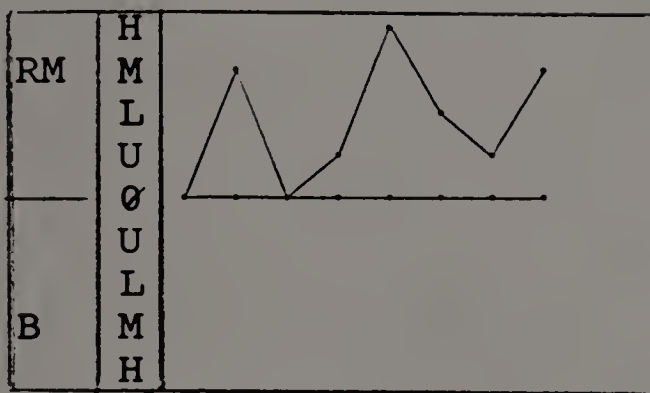
AMNE (YG): 3-1
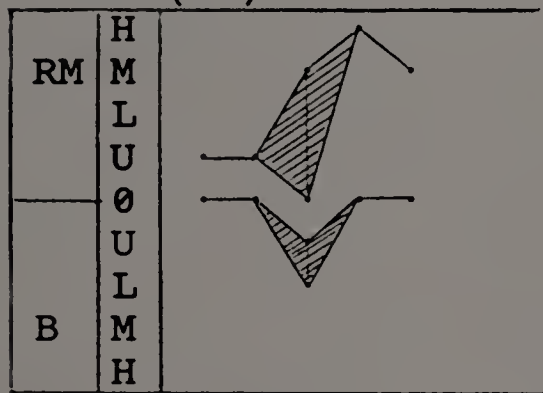
AMNE : 3-2
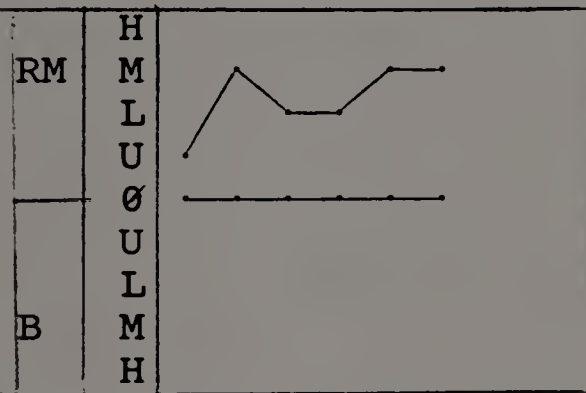
TOJU (YB): 1-1
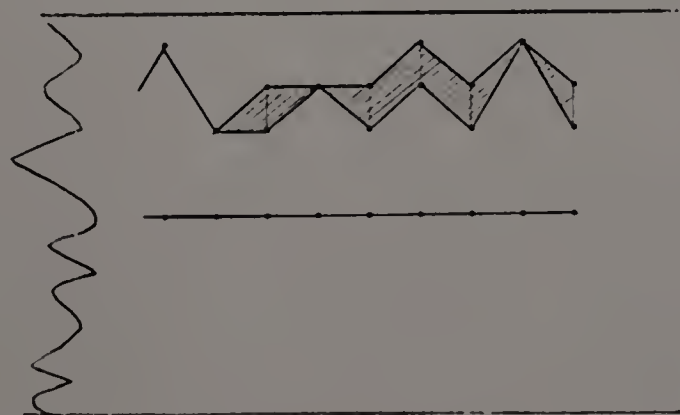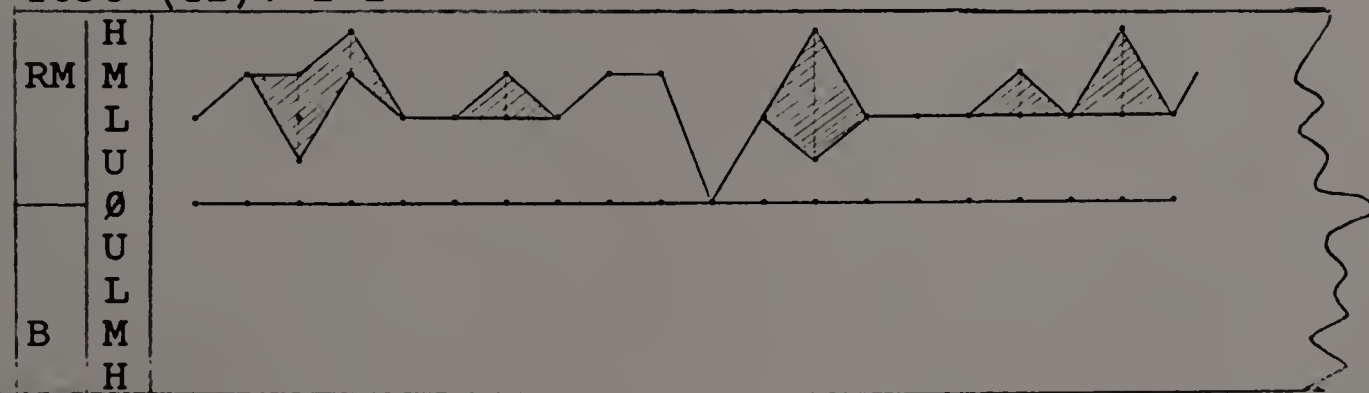
TOJU (YB): 1-2
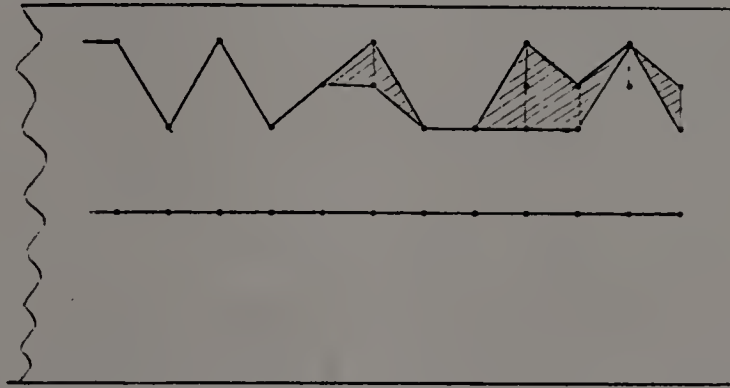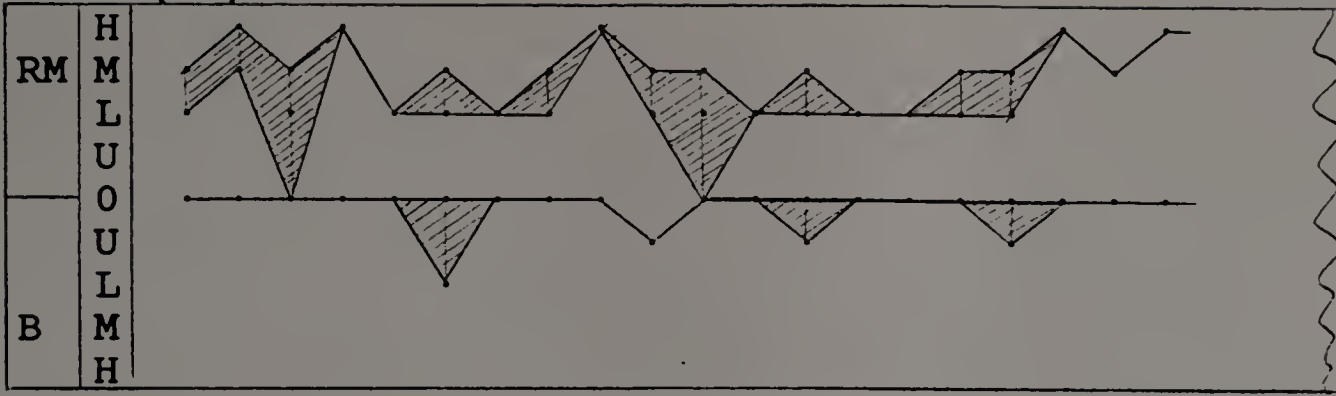
TOJU (YB): 2-1
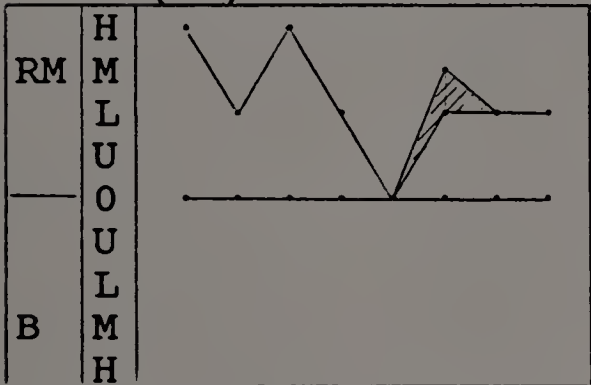
TOJU : 2-2
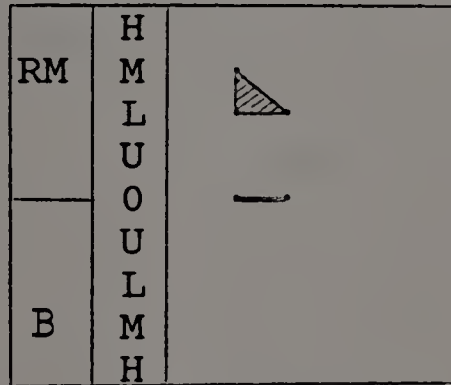
TOJU (YB): 3-1
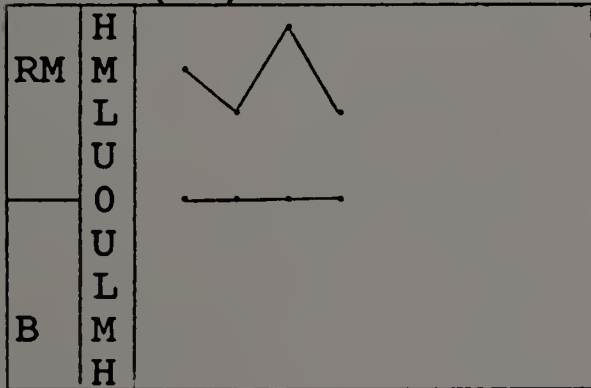
TOJU : 3-2
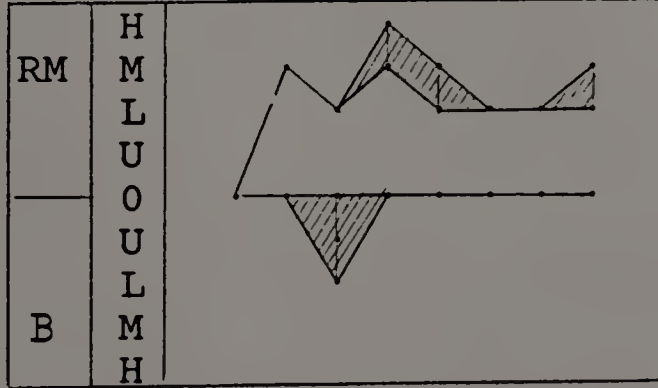
BLCL (YB): 1-1
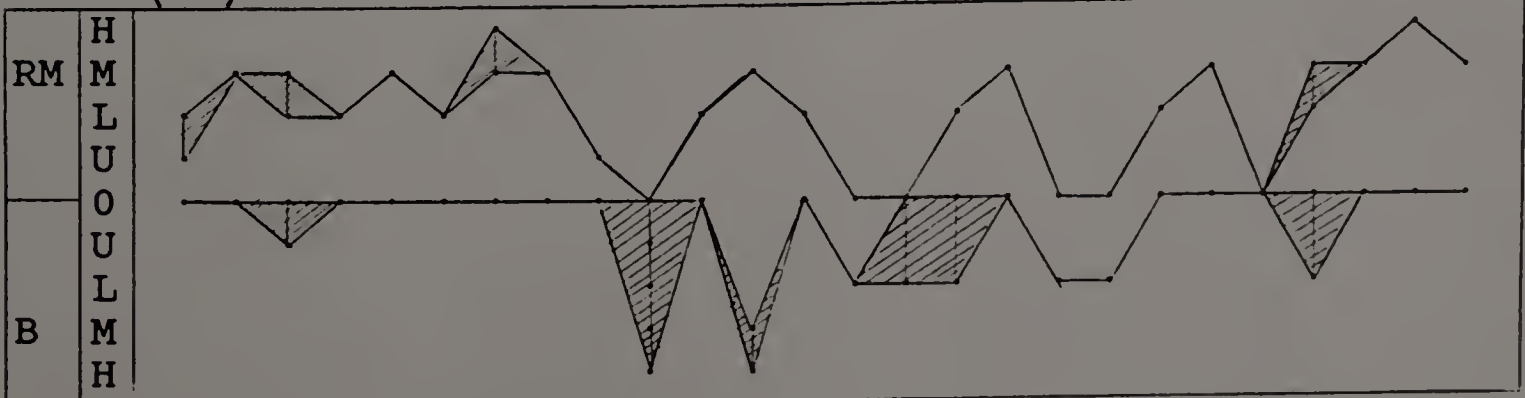
BLCL (YB): 1-2
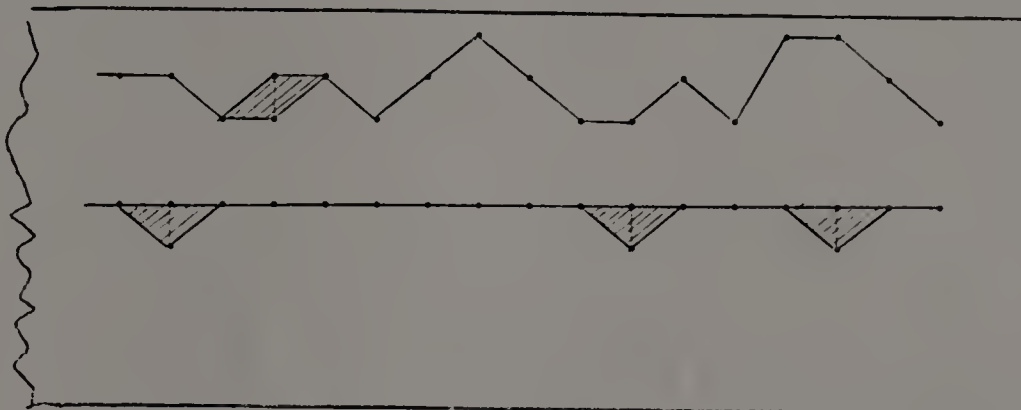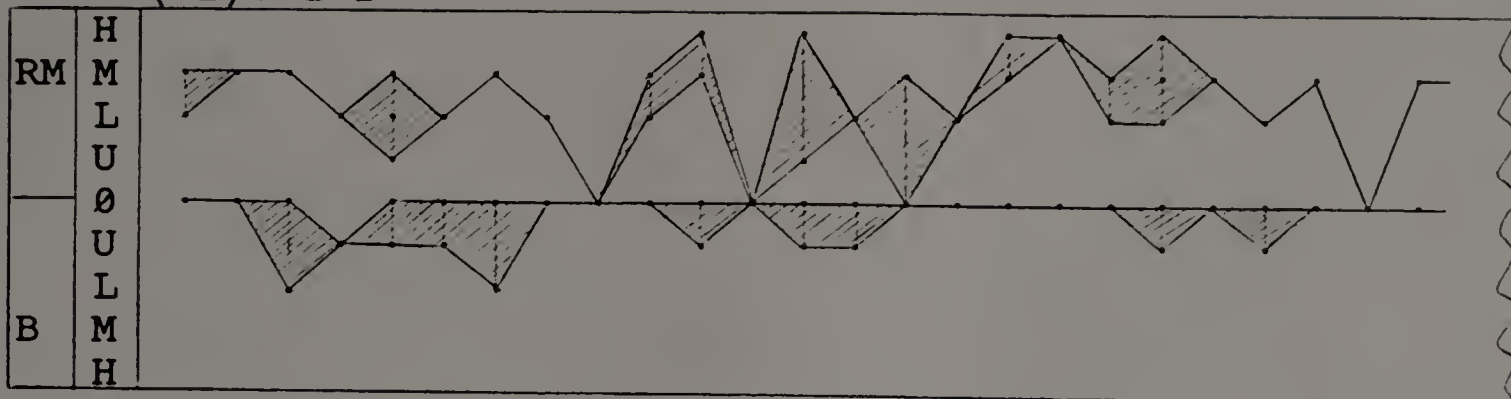
BLCL (YB): 2-1
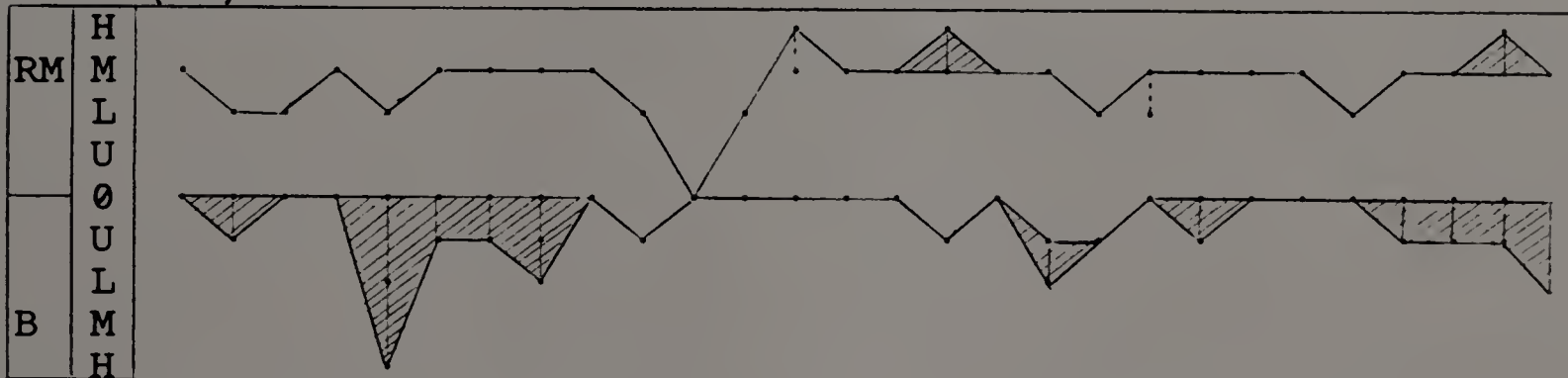
BLCL (YB): 2-2
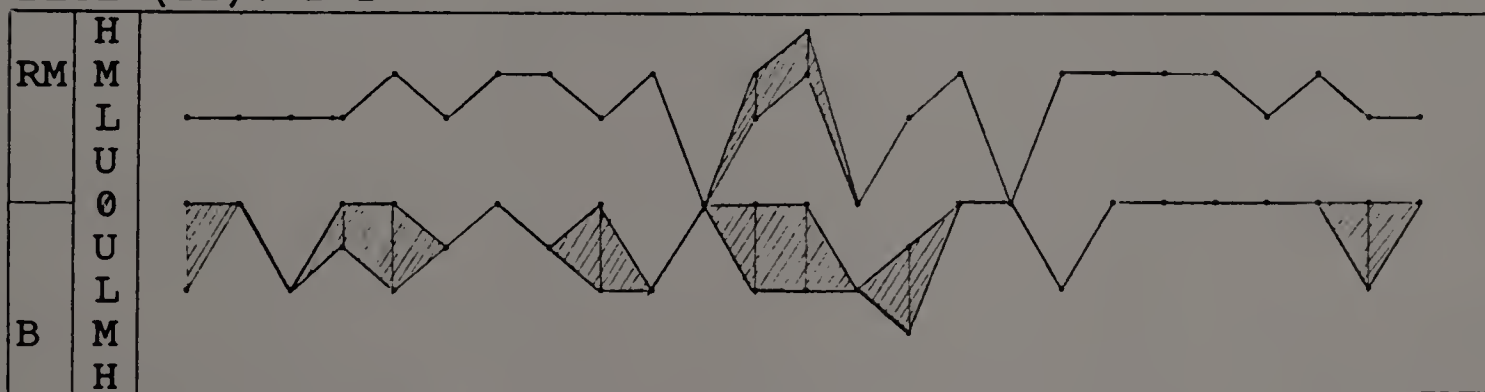
BLCL (YB):3-1
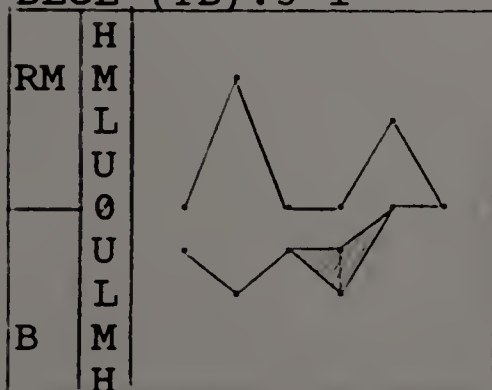
BLCL (YB):3-2
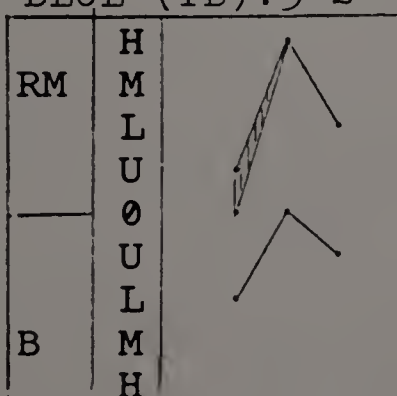
Older Dyads

JADY (OB): 1-1
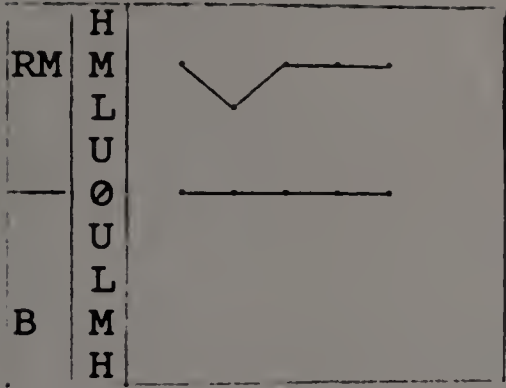
JADY (OB): 1-2

JADY (OB): 2-1

208
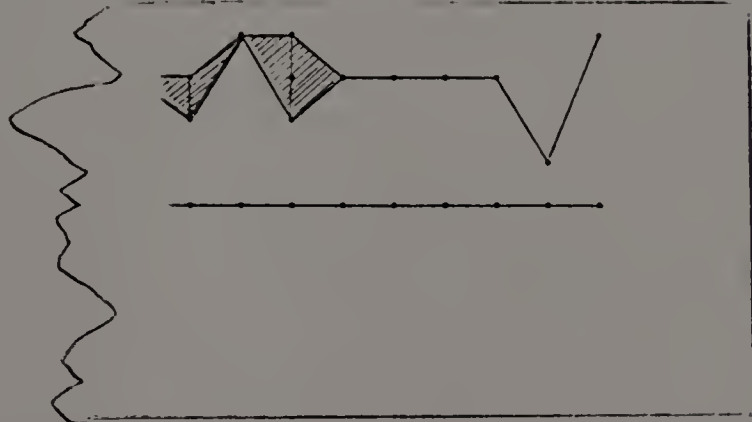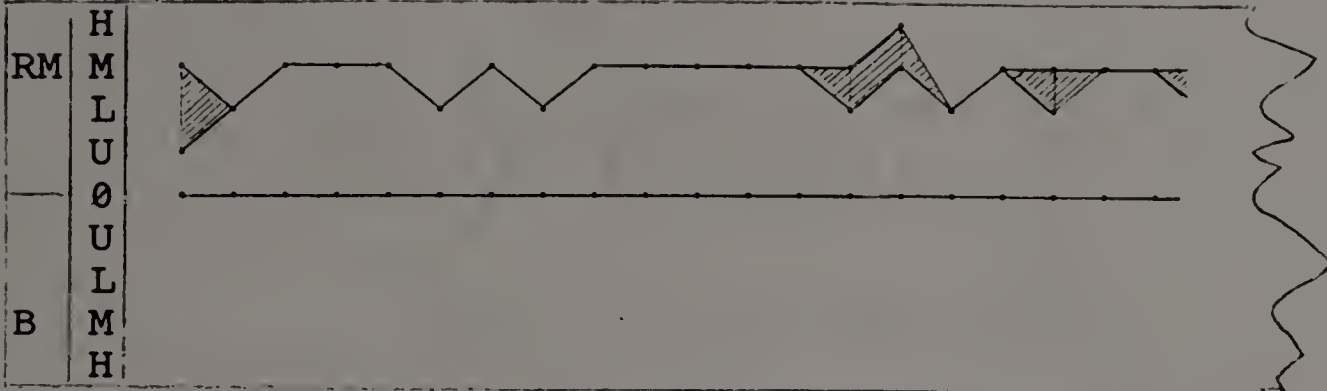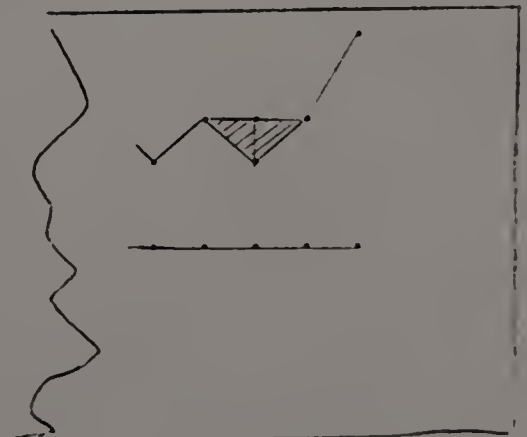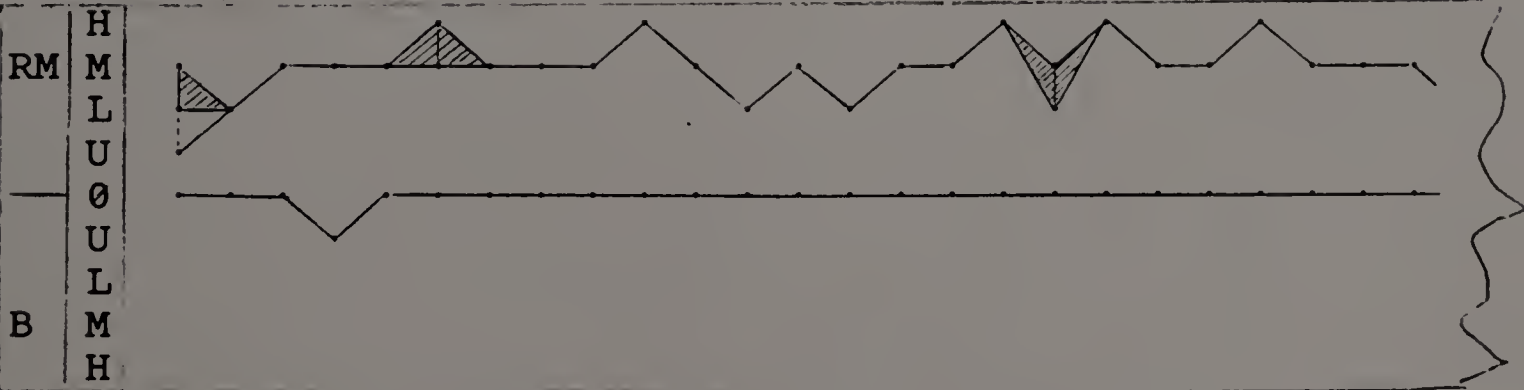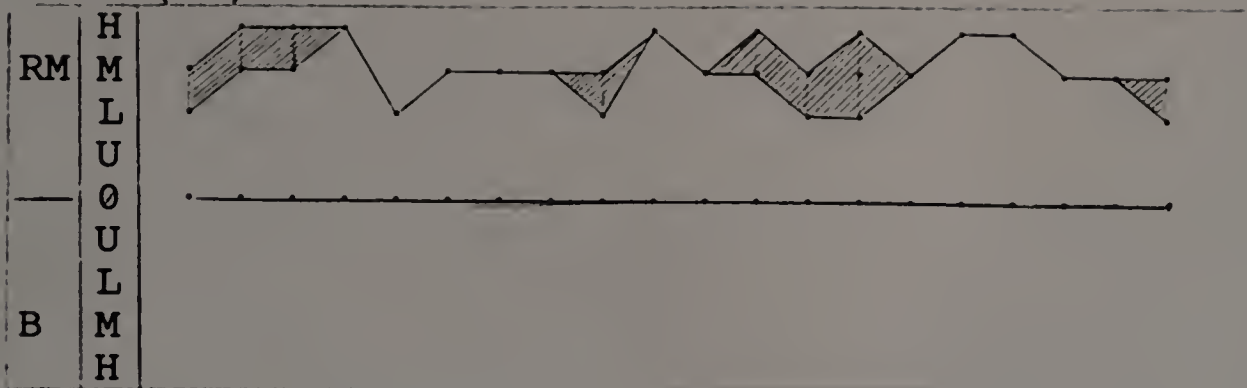
JADY (OB): 2-2

JADY (OB): 3-1
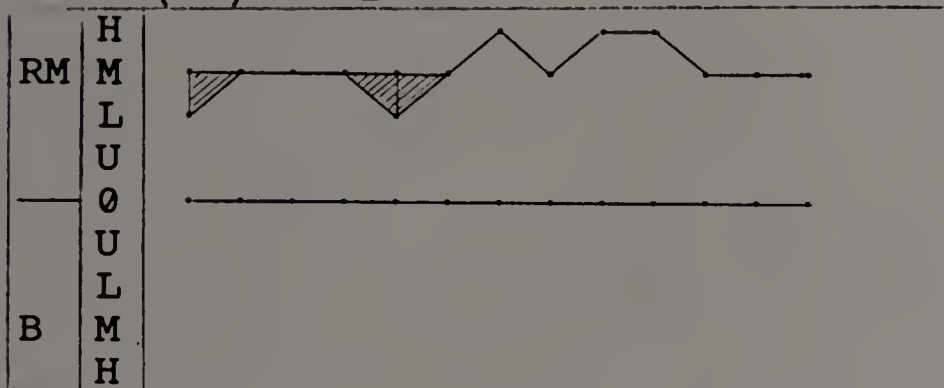
JADY (OB): 3-2
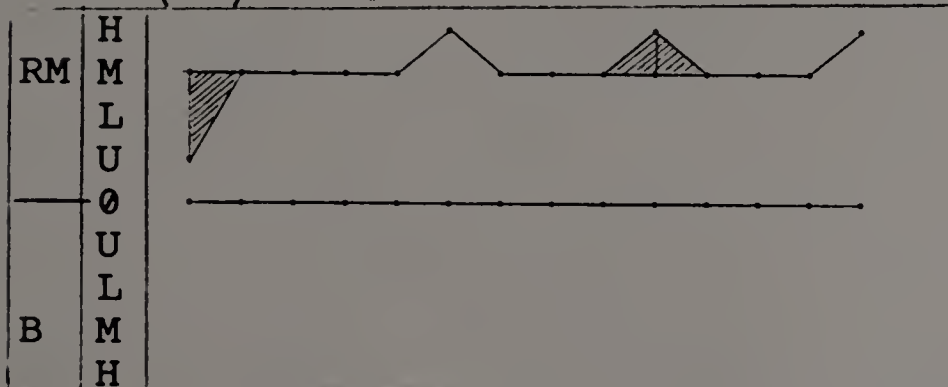
LUAD (OB): 1-1
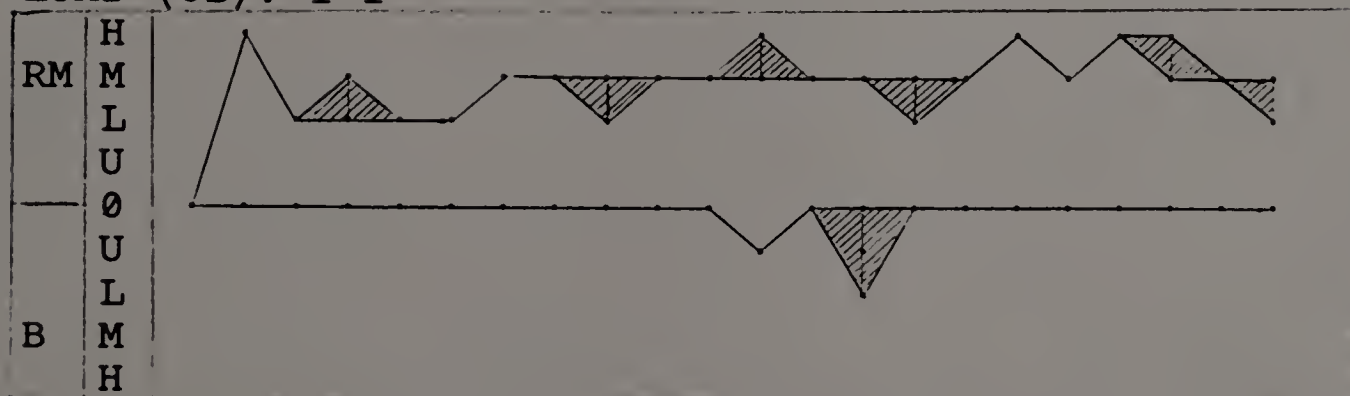
LUAD (OB): 1-2
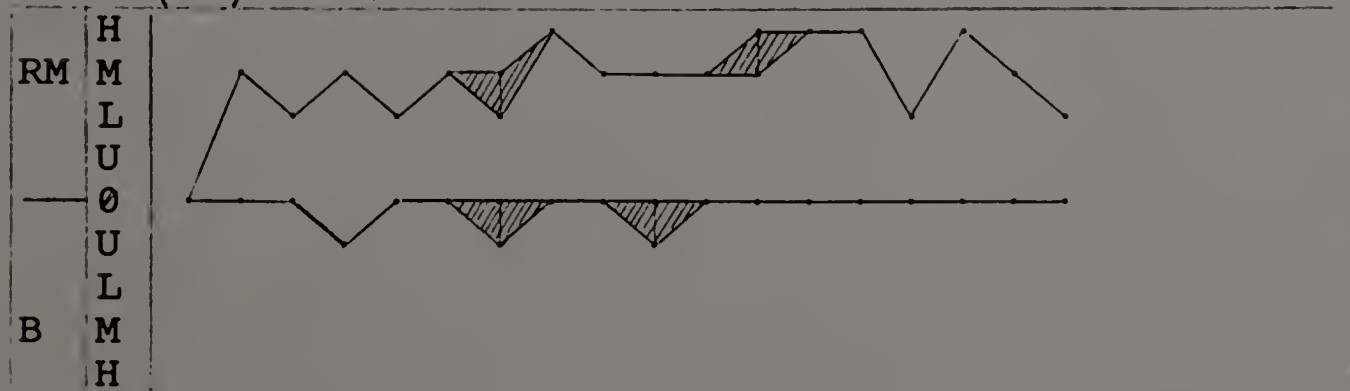
LUAD (OB): 2-1
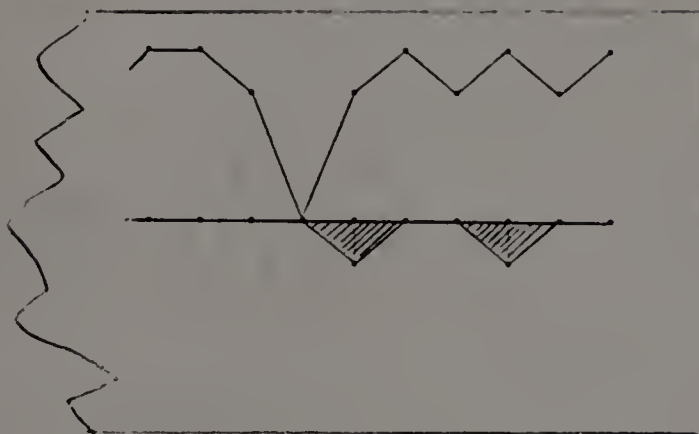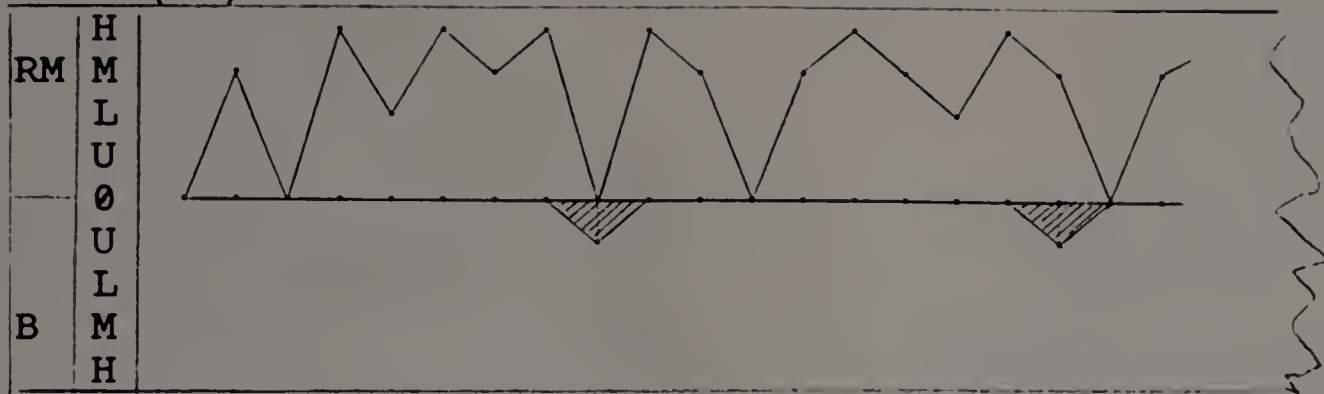
LUAD (OB): 2-2
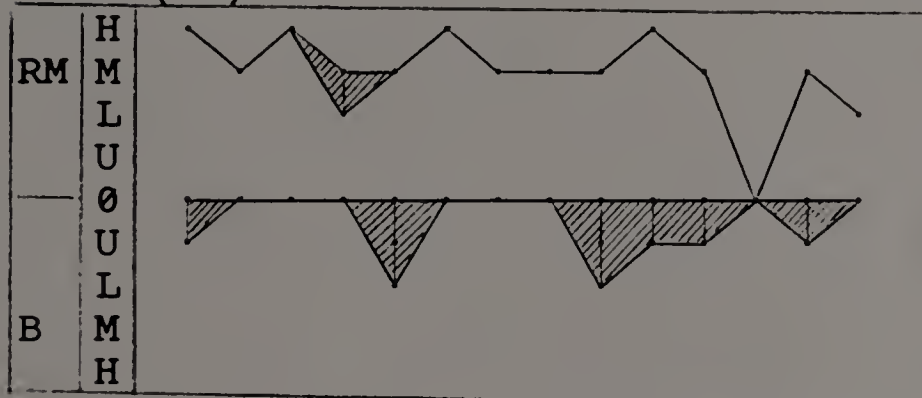
LUAD (OB): 3-1
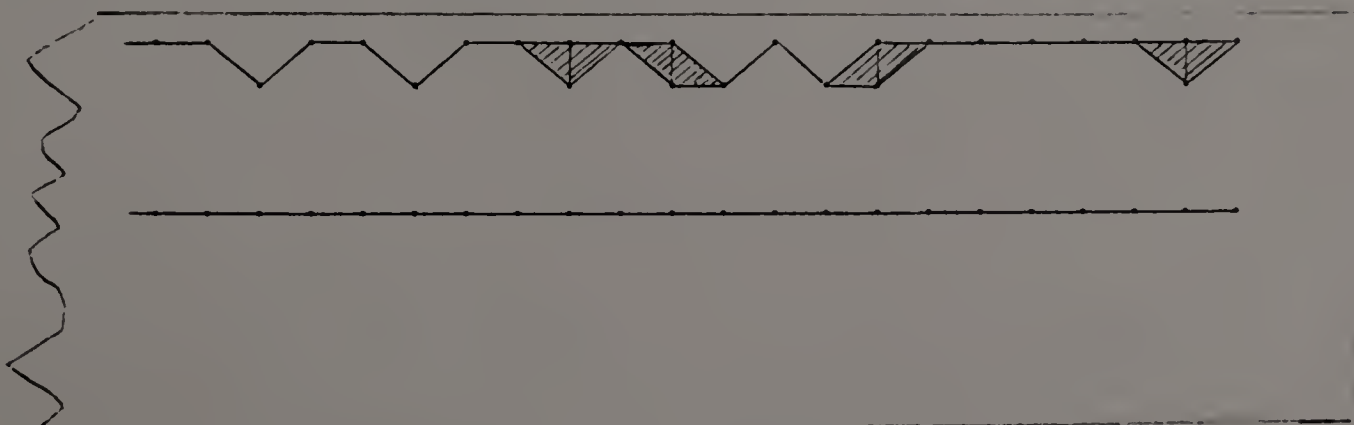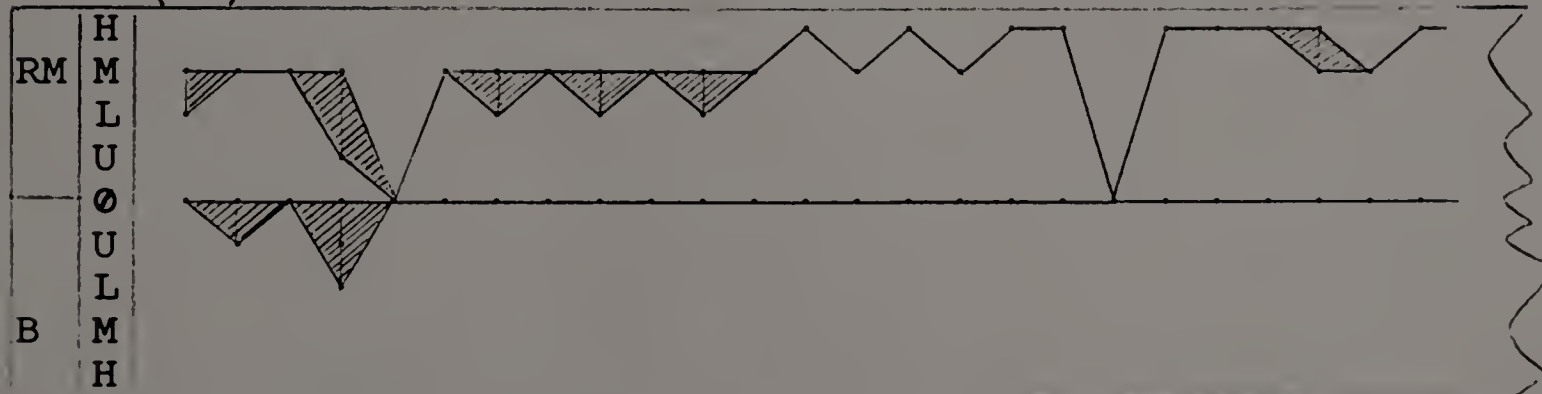
LUAD (OB): 3-2
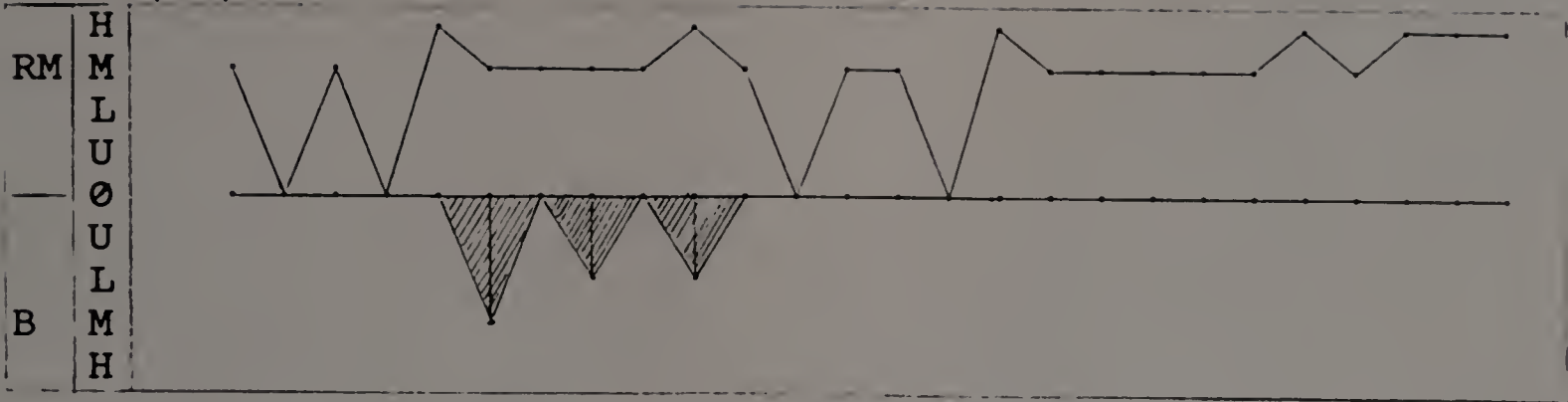
TRJO (OB): 1-1
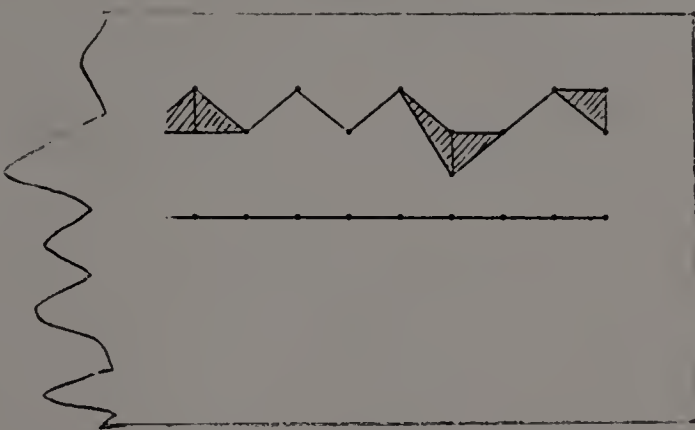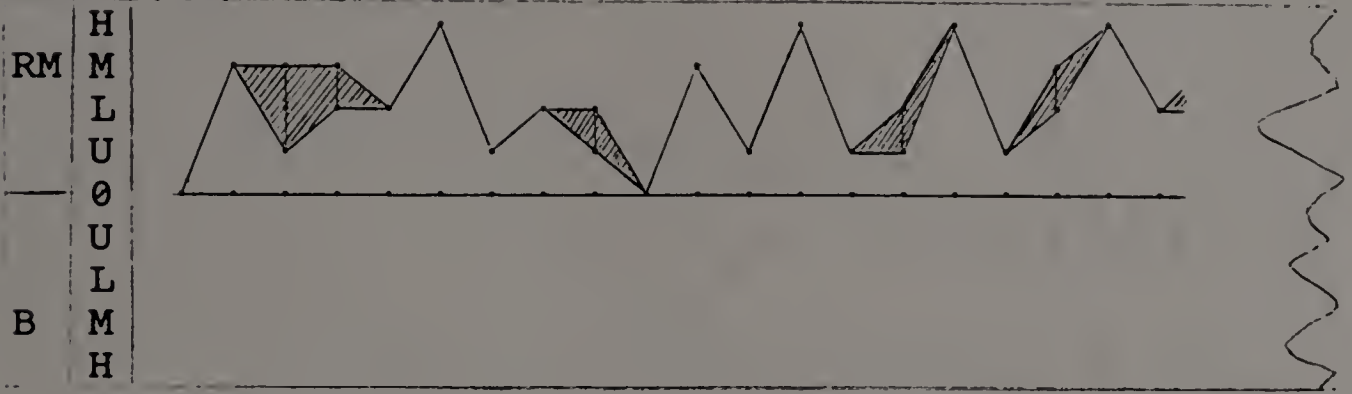
TRJO (OB): 1-2
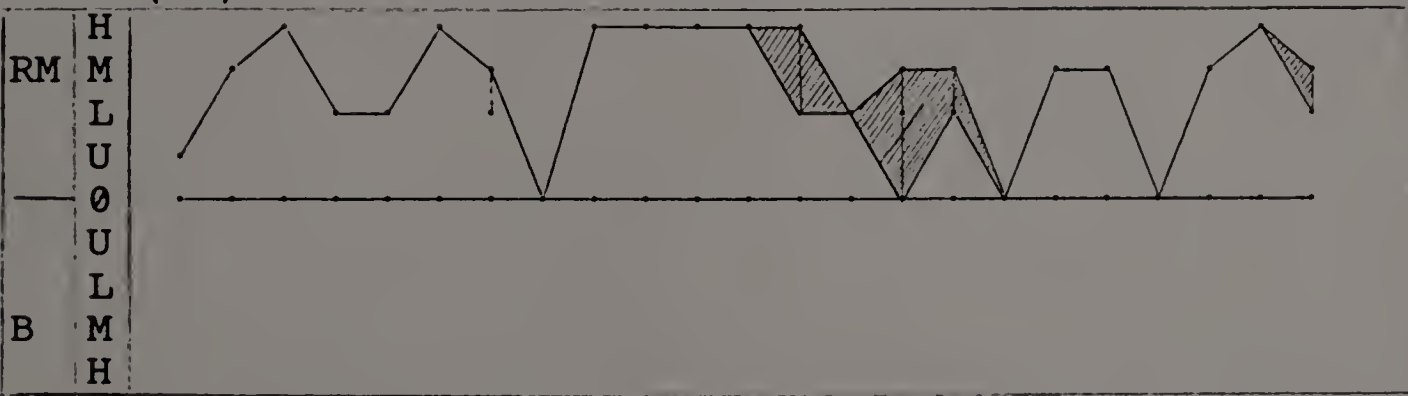
TRJO (OB):2-1
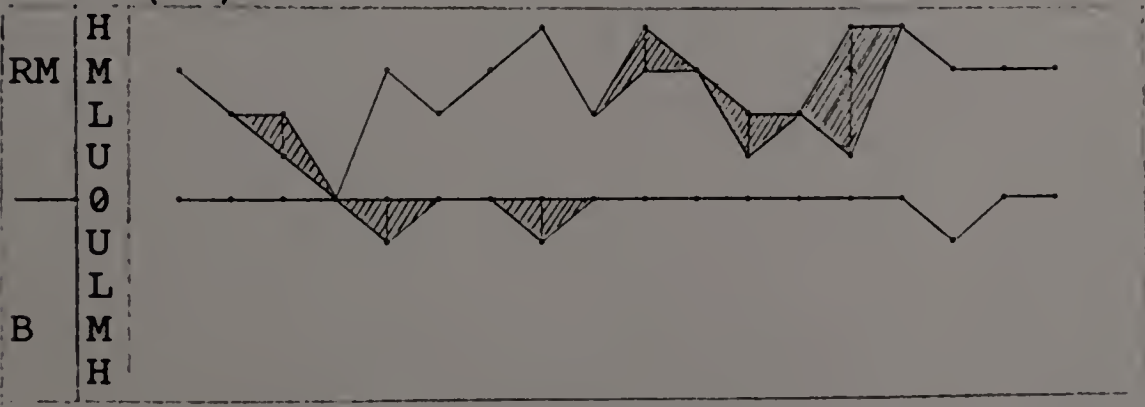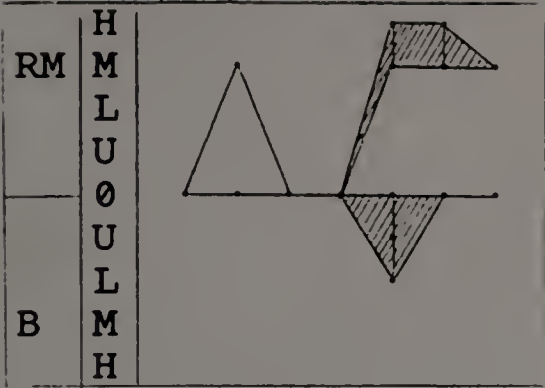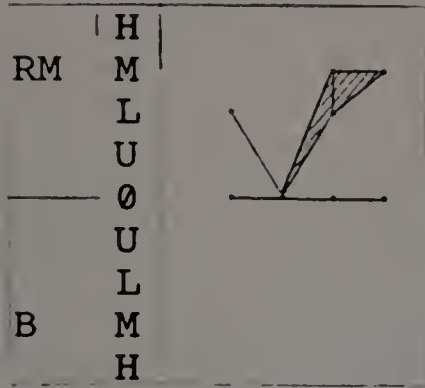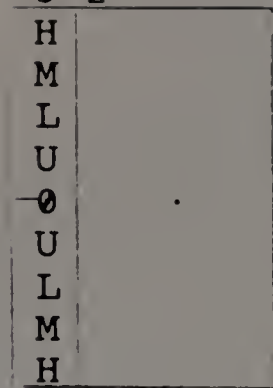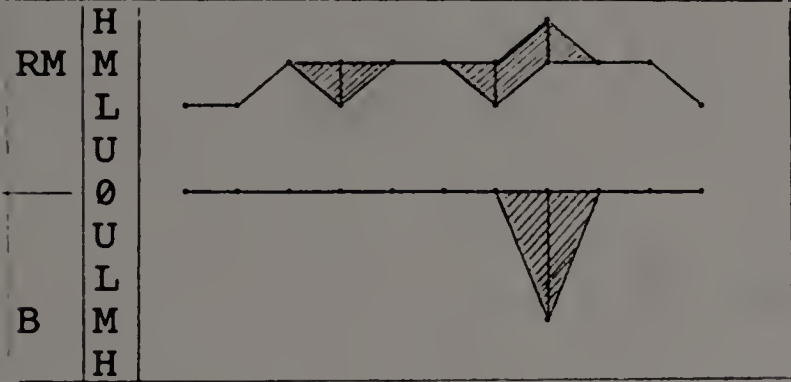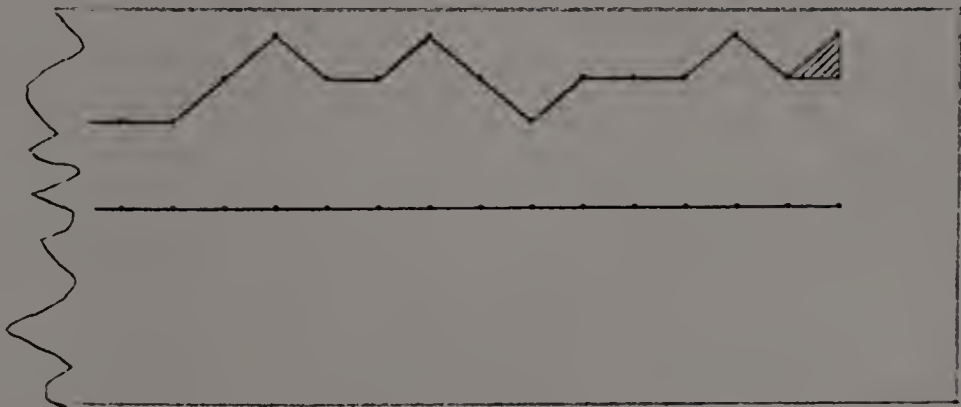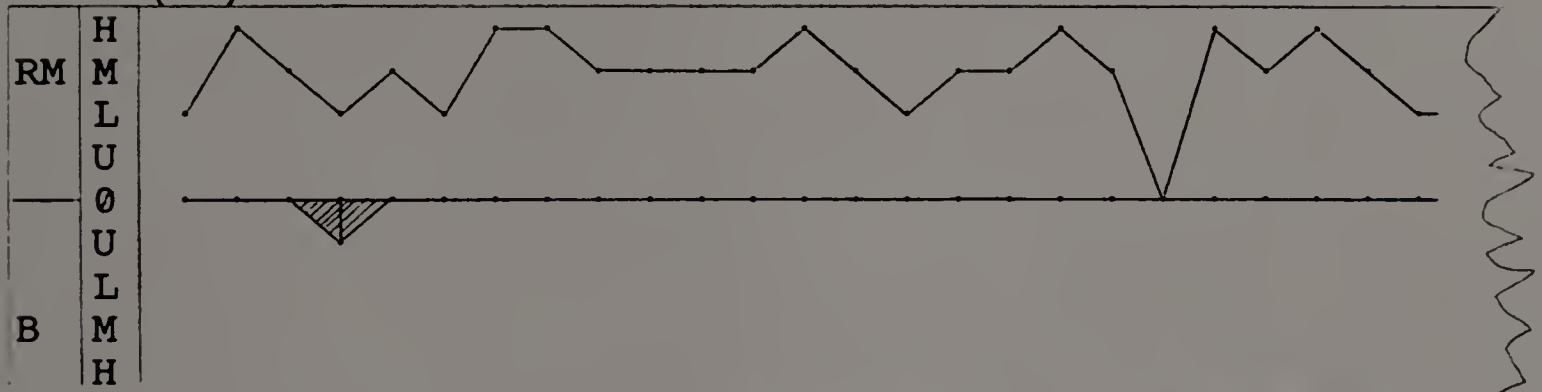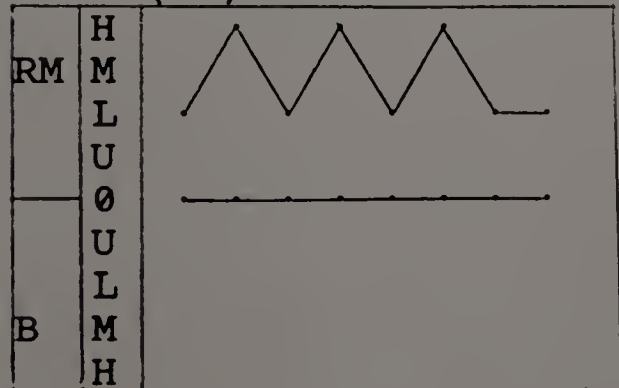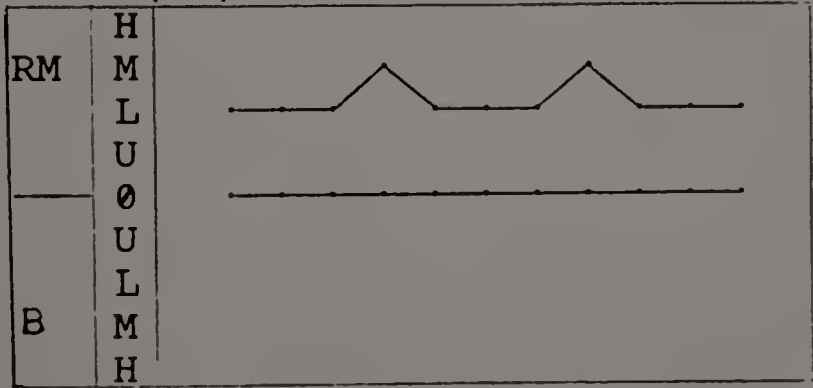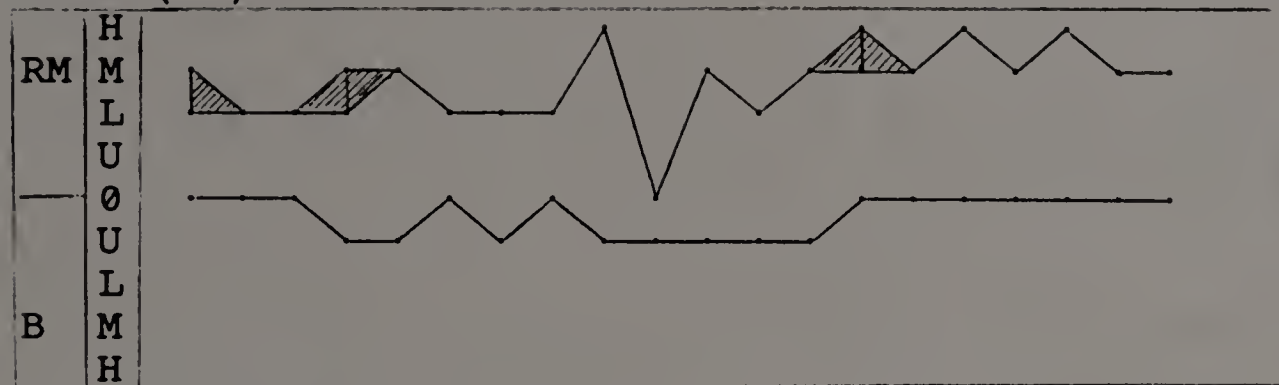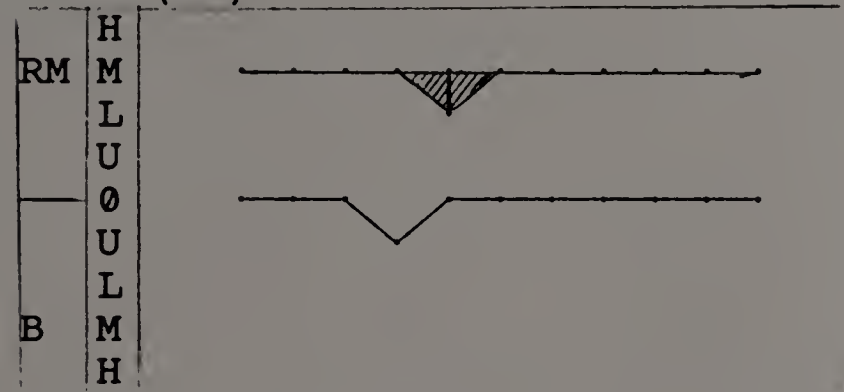
CATH (OG): 3-1
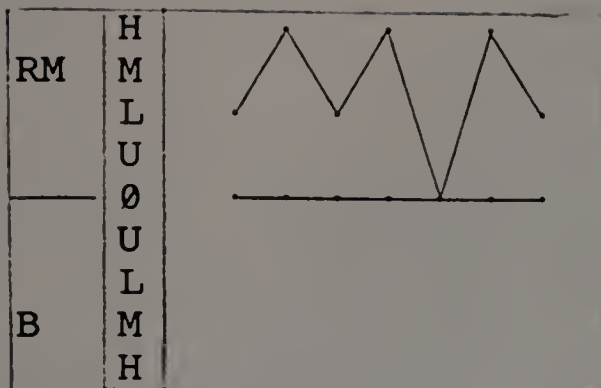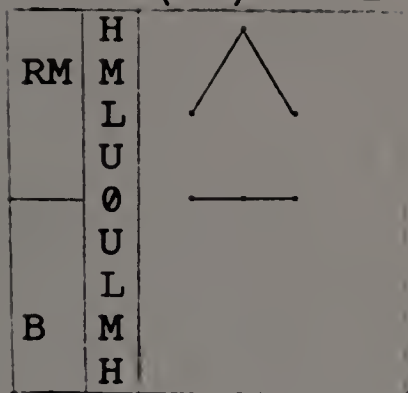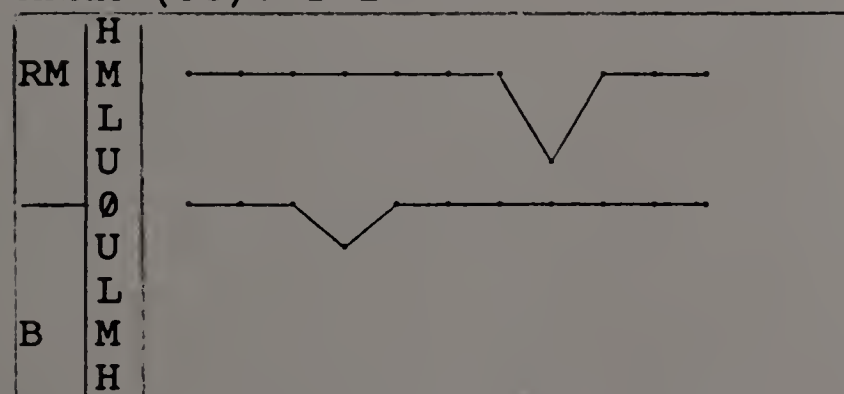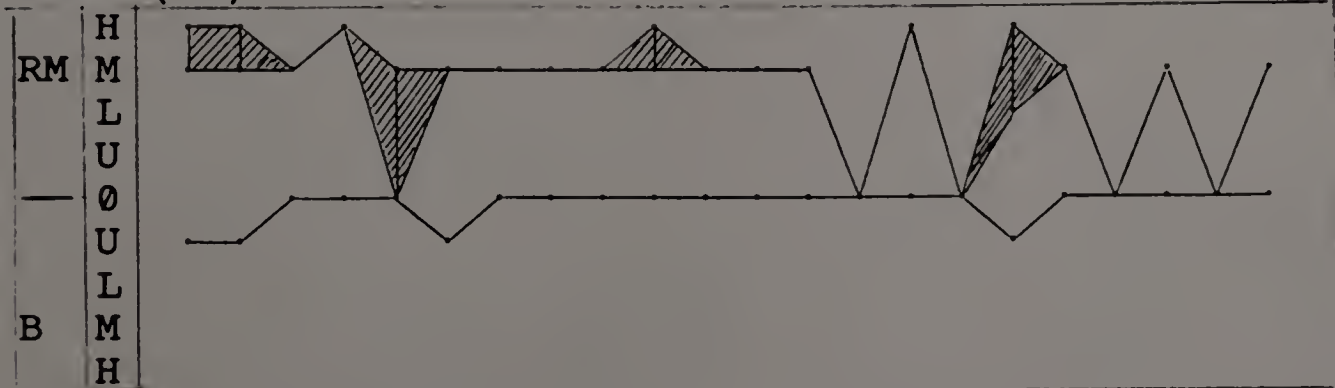
ANMA (OG): 1-1

ANMA (OG): 1-2
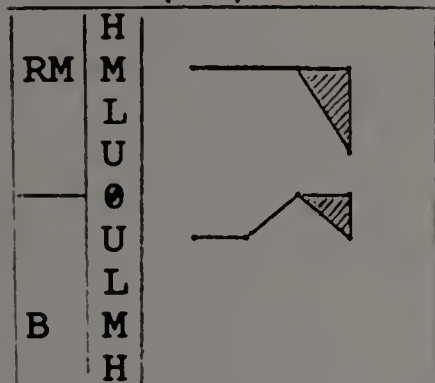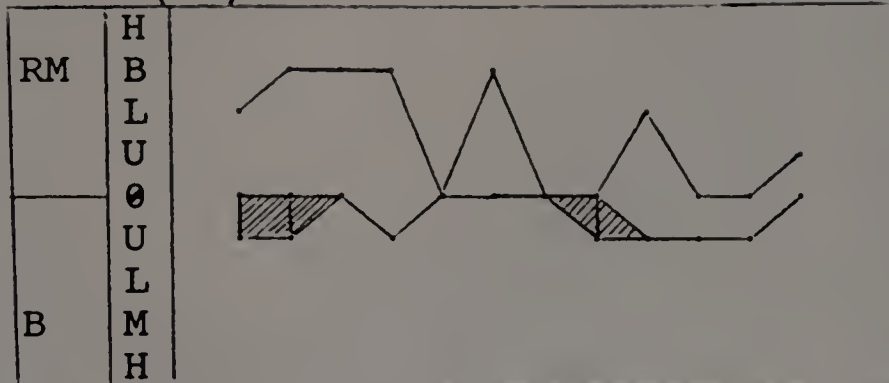
ANMA (OG): 2-1

ANMA (OG): 2-2

ANMA (OG): 3-1

ANMA (OG): 3-2

REFERENCES

Ackerman, B. P., Szymanski, J., & Silver, D. (1990). Children's use of the common ground in interpreting ambiguous referential utterances. Developmental Psychology, 26, 234-245.

Allen, V. L. (1976). Children helping children. In J. R. Levin & V. L. Allen (Eds.), Cognitive Learning in Children; Theories and Strategies. New York, Academic Press.

Ames, G. & Murray, F.B. (1982). When two wrongs make a right: Promoting cognitive change through social conflict. Developmental Psychology, 18, 894-897.

Azmitia, M. (1988). Peer interaction and problem solving: When are two heads better than one? Child Development, 59, 87-96.

Bakeman, R. (1984). Methodological Afterword: From Protoaskers to Panaskers. In L. Feagans, C. Garvey, R. Golinkoff, M. Greenberg, C. Harding and J. Bohannon (Eds.), The Origins and Growth of Communication. Ablex Pub. Co. Norwood, NJ.

Beal, C. (1990). Development of knowledge about the role of inference in text comprehension, Child Development, 61, 1011-1023.

Beal, C. (1988). Children's knowledge about representations of intended meaning. In J. W. Astington, P. L. Harris, & D. R. Olson (Eds.), Developing Theories of Mind. Cambridge University Press, Cambridge.

Beal, C. & Flavell, J. H. (1984). Development of the ability to distinguish communicative intention and literal message meaning. Child Development, 55, 920-928.

Bearison, D. J., Magzamen, S., & Filardo, E. K. (1986). Socio-cognitive conflict and cognitive growth in young children. Merril-Palmer Quarterly, 32, 1, 51-72.

Bearison, D. J. (1982). New directions in studies of social interaction and cognitive growth. In F. C. Serafica (Ed.), Social-Cognitive Development in Context. The Guilford Press, New York.

Beaudichon, J. (1981). Problem-solving communication and complex information transmission. In W. P. Dickson (Ed.), <u>Children's Oral Communication Skills</u>. Academic Press, Inc.: New York.

Bell, N., Grossen, M., & Perret-Clermont, A-N. (1985). Sociocognitive conflict and intellectual growth. In M. W. Berkowitz (Ed.), <u>Peer Conflict and Psychological Grwoth</u>. New Directions for Child Development, 29. San Francisco: Jossey-Bass, Inc.

Brown, G., Anderson, A., Shillcock, R. & Yule, G. (1984). <u>Teaching Talk: Strategies for Production and Assessment</u>. Cambridge University Press, Cambridge.

Bruner, J. (1987). The transactional self. In J. Bruner & H. Haste (Eds.), <u>Making Sense: The child's Construction of the World</u>. New York, NY: Methuen & Co.

Bruner, J. (1983). <u>Child's Talk: Learning to Use Language</u>. W.W. Norton & Co. N.Y.

Carroll, J. M. (1980). Naming and describing in social communication. <u>Language and Speech</u>, 23, 4, 309-322.

Chi, M., Glaser, R., & Rees, E. (1982). Expertise in problem solving. In R. J. Sternberg (Ed.), <u>Advances in the Psychology of Human Intelligence</u>. 7-75, Hillsdale, NJ; Erlbaum.

Clark, H. H., & Schaeffer, E. F. (1989). Contributing to discourse. <u>Cognitive Science</u>, 13, 259-294.

Clark, H. H., & Marshall, C. R. (1981). Definite reference and mutual knowledge. In B.L. Webber, A.K. Joshi & I.A. Sag (Eds.), <u>Elements of Discourse Understanding</u>. Cambridge University Press, Cambridge.

Clark, H. H., & Wilkes-Gibbs, D. (1986). Referring as a collaborative process. <u>Cognition</u>, 22, 1-32.

Cohen, P. R. (1984). The pragmatics of referring and the modality of communication. <u>Computational Linguistics</u>, 10, 2, 1984.

Cohen, P. R., & Feigenbaum, E. A. (1982). <u>The Handbook of Artificial Intelligence</u>. Vol. 3. Los Altos, CA: William Kaufmann, Inc.

Cole, M. (1985). The zone of proximal development:where culture and cognition create each other. In J. V. Wertsch (Ed.), <u>Culture, Communication and Cognition</u>. Cambridge University Press.

Cook-Gumperz, J. (1977). Situated instruction: Language socialization of school age children. In S. Ervin-Tripp & C. Mitchell-Kernan (Eds.), _Child Discourse_. New York: Academic Press.

Cooper, C. R. (1980). Development of collaborative problem solving among preschool children. _Developmental Psychology_. 16, 5, 433-440.

Cooper, C. R. & Cooper, Jr. R.G. (1984). Skill in peer learning discourse: What develops? In S.A. Kuczaj (Ed.), _Discourse Development: Progress in Cognitive Development Research_. 77-97, NY, Springer-Verlag.

Cooper, C.R., Marquis, A. & Edward, D. (1986). Four perspectives on peer learning among elementary school children. In E.C. Mueller & C.R. Cooper (Eds.), _Process and Outcome in Peer Relationship_. Orlando:Academic Press.

Corsaro, W. A. (1979). Sociolinguistic patterns in adult-child interaction. In E. Ochs & B. Schieffelin (Eds.), _Developmental Pragmatics_. New York: Academic Press.

Cox, M. V. & Richardson, J. R. (1985). How do children describe spatial relationships? _Journal of Child Language_, 12, 611-620.

Damon, W., & Phelps, E. (1989a). Strategic uses of peer learning in children's education. In T. J. Berndt & G. W. Ladd (Eds.), _Peer Relationships in Child Development_. John Wiley & Sons, New York.

Damon, W., & Phelps, E. (1989b). Critical distinctions among three approaches to peer education, _International Journal of Educational Research_, 13, 1, 9-19.

Deloache, J. S., Sugarman, S. & Brown, A. L. (1985). The development of error correction strategies in young children's manipulative play, _Child Development_, 56, 928-939.

Deutsch, W. & Pechmann, T. (1982). Social interaction and the development of definite descriptions. _Cognition_, 11, 159-184.

Dickson, W. P. (1982). Creating communication-rich classrooms: Insights from the sociolinguistic and referential traditions. In L. C. Wilkinson (Ed.), _Communicating in the Classroom_. New York: Academic press.

------, (1981a). Introduction. In W. P. Dickson (Ed.), Children's Oral Communication Skills. Academic Press.

------, (1981b) Referential communication activities in research and in the curriculum: Metaanalysis. In W. P. Dickson (Ed.), Children's Oral Communication Skills, Academic Press, New York.

Doise, W., & Mugny, G. (1984). The Social Development of the Intellect. New York, Pergamon.

Ellis, S., & Rogoff, B. (1986). Problem solving in children's management of instruction. In E. Mueller & C. Cooper (Eds.), Process and Outcome in Peer Relationships. Orlando, FL: Academic Press.

Evans, M. A., & Carr, T. H. (1984). The ontogeny of description. In L. Feagans, C. Garvey & R. Golinkoff (Eds.), The Origins and Growth of Communication. Norwood, N.J.: Ablex Publishing Co.

Evans, M. A., & Rubin, K. H. (1983). Developmental differences in explanations of childhood games. Child Development, 54, 1559-1567.

Flavell, J., Botkin, P., Fry, C., Wright, J. & Jarvis, P. (1968). The Development of Role Taking and Communication Skills in Children. New York: Wiley.

Flavell, J. H., Speer, J. R., Green, F. L., & August, D. L. (1981). The development of comprehension monitoring and knowledge about communication. Monographs of the Society for Research in Child Development, 46 (5, serial no. 192).

Forman, E. (1989). The role of peer interaction in the social construction of mathematical knowledge. International Journal of Educational Research, 13, 1, 55-70.

Forman, E. (1987). Learning through peer instruction: A Vygotskian perspective. Genetic Epistemologist, 2,2, 6-15.

Forman, E., & Cazden, C. B. (1985). Exploring Vygotskian perspectives in education: the cognitive value of peer interaction. In J. V. Wertsch (Ed.), Culture, Communication and Cognition: Vygotskian Perspecitives. Cambridge University Press.

Forman, E. A., & Kraker, M. J.(1985). The social origins of logic: The contributions of Piaget and Vygotsky. In M. W. Berkowits (Ed.), Peer Conflict and Psychological Growth. New Directions for Child Development, 29, 23-29. San Francisco: Jossey-Bass.

Freyd, J. (1983). Shareability: The social psychology of epistemology. Cognitive Science, 7, 191-210.

Garvey, C. (1986). Peer relations and the growth of communication. In E. C. Mueller & C. R. Cooper (Eds.), Precess and Outcome in Peer Relations. New York: Academic Press.

Garvey, D. (1975). Requests and responses in children's speech. Journal of Child Language, 2, 41-63.

Gauvain, M. & Rogoff, B. (1986). Influence of the goal on children's exploration and memory of large-scale space. Developmental Psychology, 22, 1, 72-77.

Gilligan, C. (1982). In a Different Voice: Psychological Theory and Women's Development. Cambridge, MA. Harvard University Press.

Gilly, M. (1989). The psychosocial mechanisms of cognitive constructions: Experimental research and teaching perspectives. International Journal of Educational Research, 13, 1.

Glachan, M. & Light, P. (1982). Peer interaction and learning: Can two wrongs make a right? In G. Butterworth & P. Light (Eds.), Social Cognition: Studies of the Development of Understanding. The University of Chicago Press, Chicago.

Glucksberg, S.,& Krauss, R. M. (1967). What people say after they have learned how to talk? Studies of the development of referential communication. Merril-Palmer Quarterly, 13, 309-316.

Glucksberg, S., Krauss, R. & Higgins, E. T. (1975). The development of referential communication skills. In F. D. Horowitz (Ed.), Child Development Research, 4, Chicago, University of Chicago Press.

Goodwin, M. H. (1988). Cooperation and Competition across girls' play activities. In A. D. Todd & S. Fisher (Eds.), Gender and Discourse: The Power of Talk. Ablex Publishing Co.

Goodwin, M. H. (1980). Directive/response speech sequences in girls' and boys' task activities. In S. McConnell-Ginet, R. Boker, & N. Furman (EDs.), <u>Women and Language in Literature and Society</u>. New York, Praeger. 157-173.

Goodwin, M. H., & Goodwin, C. (1987). Children's arguing. In S. U. Philips, S. Steele & C. Tanz (Eds.), <u>Language, Gender and Sex in Comparative Perspective</u>. Cambridge University Press.

Greenberg, M. T. (1984). Pragmatics and Social Interaction: Unrealized Nexus. In L. Feagans, C. Garvey, R. Golinkoff, M. Greenberg, C. Harding and J. Bohannon (Eds.), <u>The Origins and Growth of Communication</u>. Ablex Pub. Co. Norwood, NJ.

Grice, H. (1975). Logic and conversation. In P. Cole and J. Morgan (Eds.), <u>Syntax and Semantics</u>, V.3. Academic Press, New York.

Grosz, B. J. (1981). Focusing and description in natural language dialogues. In B.L. Webber, A.K. Joshi & I.A. Sag (Eds.), <u>Elements of Discourse Understanding</u>. Cambridge University Press, Cambridge.

Herber, M. (1981). Instruction versus conversation as opportunities for learning. In W. P. Robinson (Ed.), <u>Communication in Development</u>. London: Academic Press.

Hickman, M. E. (1987). The pragmatics of reference in child language: Some issues in developmental theory. In M. E. Hickman (Ed.), <u>Social and Functional Approach to Language and Cognition</u>. Academic Press.

Hickman, M. E. (1985). The implications of discourse skills in Vygotsky's developmental theory. In J. V. Wertsch (Ed.), <u>Culture, Communication and Cognition</u>. Cambridge University Press.

Higgins, E. T., Fondacaro, R., & McCann, C. D. (1981). Rules and roles: The "communication game" and speaker-listener processes. In W. P. Dickson (Ed.), <u>Children's Oral Communication Skills</u>. New York: Academic Press.

Hogrefe, C., Wimmer, H. & Perner, J. (1986). Ignorance versus false belief: A developmental lag in attribution of epistemic states. <u>Child Development</u>, 57, 567-582.

Issacs, E. A. & Clark, H. H. (1987). References in conversation between experts and novices. <u>Journal of Experimental Psychology: General</u>, vol. 116, no. 1, 26-37.

Johnson, D., Johnson, R., & Skon, L. (1979). Student achievement on different types of tasks under cooperative, competitive, and individualistic conditions. <u>Contemporary Educational Psychology</u>, 4, 99-106.

Kuhn, D. (1972). Mechanisms of change in the development of cognitive structures. <u>Child Development</u>, 43, 833-842.

Kruger, A. C., & Tomasello, M. (1986). Transactive discussions with peers and adults. <u>Developmental Psychology</u>, 22, 5, 681-685.

Lever, J. (1976). Sex differences in the games children play. <u>Social Problems</u>, 23, 478-487.

Light, P., Blaye, A., Gilly, M., & Girotto, V. (1988). Pragmatic schemas and logical reasoning in 6 to 8 years olds. <u>Cognitive Development</u>, 6.

Lloyd, P. (1991). Strategies used to communicate route directions by telephone: A comparison of the performance of 7-year-olds, 10-year-olds and adults. <u>Journal of Child Language</u>, 18, 171-189.

Lloyd, P. (1990). Children's communication. In R. Grieve and M. Hughes (Eds.), <u>Understanding Children</u>. Basil Blackwell, Oxford, UK.

Lloyd, P., Baker, E., & Dunn, J. (1984). Children's Awareness of Communication. In L. Feagans, C. Garvey, R. Golinkoff (Eds.), <u>The Orignis and Growth of Communication.</u> Norwood, NJ:Ablex-Publishing Co.

Maccoby, E. E. (1987). Gender as a Social Category. Paper presented at the Symposium at the University of Chicago. April, 1987.

Maltz, D. N., & Boker, R. A. (1982). A cultural approach to male-female miscommunication. In J. Gumperz (Ed.), <u>Communication, Language and Social Identity</u>. Cambridge University Press. 196-216.

Markman, E. (1977). Realizing that you don't understand: A preliminary investigation. <u>Child Development</u>, 48, 986-992.

Martinez, M. A. (1987). Dialogues among children and between children and their mothers. <u>Child Development</u>, 58, 1035-1048.

McTear, M. F. (1985). <u>Children's Conversation</u>. Oxford: Basil Blackwell Publisher.

Miller, P. H., Kessel, F. S., & Flavell, J. H. (1970).
    Thinking about people thinking about people thinking
    about ....: A study of social cognitive development.
    Child Development, 41, 613-623.

Miller, P. M., Danaber, D. L., & Forbes, D. (1986). Sex
    related strategies for coping with interpersonal
    conflict in children aged five and seven.
    Developmental psychology, 22, 4, 543-548.

Morrison, H., & Kuhn, D. (1983). Cognitive aspects of
    preschoolers' peer imitation in a play situation.
    Child Development, 54, 1041-1053.

Mugny, G. & Doise, W. (1978). Socio-cognitive conflict and
    structure of individual and collective performances.
    European Journal of Social Psychology, 8, 181-192.

Murray, F.B. (1983). Equilibration as cognitive conflict.
    Developmental Review, 3, 54-61.

Murray, F.B. (1982). Teaching through social conflict.
    Contemporary Educational Psychology, 7, 257-271.

Mussatti, T. (1986). Early Peer Relations: Views of Piaget
    and Vygotsky. In E. Mueller(Ed.), Process and Outcome
    in Peer Relationships. New York: Academic Press.

Olson, D. R., & Astington, J. (1987). Seeing and knowing:
    On the ascription of mental states to young children.
    Cannadian Journal of Psychology, 41, no.4, 399-411.

Perkins, S. C., Meyers, A. W., & Cohen, R. (1988).
    Problem-solving ability and response to feedback in
    peer-nominated mildly depressed children. Cognitive
    Therapy and Research, 12, 1. 89-102.

Perlmutter, M., Behrend, S.D., Kuo, F. & Muller, A. (1989).
    Social influences on children's problem solving.
    Developmental Psychology, 25, 5, 744-754.

Perner, J., & Wimmer, H. (1985) "John thinks that Mary
    thinks that ...": Attribution of second-order beliefs
    by 5- to 10-year-old children. Journal of Experimental
    Child Psychology, 39, 437-471.

Perret-Clermont, A. N. (1980). Social Interaction and
    Cognitive Development in Children. London: Academic
    Press.

Perret-Clermont, A-N., & Schubauer-Leoni, M. L. (1981).
    Conflict and cooperation as opportunities for learning.
    In W. P. Robinson (Ed.), Communication in the
    Classroom. London: Academic Press.

Perret-Clermont, A., Brun, J., & Saada, E. H. (1984). Learning: A social actualization and reconstruction of knowledge. In H. Tajfel (Ed.), <u>The Social Dimension: European Development in Social Psychology</u>. Cambridge University Press.

Piaget, J. (1926/1959). <u>The Language and Thought of the Child</u>, London, Routeledge & Kagan Paul, 1926, 3rd edition, 1959.

Piaget, J. (1965). <u>The Moral Judgement of the Child</u>. New York, Free Press.

Pratt, M.W., Scribner, S. & Cole, M. (1977). Children as teachers: Developmental studies of instructional communication. <u>Child Development</u>, 46, 1475-1481.

Radziszewska, B., & Rogoff, B. (1988). The influence of collaboration with parents versus peers in learning to plan. <u>Developmental Psychology</u>, 24, 840-848.

Robinson, E. J. (1981). The child's understanding of inadequate messages and communication failure: A problem of ignorance or egocentrism? In W. P. Dickson (Ed.), <u>Children's Oral Communication Skills</u>. New York: Academic Press.

Robinson, W. P. (1986). Children's understanding of the distinction between messages and meanings: emergence and implications. In M. Richards & P. Light (Eds.), <u>Children of Social Worlds: Development in a Social Context</u>. Harvard University Press, Cambridge, Mass.

Robinson, E. J., & Goelman, H., & Olson, D. R., (1983). Children's understanding of the rlation between expressions and intentions. <u>British Journal of Developmental Psychology</u>, 1, 75-86.

Robinson, E. J. & Robinson, W. P. (1983). Communication and metacommunication: Quality of children's instructions in relation to judgments about the adequacy of instructions and the locus of responsibility for communication failure. <u>Journal of Experimental Child Psychology</u>, 36, 305-320.

Rogoff, B. (1990). <u>Apprenticeship in Thinking: Cognitive Development in Social Context</u>. Oxford University; New York, Oxford.

Rommetveit, R. (1985). Language acquisition as increasing linguistic structuring of experience and symbolic behavior control. In J. V. Wertsch (Ed.), <u>Culture, communication and Cognition</u>. University of Cambridge Press.

Rosenthal, T., & Zimmerman, B. J. (1978). Social Learning and Cognition, New York: Academic Press.

Rubtsov, V. V. (1989). Organization of joint actions as a factor of child pshchological development. International Journal of Educational Research, 13, 1.

Rubtsov, V. V. (1981). The role of cooperation in the development of intelligence. Soviet Psychology,

Sachs, J. (1987). Preschool boys' and girls' language use in pretend play. In S. U. Philips, S. Steele & C. Tanz (Eds.), Language, Gender and Sex in Comparative Perspective. Cambridge University Press.

Scribner, S., Pratt, M. W., & Cole, M. (1977). Children as teachers: Developmental studies of instructional communication. Child Development, 48, 1475-1481.

Shantz, C. U. (1981). The role of role-taking in children's referential communication. In W. P. Dickson(Ed.), Children's Oral Communication Skills. New York:Academic Press.

Sheldon, A. (1990). Pickle fights: Gendered talk in preschool disputes. Discourse Processes, 13, 5-31.

Sodian, B. (1988). Children's attributions of knowledge to the listener in a referential communication task. Child Development, 59, 378-385.

Sodian, B. & Wimmer, H. (1987). Children's understanding of inference as a source of knowledge. Child Development, 58, 424-433.

Sonnenschein, S., & Whitehurst, G. J. (1984). Developing Referential Communication Skills: The Interaction of Role-Switching and Difference Rule Training. Journal of Experimental Child Psychology, 38, 191-207.

Speer, J. R. (1984). Two practical strategies young children use to interpret vague instructions. Child Development, 55, 1811-1819.

Tannen, D. (1990). Gender differences in topical coherence: Creating involvement in best friends' talk. Discourse Processes, 13, 73-90.

Tudge, J. R. & Rogoff, B. (1989). Peer influences on cognitive development: Piagetian and Vygotskian perspectives. In M. Bornstein & J. Bruner (Eds.), Interaction in Human Development. Hillsdale, NJ: Erlbaum.

Verba, M. (1987). Cooperation, tutoring and imitation in social symbolic play: The role of the older child. Paper presented at the Biennal Meeting of the Society for research in Child Development, Baltimore, April 23-26, 1987.

Vygotsky, L. S. (1981). The genesis of higher mental functions. In J. V. Wertsch (Ed.), <u>The Concept of Activity in Soviet Psychology</u>. Armonk, NY: Sharpe.

Webb, N. M. (1982). Peer interaction and learning in cooperative small groups. <u>Journal of Educational Psychology</u>, 74, 642-645.

Webb, N. M. (1989). Peer interaction and learning in small groups. <u>International Journal of Educational Research</u>, 13, 1, 21-39.

Wertsch, J. V. (1985). Adult-child interaction as a source of self-regulation in children. In S. R. Yussen (Ed.), <u>The Growth of Reflection in Children</u>. Orlando, Fl.: Academic Press.

Wertsch, J. V., & Hickman, M. (1987). Problem solving in social interaction: A microgenetic analysis. In M. Hickman (Ed.), <u>Social and Functional Approaches to Language and Thought</u>. Orlando, Fl: Academic Press.

Youniss, J. (1983). Beyond ideology to the universals of development. <u>Contributions to Human Development</u>, 8, 31-52.