Metacognitive content of mothers' verbal directives to preschool children

Susan Jaycox Kontos
Iowa State University

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METACOGNITIVE CONTENT OF MOTHERS' VERBAL DIRECTIVES TO PRESCHOOL CHILDREN

Iowa State University

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Metacognitive content of mothers' verbal
directives to preschool children

by

Susan Jaycox Kontos

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Iowa State University
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1980

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Introduction

In the last ten years, interest in a phenomenon termed "metacognition" has burgeoned. This phenomenon was first identified in the developmental literature by Flavell (Flavell, 1970; Flavell, Friedrichs, & Hoyt, 1969; Moely, Olson, Halwes, & Flavell, 1969) in his investigations concerning the production/mediation deficiency hypothesis in young children's memory development. During this phase of his work, Flavell began to notice an important relationship between how a subject approaches a memory task and what that subject knows about his/her memory states and processes. He then concluded (Flavell, Friedrichs, & Hoyt, 1970) that to study the nature and development of children's knowledge and awareness of their own memory systems (or metamemory) was an important area of inquiry. Not surprisingly, a barrage of research concerning metamemory was produced in an attempt to describe this phenomena as observed in children. This mass of literature has been thoroughly reviewed by both Flavell and Wellman (1977) and Brown (1977a).

Within the last five years, the concept of metamemory has been joined by other "metas" to include such cognitive processes as language, communication, comprehension, reading, and general problem-solving. Consequently, the term metacognition has been used as an umbrella term to include all of these areas (and others unnamed). According to Brown and French (1979, p. 104):
Metacognition refers to the awareness about and conscious control of one's own cognitive processes, to the mental processes which can be broadly termed checking and monitoring. In a sense, what is involved is a general 'keeping an eye on' one's cognitive operations to determine when strategic attempts to learn are called for, when failures to understand have occurred, whether it is likely that a problem can be solved on the basis of old knowledge, and if not, what new knowledge must be sought, etc.

The early metacognitive studies, primarily concerned with metamemory development, involved laboratory-type memory tasks and very task-specific strategic awareness. For instance, Tenney (1975) had children create their own word lists under three different instructions. One group was asked to free associate to a given item, another group was asked to list three words that would be easy to remember along with a given item, and the third group was asked to generate three words that were in the same category as the given item. Clustering (categorization) in the lists generated was assessed and one week later a recall session was held. Results indicated that the kindergartners could cluster when asked and had better recall when they did. However, without instructions they rarely categorized spontaneously. The older subjects showed increasing tendencies with age to produce categorized lists. This was a clever, informative experiment, yet it dealt with a behavior (knowledge and awareness of categorizing as a mnemonic device) that has few applications outside of similar list-learning type tasks.
More recently, both Brown (Brown & Campione, 1978; Brown & DeLoache, 1978; Brown, in press) and Flavell (Note 1) have suggested that several metacognitive skills can be identified and that these skills can be applied generally across a wide variety of problem-solving situations. Brown and Campione (1978) refer to these general metacognitive skills as self-interrogation. Subsumed under self-interrogation are such activities as checking, planning, asking questions, self-testing, and monitoring ongoing attempts to solve problems (Brown, Campione, & Barclay, 1979). Such a broad, general conceptualization of metacognitive skills is more useful since general skills can be applied to a variety of task settings and transfer to a skill between task settings is more likely. Due to the broad and general usefulness of Brown's classification of metacognitive skills, she and her colleagues contend that these are skills worthy of direct training attempts in populations having metacognitive deficits (Brown, 1977a; Brown & Campione, 1978; Brown, Campione, & Barclay, 1979). Flavell (1979) also has suggested that increasing metacognitive knowledge and monitoring skills in those who lack them is a valuable educational objective. Who lacks the most in metacognitive skills and what are the deficits?

Research has produced abundant evidence that both young children and retarded children are two populations with great difficulty in directing and regulating their own goal-directed
activities (Brown, Campione, & Barclay, 1979; Brown, 1977a; Brown, in press). Brown (in press) has outlined several major areas of metacognitive difficulty for these children:

1. Recognizing a need for strategic intervention when problem difficulty increases

2. Using inferential reasoning to assess the probability that an assumption is true, given the information they already have (or knowing what you do and do not know when reasoning from incomplete knowledge)

3. Predicting the outcome of strategy utilization both before and after the fact

4. Predicting task difficulty

5. Planning ahead for strategic study-time apportionment

6. Monitoring the success of a strategy so that it can be terminated when successful and changed if unsuccessful.

One also could include such deficiencies as an inaccurate concept of one's own cognitive abilities and traits (similar to mnemonic self-concept as defined by Flavell and Wellman, 1977) and a tendency not to recognize when a failure of comprehension in task instructions has occurred (Markman, 1977). Both of the latter two are aspects of "knowing when you know."

Research concerned with training and transfer of metacognitive skills in children has been conducted by Ann Brown and her colleagues. Brown's metacognitive training efforts have been focused mainly on retarded children. She found that retarded children can be successfully trained in a specific metamnemonic awareness and that their performance could be maintained over a year's time (Brown, Campione, & Murphy,
1977). There was no evidence, however, for generalization to new situations. Brown's recent published work (Brown, Campione, & Barclay, 1979) utilized less task-specific skills and concentrated on training two groups of retarded children (mean mental age for one group was six years; for the other it was eight years) in a general metacognitive skill; assessing readiness for recall through self-testing. This time, not only did she find maintenance of post-training performance levels after one year, she also found generalization of the self-testing strategy to a new task involving extraction of the main idea from prose passages. However, in all instances, both maintenance and generalization effects were present for the MA 8 group, but not for the MA 6 group. Thus, for older, retarded children, direct training of general metacognitive skills can have somewhat durable effects and can transfer across tasks. One can probably assume that normal older children could be trained with similar results.

But what of the younger children? The root of their metacognitive problems is difficult to assess. One potentially influential variable that differentiates the younger from the older children is exposure to formal schooling. Cross-cultural research in cognition has consistently shown that schooling has a strong influence, independent of age, on how a person thinks (Cole & Scribner, 1974; Cole & Scribner, 1977; Sharp, Cole, & Lave, 1979). Differences between schooled and
unschooled subjects do not occur in all intellectual activities, but are evident in tasks where competing alternatives to solutions exist, and where a strategic approach is desirable (and, needless to say, where metacognitive skills are most useful). Tasks which predetermine a response pattern or which have minimal task demands are performed equally well by schooled or unschooled subjects (Brown, 1977b; Cole & Scribner, 1974; Sharp, Cole, & Lave, 1979). Such findings clearly have implications for differences in the metacognitive activities of younger and older children since young children are the primary unschooled population in the United States.

The child's transition from home to school environment is seen by some as crucial to metacognitive development. Upon entering school, says Brown (1977a, p. 121),

Children are expected to make the transition from the context-bound, experiencially-based, play-centered culture of preschool life, to the context-free, impersonal, learning-for-learning sake atmosphere of the schools.

In a technological society, she states, formal schooling is the context in which such skills as "... deliberate remembering as an end in itself rather than as a method of achieving a meaningful goal" are emphasized and refined. According to Brown (1977a, p. 117), "Outside the school setting, in unschooled populations, including that of the preschool child, such activities are rarely, if ever, encountered." In other words, Brown seems to be postulating a discontinuity between
the home and school environment that may partially explain the
differences in the level and trainability of metacognitive
skills between younger and older children.

This discontinuity between the metacognitive environment
of home and school has been discussed by Brown and others, but
until recently, little or no research has taken place concern­
ing specific aspects of these environments. Lange (Note 2) has
reasoned that it makes sense to draw distinctions between the
cognitive requirements placed on preschoolers in the home
versus those placed on older children in the schools since data
clearly indicate that use of adult-like metacognitive strate­
gies becomes prevalent in school-aged children. However, docu­
mentation is vital as a starting point in evaluating the
hypothesis that age differences in cognitive and metacognitive
abilities arise in large part due to differential exposure to the
experiences and demands that characterize formal schooling
environments.

James Wertsch, a linguist, has developed a theory con­
cerning the origins of cognitive self-regulation in young
children and bases it on the ideas of L. S. Vygotsky (Hickmann
& Wertsch, 1978; Wertsch, Note 3; Wertsch, Hickmann, McLane, &
Dowley, Note 4; Wertsch, Note 5; Wertsch, 1979). According to
Vygotsky (1978, p. 57), "All the higher functions originate as
actual relations between human individuals." In other words,
higher mental processes in children function first on the
social level (between people or interpsychic) and later on the individual level (intrapsychic). Preschool-aged children, from this perspective, are still operating at the social level. Therefore, in order to discover the origins of metacognitive skill, one must observe children in social interaction. Wertsch contends that the research to date has been unable to address the issue of the origins of metacognition because it has concerned itself with the child alone, and with how metacognitive skill evolves once it has appeared. It is his belief that the origins of metacognition lie in adult-child interaction, primarily verbal directives. The adult-child interaction comprises the metacognitive environment which forms the basis for self-regulation in the child. In Wertsch's view, "other-regulation" precedes and makes possible self-regulation in children. As stated by Hickmann and Wertsch (1978, p. 1):

... being led through a task by means of other-regulation from adults (or older children) is the primary way in which the child acquires a first level of understanding of a problem-solving plan or strategy.

In another paper, Wertsch (Note 3) enumerates the kinds of things a mother might be expected to do in order to provide metacognitive regulation for her child. They include:

1. Goal direction

2. Making certain that the child is aware of the perceptual or conceptual facts which are relevant to the task

3. Arranging the environment in such a way that the child will be able to deal with each step of the task separately.
4. Reminding the child where he/she is in the task.
This list is certainly not complete nor do the items apply universally. They do provide a beginning from which to investigate the metacognitive content of maternal verbal directives toward children in problem-solving situations.

Descriptions of the metacognitive environment of the home are needed before clear data-based distinctions can be made between the metacognitive environment of the home for the young child and the school for the older child. Also, careful investigation of the social interactional origins of metacognitive skill is necessary, particularly if Wertsch's theory is to be tested.

Statement of the Problem

The present study attempts to characterize the metacognitive environment of the home for the preschool child as represented in the verbal directives of mothers during a problem-solving task. The assumption is made that the mothers' and children's behavior in a laboratory setting can be generalized to the home environment. Whether or not mothers attempt to regulate the problem-solving behavior of preschool children also will be examined. Other variables of interest are improvement in children's success in the problem-solving task as a function of help from their mothers, the tendency of mothers to relinquish control for guiding the problem solution over time, and differences in the content of the mothers'
verbal directives as a function of age of their child.

Null Hypotheses

1. The amount of metacognitive content in the verbal directives of mothers toward preschool children in a problem-solving task does not exceed zero.

2. Metacognitive content of mothers' verbal directives will not differ as a function of age of child.

3. No differences exist in the proportion of interrogatory verbal directives to declarative/imperative verbal directives in the first half of the interaction session compared to the last half.

4. No improvement in children's success in a problem-solving task will occur following interaction with their mothers.

Operational Definitions

1. Problem-solving task or situation: Involvement in the completion of a difficult form-board puzzle.

2. Interaction session: That segment of the study in which a mother helps her child complete a puzzle.

3. Verbal directives: Single meaningful statements that can take two forms:
   a. Interrogatory - Open-ended questions requiring production or retrieval of information.
   b. Declarative/imperative - Statements, commands, and rhetorical or verification questions.

4. Success in a problem-solving task:
   a. Number of pieces correctly placed on the puzzle.
   b. Amount of time between beginning of the interaction session and the first successful form placement.
   c. Ability to verbalize a strategy principle utilized to complete the puzzle.

5. Metacognitive content: Statements by the mothers which fall into one of the following categories:
   a. Goal direction - Reference to the end-state of the puzzle.
b. Making child aware of perceptual or conceptual facts relevant to the task -
   1) References to form, shape, direction, relationships to peg configurations on the board, etc.
   2) Cues concerning location on the board only

c. Verbalization of a strategy principle - Reference to a systematic method for completing the task efficiently

d. Reminder of what stage of the task is being completed -
   1) Initiating a piece placement
   2) Reference to what was just done, what is to be done next, etc.

e. Monitoring success or failure of piece placement - Reference to whether it is worthwhile to continue on a particular piece.
Mothers and Cognitive Development

Previous to the 1960s, interest in relations between parent and child behavior was primarily directed toward such dependent variables as the child's physical or social development, and general adjustment factors (Freeberg & Payne, 1967). During the 1960s, researchers began to focus upon the relationship between parent behaviors and cognitive or intellectual development in children. By examining research in this area, it will be possible to determine whether or not a systematic relationship between mothers' behavior and cognitive development in the child has been established. The studies can be grouped according to the type and specificity of maternal behavior examined.

Global childrearing variables. In 1963, Elizabeth Bing examined the relationship of mothers' childrearing practices to children's cognitive development. Fifth-grade children were divided into high and low verbal groups based on relative size of verbal scores as opposed to spatial and numerical scores on an IQ test. All children had similar total IQ scores. Mothers' childrearing behavior was assessed primarily by an interview and a questionnaire. An interaction situation between each mother and child also was observed. T-statistics were computed to detect significant differences between means.
of the high verbal and low verbal groups for boys, girls, and the sexes combined for all dependent variables. Only means and $p$ values were reported, however. Results showed that mothers of high verbal children tended to give more verbal stimulation, were more critical of poor academic achievement, were more restrictive, and gave more help during the interaction session ($p < .05$). Bing concluded that high verbal ability in children is facilitated when a mother is demanding and somewhat intrusive in the context of a close relationship while a child whose mother allows a considerable amount of independent experimentation tends to display high nonverbal ability.

Dyk and Witkin (1965) attempted to relate family experiences to the development of differentiation (e.g. field independence) in elementary school-aged children. Their measure of family experience consisted of a retrospective verbal report from the mother. They found that girls differentiated to a lesser extent than boys, and that girls and field-dependent boys seemed to have been reared similarly. That is, mothers of girls and field-dependent boys emphasized social skills and tended to be less accepting of assertiveness. Mothers who encouraged autonomy and curiosity were more likely to have field-independent children (especially boys). Interestingly, an over protective mother-child relationship, while inhibiting differentiation, seemed to facilitate verbal skill.
Busse (1969) looked at the childrearing antecedents of flexible thinking (the ability to consider alternative means to an end) in black, fifth-grade boys. Both parent behavior and attitudes were measured. Each parent was asked to teach his or her son how to master four tasks and scores were derived from behavior exhibited during this teaching session (e.g. autonomy, love, hostility, etc.). Also, selected items from the Parental Attitude Research Instrument (Nichols, 1962; Zuckerman, 1959) were administered and the scores were factor analyzed to form six mother factors and eight father factors. Flexible thinking in the boys was measured by a flexible thinking factor score from a previously designed instrument by Busse. Linear and quadratic trend analyses were computed between each of the parent variables and the boys' flexible thinking scores. Since he regarded it as an exploratory study, Busse adopted the .10 level of significance.

Linear relationships were found between flexible thinking and such variables as mother commands ($F(1,45)=4.40$), "father love" ($F(1,45)=3.16$), and two father factors, "powerlessness vs. powerfulness" ($F(1,45)=6.96$), and "rigid, absolute vs. warm, sympathetic standards" ($F(1,45)=3.39$). Significant quadratic trends were found on the following variables: mother manipulation ($F(1,45)=5.17$), mother commands ($F(1,45)=3.43$), father manipulation ($F(1,45)=4.76$), and three father factors: "active vs. ignoring role with children" ($F(1,45)=3.69$), "discouraging
vs. tolerating physical aggression in children" ($F(1,45)=4.95$), and "powerlessness vs. powerfulness" ($F(1,45)=2.91$). These results indicated that moderate amounts of control by mothers and fathers led to more flexible thinking in their sons than did low or high amounts of control.

The relevance of socialization practices to spatial-perceptual abilities of sixth-grade boys in Newfoundland and Labrador was examined by Pauline Jones (1976). Spatial-perceptual abilities were measured by the Embedded Figures Test, the Block Design from the WISC, and the spatial subscale from the Primary Mental Abilities Test. Socialization practices were measured by a questionnaire devised by Witkin based on the interview questions used by Dyk and Witkin (1965). Jones found that mothers who fostered spatial-perceptual abilities were those concerned with independence training and who used consistent, rational, nonindulgent discipline. They did not view the child as delicate nor did they suppress aggression zealously, childrearing was not seen as burdensome to these women, and they seemed satisfied with motherhood.

**Maternal teaching style.** Several studies have chosen to observe discrete behaviors in mothers during a teaching task with their child. By attending to patterns of these discrete behaviors that appear, it is possible to describe a variable referred to as "teaching style."
Steward and Steward (1973) observed six mothers and their three-year-old sons from each of seven ethnic groups in a teaching situation. Each teaching session was videotaped and then divided into units of analysis called "teaching loops." A teaching loop consisted of gaining the child's attention, giving the child an instruction, the child's response, and feedback to the child's response. The coding procedure looked at the content of the teaching loop and where a behavior occurred in the loop sequence. For instance, instructions were coded for original vs. embroidered content, level of information, and amount of specificity, and a child's response was coded as accept, passive, ignore, reject, or demand. Other major variables of interest were total time in teaching-learning interaction, number of teaching loops completed by the mother, and pacing, defined as the ratio of number of teaching loops to the total time.

One-way analyses of variance were conducted on each dependent variable with ethnic group as the independent variable. Cell means were compared at the .05 significance level using Duncan's multiple range tests. In each case, there were significant differences between ethnic groups (p < .05). In other words, Steward and Steward found that ethnicity was a good predictor both of maternal teaching and of the child's response. For instance, Anglo mothers carefully set up the teaching loops, used embroidered instructions and also used informational feed-
back to the child. Chinese mothers used very specific instructions and large amounts of positive feedback. Mexican mothers presented fewest teaching loops, were slow paced, used adult-worded instructions, and gave the largest amount of negative feedback. The authors concluded that mothers in different ethnic groups are creating unique learning environments for their children resulting in differing skills and expectations their children take with them to the classroom.

David Wood conducted a series of three studies (Wood & Middleton, 1975; Wood, Bruner, & Ross, 1976; Wood, Wood, & Middleton, 1978) that examined teaching style of mothers and tutors with children in a problem-solving situation. The first study (Wood, Bruner, & Ross, 1976) involved observing a "tutor" assist a child in a problem-solving task. These observations led Wood (Wood & Middleton, 1975) to hypothesize that effective instruction involves setting goals the child can recognize but not produce, and asking the child to do a bit more than he/she is currently capable. In the second study (Wood & Middleton, 1975), mothers were instructed to help their preschool-aged children complete a pyramid puzzle. Each mother-child pair was videotaped during this session and at its completion, the child was asked to complete the puzzle again alone. The behavior of interest was the mother's level of intervention as the session progressed and how she modified her intervention based on the child's responses. Also of interest was the relationship
between mother's intervention approach and her child's ability to perform the task alone. Wood and Middleton defined a "hypothetical measure" referred to as the "region of sensitivity." A child's region of sensitivity was determined by the instructional level that was just above his/her success boundary. There was a significant correlation ($r = .91$) between the percentage of interventions in the region of sensitivity and the probability that a mother would shift her instructional level contingent on the child's success or failure of response. The authors interpret this finding as evidence that a mother's tendency to intervene at the child's region of sensitivity is not due to knowledge, preference, or style, but to active attempts to adapt her instructional level to the child's level of functioning. Further analyses revealed significant correlations between each measure of mothers' instructional activities and the child's ability to complete the task alone (average correlation = .84). In other words, a mother who attends to her child's performance, who slants her instructions to an optimal level and then shifts that level (lower as the child succeeds and higher while the child fails) according to her child's performance, is most likely to enhance effective performance in her child. Wood and Middleton see the instruction process as a problem-solving endeavor in itself, and point to their study as evidence of the social interactional component to intellectual development.
Wood, Wood, and Middleton (1978) used information gained in the earlier studies and tried to experimentally test predictions concerning the effectiveness of several strategies for teaching three- and four-year-old children to solve a difficult task. Based on previous observations of mothers' behavior, the authors identified four teaching strategies: 1) demonstration: the instructor performs the solution while child observes; 2) verbal: instructor tells child the procedure with no demonstration; 3) swing: nonspecific verbal encouragement is alternated with demonstrations; 4) contingent: the level of intervention is dependent on child's success or failure. It was predicted that the contingent strategy would be most effective and that the demonstration strategy would be least effective. To test this hypothesis, thirty-two preschoolers were placed in one of four experimental groups. Each group was taught to solve the pyramid puzzle by a tutor using one of the four designated teaching strategies. Following instruction, the child was asked to complete the pyramid alone. The hypothesis was partially confirmed in that contingent teaching was significantly more effective in terms of children's post-instruction performance ($F(3,28)=9.206$). However, the demonstration method was not significantly different in effectiveness from the verbal or swing strategies. To Wood et al., this study provided evidence of a causal relationship between maternal teaching behavior and child problem-solving performance and
corroborates the hypothesis that presenting a child with "problems of controlled complexity" characterizes effective instruction.

Hess (1969) and Hess and Shipman (1967) reported that results of a study of 163 black mothers and their preschool children from four different socioeconomic backgrounds. In the study, mothers were interviewed about their activities with their child, daily schedules, each mother-child pair participated in an interaction session in which the mother taught the child three simple tasks. Hess and Shipman (1967) focused on two maternal strategies, control processes and the patterning of stimuli, and their relationship to cognitive process in the child.

Three types of maternal control were identified. The imperative normative approach involves establishing control based on an orientation towards rules, parental status, and the inhibition of any debate or search for a rationale. The subjective orientation bases its appeal for control on the internal states or feelings of the individuals involved. The child's feelings and preferences are taken into account and perspective-taking ability is encouraged. Finally, cognitive-rational appeals take a reasoned approach and emphasize antecedent-consequent relations among events (e.g. if you do this, then that will occur). Alternatives are considered, debate is encouraged as is environmental exploration for the
purposes of maximizing distinctions between possibilities. According to Hess and Shipman (1967), children are oriented toward cues in the environment by these maternal strategies.

Patterns of maternal regulatory behavior and cognitive performance of the child were correlated. Imperative-normative regulation was negatively correlated with Stanford-Binet scores \( r = -0.32 \), use of relational categories \( r = -0.20 \), and number of scorable responses by the child \( r = -0.24 \). Positive correlations were obtained between measures of cognitive-relational orientation in the mother and the child's IQ \( r = 0.18 \), and performance on a block sorting task \( r = 0.30 \) and \( 0.25 \). These results were interpreted as evidence that control style determines how and how often a child is able to consider alternatives of action and thought. Predetermined solutions or restriction of the consideration of alternatives produce modes of thought that are impulsive, present-oriented, and lacking in sequentiality, according to Hess and Shipman, and therefore one might expect the obtained negative correlations between imperative-normative regulation and IQ.

Maternal control of stimuli (or organization of information) was measured during the maternal teaching task. Each mother taught her child two sorting tasks and how to copy designs on an Etch-A-Sketch toy. Conversation during the session was recorded and a simultaneous behavioral description was made from which a typescript was produced. The typescripts were
divided into message units (transmission of a single thought) that were coded as being informing, motivating, orienting, seeking physical vs. verbal feedback, and positive vs. negative reinforcement. In the Etch-A-Sketch task, maternal message units were coded for degree of specificity and precision. Relationships of maternal teaching behavior to child's IQ and task performance were examined. The most important relationship appeared to be a strongly negative one between emphasis on block placement (physical feedback) by the mother and measures of task performance by the child. Amount of specificity and precision in the mother's communications (referred to as cognitive content) was strongly related to the child's task performance and IQ.

Hess (1969) discussed the study referred to above, but includes follow-up data. Later school performance of the children included in the above study (measured by grades and objective test scores) was positively correlated to the effectiveness of maternal teaching style in the previous study (the correlations were not reported). Effective teaching styles were characterized by specific directions and feedback, frequent orienting and elicitation of cooperation, praise, and use of complex, standard English. Middle class mothers, said Hess, were more likely to exhibit these characteristics.

A cross-cultural study was conducted in Guatemala by Rogoff (1977) in order to relate mothers' teaching style to children's
memory performance. Sixty nine-year-old children were given four memory tests involving visual recognition, visual recall, verbal recognition, and verbal recall tasks. Thirty-one of these children were then selected to participate in a teaching task with their mothers based on their memory test performance. Two summary scores for verbal and visual memory were created by summing the recognition and recall score for each. A median-split of the visual and verbal standard scores was computed, and subjects best representing the four combinations of scores (high on each, low on each, or high on one and low on the other) were selected.

Mothers of the selected children were asked to instruct them in building a tinker toy object for which she, but not the children, could see a model. Each instruction was coded by observers as verbal or demonstration. Analysis of variance showed that mothers who provided more verbal instruction had children with better verbal memory scores ($F(3.27)=2.99$). Children with lower verbal memory scores had mothers who used more demonstration ($F(3.27)=6.89$). Mothers' teaching style was not related to scores on the visual memory tests.

Mothers' verbal behavior. Hess and Shipman (1965), followed by other researchers, focused upon the content of maternal speech to children. One purpose of the Hess and Shipman study described above was to detect differences in the verbal behavior between middle and lower class mothers in order to discover
what impact, if any, these differences were having on children's cognition.

In order to obtain samples of verbal behavior from the mothers, protocols from the teaching task and interview as well as from a story-telling task were produced. The mothers' speech was then characterized as adhering either to a restricted or elaborated linguistic code. Restricted code was speech that was limited in range, lacking in details of either concepts or information. Sentences were short, simple, impersonal and easily understood. Elaborated code, on the other hand, referred to speech typified by broader, more complex ideas, precision, specificity, as well as being individualized. In order to objectively classify each mother's speech as either restricted or elaborated, a coding system was developed that indexed such variables as total verbal output, use of abstract words, use of complex syntactic structures, and stimulus utilization. Lower scores for these variables implied the use of restricted linguistic codes.

Lower class mothers had low total verbal output (49 lines) compared to middle class mothers (82 lines). Moreover, lower class mothers obtained lower scores on variables related to quality of language such as adverb range (8.40 compared to 11.14 for middle class mothers), complex verb preference (51 compared to 63.25 for middle class mothers), and abstraction (2.73 compared to 5.6 for middle class mothers). No statistical tests were performed on these data. Hess and Shipman
believe that cognitive styles conducive to problem-solving and reflection are facilitated by the use of an elaborated code.

Brophy (1970) used a sub-sample of the Hess and Shipman (1965) study but did a more detailed analysis of the protocols of the mother's speech while she taught a sorting task to her child. Speech was coded separately according to whether it occurred during orientation to the task, during pre-response instruction, or during post-response feedback. The coding system differentiated between two aspects of communication specificity: 1) verbalization of specific labels: providing a specific label for relevant attributes of the stimuli; and 2) focusing: helping the child attend to relevant attributes or making them more perceptually salient. Scores were based on either frequency of response or points assigned. T-tests were performed to detect significant differences between means for each dependent variable for pairs of the SES groups. While this procedure is subject to collective alpha problems, there were more significant differences between means than expected due solely to chance.

Brophy predicted that type and timing of specificity would vary as a function of socioeconomic status and situational press (task conditions which limited the possible range of parent behavior). His hypothesis was confirmed. He found that middle class mothers obtained the highest degree of informational specificity on all but one variable. Brophy also found
that SES differences were larger in situations where the task allowed mothers greater flexibility in structuring and initiating it. The implication, according to Brophy, was that when a situation limits the range of parent behavior and presents little opportunity for parents to structure or initiate interactions, SES differences will be minimal.

Bee, Van Egeren, Streissguth, Nyman, and Leckie (1969) conducted a study designed to replicate Hess and Shipman. One hundred-fourteen mother-child pairs from lower and middle class backgrounds participated. The children were four- and five-year-olds. Most of the lower class sample was black. They recorded mother's speech to the child during ten unstructured minutes in the waiting room, during a problem-solving interaction task, and during the interview. A lengthy coding system was devised to measure such variables as quantity of speech, syntactic complexity, positive/negative feedback, information, control, etc.

The results of the problem-solving interaction indicated that lower class mothers used more physical intrusion ($t = 4.78$), less positive feedback ($t = 3.18$), more negative feedback ($t = 4.82$), and spent less time on the problem ($t = 2.26$). In the waiting room interaction, lower class mothers used more verbal control ($t = 4.47$), more disapproval ($t = 2.49$), and less information ($t = 2.00$). Middle class mothers gave more general suggestions to their children ($t = 4.50$), more frequently made suggestions in the form of a question ($t = 2.84$),
and more often told their children what they were doing correctly rather than what they were doing wrong ($t = 3.18$). Bee, et al. concluded that their study corroborated the Hess and Shipman (1965) data. It is their belief that the language environment and teaching strategies experienced by lower class children may not provide them with general problem-solving or verbal mediational skills necessary for a systematic approach to problem solutions. Bee, et al. are of the opinion that the mother's performance as a teacher is a powerful variable for predicting cognitive functioning in children.

Olmsted and Jester (1972) also conducted a partial replication of Hess and Shipman (1965). Thirty-nine middle class mothers and 32 lower class mothers and their children (grades K-3) participated. A sorting task identical to one used by Hess and Shipman (1965) was used in a teaching situation between mother and child. Mother and child speech were tape recorded and coded according to a ten-category interaction analysis system. Parallel categories identical in nature were defined for both mother and child speech. Examples of these categories are: praises, accepts, amplifies, closed vs. open questions, responds, etc. Differences in frequency of occurrence of each category as a function of social class (middle and low) were determined by computing $\chi^2$ tests.

There were no differences in maternal speech as a function of the child's age, but there were clear differences as a
function of socioeconomic level. Middle class mothers ($\chi^2_1 = 5.27$) and children ($\chi^2_1 = 5.27$) talked more during the teaching session and showed more variety in their speech ($\chi^2_1 = 14.06$ and $\chi^2_1 = 30.95$ respectively). Also, middle class mothers used more praise ($\chi^2_1 = 8.91$) and fewer closed questions ($\chi^2_1 = 4.07$), they provided a more detailed introduction to the task ($\chi^2_1 = 3.09$), and gave more specific feedback ($\chi^2_1 = 17.13$). Olmsted and Jester contend that the results of their study closely parallel those of Hess and Shipman (1965), Brophy (1970), and Bee, et al. (1969). The difficulty that lower class children may experience in adapting to middle class oriented school systems can be partially explained, according to Olmsted and Jester, by characteristic mother-child interaction.

Feshbach (1973) reported on a group of studies in which she examined reinforcement style in mothers of four-year-old children. In the first study, 109 mother-child pairs were divided into four groups based on social class (middle and lower) and ethnicity (white and black). Mothers were asked to teach their child a complex puzzle while their speech was recorded. Statements were then scored as positive if they used praise, encouragement, or affirmation, and negative if they were criticism, negations, or derogatory comments. In general, Feschbach found that white, middle class mothers used the most positive reinforcement (means = 6.5 sentences) and the least negative reinforcement (mean = 1.4 sentences) with the reverse
being the case for lower class black mothers (mean = 4.8 & 5.4 sentences respectively). The other groups fell in between. No statistical tests of significance were reported. Feshbach suggested that lower class black children are exposed to more stressful learning environments than middle class white children, and hypothesized that learning and cognitive performance may be depressed or disrupted in the context of a negatively reinforcing environment. In order to test that hypothesis against the alternative that reinforcement style is merely a sub-cultural language dialect, Feshbach tried to replicate her study in other cultures.

The replication studies were done in Israel and England (Feshbach, 1973). In each culture she identified two social classes and/or ethnic groups that displayed differential school achievement. In Israel she observed 30 Jews of Western origin (middle class) and 30 of Middle-eastern origin (lower class). The procedure was identical to the American study and again, no statistical tests of significance were reported. Mean frequencies of positive reinforcement were significantly higher for middle class Israeli mothers (mean = 6.7 sentences) than for lower class Israeli mothers (mean = 4.3 sentences). There were no significant differences in use of negative reinforcement with girls between the two groups, but for boys, the lower class mothers used twice as much reinforcement (mean = 4.6 sentences) as middle class mothers (mean = 2.2 sentences).
Therefore, she concluded that, for the most part, the reinforcement environment of the lower class black and Israeli child are comparable while middle class Israelis and Americans share common experiences.

In England, the same procedure was carried out with 50 middle and working class mothers and their four-year-old children (Feshbach, 1973). There were no significant differences in frequency of negative reinforcement between the two groups of mothers. Differences in frequency of positive reinforcement were present for boys only, with middle class mothers obtaining significantly greater scores (mean = 6.1 sentences) than working class mothers (mean = 2.7 sentences). The fact that no ethnic differences existed to exacerbate social class differences may have influenced the pattern of the results. However, Feshbach contends that the overall implications for these data correspond with the data from other groups.

Feshbach makes the point that the ability to identify reinforcement styles that correspond to socioeconomic status cross-culturally lends credence to her hypothesis that reinforcement style is an important dimension for linking socio-ethnic differences in maternal behavior to socioeconomic differences in the cognitive performance of children. She contends, therefore, that there is reasonable evidence that reinforcement style may be one important factor mediating observed socio-ethnic differences in cognitive performance and academic achievement.
Davis and Lange (1973) studied the linguistic communication style of 28 parent-couples and its relation to categorization style in their children (mean age = 53 months). Children's categorization style was assessed by administering Sigel's SCT (Styles of Categorization Test) for preschool children which involved selecting one of three pictures that went with or was like a standard. Twenty choices were made and each time the child was asked to give a reason for the selection. The responses were then coded as descriptive, relational-contextual, or categorical-inferential. Mothers and fathers told a story to their child based on a picture from the Children's Appreception Test, and also taught the child a block sorting task. The interactions were tape recorded, transcribed, and converted to message units (single, meaningful statements or questions). These message units were then coded into the same categories as the children's responses.

Results showed that parents' linguistic style varied as a function of the task. Percent of usage for the descriptive category was higher in block-sorting ($t_{27} = 2.96$ for mothers, $t_{27} = 2.31$ for fathers). For the categorical-inferential category, percent of usage was higher in story-telling ($t_{27} = 7.02$ for mothers, $t_{27} = 4.63$ for fathers). Children's predominant mode of categorizing was descriptive. Considering each parent's score separately, only one correlation was significant and that was mothers' use of categorical-inferential language.
during story-telling and the child's categorical-inferential usage ($r = .67$). When parent scores were averaged, significant correlations emerged between parents' and child's use of description on both the story-telling ($r = .46$) and block-sorting tasks ($r = .41$). Davis and Lange conclude that task-specific characteristics need to be taken into account in the future, and that the combined influence of both parents is more important than one parent in explaining children's categorizing behavior.

**Summary.** Studies of global childrearing variables have found significant correlations between the behavior of mothers and the cognitive development of their children. However, the maternal behavior variables tend to be quite broad, including a variety of behaviors that are difficult to define and measure. Autonomy, for instance, is a variable that incorporates many behaviors and attitudes that go unspecifed. Also, each of these studies has relied heavily on questionnaire for interview data for assessing maternal behavior. The pitfalls of such methods are well-known, particularly for those that require retrospection. Freeberg and Payne (1967) point out that studies dealing with elementary school children and retrospective accounts of childrearing practices by mothers are not only accepting questionable accuracy concerning the childrearing, but are implicitly assuming that a continuity of parent behavior exists from the child's early years forward. The advisability
of this approach is dubious. However, if similar relationships between parent behavior and cognitive development in children can be obtained using more refined methodology, the validity of these studies can be more strongly established.

Studies of maternal teaching style have assumed that children, in spite of being active problem-solvers, at times need intervention by a person who is more skilled, who can direct attention to critical features of the problem, can demonstrate solutions, and who can generally make the task more manageable. Researchers in this area have consistently demonstrated that patterns of maternal teaching exist, and that these patterns can be systematically related to the child's cognitive performance.

Many studies have been able to relate content and pattern of maternal speech to cognitive performance in children. Replications of the Hess and Shipman (1965) study lend strength to the reliability of several of these relationships.

Studies of the relationship between maternal behavior and cognitive development in children have consistently been able to show that the two are connected. There has been a trend toward defining maternal influences beyond the use of vague concepts such as enrichment, and focusing on more specific, more easily operationalized behaviors such as verbal patterns (Freeberg & Payne, 1967). Another improvement in the research has been the decreased usage of global measures of cognitive
functioning in children (e.g. IQ scores) (Stevens, 1972). However, in spite of improved research methods and consistent results, it is not totally clear how variations in mother-child interactions are causally linked to differences in cognitive performance in the child (Streissguth & Bee, 1972).

Some researchers have attempted to address the issue of causal relationships through intervention studies (e.g. Levenstein, 1970; Olmsted, Note 6) in which an experimental group of mothers is trained in a particular behavior and then children of experimental and control mothers are later compared on some aspect of cognitive development. For the most part, such studies have shown that modifications in children's cognitive performance can be obtained by modifying mothers' behavior (Streissguth & Bee, 1972). Intervention studies, then, have served the function of strengthening the hypothesis of causal relationships between mothers' behavior and child's cognitive performance.

Further issues that few, if any, studies have addressed are timing of maternal behavior in relation to impact on the child, and relative importance of different aspects of the mother's behavior to the child (or, delineating behaviors critical for the child's cognitive development). Still, it seems possible to speak with some confidence about demonstrated relationships between mother-child interaction and the child's cognitive development.
Mothers and Metacognitive Development

Brown (1977a) and Cole and Scribner (1977) put forth the hypothesis that age differences in cognitive and metacognitive abilities arise in large part due to differential exposure to the experiences and demands that characterize formal schooling environments. Few efforts have been made at systematically describing the cognitive demands made by school or home so that comparisons could be made. However, two researchers have attempted to characterize the memory demands of the home environment of preschoolers in order to document the presence or absence of requirements for preschoolers to learn mnemonic strategies (Horn, Note 7; Lange, Note 2).

Lange (Note 2) conducted two studies concerned with memorization demands and strategies in the home environment. In one study, 172 parents of three to five-year-old children responded to a survey containing fixed-alternative and open-ended questions. These questions concerned: 1) what information parents encourage, teach, or require their children to remember; 2) what information parents believe should be memorized at school but not at home; 3) how parents implement their memory expectations; and 4) methods parents use to teach memory skills to their children. Eighty-two teachers (41 from grades K-1 and 41 from grades 2-3) also participated in the survey. Results were reported as percentages. No statistical tests of significance were performed.
For each knowledge type listed (names of people and things, rules, explanations, and stories and phrases), parents were asked to tell whether or not they routinely encourage, teach, and/or require their child to memorize instances of the knowledge category, or if memorization for that category should wait until the child is in school. Most parents (65-70%) reported encouraging memory for the majority of knowledge types. Less than 10% of the parents believed memorization should be left to the schools.

Rules for children's everyday behavior was the knowledge category the largest number of parents claimed to have required (40% for mothers, 35% for fathers). Parents tended to make greater distinctions between teaching and requiring memorization of knowledge than second and third-grade teachers did. More than 50% of the parents claimed to frequently use repetition, delayed testing, rewards, and focusing on one memory task at a time in order to facilitate memorization. Lange notes that while advance notice of memory tests and of rewards for successful memory are likely to encourage deliberate remembering in children, few parents reported the use of such techniques (13% for memory tests and 14% for rewards) at home.

In another study (Lange, Note 2; Sullivan & Lange, 1978), Lange used a controlled observation to discover if children learn mnemonic strategies from parents in the home environment. He decided that in order to encourage parents to introduce
their children to the use of deliberate memory strategies, a
direct teaching task must be given them. For this reason, he
gave each parent 20 colored pictures of familiar objects and
asked them to help their child remember the names of them for
a later free-recall task administered by the experimenter.
Thirty-two parent-couples and their three- and four-year-old
children participated in the study. Contrary to his hopes,
Lange found that parents used few novel strategies with chil-
dren. The only frequently used strategy by the parents was
simple naming (39% for mothers and 49% for fathers). Also, no
significant correlations were found between parent's use of
teaching strategies and the child's performance on the free-
recall test. In order to find an explanation for this,
parents' statements were coded to discriminate whether they
required the child to "operate" on the items (e.g. to name,
elaborate, group) and if so, whether the child used these
strategies successfully. Fewer than 25% of parents' strategy-
related communication required the child to operate on the
items him/herself and when they did, only 19% were successful
in actually getting the child to act upon the items. The con-
clusions were that interaction with parents is not an optimal
environment for the acquisition of adult-like memory strategies
in children. Also, even those parents who do make references
to a strategic approach still do not require their children to
make use of the strategies. Lange believes the results of his
inquiry are consistent with the hypothesis that distinctions exist between cognitive and metacognitive demands made on preschoolers at home and older children in school.

A study by Horn (Note 7) used naturalistic observation to describe the memory demands made by mothers on young children during day-to-day home interaction. Ten children (5 girls and 5 boys) at two age levels (30 months and 42 months) were observed in the home with their mothers during four two-hour sessions over a two-week period. Activities and conversations engaged in by the mother-child pairs were recorded and a transcription of each session was completed. Types of questions used by mothers were of interest and were coded according to structure and content. Structure consisted of the form of the question - whether it required retrieval of specific information or verification by a yes/no answer. Content consisted of type of information asked for in the question and was divided into two categories: 1) events (e.g. ongoing, recurring, immediately past or future), and 2) knowledge (e.g. object and person names, object locations, information about numbers and letters). Dependent variables consisted of the percent of total speech falling into each category of structure and content.

One-way analyses of variance were performed on each dependent variable to detect significant differences in behavior as a function of age of the child. The total percent of mothers'
speech involving questions was 23% for two-year-olds and 20.9% for three-year-olds (no significant differences). Emphasis for mothers was on events more than on knowledge (61.5% vs. 38.5% respectively, for two-year-olds; 69.6% vs. 30.4% for three-year-olds). Event questions were more likely to require verification responses while knowledge questions were more likely to involve production responses (no age differences). For both age groups, children were more likely to respond correctly to verification questions than production questions, although three-year-olds were significantly more correct for both types of questions than two-year-olds ($F(1,19)=14.12$). Still, children of each age responded incorrectly to all types of questions (regardless of structure or content) at least 43% of the time (and sometimes 60% of the time). Horn also stated that conversations between mothers and children were predominantly present-oriented and rarely involved use of strategic memory. One might infer from these data that mothers are doing little to encourage deliberate remembering in their children. However, she presented no data supporting this contention. This study does little to support or refute the hypothesis of home vs. school distinctions with respect to cognitive or metacognitive demands. However, in light of the low accuracy of children's responses to their mothers' questions, the data do lead to speculation that the type of cognitive demands made by mothers could be controlled more by the child's ability level.
than any tendency on the mother's part to implement such demands.

James Wertsch conducted a study designed to test his hypothesis that children learn self-regulation through other regulation and primarily by the mother's verbal directives (Hickmann & Wertsch, 1978; Wertsch, Note 3; Wertsch, Hickmann, McLane, & Dowley, Note 4; Wertsch, Note 5, Wertsch, 1979). In his study, eighteen mother-child pairs (six 2-1/2-year-olds, six 3-1/2-year-olds, six 4-1/2-year-olds, and their mothers) were videotaped while the mother was helping her child to make a puzzle in accordance with a model. All utterances made by the mother and child were transcribed and the transcripts were coded from the videotapes for gazing, pointing, and handling of puzzle pieces by mother and child. Three sources of control for guiding the puzzle solution were identified. These three sources were: mother, mother/child, and child. Areas of strategic responsibility were delineated (e.g. check model, piece selection) and the source of control for each area of responsibility for each puzzle piece placement were recorded. Unfortunately, Wertsch chose not to analyze his data quantitatively. Instead, he primarily reported from those transcripts that exemplified what he saw as trends in the data. In addition, he has referred to his analysis as microgenetic since he is observing change during the interval of a single interaction session.
According to Wertsch, mothers in his study began helping their children complete the puzzle by first taking complete responsibility for piece selection and placement as well as using highly explicit directives. However, as the session progressed, mothers took on less responsibility for directing the task while the child took on more, and mothers' directives became less explicit. Wertsch also provided examples of cases where the transition from other- to self-regulation failed to occur due to "limitations in the child's cognitive abilities." These cases appeared to involve primarily the younger children. Still, Wertsch, et al. concluded that the mother-child dyad moved from initial mother control for strategic responsibility to eventual child control.

Summary. To date, Wertsch (1979), Horn (Note 7), and Lange (Note 2) provide all available information concerning the relation between mother's behavior and metacognitive abilities in children. However, each of these studies has its limitations, and even taken together do not provide a complete picture of the metacognitive environment of the preschooler provided by the mother. Lange and Horn each dealt with a limited aspect of metacognition and Horn failed to report some of the most relevant data. Wertsch looked at more general metacognitive skills, but analyzed his data in such a way that no quantitative characterization of it is available. His theory of the social interactional origins of metacognitive skill is
still very much in question, as are postulated home vs. school distinctions in the cognitive and metacognitive environments. There simply are not enough data to make conclusions about either hypothesis. Moreover, Horn and Lange have postulated a limited role for mother in providing a metacognitive environment for preschoolers, while Wertsch postulated an influential role for mothers in that regard. Therefore, while it appears that one can safely assume a systematic relationship between mother's behavior and cognitive performance in children, no such relationships have been documented with respect to the metacognitive environment mothers provide for their preschool children.
Method

The present study is an investigation of the metacognitive environment of preschool children as represented in the verbal directives of mothers during a problem-solving task. The central concern is whether mothers' verbal directives can be characterized as metacognitive and if so, the focus such verbal directives take. Other important concerns are differences in the content of the mothers' verbal directives as a function of age of their children as well as the tendency of mothers to relinquish control for guiding the problem solution over time. Also of interest is improvement in children's success in the problem-solving task as a function of help from their mothers.

In order to address these concerns, a three-part design was chosen. Each child was asked to complete one of three similar puzzles alone, during which several measures of his/her problem-solving performance were made. The child's mother was then asked to help her child complete a second puzzle while verbal communication with her child was tape recorded. Finally, the child completed the third puzzle alone and the problem-solving performance measures were again made. The measures of problem-solving performance included: 1) number of puzzle pieces placed, 2) time to first puzzle piece placement, and 3) ability to verbalize a strategy principle. Transcriptions of the verbal communication of the mothers were made and divided into message units. Each message unit was then
characterized as to its content and form so that the proportion of total message units falling into each category of metacognitive content and form could be specified. A measure of time each mother spent assisting her child also was taken.

Subjects

Forty-four children from age three to five years (mean age = 4.16 years) and their mothers participated in the present study. Forty-two of the mother-child pairs were volunteers recruited from the Child Development Laboratories at Iowa State University. Two Child Development Department staff members and their children also volunteered. Of the forty-four mother-child pairs originally in the study, two were dropped due to prior sibling participation, one was dropped when it was discovered the child was deaf, and two were lost due to mechanical failure. The final sample consisted of 20 girls, 19 boys, and their mothers.

The subjects represented a homogeneous group from predominantly white, middle class, and college educated families. Sixty-four percent of the mothers had college degrees. Generalizability of the results of the present study are limited by the select nature of this sample.

Problem-solving Task

In order to directly measure problem-solving performance in preschool children, it was necessary to provide a task that was difficult, but not impossible for a preschool child to complete unassisted. In the context of the present study, it
also had to be a task difficult enough that adult assistance was a logical necessity. Because of their known difficulty level, a set of form-board puzzles were selected as a task likely to meet these criteria (Doak, 1968; Pease, Note 8). Needless to say, results obtained in the present study are influenced by the nature of the selected task and its difficulty level.

Three difficult peg form-board puzzles served as problem-solving tasks in each stage of the study. A fourth, easy puzzle of similar design was used as a warm-up task. Each puzzle is constructed of $\frac{1}{2}$ inch thick plexiglass measuring 9 x 12 inches. Each base has two rows of peg sets on which six forms are placed. The pegs are constructed of tubular plexiglass $\frac{1}{4}$ inch in diameter and approximately $\frac{3}{4}$ inch high. There are sets of three pegs for each of the six forms.

Four shapes are used for the forms: a circle, triangle, square, and hexagon. The easy puzzle consists of three circles, and three triangles making a total of six forms. The difficult puzzles each consist of a different combination of two out of the four shapes. The shape-pairs selected include: 1) circle and triangle, 2) circle and square, and 3) triangle and hexagon. See Appendix A for a diagram of the format of the puzzles.

The easy puzzle appears identical to difficult puzzle #1. The holes and pegs for the easy puzzle are each placed in the form of an equilateral triangle. All the triangles fit into any set of pegs for triangles in any position and all the circles fit onto any set of pegs for circles in any position.
For the difficult puzzles, however, the pegs and holes are arranged in a slightly different format, i.e. three pegs and matching holes no longer form an equilateral triangle but are slightly askew. Each form fits only on its respective set of pegs and must be turned in a certain direction in order to fit onto the base. In order that the difficult puzzles cannot be solved by rote learning, the order of peg configurations in each row is different. See Appendix A for a diagrammed explanation.

The administration of the problem-solving task involves first removing the puzzle pieces and placing them on a table above the puzzle form-board. A picture of the puzzle is placed to the right front of the child. The child is told to begin the puzzle only after the puzzle pieces and picture are in place. Five minutes are allowed for work on the puzzle. Three measures of problem-solving performance are made. In order to measure amount of trial and error occurring at the beginning of the task, time is recorded for the interval between the beginning of the session and the first puzzle piece placement. The number of puzzle pieces correctly placed at the end of five minutes is recorded. In order to elicit the verbalization of a strategy principle, the child is asked, "What did you do to try to get those pieces on the puzzle?" The responses to this question are recorded.

Megacognitive Content

In order to assess metacognitive content contained in verbal directives, transcripts of verbal communication must be
divided into message units. Message units are defined as single, meaningful statements or questions (Davis & Lange, 1973). Single word utterances are included in this definition. An example of a transcript divided into message units can be seen in Appendix B. The metacognitive content and form of each message unit is then designated.

In designating the form of each message unit, it was assumed that a statement, command, and verification or rhetorical question implies a person is regulating the problem-solving task while open-ended questions requiring production or retrieval of information implies an attempt to encourage self-regulation by the problem-solver. The form of each message unit is determined for the first half and the last half of the total message units. To determine first and last halves of the message units, each transcript is divided by taking the median of the total number of message units. Statements numbered below the median point are designated as the first half; those numbered above the median point are designated as the last half. The proportion of message units phrased as open-ended questions in the first half, and the proportion for the last half are determined by dividing the total open-ended questions of each half by the number of message units in each half.

The categories of metacognitive content were formed by suggestions in the metacognitive literature and through pilot testing. Wertsch (Note 6) enumerated several categories of
metacognitive content of which three applied to the task utilized in the present study. The selected categories were: 1) goal direction; 2) making certain that the child is aware of the perceptual or conceptual facts relevant to the task; and 3) reminding the child where he/she is in the task. A fourth category was added to detect any attempts by the mother to impart a problem-solving strategy. This fourth category was called "verbalization of a strategy principle."

Five mother-child pairs were pilot tested. The message units from resulting transcripts were categorized utilizing the four original categories of metacognitive content. It then became evident that two categories needed refining and one category needed to be added. The final categories of metacognitive content are:

1. Goal direction - Reference to the end-state of the puzzle
2. Making child aware of perceptual or conceptual facts relevant to the task -
   a. References to form, shape, direction, relationships to peg configurations on the board, etc.
   b. Cues concerning location on the board only
3. Verbalization of a strategy principle - Reference to a systematic method for completing the task efficiently
4. Reminder of what stage of the task is being completed -
   a. Initiating a piece placement
   b. Reference to what was just done, what is to be done next, etc.
5. Monitoring success or failure of piece placement - Reference to whether it is worthwhile to continue on a particular, or whether a piece is correctly placed
6. Other - Miscellaneous statements that do not fall into any of the above categories. Full definitions and examples of each category can be found in Appendix C.

Each message unit is placed in a category of metacognitive content or placed in the "other" category. The measure of metacognitive content consists of the proportion of total message units classified as metacognitive and the proportion of total message units falling into each category of metacognitive content.

Procedure

The study was conducted in a Child Development Department research room with a one-way vision mirror. The room was equipped with a child-level table at which the problem-solving task was administered, and a table in the corner on which were placed a tape recorder, puzzles not in use, and other supplies.

Upon arrival, the mother was taken into the observation booth behind the mirror and given a brief orientation concerning her and her child's participation in the study. The mother was first instructed as to the solution of the puzzle by demonstrating that each piece would only fit in one location and in one direction. It was suggested to her that a systematic approach of trying each piece in each direction in each potential location was most likely to be successful and that it might be good to practice with several pieces. She was told
that a picture of the end-state of the puzzle would be visible and to take care that her child did not turn puzzle pieces upside down. Each mother was instructed that she could say or do whatever she would ordinarily to help her child solve the puzzle. Finally, she was reminded that her child would be asked to solve a puzzle alone before and after the mother-child interaction session.

The child was ushered into the research room for administration of the pre-test problem-solving task. All children were randomly assigned to a puzzle order condition (Appendix A) to determine the puzzle to be used during each segment of the testing session. Each child was given the easy puzzle (described earlier) as a warm-up task. When it was completed, the child was presented with a difficult puzzle and told, "Here is a hard puzzle. See if you can make it look like the picture. Your job is to try hard for just five minutes. You may not get any pieces on, but that's okay. The important thing is to try hard." The child was then asked if he/she knew what to do. When an affirmative response was received, the child was told to begin the problem-solving task. While the child worked on the puzzle, the experimenter responded in a neutral manner to all statements or questions from the child. After \( 2\frac{1}{2} \) minutes of working, the child was told he/she was doing fine, and had more time to work. At the end of four minutes, the child was told he/she had one more minute to work. At the end of five
minutes, the child was told that the session was over, that he/she had done a good job, and that his/her mother was going to give some help on a new puzzle.

The mother was then brought into the room and seated next to the child. A lapel microphone was attached to a piece of her clothing close to her mouth. The tape recorder was turned on and a stop watch set as soon as mother and child were ready to begin. The experimenter left the room at this point so the mother-child pair could work alone. Tape recorder and stop watch were stopped by the experimenter when the final puzzle piece was placed or when the mother decided the child could go no further. Time for the mother-child interaction session was recorded.

At the end of the mother-child interaction session, the mother left the room and was replaced by the experimenter. The child was then administered the post-test problem-solving task which was identical to the pre-test task except a different puzzle was used.

When testing was completed, the tapes of each mother-child interaction session were transcribed. Each transcript was then divided into message units. In order to establish the reliability of this unitizing procedure, both the experimenter and a judge independently divided three transcripts into message units. There was 100% agreement between the experimenter and judge as to the number and content of the message units.
The experimenter categorized each message unit according to metacognitive content and form (a score sheet can be seen in Appendix D). A judge was then trained to use the scoring system in order to establish the reliability of the categories.

For training purposes, the experimenter compiled a definition of each category with a corresponding list of examples taken from the pilot transcripts (these can be seen in Appendix C). The judge was asked to read these definitions and examples before training took place. The training session included discussing definitions of each category, scoring transcripts, and discussing discrepancies in ratings between experimenter and judge. Four transcripts were independently rated by the experimenter and judge. Percent agreement between experimenter and judge was calculated. The session was ended when 90% agreement between experimenter and judge was reached.

Following training, the judge independently rated ten randomly chosen transcripts. The average agreement between experimenter and judge for the ten transcripts was 85%.

Data Analysis

The dependent variables consist of: 1) child behaviors: a) time to first puzzle piece placement after start of pre- or post-test; b) total number of puzzle pieces placed; c) verbalization of a strategy principle; 2) mother behaviors: a) percent of total message units falling into a category of metacognitive content and into each category of metacognitive
content; b) percent open-ended questions in the first half and last half of mother-child interaction session; c) time spent with child in the interaction; d) total number of message units. An arcsin square root transformation for proportions was made on all dependent variables measuring metacognitive content and form of mother verbal directives in order to increase homogeneity of variances.

In order to test the hypothesis that metacognitive content in the verbal directives of mothers toward their children does not exceed zero, means were calculated for the proportion of occurrence of each category of metacognitive content and of the total amount of metacognitive content.

To detect changes in children's problem-solving performance as a result of interaction with their mothers a 2 (time: pre- versus post-test) x 3 (puzzle) x 3 (puzzle order) analysis of covariance was performed on each dependent variable involving problem-solving performance. Age of child was the covariate, and puzzle and puzzle order were treated as nuisance variables. Order and age were between subjects variables while time and puzzle were within subjects variables. A multiple regression approach using dummy variables was utilized to compute sums of squares and appropriate error terms. Details concerning this procedure can be seen in Appendix E.

Relationships between age of the child to amount of total metacognitive content as well as to amounts of each category of
metacognitive content were determined by computing Pearson product-moment correlations for each proportion of metacognitive content paired with age.

A paired t-test was computed to test the difference between mean proportion of open-ended questions in the first half versus the last half of the interaction session.

A correlation matrix of all child variables and mother variables was obtained to determine relationships between child problem-solving performance and metacognitive content of mothers' verbal directives. The correlation of sex of child with each dependent variable served as a test for sex differences for each dependent variable.
Results

Major Findings

The purpose of the present study is to describe the metacognitive environment of preschool children as represented in the verbal directives of mothers during a problem-solving task. Differences in metacognitive content as a function of age of the child and decrease over time in maternal control for guiding the puzzle solution are examined. Improvement in children's problem-solving performance as a result of help from their mothers also is examined.

An inspection of the means for proportion of total metacognitive content and for proportion of each category of metacognitive content indicates that mothers' verbal directives can be characterized as metacognitive. These means can be seen in Table 1. The mean proportion for total metacognitive content is .69. The most frequent categories of metacognitive content are: 1) references for form, shape, etc. (.16 of total message units, .23 of total metacognitive content); 2) verbalization of a strategy principle (.16 of total message units, .23 of total metacognitive content); and 3) monitoring success and failure of puzzle piece placement (.14 of total message units, .20 of total metacognitive content). The least frequent category of metacognitive content is "task stage reminder" (.02 of total message units, .02 of total metacognitive content). The means indicate that there is a substantial
Table 1
Means and Standard Deviations for Proportion of Metacognitive Content

<table>
<thead>
<tr>
<th>Category of Metacognitive Content</th>
<th>Proportion of Total Message Units</th>
<th>Proportion of Total Metacognitive Content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>.69 (.97)</td>
</tr>
<tr>
<td>Goal direction</td>
<td>39</td>
<td>.06 (.44)</td>
</tr>
<tr>
<td>References to form, shape, etc.</td>
<td>39</td>
<td>.16 (.79)</td>
</tr>
<tr>
<td>Location cues</td>
<td>39</td>
<td>.08 (.57)</td>
</tr>
<tr>
<td>Verbalization of Strategy principle</td>
<td>39</td>
<td>.16 (.79)</td>
</tr>
<tr>
<td>Puzzle piece initiation</td>
<td>39</td>
<td>.07 (.49)</td>
</tr>
<tr>
<td>Task stage</td>
<td>39</td>
<td>.02 (.19)</td>
</tr>
<tr>
<td>Monitoring success/failure</td>
<td>39</td>
<td>.14 (.74)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Numbers in parentheses indicate the transformed value.

amount of metacognitive content present in mothers' verbal directives to preschool children in a problem-solving task.

The correlational analysis indicates that although there is not a significant relationship between age of the child and total metacognitive content, several significant relations are
present between age of the child and two categories of metacognitive content. Mothers of older children are more likely to verbalize a strategy principle \( r = .40; p < .02 \) and less likely to initiate piece placement \( r = -.44; p < .005 \). Negative correlations for age of the child with mother's use of location cues \( r = -.30; p < .06 \) and use of task stage reminders \( r = -.29; p < .07 \) approach significance. The null hypothesis of no relationship between age of the child and metacognitive content of mothers' verbal directives is rejected.

The results of the paired t-test between proportion of open-ended questions in the first half \( (M = .09, \text{transformed mean} = .50) \) versus the last half \( (M = .07, \text{transformed mean} = .47) \) of the mother-child interaction session show that there are no significant differences. Mean proportions of open-ended questions in each half reveal that they were both low in frequency. The null hypothesis of no differences in proportion of open-ended questions in the first half versus the last half of the interaction session is not rejected.

The analysis of covariance reveals that, when age, puzzle, and puzzle order are controlled, there is improved problem-solving performance by the children on the post-test for number of puzzle pieces placed \( F = 6.7; df = 1,23; p < .05 \) and verbalization of a strategy principle \( F = 8.37; df = 1,27; p < .01 \). No improvement occurred in amount of time children required to place the first puzzle piece between the pre-test
and post-test. Means for problem-solving performance can be seen in Table 2. The null hypothesis that no improvement in children's success in a problem-solving task will occur following interaction with their mothers is rejected.

Ancillary Findings

Significant correlations are found between age of the child and total number of message units ($r = - .63 ; p < .0001$) and between proportion of open-ended questions in the first half of the mother-child interaction session and proportion of total metacognitive content ($r = .45 ; p < .005$).

The total amount of metacognitive content is not related to problem-solving performance in the child for either the pre-test or post-test. However, there are significant relationships between specific categories of metacognitive content and children's problem-solving performance for both the pre-test and the post-test.

Frequency of mother's initiating puzzle piece placement is significantly correlated with number of puzzle pieces placed by the child ($r = -.35 ; p < .03$) and with verbalization of a strategy by the child ($r = -.62 ; p < .0001$) in the pre-test. Mothers' references to form, shape, etc. of puzzle pieces are significantly related to number of puzzle pieces placed by the child ($r = -.41 ; p < .02$) and child's time to first puzzle piece placement ($r = .37 ; p < .03$) in the post-
Table 2

Children's Problem-solving Performance for Pre- and Post-test

<table>
<thead>
<tr>
<th>Performance Measure</th>
<th>Pre-test</th>
<th></th>
<th></th>
<th>Post-test</th>
<th></th>
<th></th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td>N</td>
<td>M</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>Number puzzle pieces</td>
<td>39</td>
<td>1.72</td>
<td>2.11</td>
<td>36</td>
<td>2.66</td>
<td>2.34</td>
<td>6.72*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>df = 1,32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time to first puzzle piece placement</td>
<td>39</td>
<td>184.82</td>
<td>118.15</td>
<td>37</td>
<td>147.78</td>
<td>111.88</td>
<td>.04</td>
</tr>
<tr>
<td>(in seconds)</td>
<td></td>
<td></td>
<td></td>
<td>df = 1,33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbalization of a strategy principle</td>
<td>33</td>
<td>.33</td>
<td>.49</td>
<td>36</td>
<td>.64</td>
<td>.49</td>
<td>8.37**</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>df = 1,27</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p < .05.
** p < .01.

test. Frequency of task initiation by the mother is significantly correlated to number of puzzle pieces placed by the child (r = -.41; p < .02), child's time to first puzzle piece placement (r = .36; p < .03) and verbalization of a strategy principle (r = -.52; p < .001) in the post-test. The correlation between frequency of task stage reminders by the mothers and child's time to first puzzle piece placement in the post-test approaches significance (r = .30; p < .07).
Total number of message units spoken by the mother is significantly correlated to both pre-test and post-test performance scores by the child. However, the correlations are higher for the post-test scores than for the pre-test scores. For instance, the relationship between number of mother's message units and number of puzzle pieces placed by the child in the post-test ($r = -0.53; p < 0.0009$) is stronger than the relationship of the same two variables for the pre-test ($r = -0.36; p < 0.03$). Similarly, number of mother's message units is more highly correlated to child's time to first puzzle piece placement in the post-test ($r = 0.58; p < 0.0002$) than in the pre-test ($r = 0.39; p < 0.02$), and to child's verbalization of a strategy principle in the post-test ($r = -0.52; p < 0.001$) than in the pre-test ($r = -0.42; p < 0.02$).

Data pertaining to verbalization of a strategy principle by the child were obtained on 33 children for the pre-test and on 36 children for the post-test. In the pre-test, eleven children verbalized at least one strategy (five of these children mentioned two strategies). Ten out of these eleven children stated that they looked at the picture of the puzzle to help them. For the post-test, 23 of 36 children mentioned at least one strategy used (ten of these children mentioned two or more strategies). Twenty-one children said they referred to the picture of the puzzle to help them. Turning puzzle pieces around was mentioned eleven times and trying new
locations was mentioned five times.

The correlations of each of 15 dependent variables with the child's sex indicate that only one variable (child's time to first puzzle piece placement) is significantly correlated with sex of the child ($r = .31; p < .06$ for the pre-test score; $r = .34; p < .04$ for the post-test score). One significant correlation out of 15 is chance level occurrence.

The analysis of covariance revealed a significant effect for the covariate (age of child) on each of the children's problem-solving performance measures. Older children placed more puzzle pieces ($F = 10.83; df = 1,33; p < .01$), took less time to place the first piece ($F = 12.6; df = 1,34; p < .01$), and were more likely to verbalize a strategy principle ($F = 24.755; df = 1,32; p < .01$). Children's problem-solving performance did not vary as a function of puzzle order. However, there was a difference in number of puzzle pieces placed as a function of puzzle ($F = 4.89; df = 2,32; p < .05$). Puzzle 2 was the hardest, while puzzle 3 was the easiest.
Discussion

The purpose of the present investigation is to examine the metacognitive content of mothers' verbal directives to preschool children during a problem-solving task. Differences in metacognitive content as a function of age of the child, decrease over time in maternal control for guiding the puzzle solution, and improvement in children's problem-solving performance after help from their mothers are explored.

The present findings support Wertsch's (1979) view that preschool children are exposed to strategic regulation in the verbal directives of their mothers. The substantial presence of several categories of metacognitive content in mothers' communication to children supports this view. These results are in contrast to those of Lange (Note 2) and Horn (Note 7) who have documented a low level of metacognitive demands made of preschool children by their parents. The compatibility of the findings in the present study with those of Wertsch may be partially attributable to a similarity in task setting. Each study involves mothers, preschoolers, and a puzzle. Lange's study (Note 2), on the other hand, involved a rote memorization task, one with little ecological validity and highly dissimilar to a puzzle task. The Horn study (Note 7) was a naturalistic observation in which the probability of observing a task requiring strategic intervention was low compared to the studies of Lange (Note 2), Wertsch (1979), and the present
investigation. Taken together, these data may reveal that when a task with some ecological validity occurs requiring strategic intervention, parents can and will involve themselves in regulating their child's problem-solving behavior. The use of naturalistic observation to detect metacognitive demands by parents may be a weak approach since time and the heterogeneity of home activities may dilute observed frequencies of such behavior.

The dilution of observed frequency of strategic regulation by parents also may be important when comparing home versus school environments relative to metacognitive demands. Certainly it is difficult to compare the impact of the relatively homogeneous school environment for five hours each day with the impact of the more enduring, heterogeneous home environment. The present study and Wertsch's (1979) study may indicate that when the research setting is task-oriented (as school is) and parents are familiar with the task (as teachers generally are with theirs), preschool children are exposed to metacognitive demands by their parents. Therefore, Brown (1977a) and Lange (Note 2) may be premature in suggesting that the metacognitive environments of the home for preschoolers and school for older children (all things being equal) are distinct.

The relationship between age of the child and metacognitive content of mothers' verbal directives does not present clear-cut trends. The results differ depending upon whether
or not the variable of interest is total amount of metacognitive content, or amount of a particular category of metacognitive content. Proportion of total metacognitive content does not correlate significantly with age of child while total number of message units does (negatively). One might infer that over-all, mothers of younger children are using more task-irrelevant statements. The increased frequency of task-irrelevant statements with younger children may reflect the presence of what Wertsch (1979) calls first-level interaction. First-level interaction is in operation when a child has such limited understanding of the task situation that communication between adult and child is difficult. In the context of the present study, the younger children's limited understanding of the task may have increased their off-task behavior which, in turn, is reflected in the mother's speech. The older children, on the other hand, may understand the task sufficiently that their attention is focused solely on the puzzle and consequently mothers' speech also is narrowed to task-specific statements for the most part.

Maternal use of several categories of metacognitive content is significantly related to age of child. The negative correlation between age of child and mother's tendency to initiate puzzle piece placement may reflect an increased need for mothers of younger children to promote task involvement in their children. If first-level interaction is taking place
with the younger children, it is understandable that the mothers involved would need to frequently initiate piece placement since the younger children are more likely to be involved in off-task behavior. Mothers of older children are more likely to verbalize a strategy principle. This type of verbal directive is at a more complex level of regulation than other types of metacognitive content (puzzle piece placement, for instance) and therefore is logically used more frequently with older children who more fully grasp the demands of the task situation.

No differences occurred in proportion of open-ended questions in the first half versus the last half of the mother-child interaction session. In fact, open-ended questions were not used frequently at any time. If open-ended questions represent attempts by mothers to encourage self-regulation in children then these results indicate that mothers are maintaining control over the puzzle solution during the entire mother-child interaction session. A significant correlation between proportion of open-ended questions in only the first half of the mother-child interaction session with proportion of total metacognitive content may indirectly reflect a tendency to use open-ended questions slightly more when first helping the child, but subsequently abandoning that approach when it fails to succeed. Nevertheless, the present study fails to corroborate Wertsch's (1979) evidence that mothers
tend to turn over regulation of problem-solving to the child as time progresses. The difficulty of the problem-solving task may control how successful the mother is at encouraging self-regulation in the child through the use of open-ended questions.

The improvement in children's problem-solving performance for two out of three measures (number of puzzle pieces placed and verbalization of a strategy principle) on the post-test compared to the pre-test suggests that other-regulation by mothers may improve self-regulation in children. The evidence is strengthened by the correlational analysis. While proportion of metacognitive content for mothers and problem-solving performance for children show significant relationships for both the pre-test and post-test scores, these relationships tend to be both more frequent and stronger for post-test scores. For instance, there are two significant correlations between proportion of total metacognitive content and pre-test performance while there are five significant correlations for the post-test performance and a sixth that approaches significance. Out of 21 possible correlations, neither a total of two or of five significant correlations provides overwhelming evidence. Still, the trend suggests that interaction with their mothers improved children's problem-solving performance. Additional support is provided by the relative size of the correlations between total number of message units with pre-test scores.
versus post-test scores. The average absolute value of the correlations between total number of message units and pre-test scores is .39; for post-test scores the average absolute value is .54. Each is a statistically significant relationship, yet it is much stronger for the post-test scores. These results lend credence to the theory that other-regulation leads the way to self-regulation (Wertsch, 1979).

Results relating to actual strategies verbalized by the children are congruent with other data dealing with metacognitive awareness in young children. The children in the present study most frequently stated that they used the picture of the puzzle to help them place the puzzle pieces. This is consistent with evidence that young children frequently rely on sources external to their own mental processes to regulate cognitive activities (Kreutzer, Leonard, & Flavell, 1975; Wellman, Ritter, & Flavell, 1975).

**Implications**

The present study shows that a considerable amount of metacognitive content is present in the verbal directives of mothers to preschoolers in a problem-solving situation. The presence of metacognitive content is direct evidence that mothers do attempt to regulate the problem-solving behavior of their children. There is also moderate support to show that mothers alter how they regulate their child's problem-solving
depending on the child's age. While the total amount of maternal regulation does not differ as a function of age of the child, mothers are more likely to use a more complex form of regulation (verbalization of a strategy principle) with older children and a simpler form focused on initiating piece placement with younger children.

The present results indicate that mothers do not tend to relinquish control for the puzzle solution over time. On the contrary, it appears that mothers maintain control throughout, and some evidence exists to show that attempts by mothers to turn over control during the first half of the mother-child interaction session are abandoned in the last half.

Finally, the present investigation suggests that help by their mothers improved children's problem-solving performance.

Since mothers do regulate their children's problem-solving, and since children's problem-solving performance seems to improve as a result, there are strong suggestions that self-regulation does originate in other-regulation. In other words, a social-interactional component to the acquisition of self-regulation in children is implied. In addition, hypothesized discrepancies between the metacognitive demands of the home for preschoolers versus school for older children may be inaccurate. When task setting is controlled, there may be few differences between the metacognitive environment of the home and school.
Implications for Future Research

The present study was designed to investigate the metacognitive content of mothers' speech to their children in a problem-solving setting and to determine whether this form of other-regulation by the mother would facilitate later self-regulation by the child as reflected in problem-solving performance. The high amount of metacognitive content in maternal speech and its seeming positive impact on the problem-solving performance in children provide many questions for future research.

A clear-cut delineation of the relationship that age of the child and task difficulty have with amount and type of metacognitive content used by mothers would be desirable. It is possible that there would be a greater tendency for mothers to relinquish control of the puzzle solution with an easier task. Since task difficulty and age of the child are related, it is sensible to manipulate both variables simultaneously.

Another interesting variation would be to determine difficulty level between and within categories of metacognitive content. It may be that frequency of maternal use of a particular category does not alter for children of different ages, but the difficulty level of the statements may change.

The present study should be replicated using fathers as the adults in place of mothers. In this way, comparisons could be made between parents, and a fuller characterization
of the metacognitive environment of preschool children could be made.

Helpful additions to the present study would be videotaped records of the mother-child interaction session. Videotapes would make it possible to include details of nonverbal behavior in the transcripts and make interpretations of the mothers' statements clearer. Also, inclusion of the child's conversation would allow further analyses concerning the immediate impact of the mother's statements on the child's performance. Such detailed analyses would make causal inferences between mothers' statements and children's problem-solving performance easier.

In order to directly compare home and school with respect to their metacognitive environments, task setting and time must be controlled. However, another valuable comparison between home and school is the "density" of metacognitive demands for each. It may be that there are equal amounts of metacognitive demands made verbally by mothers and teachers, but that teachers' demands are more concentrated since they have fewer hours with the children. The home versus school distinctions may lie in the density aspect rather than in frequency of metacognitive demands.

Limitations of the Study

The sample of mothers participating in the present study is certainly not representative of the general population.
Therefore, the generalizability of these results is limited to the population of white, middle class, highly educated mothers and their children.

A control group of children who completed each of the three puzzles alone with no mother-child interaction component was not obtained. Therefore, it is possible to infer that improvement in problem-solving performance by the children was due to practice effect rather than to help they received from their mothers. However, there are indications in the data that this is not totally the case. Also, while each puzzle the child completes requires a similar approach, it does require a different solution. Therefore, a control group, while not essential, might be desirable in order to make clear inferences from the data.
Summary

The present study was designed to describe the metacognitive environment of preschool children as represented in the verbal directives of mothers during a problem-solving task. Differences in metacognitive content as a function of age of the child, decrease over time in maternal control for guiding the problem solution, and improvement in children's problem-solving performance following help from their mothers were examined. Subjects included 39 3-, 4-, and 5-year-olds with their mothers. Each child was asked to complete one of three equivalent puzzles alone, and three measures of his/her problem-solving performance were made. The problem-solving performance dependent measures consisted of: 1) number of puzzle pieces placed, 2) time to first puzzle piece placement, and 3) verbalization of a strategy principle. Each mother was then asked to help her child complete a second puzzle while her verbal communication was tape recorded. Finally, the child completed the third puzzle alone and the three problem-solving performance measures were again made. Transcriptions of the verbal communication of the mother were made, divided into message units, and categorized according to metacognitive content and form. Dependent variables for mother behavior consisted of proportion of total number of message units in each category of metacognitive content and form. Means were calculated for proportion of each category of metacognitive content. A paired
A t-test was computed to detect differences in proportion of open-ended questions in the first half versus the last half of the mother-child interaction session. To detect changes in children's problem-solving performance following interaction with their mothers, a 2 (pre- versus post-test) x 3 (puzzle) x 3 (puzzle order) analysis of covariance was performed. Age of child was the covariate and puzzle and puzzle order were treated as nuisance variables. Pearson product-moment correlations were computed for age of the child, the three problem-solving performance measures, and the measures of metacognitive content and form. Results indicated that: 1) a considerable amount of metacognitive content is present in the verbal directives of mothers to preschoolers in a problem-solving situation, 2) mothers alter their verbal directives somewhat, according to the age of their child, 3) mothers do not relinquish control for guiding the puzzle solution to the child, and 4) children's problem-solving performance improved after receiving help from their mothers.

Results were interpreted as evidence of a social interactional component to the origins of self-regulation in children. In addition, questions were raised about hypothesized discrepancies in the metacognitive demands of home versus school in light of the large amount of metacognitive content present in mothers' verbal directives.

Implications for future research were presented, and limitations to the present study were cited.
Reference Notes


References


Moely, Barbara, Olson, Frances, Halwes, Terry, & Flavell, John. Production deficiency in young children's clustered recall. Developmental Psychology, 1969, 1, 26-34.


Appendix A: Diagrams of Puzzles and Puzzle Order Conditions
Puzzles*

Puzzle #1

Puzzle #2

Puzzle #3

*Number inside geometric shapes indicates placement of peg configurations

Puzzle Order Conditions

<table>
<thead>
<tr>
<th>Order:</th>
<th>Puzzle Number:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1  2  3  3</td>
</tr>
<tr>
<td>2</td>
<td>2  3  1  1</td>
</tr>
<tr>
<td>3</td>
<td>3  1  2  2</td>
</tr>
</tbody>
</table>
Appendix B:  Example of Transcript Divided into Message Units
O.K. let's see if we can do a good job this time. I will help you.

That's right, this one goes over here. Yea, and try to get it on the holes. Let's see maybe it goes over there maybe it doesn't I don't know. There's some holes, good. Good. O.K. It says it does, alright. Let's try it, oh, it doesn't fit that way. O.K. tell you what, will turn it around. Um, doesn't go there. How about down here? Susan moved them around?

Let's see if that hole can fit on there. O.K. Ah, alright let me turn it this way. Can you do it? O.K. You do it. No. Got to turn it around. Oh, wrong holes. I'll bet there, no. Fooled me. Think it goes up here then. Cause see there's one in this corner here. Maybe that's where it goes. Wouldn't be nice if we could get one? Oh hard work.

O.K. Let's see. Nope, boy I tell you these are hard puzzles aren't they? O.K. let's try this one again here. Ah I got it. Now where's the triangle go? One go there, one go there, and one goes there. Think so? Bet that's right. Uh-huh. O.K. keep trying you just have to keep turning it around. There's a hole. But you have two more now to get it on. You can? Well let's leave that one there maybe we can do another circle. Maybe there's a circle that goes there. Try that one. No that's kind of stuck isn't it? Uh that's not on all the way. No that's not on. Oh you can? Ha. That's the way you did the very very hard puzzle isn't it? But you know what? The problem is now we have all these things left, what you we going to do with those?

Huh? No. It doesn't look like that does it? It certainly doesn't look like that. O.K. now that you did those, let's see if we can arrange it to look like that picture. Remember that picture there?
Appendix C: Definitions and Examples of Categories of Metacognitive Content
MAKING CHILD AWARE OF PERCEPTUAL OR CONCEPTUAL FACTS RELEVANT TO THE TASK: B. Cues concerning location on the board only using nonspecific referents (here, there, where).

Examples:

Try it once more, it could have worked there.
*Where does this square go?
Let's try that in the other corner.
Maybe it will work down here.
We'll try it there now.
Let's see if that one will fit right there.
Let's try to get this one over here.
Let's try the other corner.
Now - you want to try here.
Can you try here?
Try it up here.
You know, I think it might work up here.
Shall we try it up here in this corner?
You want to try to put this one on here?
Let's start off here.
Let's try another one over there.
Can you try it way over on the other end?
Okay, why don't we try the square down there now.
Can you try that one right there?
It's got to go there.
One goes there, one goes there, and one goes there.
It must go in one spot.
May on that one.

*Open-ended
REMINDER OF WHAT STAGE OF TASK IS BEING COMPLETED: B. Reference to what was just done, what is to be done next, etc.

Examples:

Can we keep going?
Next we need to . . . . . . . .
*What piece do we need next?
After . . . . . . . then we need to . . . . . . . .
What do we need to do after this?
Now there's only two places left.
There's two triangles left.
Now one more triangle left.
We've only got one circle left.
We've got one more circle to try it one.
*What do we have left?
It all you got left.
*Now what does that leave you?
So that should fit there since that's the only one left.
It has to fit one of them because there are only two left.

*Open-ended
GOAL DIRECTION: These statements make reference to the end-state of the puzzle, or try to remind the child of that end-state primarily by referring to the picture that depicts the end state.

Examples:

Let's look at this picture cause this picture will tell us how to do it or help us tell us how to do it.

Look up here at this picture.
You see what's up in the corner? (when connected to picture refs.)
Let's look at the picture.
You want to take a look at the picture to see where that might go cause there's only one place left for a square.
How are we going to know where the circles go and where the squares go?

*How are you going to know where they go?
Can you look up here at the picture?
That's the only way you know where a square goes or where a circle goes.
That's why she gave you the picture.
Look it - is that a square there?
You're not looking at the picture.
Look at the picture - we have a square there and a square in this corner.

Doesn't fit there so let's try it over here cause in our picture the circle goes over here too.

One think that I think is going to help us is if we look at this picture.

Look at the picture.

See the picture?

See - this little one over here is like this little one over here. (refers to picture)
Now look here and see what shape goes in the corner.
Is that the way it goes in the picture?

*What can tell you which shape goes there?
When the puzzle is done, it should look like that.
The picture will tell you where to put the pieces.
Does that look like that?

*Open-ended
VERBALIZATION OF A STRATEGY PRINCIPLE: Reference to a systematic method for completing the task efficiently. Includes turning puzzle pieces, doing one piece at a time, trying another location after one place doesn't work, and cuing child into previously verbalized strategies.

Examples:

Alright, let's turn it a little bit.
Try it again. (when following the previous sentence)
Turn it one more time.
Just keep turning it until you find it in the right place.
Let's turn to watch.
Let's just turn it real slow.
Let's turn it one more time.
No, let's turn it again.
If it doesn't fit the first time, like that, then you turn it and see if you can match it up and turn it again.
And it doesn't fit there so let's try it over here in this square.
Well, now you have to try all three places...
Let's just try one at a time.
Try that one and turn it all three ways.
Nope - so turn it.
Pick it up and turn it.
Why don't you turn it one more time?
Turn, turn, okay, keep turning.
Move it around the little pegs.
Okay - now you keep turning and see if it will fit on the three little pegs.
Turn. Rotate that piece so that you can make sure you've tried every direction.
You want to turn it some more?
Can we turn it?
You want to try turning some of these around on some of the pegs like I am?
You keep turning that one around to see if it will fit.
You will have to turn this one.
Keep turning it around.
If it doesn't work one way, turn it just a tad.
If it doesn't work one way, turn it to the next hole and see if it works that way.
Now it doesn't work that way, try it the next way.
Try it all three ways.
No - turn it one more.
That's good to turn it like that.
Turn it.
Try every direction of each shape; then turn it over and try again.
Finish one piece before you try another one.
Try both sides of each piece before you go on to another one.
When your piece doesn't fit on one place after you've tried every way, then go on to another place.
MONITORING SUCCESS AND FAILURE OF PIECE PLACEMENT: References to whether or not a piece has been successfully placed or to whether it's worthwhile to continue. (Does not take precedent to other categories when they are combined)

Examples:

It didn't work, did it?
Instead of keeping working on that one, let's try another circle.
Getting close.
I think we've tried hard enough on that one.
You got it quite right.
No, it doesn't fit.
Almost.
*Does it fit?
Does it fit that - no.
Doesn't fit that way.
No - that one doesn't work.
Okay, so it doesn't seem to want to go there.
Oh, you know I guess it doesn't fit there.
It just didn't work on that one does it?
Well. Let's see, a circle won't go there.
Let's try it someplace else.
I think you're done.
You've got three squares on.
You got it!
Try again on a different triangle.
That way - not like that (piece placement)
Shall we try another one?
You've almost got it.
There you go, you have all three squares on right.

*Open-ended
MAKING CHILD AWARE OF PERCEPTUAL OR CONCEPTUAL FACTS RELEVANT TO THE TASK: A. References to form, shape, direction, relationships to peg configurations on the board, relationships between form, shape, and direction, etc.

Examples:

Let's not turn them over.
Let's keep them up that way.
Now we have to pick up - we have to put it on - we have to fill all the holes at one time.
Instead of the circle, let's try a triangle.
Is it upside down?
So we need a triangle right here.
Circle goes here.
*What shape is that?
That a circle?
We have to turn it over.
Now you keep turning it around until the little pegs have to line up with the hole.
Just move it just real slow and it kind of pops - pop.
See if the pegs go in the hole.
Straighten her up.
Had it upside down.
Now does it have to fit only in certain places, right?
You got to make sure all three holes are over all three pegs.
It's got to be clear over on those pegs.
See, there's another square that goes over in this corner, let's try it on these three pegs.
It goes down in the middle on the bottom.
Right here on these three pegs.
I think you turned it two times.
*Let's see - is there another place for a square?
Is there another place for a circle?

*Open-ended.
That hole will not fit over that peg.
Is your triangle going in the right direction?
*Should a square or a circle go in that place?
Are those the right holes for those pegs?
Put the hexagon where the triangle is.
Try a triangle on the pegs.
See if it goes that way.
Try that hole.
Push this one a little bit that way.
There's one more way to go.
Try it this way.
*What other pieces do we have?
In the middle.
That hole will not fit over that peg.
REMINDER OF WHAT STAGE OF TASK IS BEING COMPLETED:  A. Initiating a piece placement.

Examples:
You have to give these a try.
Let's try this one just like you did the other one.
You want to try that?
Okay, grab a circle.
Come on, choose a piece.
Let's try that one, yeah.
Let's try a triangle.
Try it.
You want to try again?
Shall we try this piece?
Yes, well let's give it a try.
Let's see, shall we try some more of these?
You want to work on that one?
Gee, let's work on these guys.
Now you try it.
You want to work on that one?
Do you want to put it on?
Now you want to try to put that on?
Now let's work on this one.
Why don't you try it?
Okay, now you try to put that one on.
Let's don't play with puzzle pieces, let's try to get them in.
Well, you want to try the other square?
Now let's try a circle.
Let's try that.
Let's try that one - a square.
Try it one more time.
Well, you have to pick it up and try it.
Would you want to try and get this triangle in place?
You want to start with circles or triangles?
Try it again on the pegs.
See if that goes on.
THESE ITEMS GO IN THE 'OTHER' CATEGORY

***Monitoring physical or motor actions - these are statements that refer to physical handling of the puzzle pieces only rather than solutions to the puzzle.

Examples:
Okay, lift.
Well, no, let's take it off.
Lift it up.
Do it kind of slow.
Push, push, push.
Give it a little push.
Pick it up.
That's stuck, isn't it?

***Motivational statements - these are statements that don't directly refer to the puzzle solution, but to the child's involvement in the solution or attention to the puzzle.

Examples:
Let's try.
Let's not give up.
Look at this.

***Additional examples:
One of them's got to fit.
It has to fit someplace - it was on there when we started.
Must fit something.
Right.
There.
No.
Yes.
Or.
All right.
Appendix D: Score Sheet for Metacognitive Content
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Appendix E: Dummy Variables for Regression Analysis and the Analysis of Variance
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Regress:

- Y on age, X1, X2
- Y on X1-X37 (total)
- Y on X1-X4,X6-X37 (drop time)
- Y on X1,X2,X5-X37 (drop puzzle)
- Y on X3-X37 (drop order)
- Y on X1-X5 (drop child)

Error term for between subjects variables (order, age) =

\[ \text{subj/age & order} \]

\[ SS_{\text{subj/age & order}} = SS_{\text{subj}} - SS_{Y\cdot\text{age}} \]

\[ SS_{\text{subj}} = SS_{Y\cdot\text{total}} - SS_{Y\cdot X1-X5} \]

Error term for within subjects variables (time, puzzle) =

\[ SS_{\text{resid}(\text{total})} \]
### Analysis of Variance

**Dependent variable: Number of puzzle pieces placed**

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**Dependent variable: Time to first puzzle piece placement**

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**Dependent variable: Verbalization of a strategy principle**

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** *p < .01.