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The Adult-Child Dyad as a Problem-solving System

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WERTSCH, JAMES V.; MCNAMEE, GILLIAN DOWLEY; MCLANE, JOAN B.; and BUDWIG, NANCY A. *The Adult-Child Dyad as a Problem-solving System*. CHILD DEVELOPMENT, 1980, 51, 1215-1221. This study investigates the way that mothers and their preschool children divided up the strategic responsibilities for carrying out a problem-solving task which involves making a puzzle in accordance with a model. The interaction of 18 mother-child dyads was videotaped and analyzed for verbal and nonverbal devices used by the adult to regulate the child's behavior. The child's eye gaze to the model was used as a measure of how well he or she was following an effective strategy. It was found that with an increase in age there was a decrease in the proportion of these eye gazes that were regulated by the adult and thus an increase in self-regulated strategic behavior. In addition, it was found that when an older child looked at the model, he or she was likely to carry out the subsequent steps necessary to select a piece and insert it correctly and independently in the copy puzzle, whereas younger children were likely to need additional adult assistance after an eye gaze to the model. This is interpreted as suggesting that older children differed from younger ones in their understanding of the strategic significance of gaze behaviors and that the adults' communicative moves were fulfilling different functions for children at different ages. It is argued that an analysis of how adult-child dyads carry out tasks requiring strategic skills can result in a better understanding of the origins and development of these skills in independently functioning cognitive agents.

In recent years there has been a growing concern in the field of cognitive development with the issues of metacognition and strategic behavior. Investigators such as Flavell (1976, Note 1) and Brown (1978a, 1978b) have argued that the issues of how children develop the abilities to plan, regulate, and reflect on their own activity are of central concern in understanding the ontogenesis of cognitive functions such as memory and problem solving. Most of the research in this area has been concerned with how children perform at various developmental levels when confronted with a task situation which requires them to function as an independent agent. In this paper we will be concerned with how strategic problem-solving activities are carried out by children in

collaboration with adults. That is, rather than focus on the problem-solving activities of the child acting as an individual, we will be concerned with how these activities are undertaken in a type of social system which plays a very important role in the young child's life: the adult-child dyad.

The most important reason for analyzing how the young child carries out tasks by participating in a social group (in our case, the adult-child dyad) is that a better understanding of the social processes in this group may provide the key to understanding how the child will later function as an independent cognitive agent. Such an approach to understanding how individuals' cognitive abilities re-

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flect earlier social interaction was proposed several decades ago by Vygotsky. He argued that "any function in the child's cultural development appears twice, on two planes. First, it appears on the social plane and then on the psychological plane. First it appears between people as an interpsychological category and then within the child as an intrapsychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts and the development of volition" (in press). In this quote and elsewhere, Vygotsky was not simply proposing that children learn as a result of having been taught by adults. Rather, he was arguing that some of the very same distinctions that we may wish to make in analyzing social groups can be used in analyzing the functioning of an individual acting as an independent cognitive agent. He was arguing that the way an activity is divided up among participants in a group problem-solving situation constrains the way it can be carried out at a later stage in ontogenesis or in cultural history by the individual.

In this paper, we will argue that this is the case with the "intrapsychological category" of strategic problem solving. We will argue that before the child is able to function as an independent (i.e., self-regulated) problem solver, the adult in the adult-child dyad functions to plan, regulate, and reflect on the problem-solving task at hand. Instead of having a single individual who is responsible for planning and monitoring the strategies for reaching a goal and for carrying out the behaviors involved, these responsibilities are divided up between two individuals who function in an integrated social system.

If the mature problem solver, acting as an individual, carries out a task through self-regulation, the strategic responsibilities in the adult-child social system are distributed such that the young child carries out the behaviors necessary to complete a task through what we will call "other-regulation." In cases where other-regulation is involved, many of the child's overt behaviors may be identical with those carried out through self-regulation, but the adult will have taken over the strategic responsibility for directing these behaviors. The problem-solving task we will consider here involves constructing an object in accordance with a model. Specifically, we used a puzzle-making task in which the final product was to be identical with a model provided to the subjects.

Method

Subjects.—Eighteen mother-child dyads participated in the study. The dyads were divided into three groups of six dyads each on the basis of the child's age. The mean age of the children in the first group was 2-9 (ranging from 2-7 to 2-11), in the second group it was 3-7 (ranging from 3-6 to 3-9), and in the third group it was 4-5 (ranging from 4-5 to 4-7). We will refer to these groups as the 2½-, 3½-, and 4½-year-old groups, respectively. Three male and three female children were included in each of the age groups. All the children came from middle-class families and were attending a Montessori preschool in a suburb of a large midwestern city. They were randomly selected from students in this preschool who were from intact families and who were within 5 months of 2½, 3½, or 4½ years of age.

Each mother was asked to participate with her child in a study of "mother-child interaction." It was explained to the mothers that the purpose of the study was to explore ways in which young children learn in everyday interaction with their mothers.

Materials.—The problem-solving task in this study required the dyad to make a puzzle in accordance with a model puzzle which depicted a truck (see fig. 1). The pieces making up the puzzle fall into two categories. First, there were pieces which could fit into only one space in the puzzle. These were the "non-cargo" truck pieces (pieces 9-14) which depicted parts of the truck such as the windows, headlight, and truck body. The subjects received the exact number of noncargo pieces needed to complete this section of the puzzle. Since there was only one piece for every non-cargo place in the puzzle, it was not necessary to consult the model in order to insert these pieces correctly. The second group of pieces (pieces 1-6) were all one size and could fit into more than one place in the puzzle. These square pieces made up the "cargo" section of the puzzle. Each dyad received enough cargo squares to complete the puzzle correctly plus several extra ones (two red and two green squares as well as a duplicate of each cargo square that was supposed to be used). The correct decision as to which squares were to be used in the copy and where they were to be inserted could only be made by consulting the model.

Procedure.—The study took place in an empty classroom at the Montessori school which the children attended. Two female re-

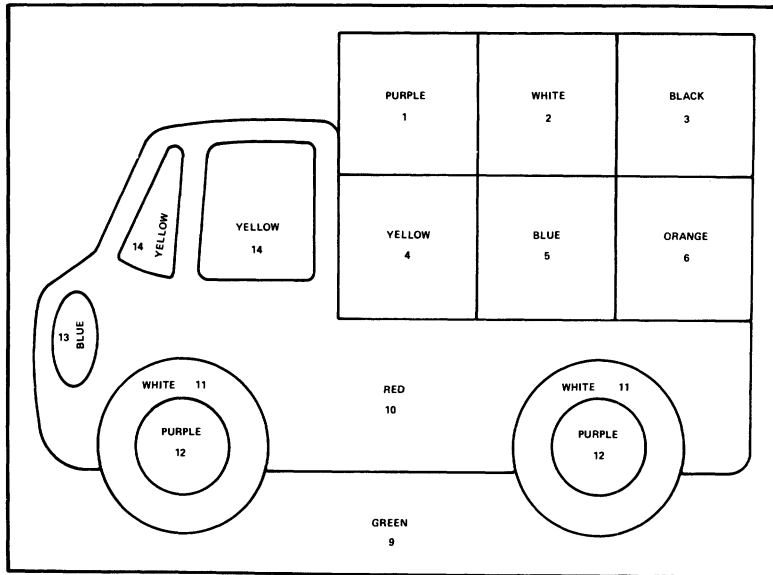


FIG. 1.—Truck puzzle

search assistants served as experimenters throughout the study. The observation sessions lasted an average of 20 min and were videotaped in their entirety.

At the beginning of each session the dyad was asked to make a simple puzzle involving geometric shapes in accordance with a model. This puzzle included a yellow triangle, circle, and diamond which were to be inserted into a blue background. The child and the mother sat side by side on the floor. The model was placed in front of the mother, the copy was placed in front of the child, and the pieces to be inserted into the copy puzzle frame were placed off to the child's side. The set of pieces given to the child included three yellow geometric shapes to be used in the copy as well as pieces of other colors and shapes. Thus the task involved using the model to select the correct items from the pile of pieces and to insert them correctly in the copy puzzle. The task began when the experimenter placed the model puzzle in front of the mother and the completed copy in front of the child. The experimenter pointed out to them that the two puzzles were exactly the same. She then explained that she was going to take the copy apart and put the pieces, as well as other pieces, off to one side. The experimenter told the mother that we wanted her to help her child whenever she thought he or she needed assistance. The child remained at the mother's side throughout the session and could therefore hear all of these instructions. Most children

found this warm-up puzzle task quite easy. All of the 3½- and 4½-year-olds as well as three of the 2½-year-olds completed it correctly. The main purpose of the task was to acquaint the mother and child with the procedure of making a puzzle in accordance with a model.

After the mother and child had completed this warm-up task, or the mother had decided that the child had "had enough," the experimenter presented the truck puzzle materials as follows. She placed the model puzzle in front of the mother and the completed copy puzzle in front of the child. After the mother and child had seen these puzzles, the experimenter dismantled the copy puzzle and placed all the pieces, as well as the extra cargo squares, off to the side near the child. The model puzzle was left in front of the mother. Both she and the child could consult it while making the copy. The instructions for this task were given to the mother while the child was sitting beside her. They were as follows: "Here we have two more puzzles. As you can see, the two trucks are exactly alike. Now I will take this truck apart and give you some extra pieces. We would like [child's name] to make this puzzle [pointing to the copy] look exactly like the model, with all the same colors in the same places in the cargo area. We want you to help [child's name] whenever you feel he [or she] needs it."

If the dyad was successful in completing the truck puzzle task, the mother and child

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kept the model puzzle and were presented with another identical copy truck puzzle. This time the experimenter removed only the six cargo pieces from the copy and placed them in a pile with the extra cargo squares. The instructions for this task were: "Now here we have another truck puzzle. As you can see, the truck body is all filled in exactly like the model. We want [child's name] to fill in only the cargo area so that it looks exactly like the model. Again, you can help if you think he [or she] needs it."

Coding.—All utterances by the experimenter, mother, and child were transcribed. Information from the videotapes was then added to the transcriptions so as to reflect various nonverbal behaviors which occurred simultaneously with the speech. The following behaviors were coded: the child's gazes, the mother's and child's pointing gestures, and the mother's and child's handling of the pieces. The child's gazes were coded to indicate whether the child was looking at the model, the copy, the pile of pieces, a piece in either the mother's or the child's hand, or at the mother. Gazes elsewhere—such as toward the camera, other objects irrelevant to the task, or the experimenter—were coded as "off task." Since eye gazes to the model constituted one of the most crucial measures in our argument, three of the transcripts were coded for this behavior a second time by two independent scorers. The two codings of eye gazes to the model agreed to within at least three words 94.8% of the time.

Both the mother's and child's pointing behaviors were coded to indicate where the point was started and completed. The object or location being pointed to was also coded. This included points to the model, the copy, the pieces pile, or a piece in either the mother's or the child's hand. Finally, the handling of pieces by both the mother and the child was coded. Sorting, dropping, picking-up and placing-down behaviors were noted on the transcripts. Both correct and incorrect placement of pieces, as well as the adjustment of pieces, in the copy were coded.

After coding the behaviors above, the interaction of each mother-child dyad was divided into a series of "episodes." An episode was defined as the segment of interaction centered around one piece of the puzzle. It included the mother's and the child's speech and actions concerned with identifying the piece

to be used (by consulting the model), selecting the piece from the pieces pile, and inserting it into the copy. After two coders working together had identified all the episodes in the transcripts, a third coder, working independently, scored the interaction (using both the transcripts and the videotapes) for one-third of the dyads. The two scorings of episode boundaries agreed to within at least three words or one eye gaze 86.4% of the time. Since some dyads involving the younger children did not complete the puzzle the first time, and since some children inserted pieces and later returned to change them, the number of episodes is not the same for the 2½- and 3½-year-old dyads. In contrast, all of the 4½-year-olds completed all six cargo episodes in both attempts. The mean number of episodes carried out by the dyads in the three age groups is given in table 1.

Results

The present analysis of monitoring will be based on whether the child consulted the model and what happens before and after he or she does so. As noted earlier, consulting the model was a necessary part of the task only when the child was doing the cargo section of the puzzle. This difference in task requirements was reflected by the fact that the mean number of children's gazes to the model per cargo episode was 1.81, whereas the mean number of children's gazes to the model per noncargo episode was 0.44. This difference is significant, $t = 5.11$, $p < .005$. The fact that the children consulted the model more frequently during cargo than during noncargo episodes was undoubtedly partly attributable to the fact that the mothers made more attempts to get the child to consult the model during the first type of episode. For instance, the mean number of times the mothers pointed to the model was 0.60 per cargo episode, whereas it was only 0.23 per noncargo episode. This difference is also significant, $t = 2.47$, $p < .02$. Given these facts, the rest of our analysis will be concerned primarily with the children's eye gazes during the cargo episodes.

The mean number of gazes at the model per cargo episode is reported in table 1. The frequency of gazes per cargo episode varies widely among individuals, especially among the 2½-year-olds. However, a one-way analysis of variance indicated that there was no significant age trend in these data, $F < 1$.¹

¹ The analysis reported here used raw frequency scores. An analysis of variance was also carried out on square root transformed scores. It yielded the same results, $F < 1$.

TABLE 1
 VARIOUS MEASURES OF MOTHER AND CHILD BEHAVIOR WHILE THEY
 COMPLETED CARGO EPISODES, BY AGE OF CHILD

MEASURE	AGE OF CHILD					
	2½		3½		4½	
	Mean	SD	Mean	SD	Mean	SD
Cargo episodes completed (<i>N</i>).....	8.67	4.23	15.67	2.43	12.00	.00
Gazes at model (<i>N</i>).....	16.33	19.97	28.17	6.57	20.50	5.44
Gazes at model per cargo episode (<i>N</i>).....	1.91	1.62	1.82	.47	1.71	.45
Proportion of gazes at model which were other-regulated.....	.76	.25	.29	.18	.13	.12
Proportion of instances when adult intervened between other-regulated gaze at model and correct insertion of cargo square.....	.96	.07	.56	.31	.33	.39
Proportion of instances when adult intervened between self-regulated gaze at model and correct insertion of cargo square.....	.98	.03	.56	.21	.35	.15

Our main interest, however, is not in the total number of gazes at the model. Rather, it is in who regulated these gazes. In order to deal with this issue, we analyzed all the instances of children's gazes to the model puzzle during the cargo episodes. Each gaze was classified as being either other-regulated or self-regulated on the basis of the following criteria. A gaze to the model was coded as other-regulated if one or more of the following behaviors occurred before the eye gaze but after the child's previous gaze at the model or the beginning of the episode in which the gaze occurred: (a) the mother pointed to the model puzzle, (b) the mother made a complete utterance which explicitly mentioned the model puzzle (e.g., "Where's the blue one in the other puzzle?"), or (c) the mother made a complete utterance which implicitly directed the child to consult the model puzzle. This last type of behavior constitutes what Wertsch (Note 2) has labeled an "abbreviated" directive. It does not explicitly direct the child to consult the model, but in order to respond appropriately, the child must do so. An example is, "What color do you need next?"

A gaze to the model was coded as self-regulated if the mother did not carry out any of these behaviors before the gaze but after the child's previous eye gaze or the beginning of the episode in which the gaze occurred. These criteria resulted in counting as self-regulated those gazes which were not immediately preceded by a behavior on the mother's part which could be construed as an attempt to direct the child to look at the model puzzle. This coding procedure probably resulted in

coding as other-regulated some gazes to the model which were in fact initiated by the child. This is so because there were undoubtedly instances in which a child intended to look at the model without any guidance, but the mother said something or pointed to the model just before he or she did so. Although such problems may have caused a few miscodings, we relied solely on the objective behavioral criteria of the child's eye gaze and the mother's communicative behavior in determining whether the gaze was other-regulated.

There were relatively few instances in which a mother failed in her attempt to get her child to look at the model. In the 218 cargo episodes we examined there were 27 such instances. Although the number of these unsuccessful attempts at other-regulation decreased with age (from 15 for the 2½-year-olds to zero for the 4½-year-olds), the age trend was not significant, $F(2,15) = 3.20, p > .05$.

If the ontogenesis of monitoring skills is manifested by a shift of responsibility from the adult to the child (i.e., from other-regulation to self-regulation), one would expect to see a decrease in the proportion of other-regulated gazes to the model as children grow older. In table 1 we have presented the proportion scores of children's eye gazes to the model puzzle which were other-regulated. The table reveals a marked decrease in the proportion of other-regulated gazes with age. A one-way analysis of variance of these proportion scores reveals that the differences among the groups are highly significant, $F(2,15) = 14.90, p < .001$.² Scheffé post hoc comparisons indicated

² The analysis reported here used raw proportion scores. An analysis of variance was also carried out on arcsin transformed scores. It yielded the same results, $F(2,15) = 14.11, p < .001$.

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that the mean proportion of other-regulated gazes for the 2½-year-old dyads was significantly ($p < .05$) different from both that of the 3½- and the 4½-year-old groups. The comparison between the proportion scores of the 3½- and the 4½-year-old groups was not significant. Thus there is evidence for an ontogenetic shift from other-regulation to self-regulation of eye gaze to the model.

Further analysis of the other-regulated gazes to the model revealed an additional age-related difference. This difference is concerned with how effective the child was in utilizing the adult's utterance and/or pointing which preceded the gaze. In order to compare subjects in this area, we categorized all the other-regulated gazes into (a) instances where there was no further intervention by the adult after the gaze and before the insertion of the cargo square correctly in the copy and (b) instances where the adult intervened at least once after the child's gaze to the model and before the child inserted the cargo square correctly in the copy.

In order to analyze the overall incidence of other-regulated gazes to the model which did not lead directly (i.e., without further adult assistance) to the child's insertion of the cargo square correctly in the copy, we used the following proportion score for each child: (number of cases where adult intervened between other-regulated gaze at model and child's insertion of cargo square correctly in copy)/(total number of other-regulated gazes at the model). The proportion scores are reported in table 1. A one-way analysis of variance was carried out on the proportion scores. The age difference was significant, $F(2,15) = 6.03$, $p < .025$.³ Scheffé post hoc comparisons indicated that the mean proportion scores for the 2½-year-old group was significantly ($p < .05$) different from that of the 4½-year-old group. No other comparisons were significant. A similar proportion score for self-regulated gazes at the model was calculated for each child as follows: (number of cases where adult intervened between self-regulated gaze at model and child's insertion of cargo square cor-

rectly in copy)/(total number of self-regulated gazes at the model). The mean proportion scores are reported in table 1. A one-way analysis of variance of these proportion scores revealed a significant age difference, $F(2,13) = 6.33$, $p < .02$.⁴ Scheffé post hoc comparisons indicated that the mean proportion score for the 2½-year-old group was significantly ($p < .05$) different from that of both the 3½-year-old group and the 4½-year-old group. The comparison between the 3½-year-old and the 4½-year-old groups was not significant.

As can be seen in table 1, the proportion scores for adult intervention after a gaze at the model are almost identical for other-regulated and self-regulated gazes. Overall, these results indicate that when the younger children in our study looked at the model (regardless of whether this behavior was self-regulated or other-regulated), they were often unable to extract the relevant information from the model or they were unable to use this information in making appropriate decisions about what to do next. In contrast, older children were more likely to realize the strategic significance of the information from the model. This is evidenced by their capacity to act independently in carrying out all the subsequent steps required to select and insert a cargo square correctly in the copy puzzle.

A final analysis that we conducted was aimed at determining whether there was evidence for what Wertsch and Stone (1978) have labeled "microgenetic" progress from other-regulated to self-regulated gazes to the model. That is, we were concerned with whether there was any evidence that this transition occurred within the interaction sessions as opposed to the ontogenetic transition we found. While there were individual cases where this microgenetic transition occurred, the collective data did not support such a conclusion. We arrived at this conclusion by comparing the proportion of the first half of the gazes to the model in each session that were self-regulated with the proportion of the second half of the eye gazes to the model. The sum of the difference scores was 0.006.

³ The analysis reported here used raw proportion scores. An analysis of variance was also carried out on arcsin transformed scores. It yielded the same results, $F(2,15) = 6.28$, $p < .025$.

⁴ The analysis reported here used raw proportion scores. An analysis of variance was also carried out on arcsin transformed scores. It yielded the same results, $F(2,13) = 14.12$, $p < .001$. There are only 13 degrees of freedom associated with the denominator of this F ratio because no self-regulated gazes to the model puzzle occurred for two of the 2½-year-old subjects. Therefore, they were dropped from this analysis.

Discussion

Our results support the notion of an ontogenetic transition from other-regulation to self-regulation in connection with a crucial strategic step (looking at the model) in our task setting. In addition, our data indicate that in those cases where this strategic behavior was carried out (either through other-regulation or self-regulation), older children were likely to go on to carry out the entire sequence of actions necessary to select a piece and insert it correctly in the copy puzzle, whereas younger children usually required additional help from the adult. There are two points we would like to discuss about these findings.

First, it should be kept in mind that all of our dyads were comprised of middle-class children who were attending a Montessori preschool and their mothers. Although we have not yet specifically explored the ways in which adult-child interaction is carried out in other cultural and subcultural groups, we would not be surprised to find some important differences.

Second, the fact that adults were more likely to provide assistance to younger children than to older ones after a gaze at the model suggests that children from different age groups did not have the same understanding of the strategic significance of this gaze behavior. When working with younger children, the mothers often had to take on the responsibility for making certain that information from the model was used appropriately, whereas older children could make appropriate use of this information without adult assistance. An implication of this fact for other-regulation is that the mothers' communicative moves functioned differently for children at different ages. Even though the mothers may have been requesting the younger and older children to carry out the same behavior (look at the model), the younger ones apparently did not interpret the adults' communicative moves as being about strategic actions appropriate for a particular goal, whereas the older ones did.

Whatever the final status of notions such as "metacognition" and "strategic activity" turns out to be, our point here is that cognitive processes often do not appear for the first time after the child has already begun to function as an independent agent. Rather, adult-child interaction is often structured such that the processes are carried out on what Vygotsky called the interpsychological plane before they appear on the intrapsychological plane. Taking the social origins of cognitive processes into account may be one of the most important steps to developing a more complete understanding of their history and final form.

Reference Notes

1. Flavell, J. H. Metacognition. Paper presented at the annual meeting of the American Psychological Association, Toronto, 1978.
2. Wertsch, J. V. The social interactional origins of metacognition. Paper presented at the biennial meeting of the Society for Research in Child Development, San Francisco, 1979.

References

- Brown, A. L. Knowing when, where, and how to remember: a problem of metacognition. In R. Glaser (Ed.), *Advances in instructional psychology*. Hillsdale, N.J.: Erlbaum, 1978. (a)
- Brown, A. L. Metacognitive development and reading. In S. J. Spiro, B. Bruce, & W. F. Brewer (Eds.), *Theoretical issues in reading comprehension*. Hillsdale, N.J.: Erlbaum, 1978. (b)
- Flavell, J. H. Metacognitive aspects of problem solving. In L. B. Resnick (Ed.), *The nature of intelligence*. Hillsdale, N.J.: Erlbaum, 1976.
- Vygotsky, L. S. The genesis of higher mental functions. In J. V. Wertsch (Ed.), *The concept of activity in Soviet psychology*. White Plains, N.Y.: Sharpe, in press.
- Wertsch, J. V., & Stone, C. A. Microgenesis as a tool for developmental analysis. *Quarterly Newsletter of the Laboratory of Comparative Human Cognition*, 1978, 1, 8-10.