DOCUMENT RESUME

ED 264 962 PS 015 556

AUTHOR	Perlmutter, Marion; And Others
TITLE	Social Influence on Preschool Children's Computer Activity.
SPONS AGENCY	National Inst. of Education (ED), Washington, DC.
PUB DATE	Aug 85
GRANT	NIE-G-3-0032
NOTE	54p.; Paper presented at the Annual Convention of the American Psycological Association (Los Angeles, CA, August 23-27, 1985).
PUB TYPE	Reports - Research/Technical (143) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC03 Plus Postage.
DESCRIPTORS	Affective Behavior; Cognitive Processes; *Computers; Early Childhood Education; Educational Benefits; *Learning Activities; *Peer Influence; *Preschool Children; Problem Solving; Retention (Psychology); *Social Influ nces
IDENTIFIERS	*Social Interaction

ABSTRACT

Thirty four-year-olds and 30 five-year-olds participated in a study of social influences on computer activity. During a first session children were individually pretested for general cognitive level and alphabet and number skills; during a second session they were given individual training on the computer; during third and fourth sessions half of the childen were observed while working alone at a computer and half were observed while working with a peer at a computer; and during a fifth session each child was individually tested for retention and feelings about the computer experience. In general, behavior of paired children was more engaged and more effective than that of nonpaired children, but was not more efficient. In addition, children who worked with a peer were observed showing more positive affect, rated their affect higher, and retained more about the experience than children who worked alone. Research conclusions also suggested that the advantages of peer interaction increased over the preschool years and that dyadic computer activity is educationally feasible and useful for young children. The results were discussed in terms of a four level-framework of social influence which hypothesized that subjects' skill level relative to task difficulty determines the nature of social influence. (DST)

Social Influence on Preschool Children's Computer Activity

Marion Perlmutter

Stephanie Behrend

Department of Psychology
University of Michigan

and

Alexandra Muller

Center for Research in Human Learning
University of Minnesota

Running Head: Social Influence on Computer Activity

ABSTRACT

Thirty 4-year-olds and 30 5-year-olds participated in a study of social influences on computer activity. During a first session children were individually pretested for general cognitive level and alphabet and number skills; during a second session they were given individual training on the computer; during third and forth sessions half of the children were observed while working alone at a computer and half were observed while working with a peer at a computer; and during a fifth session each child was individually tested for retention and feelings about the computer experience. In general, behavior of paired children was more engaged and more effective than nonpaired children, but it was not more efficient. In addition, children who worked with a peer were observed showing more positive affect, rated their affect higher, and retained more about the experience than children who worked alone. A number of age x condition interactions suggested that the advantages of peer interaction, increases over the preschool years. The results were discussed in terms of a four level framework of social influence which hypothesizes that subject's skill level relative to task difficulty determines the nature of social influence.

Social Influence on Preschool Children's Computer Activity

The purpose of the present research was to examine the influence of social interaction on preschool children's computer activity. As computers become common in children's lives, it is increasingly important to assess the potential educational feasibility and value of computers for young children as well as to assess the most effective ways to introduce children to computers. In addition, computer activity involves many problem solving skills that have been the focus of past research on cognition. Thus, computers provide an ecologically useful context in which to extend the study of children's problem solving and cognitive development.

Most previous research on children and computers has focused on elementary and high school children. The earliest age at which children can benefit from computers remains undetermined, and questions concerning the cognitive skills that are necessary for children to make good use of computers is still controversial (Barnes & Hill, 1983; Brady & Hill, 1984; Clements & Gullo, 1984; Getman, 1983; Pea & Kurland, 1983; Sheingold, Kane, & Endreweit, 1983). On the one hand, Barnes and Hill (1983) have proposed that children must be past the preoperational stage to be able to effectively utilize computers. They suggest that until children are at an operational level they are not capable of controlling the symbols basic to effective learning with computers. On the other hand, Pea and Kurland (1983) have argued that there presently is not enough evidence to argue that a particular developmental level is needed for computer use to be profitable. Similarly, Papert (1980) has rejected the idea that young children lack the specific cognitive skills required to make use of computers and suggested instead that even very young children can learn to program.

Although this controversy continues, young children are, and are likely to continue to be given access to computers in preschool classrooms (Frank, 1981). Moreover, it seems likely that whether children benefit from this technology will depend less upon their absolute cognitive level than upon the match between their cognitive level, the software they are exposed to, and the age appropriateness of the context that is provided. Poorly conceived software will be of little value to even mature children, and an unmanageable social context will interfere with all activity including that around a computer.

Virtually all of the educational software available today has been written with the intent that the user will use it individually. Yet, in most schools the child to computer ratio is much higher than 1:1. Early findings suggest that young children's computer use may be a surprisingly social activity (Hawkins, Sheingold, Gearhart, & Berger, 1982; Hawkins, 1983; Levin & Kareev, 1980; Muller & Perlmutter, in press; Piestrup, 1982; Rosengren, Gross, Abrams, & Perlmutter, in preparation; Ziajka, 1983). For example, Muller and Perlmutter (in press) found that preschool children collaborated on computer activities more than they collaborated on other classroom activities, and Rosengren, Gross, Abrams, and Perlmutter (draft manuscript) found that solitary computer use was rare in a preschool classroom.

Thus, an emerging literature suggests that young children can work together at computers and may in fact prefer to do so. The potential benefits or limitations of working at a computer alone or with another still are not known. However, there are both practical and theoretical justifications for investigation of this issue. From a practical perspective, the early age and group situation in which computers are introduced to children justifies examination of early peer interaction at computers. Moreover, current concerns of parents and educators about whether computers promote social isolation make comparisons of individual versus dyadic computer activity particularly timely. From a theoretical perspective, the prevalence of social activity in the preliminary studies of young children and computers suggests that this activity may be important. Moreover, although a satisfying conceptualization of social context is not currently available, the relevance of social context to cognition has been indicated in a number of domains.

The effects of early social interaction on problem solving is a research topic that is now recognized to be critical for understanding cognitive development. Investigators in this area have become increasingly sensitive to the potential value of social interaction for problem solving and cognitive development. For example, Vygotsky (1978) and others working from the dialectic perspective (e.g. Luria, 1979; Wertsch, 1985), as well as Piaget (1960) and others working from the structuralist perspective (e.g. Murray, 1972; Perret-Clermont, 1980), have argued that children's cognitive systems are strongly influenced by their social encounters. Yet, relatively little research on cognitive development has focused on such social input.

Because young children had been assumed to lack the necessary skills to structure problem solving interaction, the empirical research that has been carried out on social interactional effects on cognitive development has primarily involved adult-child interactions (e.g. Kontos, 1983; Wertsch, 1978). Of the studies that have been carried out on child-child interaction, most have involved older children. Recently however, as preschool children have been found to be more competent in interactive situations than was previously believed (see Brownell, 1982; and Gelman, 1978 for reviews), child-child interactions have become the focus of some research on early cognitive development. For example, Cooper (1980), Bar-Tal, Ravir, and Goldberg (1982), Pratt, Scribner, and Cole (1977) have shown that children as young as preschool age can work effectively together. Yet the value of such interaction for cognitive development still has not been demonstrated. Moreover, our understanding of the mechanisms by which social interaction may promote effective problem solving still is limited.

A number of possible mechanisms have been hypothesized to mediate social influence on cognition. These include social reinforcement (Bandura, 1977; Dollard & Miller, 1950), imitation (Bandura, 1977; Miller & Dollard, 1941), conflict of ideas (Piaget, 1968; 1970), regulation (Vygotsky, 1978), and explanation (Gagne, 1977). However, the importance of these mechanisms has not been universally accepted. For example, some researchers have argued that modeling alone cannot actually account for the improvement that is observed following social interaction (Ames & Murray, 1982; Cooper, 1980; Mugny & Doise, 1978; Glachan & Light, 1982). In studies of symmetric peer interaction, children who prior to the study did not exhibit knowledge of a correct solution are grouped together, thus presumably minimizing the likelihood of productive imitation. In general, these studies have shown that children of equal ability who work together can profit from the interaction. That is, correct solutions arise from the interaction itself. A synergy between two inferior strategies seems to generate a superior strategy, but the nature of this synergistic process remains unclear.

Our own view is that within any particular context the mechanisms and effects of social interaction depend upon an individual's skill level relative to the task at hand, as well as upon the skill level of the social other relative to the individual of focus. More specifically, we propose that there are four levels of social influence that operate between five performance stages. We assume that subjects' performance can be characterized as uninvolved, engaged, effective, efficient, or generalized, and that such stages of performance correspond to subjects' skill level relative to task difficulty. Increasing developmental level, or increasing task simplicity, is assumed to lead to higher stages of performance. Likewise, providing social input is hypothesized to produce higher stages of performance, although this improvement may depend upon the skill of the social other. While early improvements in performance can occur with even matched level social input, more advanced performance gains may require expert input. From this perspective level of social influence is expected to increase with age if task difficulty is held constant, and decrease with task complexity if developmental level is held constant. The framework is summarized in Table 1.

Insert Table 1 about here

As may be seen in the table, the mechanisms of social influence that are hypothesized at Level I are most similar to those suggested by social learning theorists (e.g. Bandura, 1977; Dollard & Miller, 1950; Miller & Dollard, 1941). At this stage, an individual's performance alone is uninvolved. Social input operates on affect to yield engaged but not necessarily effective performance. The other person motivates behavior by reinforcing it. This Level I social input might colloquially be stated simply as "do something." Such input should improve performance regardless of whether it comes from a another individual of equal skill or from a more expert other person.

At Level II the mechanisms of social input are most similar to those suggested by Piaget (1968). When an individual's solitary performance is engaged but not effective, social input operates on action and leads to effective but not necessarily efficient performance. The other person conflicts or challenges ones own behavior and leads to variation in behavior and thought. It should be noted that at this level the social input catalyzes change but does not actually provide the substance of it. This Level II social input might be colloquially stated as "there is another way to do it." Such input should improve performance regardless of whether it comes from a matched or more expert other person.

At Level III the mechanisms of social input are most similar to those suggested by Vygotsky (1978). When a person's solitary performance is effective but not efficient, social input may operate on strategy to yield efficient but not necessarily generalized performance. The other person's input directs or regulates ones own thought or behavior and thereby increases its efficiency. The substance of the other person's regulation is actually internalized and comes to coordinate one's own behavior. This Level III social input would be colloquially stated as "do it this better way." Such input is only expected to improve performance if it comes from another individual who is more expert than the subject.

Finally, at Level IV the mechanisms of social input are those that seem to be assumed by most pedagogical practice. When solitary performance is efficient but not generalized, social input should operate on understanding to yield generalized performance. The other person can provide a conceptualization or explanation of a task or situation. The input at Level IV might be viewed as metainformation. It would be colloquially stated as "this is why it works." Level IV social input only is expected to improve performance if it comes from another individual who is more expert than the subject.

Figure 1 portrays the hypothesized progression of social influence by showing the quality of performance expected without social input, with matched social input, and with expert social input. As is indicated social input generally improves performance. However, improvement is expected only within a limited range from that attained in solitary activity and maximal gain may require expert input. The assumption that social input only improves performance within a limited range is similar to the idea of a zone of proximal development that is central to Vygotsky's theory and is also consistent with numerous formulations that incorporate a notion of optimal discrepancy (e.g. Kagan, 1970). The assumption that expert input may be required to maximally improve performance is an extension of previous formulations that generally have been inexplicit on this point. Social input from a similarly skilled other person only is expected to facilitate performance through Level I and Level II. Although a similarly skilled other person may reinforce (Level I), conflict (Level II), direct (Level III), or explain (Level IV) behavior, their directions and explanations are not likely to be very useful. On the other hand, reinforcement and conflict, even from a similarly skilled other person, should reinforce or vary behavior and therefore lead to higher stages of performance.

Insert Figure 1 about here

As suggested in the right most column of Table 1, different measures of subjects' performance are most useful for inferring each level of social influence. Level I influence is assumed to operate on affect and to lead to more engaged behavior. It should increase positive affect, increase time on task, and increase number of responses. Level II influence is assumed to operate on action and to lead to more effective behavior. It should increase the diversity of responses and the number of correct responses. Level III influence is assumed to operate on strategy and contribute to more efficient behavior. It should to increase the percentage of correct responses and decrease the time to correct response. Finally, Level IV influence is assumed to operate on understanding and to produce more generalized behavior. It should enhance transfer.

The present research focussed on the nature and impact of social interaction on preschool children as they worked with a computer. Differences between working alone and working with a peer were examined within a framework of social influence on cognition that suggests that effects of social interaction depend upon the developmental level of an individual relative to the difficulty of the task and the expertise of the other. In the present study only peer dyads were investigated but development level and task difficulty were varied by including younger and older preschool children and by examining performance on the same tasks over two sessions. The older children were expected to be at higher performance stages and therefore to be affected by higher levels of social input than the younger children, and across age, lower levels of social input were expected in Session I than Session II. Dependent variables included measures of enjoyment of computer use, effectiveness with software, efficiency with software, and long-term retention of the materials involved in the computer sessions. These measures permitted assessment of social influence on affect, action, and strategy.

METHODS

Subjects

The subjects were 60 middle-class children (30 male and 30 female) who attended suburban child care centers that did not have computers. The mean age of the boys and girls was identical, 4 years, 8 months. Subjects ranged in age from 3 years, 11 months to 5 years, 8 months. One half of the children constituted a younger group (mean = 4 years, 6 months) and one half formed an older group (mean = 5 years, 2 months). Balanced with regards to age and sex, 20 children were randomly assigned to an alone condition, and 40 children (20 pairs) were randomly assigned to a paired condition. The paired children were always paired with another child who was of the same sex and approximately the same age. Partners were always from the same classroom, but were not usually special friends. The mean Peabody Picture Vocabulary Score for the sample was 110 (range 77 to 154) and did not differ for the two experimental groups. The mean McCarthy score for the sample was 7.1 (range 2 to 14) and also did not differ for the two experimental groups.

Apparatus

An Apple II computer with 48K memory, black and white monitor, two disk drives, and standard keyboard were used for the computer sessions. The software used was a modification of a commercially produced diskette purchased from the Minnesota Educational Computing Consortium. There were three letter-related programs (two alphabet sequence games and one game involving identification of the initial letter of a picture label) and three number-related programs (all involving counting). The games were represented on a menu by a picture and a number. In order to select a program the child was required to press the number corresponding to the picture of the game they wanted to play. All six programs required only a single keystroke for response. To advance from item to item within a program required a correct response or three consecutive errors. After three errors were produced, the program presented the correct answer and progressed to the next item. Pressing the escape and letter N keys resulted in returning to the menu, which enabled the children to switch programs.

Procedure

Pre-test Session: During a preliminary session four pre-tests were individually administered to each subject. To be included in the sample children had to satisfactorily complete the first two tests which assessed **alphabet** and **number skills**. Each child was asked to say their ABC's and to verbally count as high as they were able. They were scored for the number of letters recited and the number of errors made up to the last letter correctly recited, and for the number of errors made to 10. Children were also given the **Peabody Picture Vocabulary Test** (form M) and the Draw-A-Design subtest of the **McCarthy Rating Scales for Children.**

Introduction Session: The children were individually introduced to the computer and programs by an experimenter. They received verbal explanations and hands-on experience by playing one alphabet and one counting program with the experimenter until they had given three correct answers for each program. Children were given i[illegible]ions on how to start a new game and how to change games. After they had played the two games with the experimenter they were told the name and number of all games, and asked whether each game was about letters or numbers. The children were asked to choose one game that they then played independently for 5 minutes.

Computer Sessions: After the introductory session the children were given two 15 minute sessions at the computer where they either worked alone or with a peer. The program menu was presented on the screen and the experimenter reminded children how to begin and change games. Paired children were told that no fighting was allowed and that they had to "play like friends." All children were asked what game they wanted to play first. When they selected the game the session began. During the computer sessions children were allowed to decide which programs they played as well as when and how often they changed programs. The experimenter intervened only when directly questioned, when the children indicated that they could not proceed, and in the rare occasion that disruptive behavior occurred. The first computer session was two to three days after the introductory session and the second computer session followed approximately four days after the first.

During each computer session the computer recorded several variables. These were the **number of programs accessed, number of correct responses, number of incorrect responses, total time on t--k** (e.g. the amount of time elapsed from presentation of an item until a child selected an answer), **time to correct responses**, and **time to incorrect responses.**

During each computer session an observer was seated beside the children in such a way that she could view both the children and the computer screen. The observer coded children's behavior according to a coding scheme derived from Bar-Tal, Raviv, and Goldberg (1982), and Muller and Perlmutter (in press). The eleven behavioral categories are summarized in Table 2. Instruction was only applicable for pairs. Each instance of instruction was coded as **doing** (pushing a button for a partner), **showing** (little verbal explanation, mostly pointing or gesturing), or **directing** (verbally saying what needed to be done or what would happen next without gesturing or pointing). Each instruction was also coded as either **self-initiated** or **other initiated** (responsive to another's question), **content-related** (pertaining to the content of the games) or **computer-related** (pertaining to the actual operation of the computer), **accurate** or **inaccurate** (correct or incorrect), and **effective** or **ineffective** (carried out or not carried out by partner). The remaining categories were applicable to behavior in both the alone and pairs condition. These involved the recording of each instance of **showing positive affect**, **questioning observer**, and **description**.

Insert Table 2 about here

Two observers practiced coding together until a criterion of at least 80% agreement was obtained on all categories. Agreement was considered to have occurred when both observers categorized the behaviors identically. Percent agreement of occurances were calculated by dividing the number of agreements by the total number of behaviors recorded. The final inter-observer agreement on 26% of the computer sessions averaged 90% for all categories, with a range of 81% to 100%.

At the end of each computer session **affect ratings** were obtained by asking each child individually to indicate how much they enjoyed working with the computer. Children were shown a series of five simple faces that represented a range from a big frown to a big smile and were instructed to point to the face that was most like theirs when playing at the computer.

Post-test Session. Approximately two weeks following the third computer session the children were individually tested for their memory of the sessions. The memory test was divided into two sections, recall and recognition.

For the **recall test**, children were asked how many games there were and the names of them. They were then asked what they remembered about the games. Finally, children were asked if they remembered how to start and change games. Recall scores were obtained by adding the number of correct answers. A total score of 35 was possible on the recall test.

For the **recognition test**, children were shown a reproduction of the program menu and again asked the same questions as in the recall test. In addition, for any game that the child had given no content or operational information he or she was asked whether that specific game was about letters or numbers. As with the recall test, recognition scores were obtained by adding the number of correct answers. A total score of 41 was possible on the recognition test.

Finally, a **post-test affect rating** was obtained. Each child was again shown the series of five faces and asked to point to the face that "looked like you when you played with the computer."

RESULTS

Each dependent measure was analyzed in a 2(condition) x 2(age) x 2(gender) x 2(session) mixed analysis of variance. Several of the dependent variables were recorded by the computer, and therefore were available only as session totals, not as individuals' scores. For these variables two analyses were carried out. Session scores were used to compare the activity observed by children in the alone and paired conditions. These session scores also reflected performed activity for children in the alone condition. However, because the computer could not distinguish which member of the pair made a response, these session scores did not capture performed activity of individual children in the paired condition and in fact represented approximately twice the actual activity of each child in the paired condition. Thus, for subjects in the paired condition estimated performance scores were calculated by halving the computer recorded responses. Thus, for children in the alone condition performed and observed activity was always the same, and for children in the paired condition performed activity was always estimated to be one half of observed activity.

Considering the data only at the level of session (i.e. observed activity) or only at the level of subject (i.e. performed activity) biases interpretation and can lead to artifactual conclusions. Thus, the perspective of both subject and session analyses are included. In general, the results of these analyses converged to solidify interpretation. Thus, the data generally are emphasized at the level of subjects, not sessions. However, in some instances the nature of difference between solitary and dyadic experience will be elucidated by referring to both performed and observed activity.

All experimenter recorded data were available for subjects and are reported as performed data. Except where otherwise noted, all Fs reported are significant at an alpha level $\leq .05$. Main effects and interactions that are not reported were nonsignificant.

Time on Task

Children spent approximately 8 minutes of each 15 minute session on task, that is in selecting answers. The remaining 7 minutes was time that occurred between the selection of games. While children who worked in pairs spent somewhat less time on task than did children who worked alone, and all children spent less time on task during the first than during the second session, neither the condition or session main effects were statistically significant. There was, however, a significant condition x session interaction, $F(32)=4.66$. During the first session children working alone spent only slightly more time on task than children working in pairs (9.2 vs. 9.0 minutes), but during the second session this difference was over a minute (7.5 alone vs. 6.4 pairs).

Number of Programs

On average each child accessed 2.15 different programs during each 15 minute session. The number of programs accessed increased significantly from 2.0 during Session 1 to 2.3 during Session 2, $F(32) = 8.17$. Moreover, children in the alone condition (2.25) accessed significantly more programs per session than children in the paired condition (1.55), $F(32)=57.42$. Nevertheless, because children in the paired condition were exposed to programs that they themselves accessed, as well as to programs that their partners accessed, children in the paired condition (3.10) actually observed more programs than children in the alone condition (2.25), although this difference did not reach statistical significance.

Number of Responses

An average of 32 responses were produced during each session The amount of responding did not change significantly across sessions but it did differ significantly in the two conditions. On average each child in the alone condition produced more responses than each child in the paired condition, $F(32) = 24.28$. However, children in the alone condition observed fewer responses than children in the paired condition, $F(32) = 10.31$. These condition main effects were qualified by significant age x condition interactions in both the performed, $F(32)=4.1$, and observed, $F(32)=7.2$, analyses. As may be seen in the top panel of Figure 2, while the older children showed a somewhat lower level of responding with a peer, this difference was more pronounced for the younger children. As may be seen in the bottom panel of Figure 2, for younger children similar amounts of activity were observed in solitary and dyadic sessions, but for older children more activity was observed during dyadic sessions. Sex x condition interactions were also obtained in the performed, $F(52)=4.86$, and observed, $F(32)=5.81$, analyses. The pattern of performance of boys was similar to that of older children and the pattern of performance of girls was similar to that of the younger children.

Insert Figure 2 about here

Correct Responses

Correct responding was more frequent, $F(32) = 21.28$, as well as more rapid, $F(30) = 11.65$, in Session 2 than in Session 1. Moreover, children in the alone condition produced more correct responses than children in the paired condition, $F(32)=31.49$. Again, however, significant age x condition interactions on the performed, $F(32)=4.28$, and observed, $F(32)=6.18$, data qualified these findings. As may be seen in Figure 2, for older children the number of correct responses performed in pairs was less than alone, but the number of correct responses observed in pairs was greater than alone. On the other hand, for younger children fewer correct responses were performed or and observed by children working in dyads. Significant sex x condition interactions in the performed, $F(52)=9.03$, and observed, $F(32)=6.55$, analyses again indicated a more immature pattern of interaction for girls than for boys.

The percentage of responses that were correct for each age x condition group is shown in Figure 3. As may be seen, both younger and older children who worked alone tended to respond more correctly (71% versus 62%) than children who worked in pairs. However, this difference failed to reach statistical significance.

Insert Figure 3 about here

Incorrect Responses

Incorrect responding was more rapid, $F(30) = 12.13$, but not more frequent in Session 2 than Session 1. In addition, as may be seen in Figure 2, while children in the two conditions did not differ in performance of incorrect responses (top panel), children in the paired condition observed more incorrect responses than children in the alone condition (bottom panel), $F(32) = 4.77$.

Neither the age x condition nor sex x condition interactions were statistically significant for incorrect responding.

Affect Ratings

Children all apparently enjoyed working with the computer. The mean affect ratings, on a scale from 1 to 5, were 4.66 after Session 1, 4.73 after Session 2, and 4.90 after the Post-Test Session. After the computer sessions girls (4.86) rated their affect higher than boys (4.53), $F(52)=9.17$. Moreover, children who worked with a peer rated their affect higher than children who worked alone. This difference was statistically significant after the computer sessions, $F(32)=6.65$, as well as after the post-test session, $F(52) = 6.16$. However, the computer session difference was qualified by significant age x condition, $F(32)=5.55$, sex x condition, $F(32)=10.58$, and age x sex x condition, $F(32)=6.65$, interactions. As may be seen in the top panel of Figure 4, the condition difference was only evident for older children. Indeed, all children except the older boys who worked alone rated their affect at or near ceiling.

Insert Figure 4 about here

Affect Behavior

The condition differences in affect ratings were corroborated by the observational data. There were almost twice as many instances of positive affect shown by children in the paired than in the alone condition, $F(52) = 40.45$. In addition, significantly more positive affect was observed in older than younger children, $F(52)=9.45$. However, as may be seen in the bottom panel of Figure 4, these effects were qualified by a significant age x condition interaction. Older pairs showed almost twice as much affect as younger pairs, but there was virtually no difference in the frequency of affect by older and younger children who worked alone.

Questions Observer

Children questioned the observer an average of 7 times per session. This questioning was significantly more frequent for children working alone (13) than for children working in pairs (4), $F(52)=57.95$. Moreover, there was a significant sex x condition interaction, $F(52)=7.42$, indicating that the condition difference was greater for boys (16 vs. 3) than for girls (11 vs. 5).

Description

Children produced an average of 59 noninstructive statements per session, either to their partner or to themselves. The children in the alone condition (67) actually produced significantly more of these descriptive verbalizations than did the children in the paired condition (56), $F(52)=6.03$. However, it should be noted that the total number of descriptions produced by the two children working together in the paired condition (112) was greater than the number of descriptions produced by individual children working in the alone condition (67).

Instruction

An average of 43 instances of instructing were recorded for children in the paired condition. Eighty-five percent of this instructing was content related and 15% computer related. Seventy-three percent was accurate and 27% inaccurate. Sixty-five percent was effective and 35% was ineffective. Seventy-four percent was self-initiated and 26% was other-initiated. While only 18% and 20% of the instructing involved doing or showing, respectively, 62% involved directing.

Eight of the pairs of children exhibited a matched level of instruction and 8 pairs showed an unmatched level of instruction, that is, one of the children instructed at least twice as often as his or her partner. Neither age nor sex significantly predicted whether pairs were matched or unmatched in their instructing. Moreover, no significant differences emerged in subsequent analyses in which performance and post-tests of matched versus unmatched pairs were compared.

Memory

Both recall and recognition scores were higher for children who worked with a peer than for children who worked alone. This difference was only marginally significant for recall, $F(52)=3.43$, $p < .1$, but was statistically significant for recognition, $F(52) = 9.30$. Moreover, as may be seen in Figure 5, for both recall and recognition the condition difference was only evident in older children, although the age x condition interactions failed to reach statistical significance.

Insert Figure 5 about here

Relationship Between Variables

In order to determine whether there was an above chance level concordance in performance of children who worked together, intercategory correlations were computed on the two scores that were available for partners in the paired condition. These results are summarized in Table 3. Because affect ratings were consistently high there was insufficient variance to permit intercategory correlations on affect ratings. On the other hand, affect behaviors of the

Insert Table 3 about here

children working in pairs was highly correlated. There was only a modest relationship in the verbal behavior of children working together. However, memory scores of paired subjects tended to be quite similar.

Multiple stepwise regression analyses were carried out to assess the relationship between all variables for both groups. Data from all 20 subjects in the alone condition were included, but data from only one half of the 40 subjects in the paired condition were included. Because only a single estimated subject score was available for each pair, a randomly chosen subject from each pair was used in these analyses. For each session measure all pretest scores and all other session measures were entered as predictors. For each post-test measure all pretest scores and session measures were entered as predictors. The results of these analyses are summarized in Table 4.

Insert Table 4 about here

Pre-test scores related significantly, but modestly, to both session activity and post-test scores. It is interesting that the McCarthy Draw-A-Design test predicted affect ratings, performance effectiveness (number correct), and performance efficiency (percent correct) about equally well. It is also noteworthy that the best predictor of both recall and recognition was the number of programs accessed. Exposure to the material, not necessarily proficient activity with it, enhanced memory. Somewhat surprisingly, in separate analyses carried out on the data from subjects in each condition the predictive power of pre-test scores was somewhat higher for children who worked in pairs than for children who worked alone. No other systematic differences emerged in the patterns of performance of children who worked in pairs versus children who worked alone.

DISCUSSION

The results of this research suggest that computer activity can be an appropriate, enjoyable, and productive activity for preschool children. Virtually all subjects indicated that they enjoyed the computer. In addition, it was apparent that the children learned and remembered a considerable amount from the computer activity, even though their experience with the computer was quite limited, extending over only a very few sessions.

The findings of the research also provide information about suitable ways to give young children early experience with computers. First they suggest that dyadic computing activity may facilitate enjoyment and learning at a computer. Several observational studies have indicated that young children tend to make computing activity a social enterprise (e.g. Muller & Perlmutter, in press; Piestrup, 1985). The present experimental study demonstrated that at least at older preschool ages this socialization at the computer is beneficial. Children who worked in pairs showed more instances of positive affect and also rated their enjoyment of the experience higher than did children who worked alone. Moreover, children who worked with a peer showed better retention of the experience. In contrast to most traditional classroom practice, these findings suggest that working in pairs is productive. In addition, the results of the study provide little justification for promoting the purchase individual computers for every child in preschool or kindergarten classes.

Although the behavior of children who worked in pairs was consistent with the emerging view that children as young as preschool age can interact effectively in problem-solving tasks (i.e. Cooper, 1980), the instructing behavior of the dyads was contrary to the current literature on young children's teaching strategies (see Ellis & Rogoff, 1982). In block design (Koester & Bueche, 1980) and classification (Ellis & Rogoff, 1982) tasks young children were found to instruct each other primarily through modeling and demonstration. In the present study more directing was observed than either other style. In addition, instruction was usually self-initiated, highly accurate, and often effective. These findings suggest that computing activity may provide young children with a task that is more conducive to helping and teaching behavior than are other tasks (also see Hawkins, Homolsky, & Heide, 1984).

Still, the results indicate that some caution should be extended when using computers with very young children. The youngest children in the present study were approximately 4 years of age. While they could successfully use the computer, their behavior was somewhat different than that of the older children. In particular, a number of age x condition interactions indicated that the advantage of peer versus solitary activity may not exist at the youngest ages. For example, the total number of responses observed was virtually the same for both conditions with younger subjects while the older pairs observed more than their alone counterparts. Of the answers observed, the younger pairs saw fewer correct answers than the younger children who worked alone, although for the older subjects the opposite was true. These findings parallel those of Leuba (1933), who reported that the performance of 4-year-old children using a peg board task was impeded when they worked in dyads, while 5-year-old's performance improved.

Dyadic experience was significantly more enjoyable as well as more productive than solitary experience only for the older children in this study. The younger children may have been more effected by the demands of the social situation and the nature of the task. In an early report, Leuba (1933), stated that he was unable to conclude which factors accounted for the improved performance of the older pairs. Yet he alluded to the impact of the social situation by examining the presence of rivalry when the children worked in pairs. More recently, Cazden, Cox, Dickinson, Sternberg, and Stone (1979) have noted that teaching requires the management of interpersonal relations as well as the transmission of information.

It is likely that the younger children found the combination of both the social and cognitive demands too taxing. The social demands of the dyadic condition required that these subjects developed a system of use that was workable for two peers using one computer. While the coding scheme did not specifically catagorize social interactions other than instructing, our informal observations were that most dyads engaged in some form of turn-taking. The relative lack of success of the younger pairs in negotiating the turn-taking is suggested by the considerably lower frequency of affect they exhibited during the computer sessions. Although there was no difference in the frequency of affect evident in the younger and older children who worked alone, the older children who worked in pairs laughed, smiled, and giggled twice as much as the younger pairs.

Thus, the overriding findings of a positive impact of peer interaction obtained in the present study may not generalize to the youngest ages included in many preschool programs. Of course, the role of the task in moderating condition effects needs to be further investigated. Because the software used in this study required some letter and number facility, it is likely that the younger children may have had more difficulty than the older children. Although there were no age differences in the pretest scores, the letter and number pretests measured productive facility with letters and numbers while the software called upon recognition. For 3 and 4 year-olds shared computer activity may not provide the benefits in affect and learning that older children experience, at least with software such as that used in this study.

Finally, the fact that children worked well at the computer after only one introductory session, and without a teacher, suggests that relatively little teacher resources need to be committed for a successful preschool computer program. In the present study the presence of a peer made it much less likely that a child called upon an adult for assistance. In addition, the information provided by peers was more often about software content than about operating the computer. Apparently even young children need little help with the actual operation of computers, and given age appropriate software they should be able to call upon each other for assistance. A related observational study that was carried out in an ongoing preschool classroom supports this finding (Rosengren, Gross, Abrams, & Perlmutter, draft manuscript).

The results of the present research also may be interpreted within a more general framework of social influence. As suggested in the introduction, and summarized in Table 1 and Figure 1, different kinds of social influence were expected at different stages of performance. Level I and Level II social influence were hypothesized to predominate at young ages. Level I influence was expected with the most immature subjects and/or on difficult tasks. In these cases social input was hypothesized simply to motivate and engage behavior. Increases in positive affect and increases in persistence at a task would be evidence of Level I social influence. Level II influence was expected with somewhat more mature subjects and/or somewhat less difficult tasks. In these cases it was hypothesized that social input would vary behavior and make it more effective. A greater diversity of responses and a greater number of correct responses would be evidence of Level II social influence. Level III and Level IV social influences were expected to occur with more mature subjects and/or easier tasks. If proficient, Level III input was hypothesized to productively regulate and increase the efficiency of behavior. If proficient, Level IV input was hypothesized to appropriately explain and increase the generalizability of behavior.

In the present study, perhaps the clearest difference between children working in pairs and children working alone was their affect. Both informal impressions and behavioral coding suggested that dyads enjoyed the activity more than individual children. This view was confirmed by the children's own enjoyment ratings. The children in the paired condition rated their enjoyment higher than the children in the alone condition immediately after their computer experience as well as two weeks later.

The evidence pertaining to whether social influence increased children's persistence at the task was less clear. The amount of time that children in the alone and in the paired condition spent on task did not differ. However, it is likely that some of the time spent by paired children, but not alone children, was required for social negotiation. Thus, the paired children may actually have spent more of their available time on task than did the children who worked alone. The number of responses produced by each child in the alone condition was greater than the number of responses produced by each child in the paired condition. This finding would seem to suggest that children who worked alone were more persistent than children who worked in pairs. However, this result should be considered in the perspective of the data on number of responses that were observed. When observed, rather than performed responses are examined it appears that children in the paired condition were more persistent and involved than were children in the alone condition. In general then, there was considerable evidence of Level I or affective social influence.

There was also some evidence of Level II or action oriented social influence. Children in the paired condition who could work on a program that they themselves accessed or on a program that a peer accessed were exposed to more programs than were children in the alone condition. Such diversification of activity was hypothesized to be an important factor in the social benefits that can occur at Level II. Further support for this view comes from the finding that the number of programs assessed was the best predictor of recall and recognition. In addition, children in the paired condition observed a significantly larger number of incorrect, but not correct, responses than did children in the alone condition. It is likely that the incorrect responses provided conflict that stimulated thinking and enhanced learning.

Behavior of children in the paired condition appeared less effective than behavior of children in the alone condition. Each child who worked alone produced significantly more correct responses than did each child who worked with a peer. Moreover, even when session data were considered, the number of correct responses produced by dyadics only equalled, but did not surpass the number of correct responses produced by individuals who worked alone. This apparent lack of effectiveness in dyadic activity should be moderated in light of the retention data. Both recall and recognition scores were higher for children who worked in pairs than for children who worked alone. These findings suggest that joint activity did promote learning.

In order for Level III strategy oriented social influence to be productive, it was hypothesized that it would have to come from a person who is more expert. Because the social input examined in the present study always came from a matched peer, it was not expected to improve performance beyond Stage 3. That is, it was expected to increase effectiveness, but not efficiency of performance. It is interesting that peers provided considerable direction to each other. Nevertheless, consistent with expectation, this instructional direction did not improve efficiency. The percentage of correct responding was actually somewhat higher for children working alone than for children working in pairs. In addition, speed to correct response did not differ for children in the alone and paired conditions.

In general, there was more evidence of social influences on the behavior of older than younger children. For example, condition differences in positive affect and recall and recognition were greater for 5 year olds than for 4 year olds. It must be noted, however, that the age x condition interactions were only significant on affect and persistence measures. It should be noted also that there was little evidence of changes in the effects of social influence over the limited time of the present study. Even in Session II, when the tasks were less novel and presumably easier for children, peer input seemed to increase enjoyment and persistence, but there was only limited evidence of increases in effectiveness and no evidence of improved efficiency. Of course, the subjects in the present study were all quite young, and the tasks were probably quite novel even in Session II. Effective action, strategy, and explanation oriented influence is not expected in subjects who are very immature or on tasks that are difficult. Further confirmation of the hypothesized interaction between subjects' skill and task difficulty will require studies involving broader ranges of age and tasks.

In summary, we have suggested that an understanding of problem solving and cognition will be advanced by studying it in a social context. The present research involving matched preschool peers extends previous work on social influences on cognition by providing evidence that symmetric social input can be beneficial at young ages. It was hypothesized that both the subjects' skill level relative to task difficulty, and the other's skill level relative the subjects' own skill level affects the nature and mechanisms of social influence. In particular, a four level conceptualization of social influence was presented. It was suggested that social input operates first at the level of affect, and with development or learning operates on action, strategy, and understanding, respectively. There was evidence of affect and action oriented peer influence, and some indication of interesting age changes in the nature and impact of these effects. In light of these results, it may be concluded that dyadic computer activity is educationally feasible and useful for young children. At least at older preschool ages, joint activity promotes positive affect and learning.

REFERENCES

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

Bandura, A. (1971). Theories of Modeling. NY: Athernon Press.

Bandura, A. (1977). Social Learning Theory. Englewood Cliffs, N.J.: Prentice Hall.

Barnes, B.J., & Hill, S. (1983). Should young children work with microcomputers - Logo before Lego? The Computing Teacher, 10, 10-14.

Bar-Tal, D., Raviv, A., & Goldberg, M. (1982). Helping behavior among preschool children: An observational study. Child Development, 53, 396-402.

Brady, E.H., & Hill, S. (1984). Young children and microcomputers. Research issues and directions. Young Children, 39(3), 28-33.

Botvin, G., & Murray, F.B. (1975). The efficacy of peer modeling and social conflict in the aquisition of conservation. Child Development, 46, 796-799.

Brownell, C. (1982). Peer interaction amoung toddler-aged children: Effects of age and social context on operrtional competence and behavioral roles. Unpublished dissertation, University of Minnesota.

Cazden, C.B., Cox, M., Dickinson, D., Steinberg, Z., & Stone, C. (1979). "You all gonna hafta listen": Peer teaching in a primary classroom. In W.A. Collins (Ed.) Children's Language and Communication: The Minnesota Symposia on Child Psychology. Vol. 12, p. 183-231. Hillsdale, NJ: Erlbaum.

Clements, D.H., & Gullo, D.F. (1984). Effects of computer programming on young children's cognition. Journal of Educational Psychology, 76(6), 1051-1058.

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

Dollard, J. & Miller, N.E. (1950). Personality and Psychology. New York: McGraw Hill.

Damon, W. (1984). Peer Education: The untapped potential. Journal of Applied Developmental Psychology, 5, 331-343.

Ellis, S., & Rogoff, B. (1982). The strategies and efficacy of child vs. adult teachers. Child Development, 53, 730-735.

Frank, M. (1981). Young Children in a Computerized Environment. New York: Hawthorn Press.

Gagne, R. (1977). The Conditions of Learning. New York: Holt, Rinehard & Winston.

Gelman, R. (1978). Cognitive development. In M.R. Rosenszweig and L.W. Porter (Eds.), Annual Review of Psychology, Vol. 29. Palo Alto, CA: Annual Review, Inc.

Getman, G.N. (1983). Computers in the classroom: Bane or boon? Academic Therapy, 18(5), 517-524.

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

Hawkins, J. (1983). Learning Logo Together: The Social Context. (Report No. 13). New York: Bank Street College of Education, Center for Children and Technology.

Hawkins, J., Sheingold, K., Gerhart, M., & Berger, C. (1982). Microcomputers in schools: Impact on the social life of elementary classrooms. Journal of Applied Developmental Psychology, 3, 361-373.

Kagan, J. (1970). The determinants of attention in the infant. American Scientist, 58, 298-306.

Koester, L.S., & Bueche, N.A. (1980). Preschoolers as teachers: where children are seen but not heard. Child Study Journal, 10, 107-118.

Kontos, S. (1983). Adult-child interaction and the origins of metacognition. Journal of Educational Research, 77, 43-54.

Kulik, J.A., Bangert, R.L., & Williams, G.W. (1983). Effects of computer-based teaching on secondary school students. Journal of Educational Psychology, 75(1), 19-26.

Levba, C. (1933). An experimental study of rivalry in young children. Journal of Comparative Psychology, 16, 367-378.

Levin, J.A., & Kareev, Y. (1980). Personal computers and education: The challenge to schools. (Report No. 98). La Jolla, CA: Center for Human Information Processing.

Luria, A.R. (1979). The Making of Mind. Cambridge, MA: Harvard Unversity Press.

Miller, S., & Brownell, C. (1975). Peers, persuasion, and Piaget: Dyadic interaction between conservers and non-conservers. Child Development, 46, 992-997.

Miller, N.E. & Dollard, J. (1941). Social Learning & Imitation. New Haven, CT: Yale University Press.

Mugny, G., & Doise, W. (1978). Socio-cognitive conflict and the structuralization of individual and collective performances. European Journal of Social Psychology, 8, 181-192.

Muller, A.A., & Perlmutter, M. (in press). Preschool children's problem solving interactions at computers and jigsaw puzzles. Journal of Applied Developmental Psychology.

Murray, F.B., (1972). Aquisition of conservation through social interaction. Developmental Psychology, 6(1), 1-6.

Papert, S. (1980). Mindstorms. NY: Basic Books.

Pea, R.D., & Kurland, D.M. (1983). On the Cognitive Prerequisites of Learning Computer Programming. (Report No. 19). New York: Bank Street College of Education, Center for Children and Technology.

Perret-Clermont, A.N. (1980). Social interaction and cognitive development in children. London: Academic Press.

Piaget, J. (1960). The Psychology of Intelligence. Totowa, NJ: Littlefield Adams.

Piaget, J. (1968). Six Psychological Studies. New York: Vintage.

Piaget, J. (1970). Piaget's Theory. In P. Mussen, (Ed.), Carmichael Manual of Child Psychology. New York: Wiley, 703-732.

Piestrup, A.M. (1982). Young Children Use Computer Graphics. (ERIC Document Reproduction Service No.ED 224 564).

Pratt, M.W., Scribner, S., & Cole, M. (1977). Children as teachers: Developmental studies of instructional communication. Child Development, 48, 1475-1481.

Rosengren, K., Gross, D., Abrams, A., & Perlmutter, M. (draft manuscript). An observational study of preschool children's computing activity.

Sheingold, K., Kane, J.H., & Endreweit, M.E. (1983). Microcomputer use in schools: Development a research agenda. Harvard Educational Review, 53(4), 412-432.

Vygotsky, L.S. (1978). Mind in Society. Cambridge, MA: Cambridge University Press.

Wertsch, J. (1978). Adult-child interaction and the roots of metacognition. Quarterly Letter to the Institute for Comparative Human Development. 2, 15-18.

Wertsch, J.V. (1985). Culture, Communication, and Cognition. Cambridge, MA: Cambridge University Press.

Ziajka, A. (1983). Microcomputers in early childhood education? A first look. Young Children, 38, 61-67.

FOOTNOTES

This research was supported by NIE Grant (# 3-0032). The authors would like to thank Margarita Azmitia for help in establishing coding reliability, John Sevcik for help in testing subjects, and Margarita Azmitia, Frances Kuo, and Steven Sternberg for commenting on an earlier version of the manuscript. Requests for reprints should be sent to Marion Perlmutter, University of Michigan, Institute of Gerontology, 300 N. Ingalls, Ann Arbor, MI 48109-2007.

TABLE 1

Summary of Four Level Model of Social Influence on Problem Solving

LEVEL OF SOCIAL INFLUENCE	**RELEVANT THEORY**	**FUNCTION OF OTHER'S BEHAVIOR**	**SUBJECT'S BEHAVIOR ALONE**	**SUBJECT'S BEHAVIOR WITH ANOTHER**	**OTHER'S BEHAVIOR**	**EXAMPLES OF RELEVANT MEASURES OF SUBJECT'S PERFORMANCE**
LEVEL I AFFECT	Social Learning	Motivates Behavior	Uninvolved ----->	Engaged	Reinforces	Affect Time on Task Number of Responses
LEVEL II ACTION	Piaget	Varies Behavior	Engaged ------>	Effective	Conflicts	Diversity of Programs Incorrect Responses Correct Responses
LEVEL III STRATEGY	Vygotsky	Regulates Behavior	Effective ----->	Efficient	Directs	Percent Correct Time to Correct Response Correct Response
LEVEL IV UNDER-STANDING	Pedogogy	Conceptualizes Behavior	Efficient ---->	Generalized	Explains	Transfer

TABLE 2

CODING CATEGORIES

Category	Definition
AFFECT	Spontaneous verbal or behavioral expressions of affect.
QUESTIONS OBSERVER	Requests information from the observer
DESCRIPTION	Description, social comment, reading from the screen, or self-speech
INSTRUCTION	
Style	
Doing	Performs required action for another child (i.e. A child pushes a key for another child.)
Showing	Demonstrates required action for another child (i.e. A child points to a specific key.)
Directing	Tells another child the required action (i.e. A child tells another child "Push the A button.")
Initiation	
Self-Initiated	Instruction not preceded by a question
Other-Initiated	Instruction preceded by another's question
Content	
Task-Related	Pertains to game content (i.e. "You have to guess the letter.")
Computer-Related	Pertains to the operation of the computer (i.e. "You have to push the return key.")
Adequacy	
Accuracy	Instruction was correct information
Effectiveness	Instruction was followed by other child

TABLE 3

INTERCATEGORY CORRELATIONS FOR PAIRED SUBJECTS

DEPENDENT MEASURE	ETA^2	SIGNIFICANCE LEVEL
Affect	.95	$p < .001$
Questions Observer	.41	ns
Description	.51	ns
Instruction	.47	ns
Recall	.64	$p < .01$
Recognition	.74	$p < .01$

TABLE 4

SUMMARY OF MULTIPLE STEPWISE REGRESSIONS

DEPENDENT MEASURE	R^2	SIGNIFICANT PREDICTORS
SESSION MEASURES		
Time on Task	.65	# Correct (.45); Time/Correct (.16); McCarthy (.04)
# Programs	.49	# Correct (.49)
# Responses	.43	Time/Incorrect (.35); Quest. Observer (.08)
# Correct	.82	# Programs (.49); McCarthy (.17); Time on Task (.14); Number Pretest (.02)
# Incorrect	.89	# Responses (.52); # Programs (.22); McCarthy (.19); Time on Task (.06)
% Correct	.79	McCarthy (.22); # Responses (.30); Time on Task (.20); Peabody (.04); # Programs (.03)
Time/Correct	.62	Time on Task (.44); # Responses (.13); Direction (.05)
Time/Incorrect	.64	# Responses (.35); Time on Task (.18); McCarthy (.06); Peabody (.05)
Affect Ratings	.15	McCarthy (.15)
Affect Behaviors	.18	# Programs (.18)
Questions Observer	.58	# Responses (.27); Time on Task (.13); Alphabet Pretest (.12); Direction (.05).
Direction	N.S.	
POST-TEST MEASURES		
Post Affect	.25	Affect Rating (.25)
Recall	.42	# Programs (.32); Number Pretest (.10)
Cognition	.30	# Programs (.30)

FIGURE CAPTIONS

Figure 1: Model of social influence.

Figure 2: Number of responses correct and incorrect for younger and older children in the alone and paired conditions.

Figure 3: Percentage of correct responding by younger and older children in the alone and paired conditions.

Figure 4: Affect ratings and affect behaviors for younger and older children in the alone and paired conditions.

Figure 5: Recall and recognition scores for younger and older children in the alone and paired conditions.

Figure 1

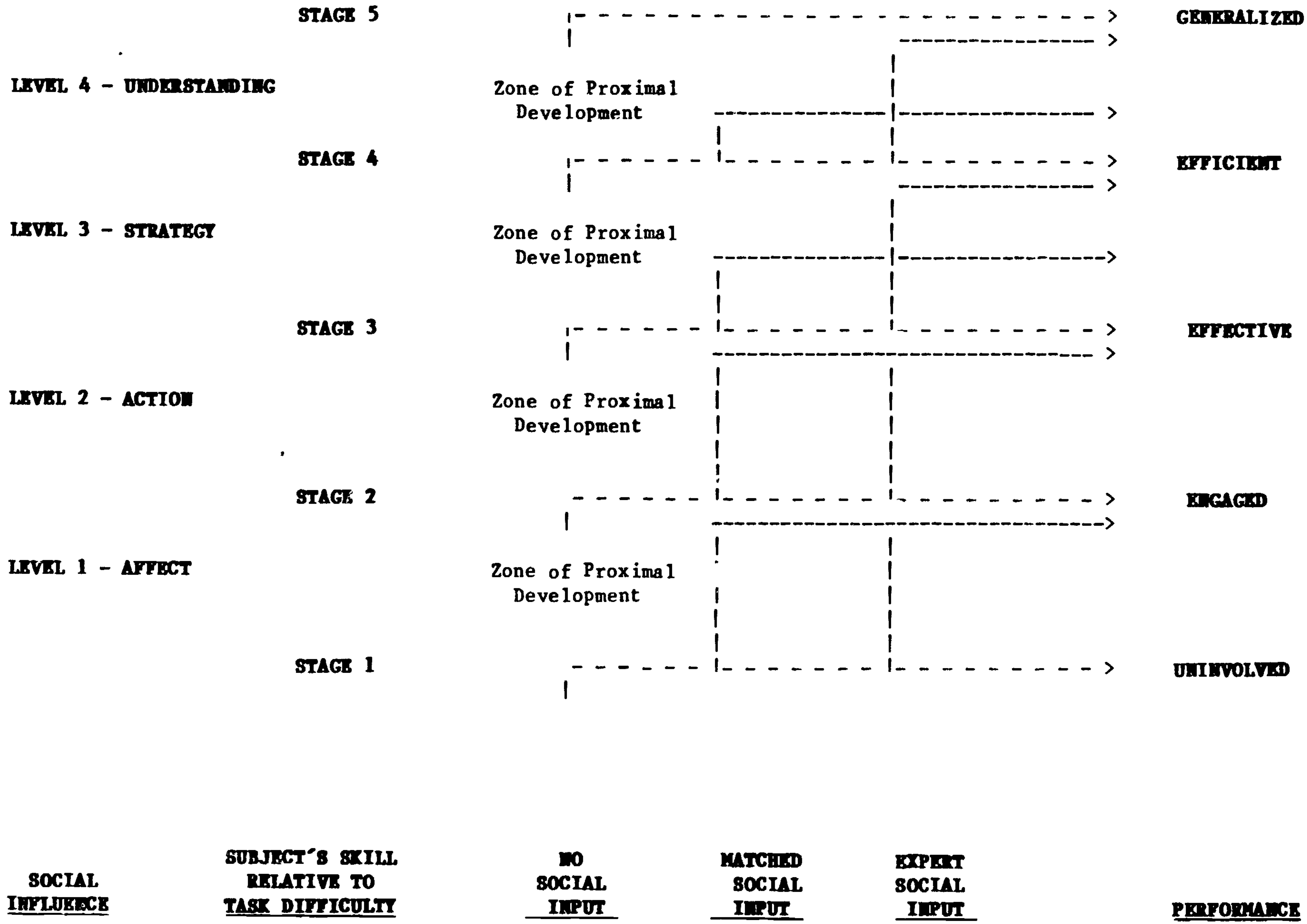
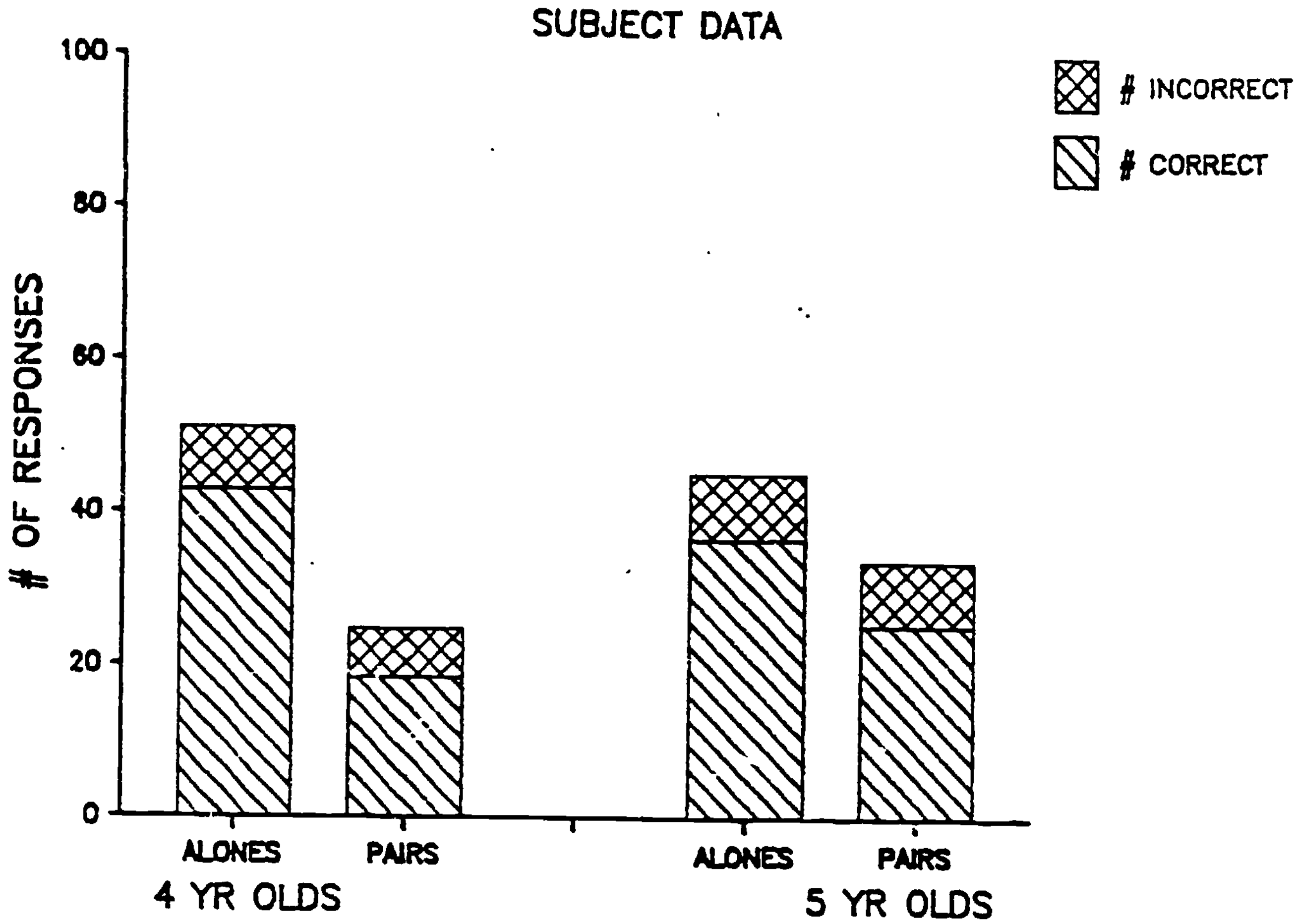

STAGE 5
GENERALIZED
LEVEL 4 - UNDERSTANDING
Zone of Proximal Development
STAGE 4
EFFICIENT
LEVEL 3 - STRATEGY
Zone of Proximal Development
STAGE 3
EFFECTIVE
LEVEL 2 - ACTION
Zone of Proximal Development
STAGE 2
ENGAGED
LEVEL 1 - AFFECT
Zone of Proximal Development
STAGE 1
UNINVOLVED
SOCIAL INFLUENCE
SUBJECT'S SKILL RELATIVE TO TASK DIFFICULTY
NO SOCIAL INPUT
MATCHED SOCIAL INPUT
EXPERT SOCIAL INPUT
PERFORMANCE

FIGURE 2


SUBJECT DATA
INCORRECT
CORRECT
OF RESPONSES
100
80
60
40
20
0
ALONES
PAIRS
ALONES
PAIRS
4 YR OLDS
5 YR OLDS

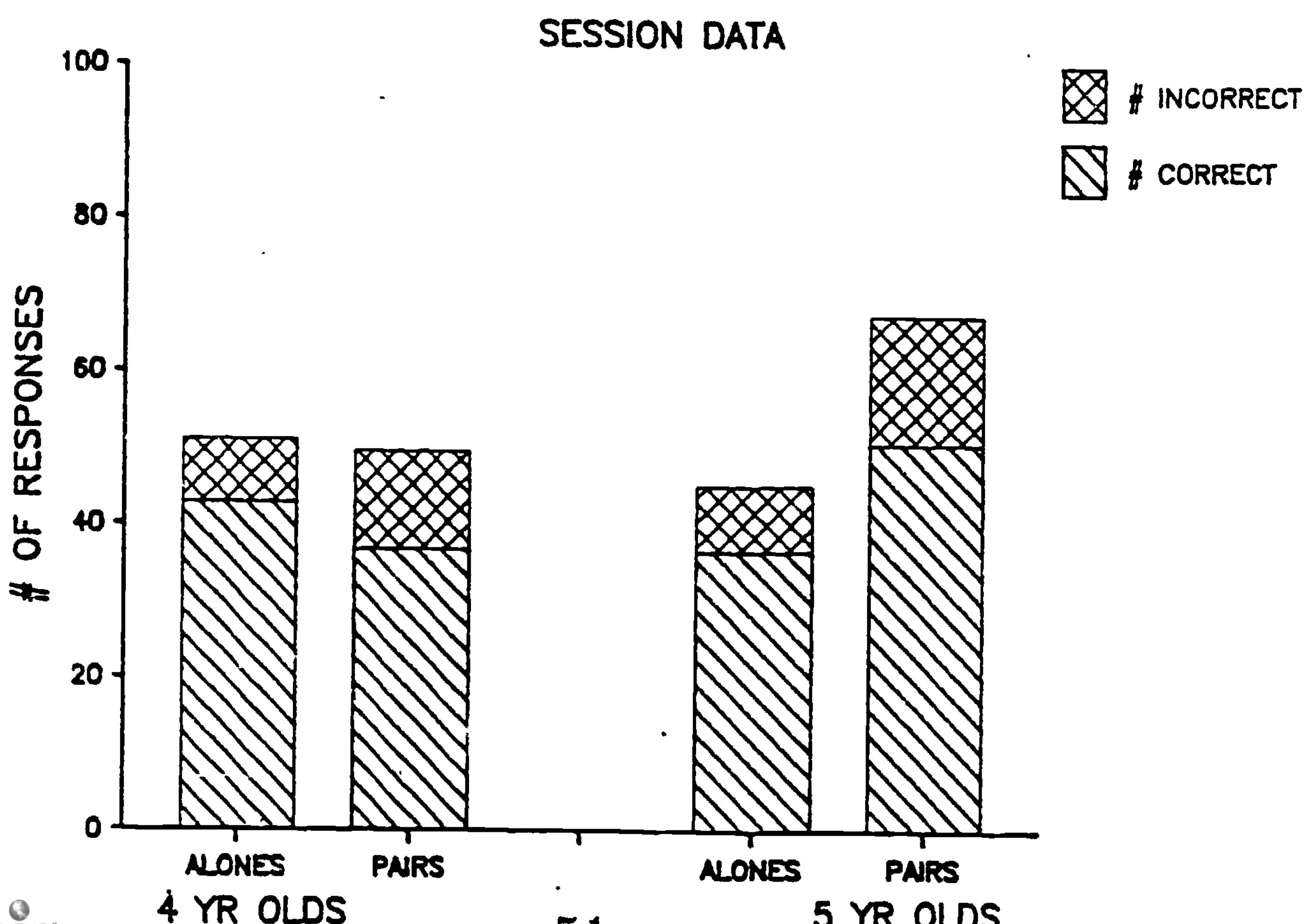

SESSION DATA
INCORRECT
CORRECT
OF RESPONSES
100
80
60
40
20
0
ALONES
PAIRS
ALONES
PAIRS
4 YR OLDS
5 YR OLDS

FIGURE 3

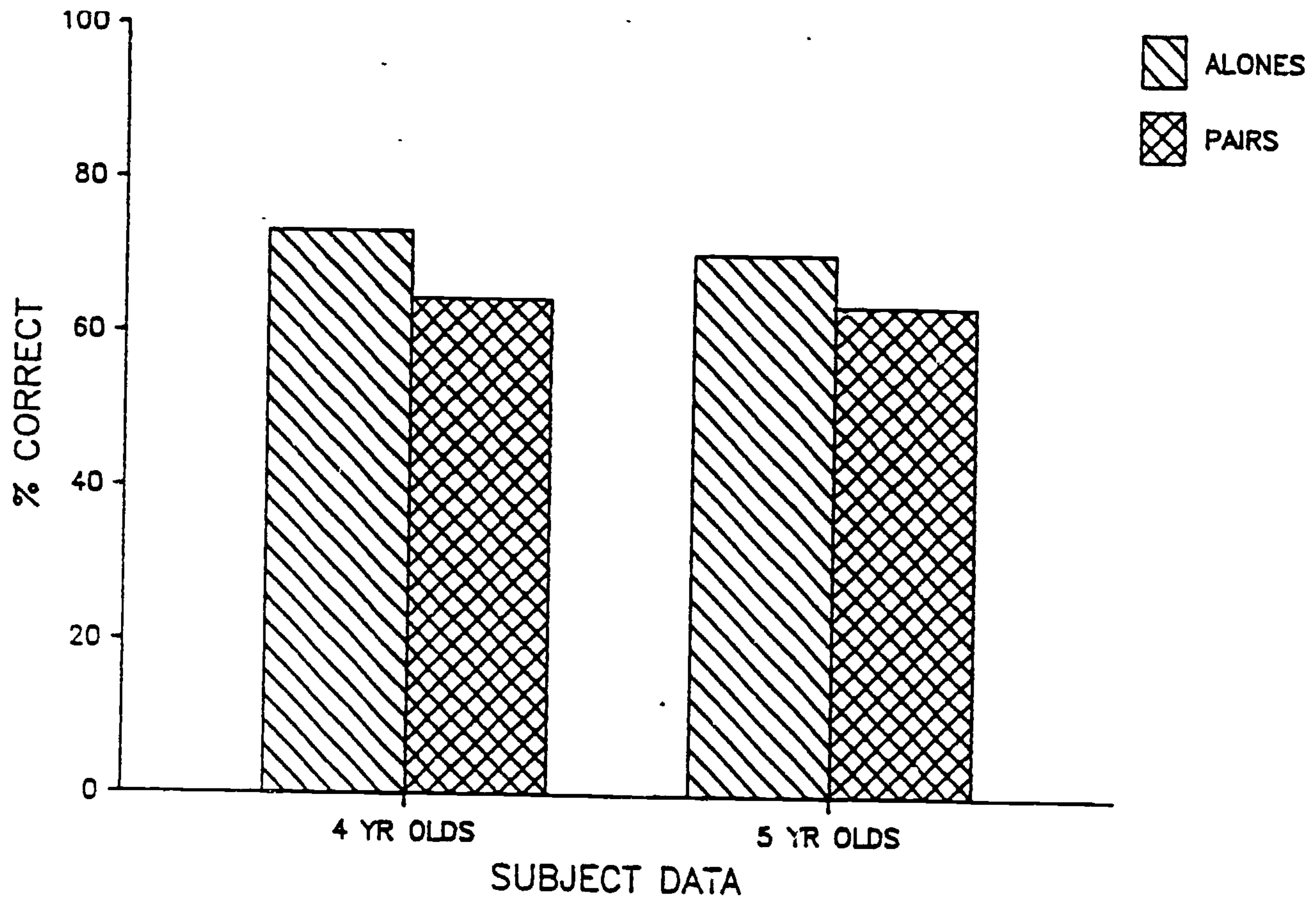
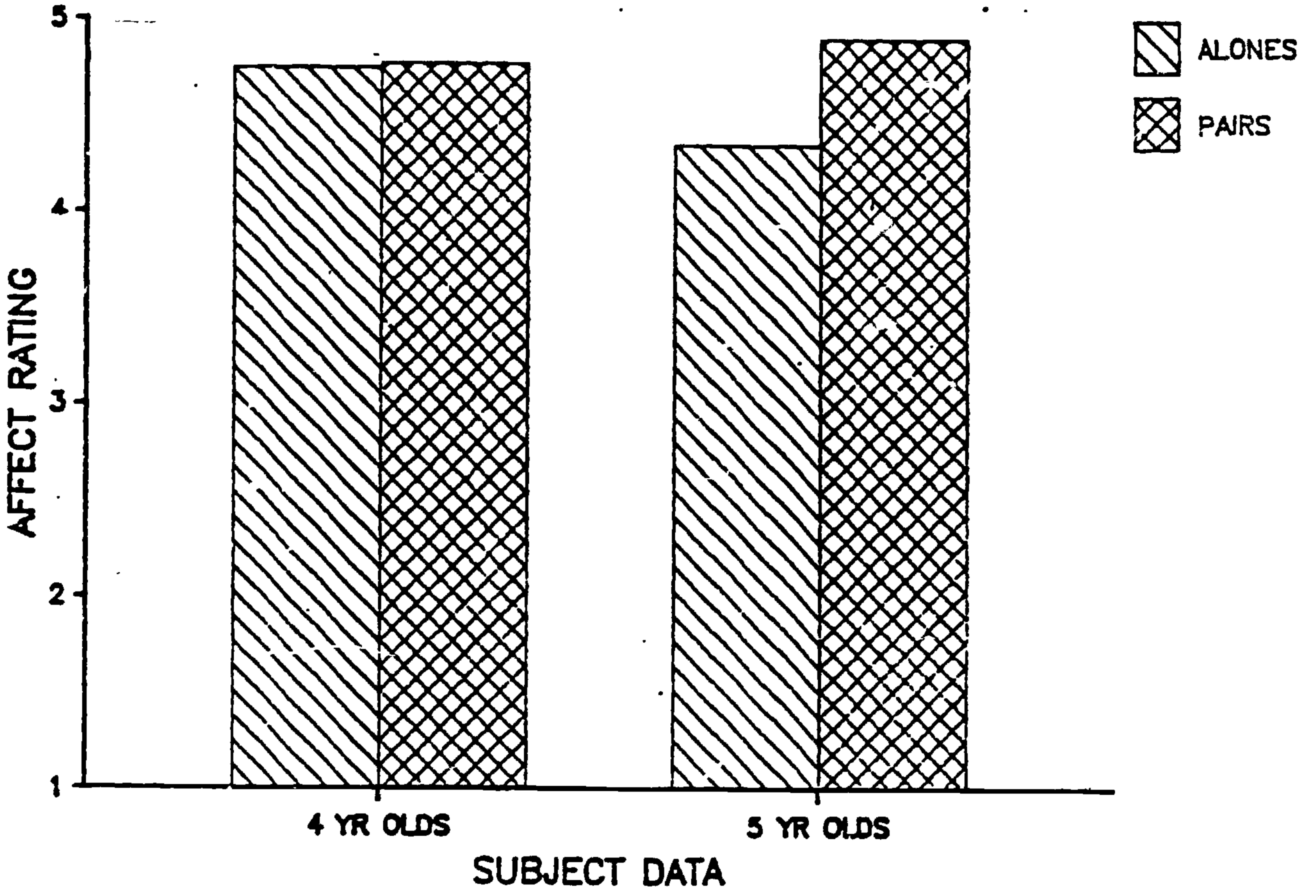
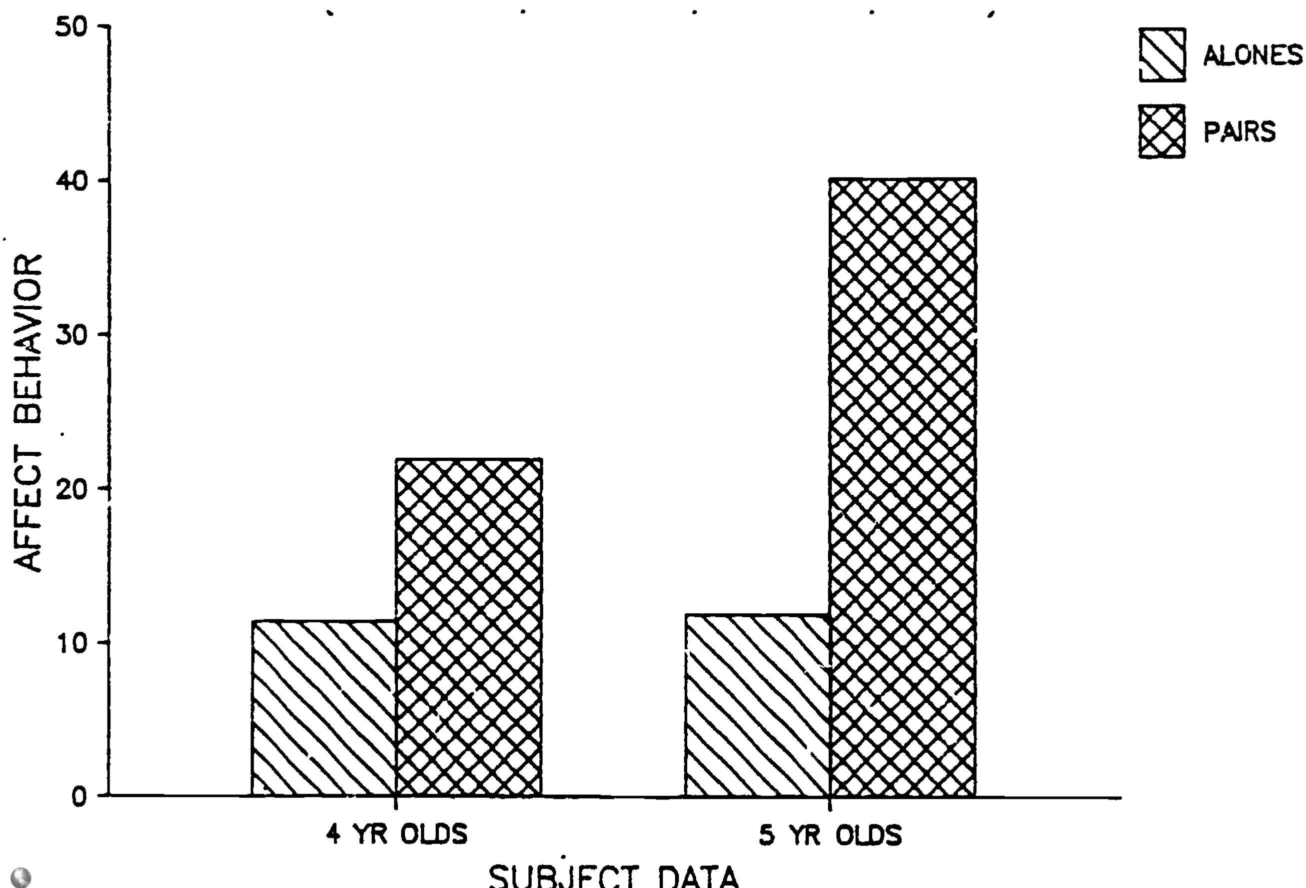

100
80
60
40
20
0
% CORRECT
ALONES
PAIRS
4 YR OLDS
5 YR OLDS
SUBJECT DATA

FIGURE 4

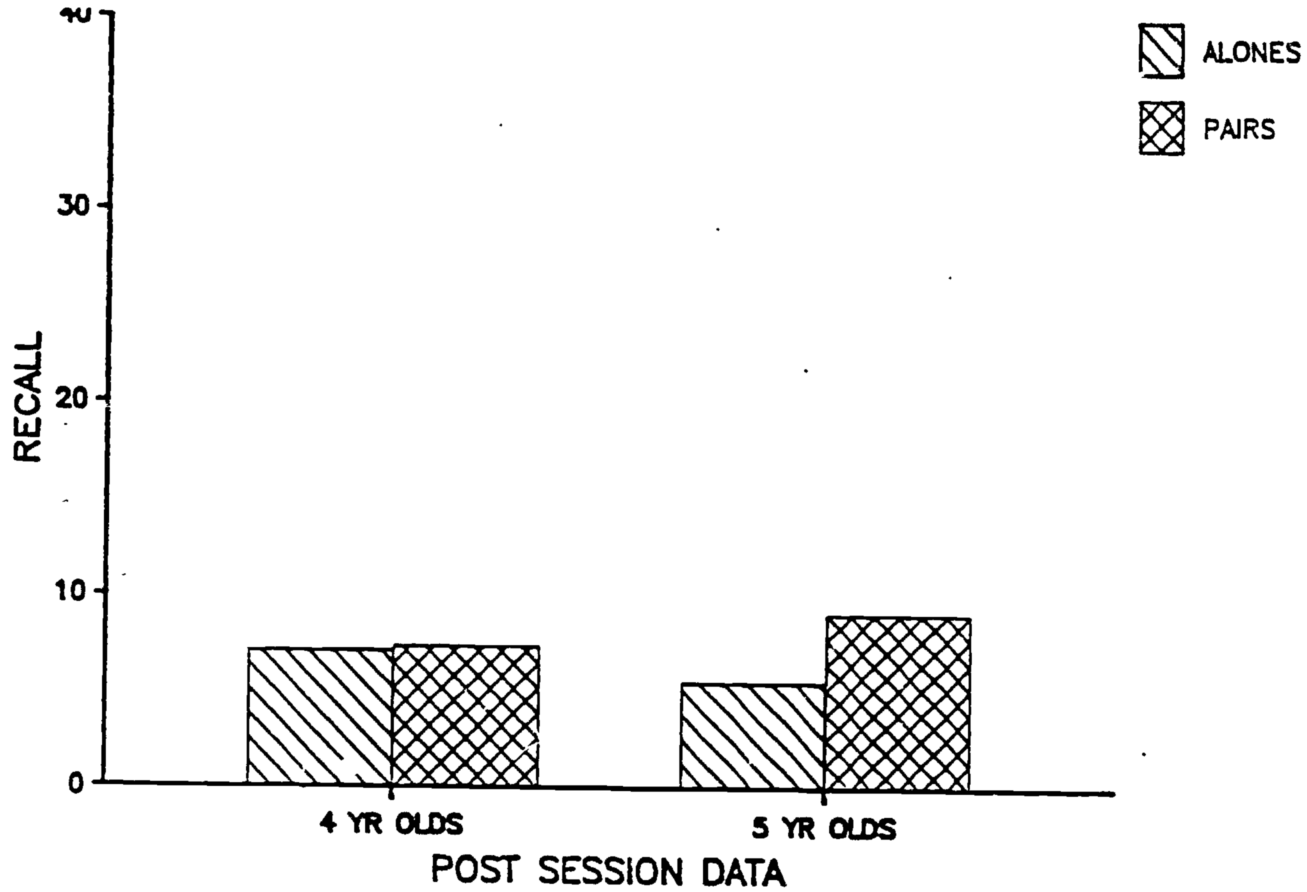


AFFECT RATING
5
4
3
2
1
ALONES
PAIRS
4 YR OLDS
5 YR OLDS
SUBJECT DATA

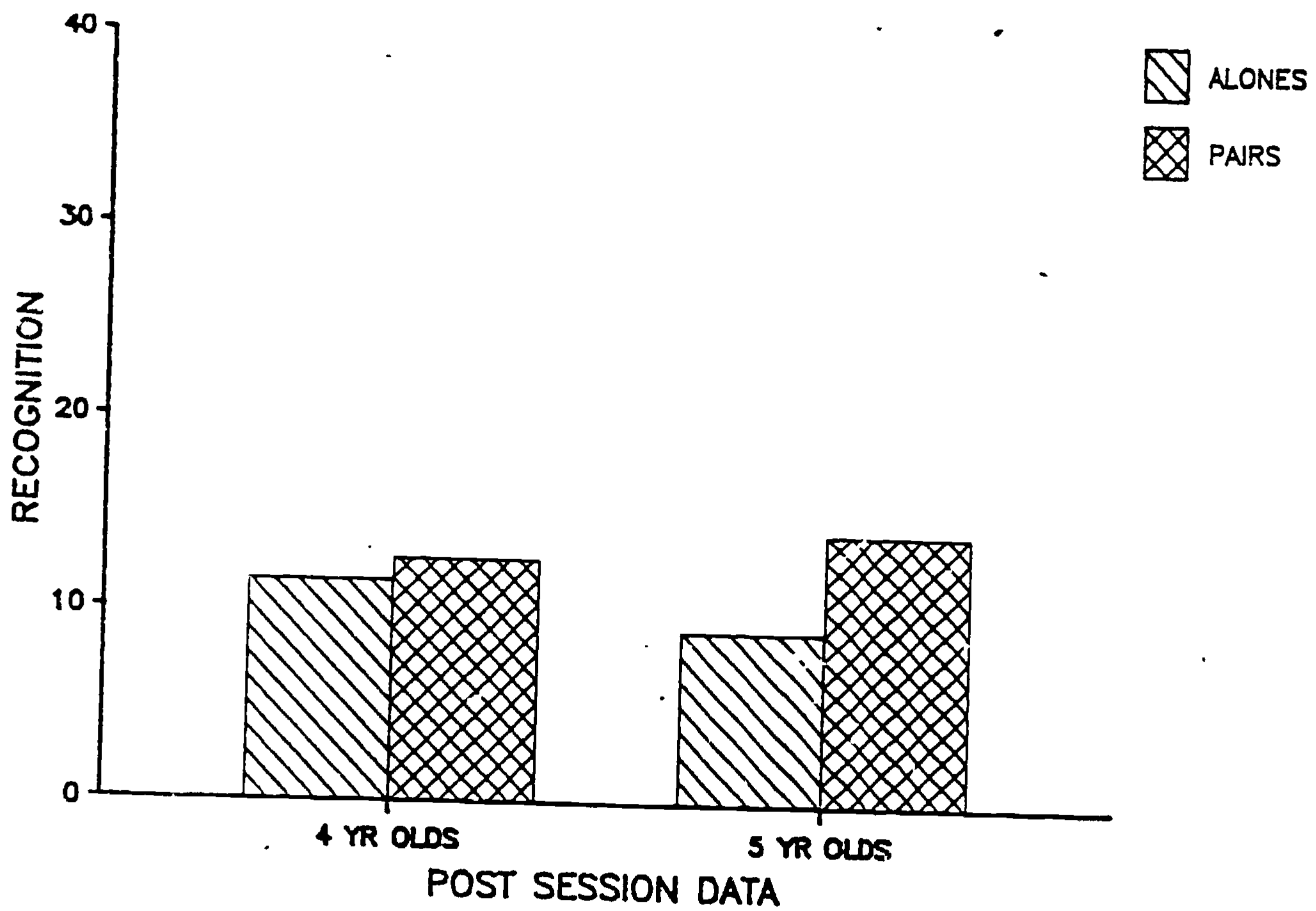


AFFECT BEHAVIOR
50
40
30
20
10
0
ALONES
PAIRS
4 YR OLDS
5 YR OLDS
SUBJECT DATA

FIGURE 5



ALONES
PAIRS
RECALL
30
20
10
0
4 YR OLDS
5 YR OLDS
POST SESSION DATA



ALONES
PAIRS
RECOGNITION
40
30
20
10
0
4 YR OLDS
5 YR OLDS
POST SESSION DATA