Chapter 6

Solving and Learning to Solve Problems in Social Context

In 1956, Piaget and Inhelder published a book that described children’s ability at tying knots. They characterized several stages of progress in this skill over the early years. Yet embedded in this description is another description, that of what a more experienced person did to arrange the situation in order to reveal as much as possible about a child’s skill at tying knots. Read the following description of the methodology Piaget and Inhelder used and take note of the behavior of the adult experimenter. It is similar to the type of graduated assistance discussed throughout this chapter as providing support for the development of problem-solving skills.

The technique employed is simple in its extreme. To start with, the child is shown an ordinary simple knot tied tightly and asked to state what it is... He is then asked to make a similar knot. If the child cannot tie a knot he is asked to form one round a thick stick or bobbin and his method of learning is studied. If he cannot succeed in this after a few attempts a knot is formed slowly whilst he watches and he is then asked to imitate the action he sees. If this also fails he is shown a piece of string in two colors (half blue, half red) and the process is explained as a story (“the red goes underneath, then on top, then inside, etc.”) as the action gradually unfolds, after which he is invited to do the same. (pp. 105-106)
Although Piaget and Inhelder documented children's age-related skill at tying knots, they never did explain how children learn to tie knots. This is a familiar story in research on cognitive development. We now have substantial understanding of children's age-related progress in various cognitive domains but limited understanding of the factors that contribute to the development of these skills or the mechanisms that set them in place. Let's examine tying knots as a case in point.

Early in life children have experience watching others tie knots. They may watch someone tie shoelaces or tie two strings together to bind a package. As parents and others tie knots in a child's presence, especially when they are doing something for the child like tying his or her shoes, the more experienced partner may make some running commentary about the activity—commentary that serves as a prelude of things to come. One day, not too far off, the child will be taught to tie a knot, perhaps in his or her shoelaces. Of course, this learning will not occur in an instant but gradually, and all types of "knotty" circumstances may be met along the way: knots that are not knots at all but simply twisted laces or knots that are tied so tightly they will never be untied. Eventually, the child's knots will come to resemble the knots and bows that mother and father make, a real accomplishment for the young child. After all, it is not easy to take two thin flexible strands and arrange them so that they will stay joined—no less to do this when one's fine motor skills are in the process of developing.

As this description suggests, it is difficult to understand how skill at tying knots develops without paying some attention to the role that social partners play in the process. After children master their first knot—typically the overhand knot—most go on to tie more complex knots. They may do so largely on their own as they play with string and cord or as they try to model knots depicted in drawings. Sometimes more complex knots are taught to children, for example, in scouting, where children study knots to get a merit badge or in sailing where children learn to tie knots in ropes in order to rig the sails. In these cases, various social mechanisms of explanation and instruction may come into play, including modeling, demonstration, instruction, and guided participation. My point is that from early on, children's developing skills in spatial representation and motor coordination coalesce in the everyday practice of tying knots, and more experienced people guide children through this learning process. Although Piaget and Inhelder (1956) provided insight into age-related changes in this skill, they did not consider the social context of how children learn to solve this particular type of problem. The goal of a sociocultural approach to problem solving is to understand and describe the social contributions to children's emerging problem-solving skills such as tying knots. More specifically, its purpose is to describe the role that social agents, both adults and other children, play in supporting and directing children's problem-solving skills.

WHAT IS PROBLEM SOLVING?

Every day people try to achieve many and varied goals. Some of these are modest, such as to have a good breakfast. Some are grand, such as to complete a long-term project at school or at work. In order to reach these goals, people engage in meaningful action, that is, people organize their actions in ways that are directed toward meeting their goals. The identification of an action goal and the delineation of steps or means to reach this goal is called problem solving. Problem solving is a central feature of human intelligence. In fact, some psychologists equate problem solving with thinking. An important feature of problem solving is overcoming obstacles that interfere with reaching the desired goal. Thus, problem solving involves a goal and one or more obstacles that need to be overcome to reach this goal.

What interests many cognitive researchers about problem solving is that it is a higher level mental function that is action-based and cognitively complex. That is, it is a purposeful, integrated aspect of human thinking that occurs during complex, voluntary, intelligent action. The term integrated refers to the fact that in order to solve a problem, a person uses many cognitive skills, including perception, memory, concepts, and perhaps language or other symbolic processes, like mathematics. Problem-solving skills are increasingly important as children get older and partake in more complex activities. Such activities typically present children with a problem or several problems to solve. Many of these activities, especially for young children, occur in social company. Thus, the social nature of problem solving and the role that social experience plays in the development of problem-solving skills are important to understand.

Developmental research on problem solving has concentrated on the emergence of certain critical components of this cognitive process. Of particular interest are how children understand or encode the problems they are trying to solve, the strategies that children have available to help them do this and how they choose particular strategies, and, finally, the role that content knowledge or expertise plays in problem solving and its development. These three aspects of problem solving develop over the years of childhood. As children get older, they encode more features of a problem, they get better at encoding features useful for solving a particular problem, and they allocate their attention more
effectively during encoding (Siegler, 1976). A sociocultural approach addresses whether experience solving problems with other people influences what children encode and seeks to discover how children encode problem information. Developmental research has also shown that as children get older, they are more likely to use strategies that help them solve problems and that children become increasingly skilled in using these strategies (Bjorklund, 1990). From a sociocultural perspective, a related issue concerns the role that the social world may play in children's selection and use of problem-solving strategies. Finally, current developmental research on the knowledge base asks whether prior knowledge enhances or biases children's problem-solving (Chi, 1978; Penner & Klahr, 1996) and how knowledge is related to strategy use in different domains (Kuhn, Garcia-Mila, Zohar, & Andersen, 1995). From the vantage point of sociocultural theory, the issue is how social experience guides children in the formulation and use of knowledge to solve problems. The research described below addresses all these issues. It suggests that the social world makes critical contributions over the course of childhood to each of these important aspects of problem solving.

**SOCIAL INTERACTION AND THE DEVELOPMENT OF PROBLEM SOLVING**

Ben, age 4, shuffles into the family room with a jar of pennies that he has been saving. He announces to his mother that he wants to count them to see how much money he has. With mother looking on, Ben dumps the coins on the coffeetable and begins to count the pennies, one by one. All is going well until he counts some pennies a second time. Mother interrupts and suggests that he put the pennies in rows so that he doesn't count any twice. Ben agrees and begins to do this, but he aligns his rows poorly. Mother shows him how to straighten them by making a few sample rows herself. She also tells him that it is important to put 10 coins in each row and no more. They finish building the rows together and then they count the pennies: there are 47. A few days later Ben tells his mother that his father gave him some more pennies so he needs to count them again. Mother looks on as Ben dumps the pennies onto the coffeetable and begins, on his own, to set up rows of 10.

Children, even very young children, have the capability to respond to and interact with other people in the course of goal-directed action. According to Bruner (1982), shared intentional action, what I refer to here as joint problem solving, is at the heart of the socialization process.

Adults use many types of behaviors to encourage children's participation in joint problem solving, including modeling, instructing, scaffolding, and guided participation. Children use some of these same behaviors when they solve problems with age mates. Through shared activity, children have the opportunity to learn about and practice problem-solving skills.

This chapter discusses joint problem solving in two types of social situations: adult-child and child-child interactions. Both have been the subject of much research and both appear to benefit children's learning, at least under certain conditions. Throughout this discussion, I address the components of problem solving, namely, encoding, strategy acquisition, and choice, and content knowledge, that appear to benefit from these interactions. Next I examine certain social factors that may influence how these transactions proceed. Characteristics of the child, the partner, the dyad, and the activity can affect how joint problem solving occurs and help determine what children learn from these experiences.

**Adult–Child Problem Solving**

*Infancy*

Even in the first year of life, children are involved with other people in activities that psychologists readily identify as joint problem solving. For instance, Rogoff, Malkin, and Gilbride (1984) observed adults as they interacted individually with one of two (fraternal) twin infants. These observations were conducted over a 13-month period, when the children were between 4 and 17 months of age. During this time the dyads played with different toys. I will concentrate on their interactions using a jack-in-the-box toy in which a bunny popped out of the container.

One way in which the adults engaged the infants in playing with the jack-in-the-box and supported the infants' learning about this toy was by organizing and managing subcomponents or subgoals of the activity. The adult's support changed over the course of the observations, as the infants matured and as they built up experience with the adults and with the toy. Early on, when the infants were 4 months old, the adults concentrated on maintaining the infants' attention to the toy, via the process called joint attention discussed in Chapter 4. When the infants were between 5½ and 12 months of age, the adults and infants displayed more mutual use of the toy, or joint involvement (Schaffer, 1992). Sometimes this was initiated by the adult and sometimes it was initiated by the infant. For example, one baby initiated joint involvement by staring at the toy and pushing it toward the adult when he was
not playing with it. Even in these early interactions, some of the comments made by the adults suggest that they were trying to instruct the children about strategies, as the following comment illustrates: "And this makes him come out" (p. 39). Finally, when the infants were 12 to 17 months of age, the joint activity shifted to an emphasis on joint management of the social relations and their connection to the play. For instance, the baby would look at the adult, who would return the gaze, just before the bunny popped out.

Like Piaget, Rogoff and colleagues (1984) conclude that babies are active seekers of information. However, they add to this the observation that more experienced partners are a common and informative part of the everyday environment in which infants learn about the world. Thus, the active efforts that babies make to seek information about the world are heavily invested in obtaining information from the social context. By seeking information from others, babies learn important things about the world more generally and about problem solving in particular. This information includes where to direct their attention and how to manipulate objects to reach their goals. These types of transactions also provide infants with practice in the interpersonal aspects of such exchanges. Because these interactions are calibrated by the adult to the developmental needs of the infant, their effectiveness in helping the infant participate in and learn from the joint activity is enhanced.

Play contexts are not the only types of interactions involving infants and adults in which joint problem solving occurs. During routine activities, like mealtime, infants are engaged in practical activities that involve all types of problem solving, and parents and other adults are there to guide the infants through these experiences. Valsiner (1984) observed 28 infants between 10 and 15 months of age as they ate a meal with the assistance of a parent. The focus of these observations was who controlled the spoon, with particular attention to when and how control of the spoon shifted from parent to child. As the infants got older, they gradually took on more of the actions, like picking up the food on the spoon, moving the spoon through the air, guiding the spoon to the mouth, and getting the food into the mouth. Again, parents managed the children's entry into each of these behaviors, or subgoals, by scaffolding the children's actions, for example, by holding the spoon as the child did an action and then by letting the child do it on his or her own when the child was deemed ready to do so.

Five important characteristics of the social context of cognitive development are already evident in these early social interactions:

1. Both adult and child are actively engaged in activities that require thinking on both their parts.
2. Both adult and child assume some responsibility for the activity.
3. Adults help the child by dividing the task into subgoals and supporting the child's participation in these smaller, more manageable units of the problem.
4. Adult-child transactions change as children develop and become capable of managing more aspects of the problem on their own.
5. Adults assist children in the use of rudimentary strategies, such as how to maneuver the handle of the jack-in-the-box to release the bunny or how to navigate the spoon to the mouth.

These characteristics describe cognitive development as both an individual and a social process. From the first year of life, intellectual change is derived from the communion of the child's emerging capabilities with the adult's guidance and support. These interactions occur in the child's zone of proximal development (Vygotsky, 1978), or region of sensitivity for learning and growth.

Toddlerhood

Social influences on problem solving blossom during the second year as children's emerging skill with language takes on an increasingly important role. During this time, when children are in the one-word stage of language development, mothers often try to elicit from children a response that indicates the child's understanding. This process not only fosters early language learning, it connects words and their referents in the context of meaningful, goal-directed action. In other words, these interactions are embedded in a rudimentary form of joint problem solving.

Research by Greenfield (1984) illustrates this process. She describes an incident in which a mother handed her son, who was early in his second year, a toy telephone and asked "D'ya wanna call Daddy?" (p. 125). After several demonstrations by the mother as to how to use the telephone along with suggestions by mother for the child to phone daddy, the child uttered an unintelligible sound while the mother held the phone to his ear. What did the mother do next? She responded by saying, "Uh huh. Hello Daddy. Hello Daddy" (p. 123). Here, a shared activity that is structured largely by the adult but relies on the cooperation, interest, and participation of the child, eventually leads to the in-
corporation of the child's verbalization into a goal-directed and meaningful action by the child.

A recent study involving mothers and children in the second year suggests that such transactions benefit children in many domains of cognitive development (Gelman, Coley, Rosengren, Hartman, & Pappas, 1998). In addition to aiding language development and giving children experience at integrating language and problem solving, adult-child interaction can enhance concept development, an area in which there is much growth during early childhood. Concept development is the foundation of the developing knowledge base, and therefore is instrumental in supporting the development of problem-solving skills.

What is interesting in the research by Gelman and colleagues is its description of the emergence in social context of this critical part of the knowledge base.

Gelman and colleagues (1998) observed children between 20 and 35 months of age as they read a picture book with their mothers. The mothers made many different types of statements about objects and features of the world that provided opportunities for children to learn new concepts. The conceptual information that the mothers conveyed was of a particular sort. In these interactions, mothers tended to direct children's attention to whole objects (e.g., balls), not parts of objects. They also made statements about object identity ("That's an aardvark"), the relations of objects to one another ("That's a desk. That's a desk, too."). general information about objects ("Bats live in caves"). and even sometimes told children about categories that are complex or richly structured ("Did you know that when a pig gets to be big they're called hogs?") (p. 125). Although it is unknown how children interpret these statements, the fact that natural discourse between mothers and children as young as 20 months of age includes information of this breadth and complexity suggests that this type of social context can be a rich source of information for children's developing knowledge base. Even though adults provide much of the content and structure in these interactions, the child's contribution to the process should not be overlooked. Mothers were able to tailor their comments to the child's level of understanding because children communicated their understanding by showing interest and acknowledging information that made sense to them.

The guidance provided by adults when children are toddlers supports the development of children's problem-solving in many ways. It directs the child's attention in new learning contexts to particular aspects of the situation and to ways of encoding incoming information. It also helps build the child's knowledge base, which is essential to problem solving and its development.

Early Childhood

Much of the research investigating how adult-child interaction relates to problem solving has included adults, typically parents, and children between 3 and 5 years of age. This age range is particularly amenable to this topic for several reasons. First, at this age children are quite competent with language and communication, which are important structural features of social-cognitive transactions involving adults and children. Second, much development in a wide range of cognitive domains is occurring at this time. Third, despite impressive cognitive changes, preschoolers are still very young, and are therefore in the company of older people much of the time. This social "co-incidence" provides substantial opportunity for more experienced individuals to direct and guide children's everyday problem solving.

Early childhood, the period that Fraiberg (1959) called the "magic years," is when children wonder about everything, especially the world in which they live. Many of their questions begin with "why" and "how." Callanan and Oakes (1992) asked parents of 3, 4, and 5-year-old children to keep diaries over a 2-week period of their children's "why" and "how" questions. The researchers were interested in many features of these conversations, including their frequency, the topics children covered, the form of speech children used, and the types of explanations parents provided in response to these questions. They found, as every parent knows, that the frequency of these questions increased over these years. Interestingly, at all of these ages "why" and "how" questions tended to be complex, that is, children rarely asked about the world by just stating "Why" or "How." Rather, their questions included reports, ideas, and observations—for example, Why is the sky blue? or How does the telephone know who to call? Most of these types of questions arose during shared activity with the parent rather than being introduced by the child when the parent and child were not jointly engaged. Finally, parents' explanations often contained information about mechanisms, that is, how the world works, as the following exchange illustrates:

**CHILD:** Where does the rain come from?

**PARENT:** First the water collects in the clouds, then they get really filled . . . (p. 222n)

For children as young as 4 years of age, more than half of the parents' conversational turns provided a causal explanation.

These results tell us several things about cognitive development during this period. First, they indicate that parents regularly provide
children with information about the world and about how things in the world work. This type of experience helps shape children’s growing knowledge base, which is critical to the development of problem solving. Second, these data confirm the view that children actively seek knowledge and that their understanding of the world often emerges in the flow of interaction with more experienced partners. Third, these observations suggest some of the unique opportunities available to children in everyday social interaction for the development of skills that are important to problem solving. I use the word unique here to emphasize the fact that these types of opportunities for cognitive growth are socially dynamic and constructed. As a result, they are not available in contexts that do not involve social interaction.

In order to better understand how social interaction with adults may lead to cognitive growth, Wood and colleagues (Wood, Bruner, & Ross, 1976; Wood & Middleton, 1975; Wood, Wood, & Middleton, 1978) conducted a series of studies. In this research, the investigators introduced, outlined, and demonstrated the process of scaffolding, which is one type of adult–child interaction that supports children’s cognitive growth. Scaffolding occurs when an adult in the course of solving a problem with a child assumes responsibility for arranging and managing the activity so that the child can participate at a level just beyond his or her current capabilities. As a result, scaffolding supports the child’s interaction in the zone of proximal development. The adult, acting on information obtained from the child, creates a situation that allows the child to concentrate on aspects of the task that are within his or her grasp. The child can then learn about the task by participating in it and experiencing a sense of accomplishment at its conclusion.

A critical feature of scaffolding is that it is adjusted over the course of a problem-solving interaction to accommodate the child’s changing degree of skill and confidence. The child’s actions clue the adult about the level of intervention or support that the child needs, and the adult then uses this information to modify his or her subsequent contribution in the interaction in a process called contingent responding. If the child is doing well, the adult can provide less support than he or she did in the immediately preceding exchange. If the child is floundering, the adult may need to provide more support.

To study in more detail how the process works, Wood and Middleton (1975) observed 12 mother–child dyads as they constructed a pyramid made of wooden blocks. The children, who were 5 to 4 years of age, initially played with the blocks on their own, then they interacted with their mothers in building the pyramid, and finally each child constructed the pyramid on his or her own. To characterize the nature of the mothers’ responses, the researchers divided the interaction into a series of episodes and then coded each of the mothers’ interactional turns according to a five-level, hierarchical sequence. These represented different levels of intervention or support by the mother and ranged from general instructions, which were the least regulating in terms of assisting or guiding the child’s actions, to manipulation of the task materials in specific goal-directed ways, which was the most regulating. The five levels were:

1. General verbal instruction.
2. Specific verbal instruction.
3. Mother shows the child which materials to use.
4. Mother provides the child with the materials to use and prepares the materials for assembly.
5. Mother demonstrates an operation, such as selecting and assembling the materials, as the child looks on.

To gauge the effectiveness of maternal instruction in the interactional flow, Wood and Middleton identified whether the child succeeded or failed in his or her problem-solving attempts in the step immediately following the instruction. They also examined maternal response contingencies and the child’s performance on the independent trial following the interaction. They found, first of all, that mothers did respond contingently to their children’s actions during joint problem solving. Mothers actively adjusted their level of assistance in relation to the child’s needs, which the researchers called the child’s region of sensitivity as indexed by the child’s performance in the immediately preceding episode. In an ideal contingent relation, mothers would either increase the help they provided after the child was unsuccessful on a turn or they would decrease their level of assistance following success by the child on a turn.

Wood and Middleton observed individual differences among the mothers in their patterns of contingent responding. This permitted examination of the effectiveness of the different types of responding. Some mothers had high rates of contingent responding, whereas others had low rates. In support of the hypothesis that contingent responding aids learning, the researchers found that mothers who had higher rates had children who performed better on the solitary posttest than mothers with lower rates. It is important to emphasize that the total amount of instruction that mothers provided did not relate to the child’s later task performance: only the mothers’ sensitive use of scaffolding did.

In an effort to clarify the causal relations in these findings, Wood, Wood, and Middleton (1978) conducted a follow-up study that in-
volved a trained experimenter working with children of this same age on the same task. Children were taught to construct the pyramid by the experimenter, who used either a contingent approach, a verbal—didactic approach, physical demonstration, or a combination of verbal encouragement and demonstration. The research team found that children instructed with the contingent approach did better on the later independent trial than children instructed in any of the other three ways. Incidentally, verbal—didactic instruction was the least effective, perhaps because it was not informed by, and therefore calibrated to, the children’s changing needs over the course of the interaction.

The main conclusion that can be drawn from these studies is that adults are capable of providing contingent responses to children’s immediate cognitive needs during joint problem solving. When adults do this, it benefits children’s learning. Now that we know it is useful, we need to know if and when it occurs. To what extent do parents provide such guidance for their children? To answer this question, Pacifici and Bearison (1991) observed adults and 2½- to 3½-year-old children as they worked on a puzzle together. Some dyads included mothers and other dyads included an experimenter who was trained to provide ideal contingent responses tailored to the child’s skill and immediate learning needs. Like Wood and his colleagues, these investigators devised a coding scheme that identified the mother’s instructions in terms of how explicit they were in addressing the child’s immediate learning needs. A response was identified as contingent if it was less explicit following a correct response by the child and more explicit following an incorrect response. To assess children’s learning, an individual posttest followed the interaction.

What did the investigators find? Mothers did respond contingently to their children, but they did so at less than the ideal rate (with the ideal rate being defined as one that was consistently and contingently provided to the child’s needs). In addition, although children who worked with mothers showed some improvement from the pretest to the posttest, those who worked with the experimenter during the “ideal” interaction had better posttest scores than children who worked with mothers. These results are consistent with those of Wood and Middleton (1975). They show that mothers sometimes responded contingently to their young children during joint problem solving and when they did it benefited learning. The results also suggest that all parent-child dyads are not the same in terms of the cognitive interactions they experience. Later in the chapter, certain characteristics of the social context of joint cognitive activity are suggested as explanations for the different patterns observed in the mother—child dyads. For now, the discussion builds on the concept of scaffolding by focusing on the different ways in which adults support children’s learning in early childhood.

Saxe, Guberman, and Gearhart (1987) observed mothers and 2½- to 4½-year-old children as they played number games together. Mothers helped the children by directing their attention to critical features of the problem situation—for example, during one counting game a mother said “This dot is next” as she pointed to the next item to count. Mothers also offered strategic assistance—for example, mothers would tell their children to count the dots in rows. Contributions to the developing knowledge base also occurred, as in questions like “What number is this?” and “What number comes after 5?” Consider the following interaction exchange as an example of how these various types of information may be woven together as adults and young children solve problems together.

MOTHER: Count the dots.

CHILD: (Recites “1” through “6” correctly while haphazardly pointing to dots.)

MOTHER: Start over and this time count the dots in rows.

CHILD: (Correctly counts the bottom row and continues to count “5, 6, 8” while pointing to the first, second, and third dots in the second row.)

MOTHER: No, what comes after 6?

CHILD: Eleven.

MOTHER: Seven comes after 6.

In this example, it is clear how the mother’s instruction is tailored to the child’s needs and is structured according to the subgoal of the problem on which the dyad is working. By breaking a problem into subgoals and focusing their assistance and instruction in these areas, adults demonstrate that a problem can be divided into parts and that these parts can be operated on individually in order to reach the overall goal—an understanding that is essential to the development and use of problem-solving skills.

Research suggests that the process of encoding may be of particular focus in the social—cognitive experiences that children have in early childhood. Wertsch, McNamee, McLane, and Budwig (1980) observed 2½-, 3½-, and 4½-year-old children as they worked with their mothers on a puzzle. The completed puzzle was supposed to look exactly like a model puzzle that was presented to the dyad at the outset of the session. The researchers were particularly interested in what the child looked at and who regulated the child’s eye gazes. Gazes were labeled
as *other-regulated* when the child gazed following a mother’s gesturing or reference to the model or puzzle pieces. For example, McLane (1981) observed the following comment by a mother:

**Mother:** What’s the [mother points to yellow square on model] color [3½-year-old child looks at model] in the bottom corner? [Child looks at copy. Then at pieces.] (p. 68)

Gazes were identified as *self-regulated* when they did not follow some guidance by mother.

The investigators observed that over these years, children’s gazes at the problem-solving materials shifted from other- to self-regulated. They also found that when younger children looked at the model puzzle, regardless of whether their gaze was self- or other-regulated, they were less able than older children to extract information relevant to puzzle completion. Did working with mother help younger children develop or refine this skill? The data suggest that working with an adult provides children with opportunities to develop this skill. Specifically, mothers tended to make comments following children’s placement errors that directed children’s attention to features of the model that were important to the part of the puzzle that they were working on, as the following case illustrates:

**Mother:** [after 3½-year-old child has misplaced a square] I think [as she points to model] you have to [child looks at model] check [child looks at copy, removes misplaced piece, places it correctly] over here. [Mother finishes pointing, child looks at model.] Ta dum! (McLane, 1981, p. 57)

This type of exchange suggests that opportunities for the development and refinement of encoding skills, which are central to problem solving, are part of adult–child joint problem solving in early childhood.

The literature reviewed so far suggests that joint problem solving involving adults and children in the preschool years may affect children’s skill at encoding problem information and their knowledge base. Is there any evidence that adult–child interaction during this developmental period benefits children’s strategy use? A study conducted by Freund (1990) that used a sorting and classification task suggests that strategy development in this period can be positively affected by problem solving with an adult. Dyads composed of 3- or 5-year-old children and their mothers were observed as they sorted miniature furniture and placed these in rooms in a dollhouse. After the interaction, children participated in an individual posttest that involved sorting and placing similar items. The assistance that mothers provided during the interaction was identified either as *low level*, that is, it included primarily item-specific comments and little strategy information; or as *high level*, which included strategy information useful for solving the problem, namely, how to group the items. Children whose mothers provided assistance that was predominantly high level were more accurate in how they grouped the items on the posttest than children whose mothers provided low-level assistance. This suggests that preschool-age children can learn about strategies for solving problems from exposure to adult strategy use during joint problem solving.

All of the research discussed above was conducted in the laboratory. Is there evidence from outside the lab that social interaction between adults and children can provide opportunities for the development of children’s problem-solving skills? Gelman, Massey, and McManus (1991) observed parents and young children as they explored specially designed exhibits at a children’s museum. One of the exhibits involved counting. The display was fitted with signs that identified the exhibit (“Counting Box”) and had written directions explaining how to play the game. Because preschoolers were unable to read the directions, the investigators were interested in whether the adults accompanying the children would seize the opportunity to instruct the children.

The researchers observed that only one-third of the adults who accompanied the children actually read the sign to the children and only one-fifth of the adults encouraged the children to do the activity. However, when adults read the signs and encouraged the children to do the activity, children were more likely to engage in it than when this information was not provided. Consistent with laboratory findings, when adults directed children’s attention to a problem or activity and defined the goals for them, children’s opportunity to learn is enhanced. However, the results also suggest that even when adults are able to scaffold children’s learning, they may not choose to do so.

A second set of observations by this same research team (Gelman et al., 1991) examined a related question: Does input from the social world need to be “face-to-face” in order for it to benefit children’s learning? To study this issue, the researchers used a museum exhibit equipped with a computer and speakers that presented and explained the exhibit in scientific terms to the children. Preschoolers were observed playing with this exhibit before and after the computer was installed. Before it was installed, few children—in fact, only one child—ever used the exhibit in a way that demonstrated any scientific understanding. But after the computer was installed, two-thirds of the children demonstrated such understanding. What does this research tell us? Information about how to solve problems comes in many
forms. Some of it comes from the task itself, some comes from social agents, and some comes from tools introduced by the social world to aid children's problem solving. These results indicate that face-to-face explanation is not a necessary condition for learning. Of course, we cannot forget that the input from the computer was designed and staged by other more experienced individuals—which is a specialized form of social interaction.

Research on adult–child interaction during the preschool years, a time of marked expansion in the range of cognitive problems within children’s grasp, is accompanied by a change in the cognitive assistance that adults provide for children during joint problem solving. Guidance is now more fluidly integrated with and reliant upon language. However, nonverbal assistance continues to play an important role, as research on eye gaze indicates. Processes of social interaction that appear to benefit cognitive growth, specifically contingent responding, are similar to those observed during the years of infancy and toddlerhood. There is some evidence that children’s skill at encoding and strategy use, along with the developing knowledge base, are influenced by social interaction in the years of early childhood. Further study of the causal connections between specific aspects of cognitive development and the social context of problem solving is needed.

Middle Childhood

There has been less research on parent–child problem solving involving children in the years of middle childhood. (This is not true in all aspects of problem solving, however. As we will see in the next chapter, research on social influences on the development of children’s planning skills concentrates rather heavily on the years of middle childhood.) It is also the case that much of the research on social influences on problem solving during middle childhood concentrates on peer interaction and teacher–child interaction. This reflects the fact that during middle childhood children’s social lives change dramatically, and therefore children’s opportunity to develop cognitive skills in so-called context also changes. Children spend more time with other children, mostly age mates. Because children of this age are under less continuous adult supervision, most of their peer experiences occur outside of adult range. Furthermore, children’s contact with adults outside the family, especially teachers, increases substantially in the years of middle childhood.

One study (discussed in Chapter 4) on the development of memory in social context is relevant to the present discussion on the development of problem-solving skills in social context. This research examined adult–child interaction as mothers worked with their 7-year-old children on a sorting and classification task (Rogoff & Gauvain, 1986). Recall children were tested after their mothers taught them how to group 18 familiar household items into six categories. On the basis of their performance on the posttest, children were identified as either low, intermediate, or high scorers. These groups were then examined in relation to the type of cognitive assistance mothers provided during the joint session, especially the types of problem-solving strategies used. Low scorers were not to any great degree exposed to the correct organization or grouping of the items during the interaction and their participation in deciding how to sort the items during the interaction was minimal. High scorers received the most guidance about the correct organization of the items and their category labels and these children participated to a large extent in the sorting decisions that were made during the interaction. Intermediate scorers had moderate levels of exposure to the category labels and moderate levels of participation. These results are similar to those found in the earlier years of childhood, and indicate that children’s participation in a social context in which strategies that are useful for solving a problem increases the likelihood that children will use these strategies in later individual performance on these same types of tasks.

Because children’s social learning opportunities in middle childhood expand to include teachers, researchers have compared the cognitive assistance provided by parents with that provided by adults who have been trained as teachers. This research shows that teachers and parents contribute differently to children’s experience during interactions involving joint problems solving. In a study with 6-year-old children, Wertsch, Minick, and Arn (1984) compared adult–child interaction with the children’s mothers and with elementary school teachers. The dyads worked on a construction task together that involved copying a three-dimensional model of a toy barnyard. The researchers studied how the various problem-solving behaviors needed to accomplish the task were performed by the partners: specifically, who looked at the model, who picked up the pieces, and who placed the pieces. They found an interesting difference between the assistance provided by mothers and that provided by teachers. Mothers were more likely than teachers to perform these three problem-solving behaviors when they worked with the children, whereas children who worked with teachers did more of these problem-solving behaviors on their own.

This difference may be due to the different levels of education that the mothers and teachers had. The mothers in this study had fewer years of schooling than the teachers. Education has been found to be an influential factor in maternal instruction (Laosa, 1980). The moth-
ers and teachers may also have had different goals when they solved the problems with the children. In other research on mother–children problem solving, Renshaw and Gardner (1990) found that most mothers adopt a learning goal rather than a performance goal when working with their children. A learning goal is associated with indirect teaching methods, including fewer regulating behaviors like checking, monitoring, and evaluation. The adults also had different relationships with the children, which also could have influenced the nature of the transactions (Gauvain & DeMent, 1991). Finally, teachers have specialized training, and this surely influences how they interact with children during joint problem solving. We now turn to a study that focused on social interaction and children’s learning with a teacher to explore in more detail how teachers may support the development of problem-solving skills.

Palinscar and Brown (1984) were interested in devising an instructional program that would help children who have difficulty comprehending what they read. The approach they developed, which is called reciprocal instruction, is based on Vygotsky’s (1978) notion of the zone of proximal development. Reciprocal instruction supports children’s learning by helping children participate in reading comprehension activities that are unable to do when they read on their own. For example, a lesson based on this approach initially involves the students and the teacher as they read a paragraph aloud. Then the teacher asks questions and examples to help the children learn how to extract meaning from the text. The teacher may begin by summarizing the main point of the paragraph, then he or she guides the children through an examination of the content of the paragraph, focusing especially on passages that need clarification. At the end of the lesson, the teacher prompts the students to anticipate what will come next. Through these graduated steps, the teacher demonstrates strategies for examining text, such as summarizing, clarifying, and predicting.

Research on this approach indicates that it does help students learn more strategically, and thereby enhances reading comprehension. The average reading comprehension score of the seventh-grade children in this research before reciprocal instruction was 20% correct. After the instruction the children’s reading comprehension averaged 80% correct—and this improvement was evident 6 months after the instruction (Palinscar, Brown, & Campione, 1993). Other research has demonstrated the effectiveness of this approach with individuals whose comprehension scores range from low to average and with children as young as fourth graders and older than seventh graders (Rosenshine & Meister, 1994, summarize these results). These findings support the general claim that solving problems with an experienced partner who targets cognitive assistance to the learner’s needs can aid the development of problem solving in a particular domain. They also support the specific claim that the strategies that children use during social participation increase the likelihood that the children will use these same strategies later on their own.

In sum, research on adult–child problem solving at different points in development reveals a consistent picture. Children are involved with more experienced partners for a very large portion of their daily lives, and these experiences often involve solving problems. There are strong indications in the research that during these interactions adults assist children in the development and use of many of the skills critical for solving problems, in particular, encoding, strategy use, and content knowledge. This does not mean that these skills originate in social interaction, though they sometimes may. Research testing this specific hypothesis has yet to be done. But research does suggest that social interaction with adults is an important source of input for children during the years in which they are developing and refining their problem-solving skills. More research is needed to pin down how specific areas of cognitive development may benefit from problem solving with adults, as well as to delineate more precisely what factors contribute to the success or failure of these transactions.

Child–Child Problem Solving

Research on adult–child problem solving reflects Vygotsky’s view that the guidance and support that occurs when children work with more experienced partners may serve as mechanisms of cognitive growth. In contrast, the Piagetian view stresses the role of cognitive conflict between partners who are closely but not identically matched in their understanding as a mechanism of individual development. From this perspective, a near-intellectual partner possessing a slightly more sophisticated understanding is the person best suited to providing intellectual impetus for growth. Although these two perspectives differ in their views on what particular arrangement of partners best facilitates cognitive growth, the main idea, that peer interaction can promote cognitive development, was proposed by both theorists (Tudge & Rogoff, 1989).

One important way in which adult–child and peer problem solving differ is when in the child’s life they begin. Whereas adult–child problem solving appears in the first year, peer problem solving comes later. How much later? Brownell and Carriger (1991) studied the early development of peer problem solving by examining the emergence of skills that are needed for this process to occur, that is, the precursors of peer
cognitive interaction. These researchers observed dyads of same-age children between the ages of 12 and 30 months. The dyads were presented with a problem that required cooperation in order to be solved. Several problem versions were used, though all involved a similar goal, which was to place small toys in a cup. In order to reach this goal, an action was required, such as pushing a lever or rotating a handle, and an obstacle, a barrier, was in place. What did the children do on these tasks? None of the 12 month olds solved the problem. Though they manipulated the materials in an effort to solve the problem, they were unable to coordinate their actions to reach the goal. Half of the 18 month olds solved the problem, but when they were presented with similar problems following success, they were unable to repeat it. All of the 24- and 30-month-old children solved the problem, and they did so multiple times.

There are several observations of interest here. First, all of the children were engaged in actions that could be called problem solving. That is, they manipulated the materials in ways that indicated some attempt to solve the problem. However, only the older children were able to coordinate their actions to reach the goal. Second, one important behavior of the older, but not younger, children that contributed to learning in social context was watching the partner’s behaviors, a process Browne and Carriger called monitoring. Although the rate of monitoring was equivalent for the 18-, 24-, and 30-month-olds, the older children were more likely to watch their partner when he or she was engaged in problem solving. Thus, it is not social attention per se but selective social attention to particular actions by the partner that is critical. These findings also suggest that very young children may face much difficulty in managing the various demands of a joint problem-solving activity. To illustrate, Table 6.1 shows the age-related patterns in the toddlers’ monitoring of one another during this task. Notice that monitoring when both children were engaged with the task increases with child age. For Brown and Carriger, this suggests that the older children were trying to establish joint task-related efforts. In contrast, younger children were more likely than older children to look at the other child when only one of the children was on task. This suggests that younger children were monitoring one another more for social than for task reasons.

It appears the younger children had greater difficulty in managing the multiple demands of joint activity. The social, cognitive, and emotional demands of joint engagement may compete or collide in such early peer interactions, and as a result these may disrupt the problem-solving activity and the chance for children to learn from the experience. Furthermore, some aspects of problem solving in social context may take precedence at certain ages. As these data suggest, the social aspects of joint cognitive activity, rather than the cognitive aspects, may be of more interest and concern to very young children. With increasing age, children pay more attention to the problem-solving efforts of other people. This may be a valuable learning tool in that it can provide children with information about the important features or actions in a problem-solving context. In many ways it is a form of social referencing, though what is being sought (or referenced) is cognitive information and not emotional information, which is typically the object of study in research on social referencing. In sum, these data indicate that children as young as 2 years of age can collaborate in certain circumstances with other children in order to solve a problem. Thus, some of the social skills required for joint problem solving are already starting to appear by this young age. Furthermore, children of this age are able in simple problem-solving situations to adjust their own actions in relation to those of a partner in order to reach a shared goal. Brown and Carriger believe that these age-related patterns relied, in good measure, on children’s increasing competence in other areas important to joint problem solving, especially communication.

Communication skills are important for children to reap the cognitive benefits of peer interaction. Much change in communication skills occurs in the preschool years. Cooper (1980) observed same-age dyads composed of either 3½- or 4½-year-old children as they balanced blocks. She found better performance by the older dyads and concluded that this was directly related to these children’s communicative skills. Older children were more responsive to their partner’s questions, which means they shared knowledge useful for solving the problem. Dyads of older children also talked more about how to label the blocks in ways that aided problem solving, suggesting that their communication focused on strategic components of the task. Finally, dyads

<table>
<thead>
<tr>
<th>Monitoring behavior</th>
<th>18 months</th>
<th>24 months</th>
<th>30 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monitor— Both task</td>
<td>6.30</td>
<td>7.40</td>
<td>8.30</td>
</tr>
<tr>
<td>Monitor— One task</td>
<td>4.70</td>
<td>3.40</td>
<td>1.70</td>
</tr>
</tbody>
</table>

with older children used more attention-focusing statements, which may have influenced how children encoded the problem space and helped the partners devise a shared definition or understanding of the problem. All of these behaviors were related to more efficient and successful problem solving by the partners. This suggests that skills that develop with age, such as communicative competence, directly impact the nature of the transactions that children have with peers during joint problem solving. This, in turn, influences the opportunities that children have when working with peers that may be useful for the development of problem-solving skills.

The research reviewed so far suggests that peer interaction can play an important role in children’s learning. But are two heads always better than one? Azmita (1988) asked this question in a study that involved 5-year-old children who worked in pairs copying a model made of plastic building blocks. This research was concerned with the general question of whether peer interaction can aid learning, as well as with the more specific question of whether certain features of peer interaction promote learning more than others. The feature of interest was expertise. Children participated in one of three conditions: (1) they worked alone, (2) they worked with a child who had the same ability as themselves on the task, or (3) they worked with a child of different ability on the task. The children had a solitary pretest and posttest in order to examine how these various social conditions related to children’s learning.

Children who work with a partner did better on the solitary posttest than those who worked alone. The benefits of collaboration were especially pronounced for children who were novices and were paired with children who were experts. What happened during these interactions that aided learning? The problem-solving behavior that distinguished novices and experts was looking at the model. Experts studied the model more than novices, indicating that they were encoding more features of the problem space. Interestingly, in same-ability dyads, experts watched each other more than novices watched each other. Thus, expert pairs studied the model and each other more than novice pairs did. What about mixed-ability dyads? When novices and experts were paired, the experts spent more time than the novices looking at the model. So what did the novices do? They watched the experts! And what they saw was someone who looked at the model—a lot.

Children’s understanding of a task before they engage in joint activity may influence what happens when children work in groups involving children of same or mixed ability. Pine and Messer (1998) observed 5- to 7-year-old children as they worked on balance beam problems in groups of four that included children of either same- or mixed-ability levels. Before solving the problems on their own, the children observed the experimenter solve several balance beam problems. The children were then assigned either to a group identified as “discussion” or to a group identified as “no discussion.” The discussion groups stayed together in their groups and talked about the balance beam problems. The no discussion groups went back to their classrooms and worked alone on these same problems. Children in the mixed-ability groups benefited more than children in same-ability groups from social experience, with one exception. Children who held to a “center theory,” the view that everything balances in the middle of the beam (which is a rudimentary and not very strategic view of the task in that only a limited number of problems can be solved successfully from this understanding), were more resistant to input from others. For these children, their skill on the balance beam remained unchanged whether or not they discussed balance beam problems with other children. These results suggest that children respond differently to information from others depending on the understanding they bring to the joint activity. These results are consistent with those by Hawkins, Homolsky, and Heide (1984), who found that changes in children’s competence from social experience may be limited to particular points or stages of skill acquisition.

These observations suggest that the opportunity to work with a peer of different expertise provides children, but especially children who are less experienced or skilled, with the chance to learn effective strategies by seeing them used, and used effectively, in the course of solving a problem. An interesting finding from the Azmita (1988) study is that same-ability dyads, compared with dyads of mixed ability, had more discussion about strategy. However, in this research, talk about strategy was not related to children’s learning from social interaction. This is interesting in relation to adult–child problem solving in which talk is a central structural feature. It appears that during peer interaction, at least in the early to middle years of childhood, opportunities to learn are largely rooted in chances to observe rather than to talk about a partner’s behaviors.

This is a puzzling finding, especially given that other research (see, e.g., Cooper, 1980) indicates that increasing communicative competence among preschoolers is related to more effective joint problem solving among peers. To explore this issue further, Teasley (1995) examined whether the type of talk that is fairly common in adult–child interaction and that has been shown to be related to children’s learning from social experience occurs when children in the years of middle childhood solve problems together. She also wondered whether, if such talk occurs, it benefits children’s learning in the same way in peer inter-
action as it does in adult-child interaction. The type of talk Teasley studied is that which emphasizes task analysis and strategy. It includes explanations, inferences, arguments, goals, plans, and strategies. Teasley called this interpretive talk, which she distinguished from descriptive talk, which includes discussion of task elements but not higher level task analysis and strategy.

In this study, dyads of 10- to 11-year-old children worked on a computer task that involved scientific reasoning. They were asked to determine how a spaceship moved, and especially to discover the function of an unlabeled computer key, referred to as “the mystery key.” Children worked in one of four social conditions: alone and encouraged to talk aloud, with a partner and encouraged to talk aloud, alone and asked not to talk aloud, and with a partner and asked not to talk aloud. These four conditions vary the extent and nature of verbal and social contact during joint problem solving and allow for closer examination of these processes.

Teasley found that the amount of talk in which children engaged, regardless of whether a child worked alone or with a partner, was related to success on the task. Also, the proportion of interpretive talk was positively related to performance and the proportion of descriptive talk was negatively related to performance. This research shows that certain types of verbalization are related to learning and suggests that the internal processing of information is different when children hear verbalizations about what they are doing. Perhaps in the course of verbalizing action, even when solving a problem alone, children may articulate or pursue ideas or thoughts that may not be considered mentally but may be helpful in learning about and solving the problem. For example, comments about motives (“Why am I doing this?”) or inferences (“So why do these two fit together?”) may be brought more into conscious awareness, and this may make them available for examination. These data do not confirm that this process is developmentally related. It is reasonable to hypothesize that with more experience solving problems, and with increasing age, that such verbalized comments may still occur, but that they may be likely to be in the form of self-talk. Although Luria (1961) argued that the verbal regulation of children’s behavior undergoes developmental change from early to middle childhood (i.e., from verbal regulation by others, to verbalized regulation by the self, to internal self-talk or self-regulation), it is possible that on new and challenging tasks even older learners may engage in and benefit from verbalized regulation either by the self or by others. Teasley’s research suggests that children in the later years of middle childhood may benefit from such talk.

Although these data suggest that verbalization by the self does ben-
not previously identified as either a close friend or as someone they disliked. A comparison of scores on the individual pretests and posttests showed that friends improved their performance following interaction more than acquaintances did. This may be explained by the fact that friends behaved differently from acquaintances during the collaborative session. Friends offered more explanations, elaborations, and critiques to each other than acquaintances did. In terms of strategy use, friends were more likely to justify their strategies and solution proposals, as well as to check and evaluate their solutions. Friends know more about each other than do acquaintances and strangers, and this may promote a different type of joint problem solving in dyads defined along this dimension. These findings suggest that during joint problem solving, friendship can benefit children's learning beyond what occurs when children work with peers who are not close friends. Thus, social relationships contribute in meaningful ways to the generation of communicative exchanges that regulate the cognitive opportunities that emerge in joint problem solving.

The evidence discussed thus far suggests that peer interaction can benefit learning. It is not clear, though, whether it is the interaction per se that matters or what the interaction contains, that is, the content that peers exchange. Recall that this same question surfaced in adult-child research and led to a study of whether face-to-face interaction was critical to the social-cognitive process (Gelman et al., 1991). Perhaps properly timed and informative feedback is sufficient to explain the benefits of peer interaction to children's cognitive development. To explore this question, Ellis, Klahr, and Siegler (1993) studied the effects of feedback and collaboration on children's learning, measured by the children's skill prior to and following the interaction. Their study focused on the domain of mathematics, specifically mathematical rules used to determine the relative values of pairs of decimal fractions. Each child solved a series of decimal problems in which he or she was asked which of two values was larger. Three social conditions were studied: children worked alone, with a partner who used the same rule, or with a partner who used a different rule. Each of these conditions was further divided into a "feedback" or a "no feedback" group. Feedback for those in the feedback group pertained to the correct answer and was provided to the child(ren) immediately following each problem. To obtain the feedback, the child(ren) pulled off a sticker covering the correct answer that was placed alongside the pair of numbers.

The investigators found that only the children who received feedback about the correctness of their answers improved their skill at solving decimal problems. Of the children who received feedback, those who worked with a partner, compared with those who worked alone, were twice as likely to improve. This indicates two points about social influences on cognitive development: one, feedback aids learning, and two, feedback in the presence of a partner enhances learning beyond receiving this same feedback when one works alone.

Further analyses of these data by Ellis (1995) looked more closely at the interactional processes in the dyads that may have led to differences in learning on this task. She found that children who generated correct strategies were likely to abandon them when their ideas were not met with interest by their partner. In contrast, children who received interest from their partners regarding their new ideas were likely to retain the correct strategy. Other social factors, like partner engagement and clarity of communication, also appear to increase the likelihood that new, correct strategies will be maintained from peer interaction.

In sum, peer interaction can be a context for individual learning and development. However, aspects of the interaction, such as relative expertise, the children's social relationship, and the availability and use of feedback, can all affect what is learned. It is clear that when problem solving occurs in a social setting, certain opportunities that can benefit learning may occur. In particular, the opportunity to elaborate or defend solutions and the chance to receive support as one tries out new or tentative strategies may enhance intellectual development in social context. Although peer interaction is less instructional than adult-child interaction, it still carries the potential to affect children's cognitive development.

THE SOCIAL CONTEXT OF PROBLEM-SOLVING INTERACTION

Recognition of the social nature of children's problem solving does not mean that this process proceeds in the same way for all children or all dyads. Characteristics of the child, the adult, the dyad, or the task may influence the course of joint problem solving, and these, in turn, may affect what children learn from social experience. The research used below to illustrate this point is not an exhaustive list of all the social-contextual factors that may contribute to this social-cognitive process. In fact, it is not clear that an exhaustive list is possible or worthwhile to generate. What is important is recognition of the complex interrelationship of social and cognitive dimensions that compose thinking in social context. This, in turn, can help direct researchers' attention to these factors in their research. Over time, this may lead to a principled understanding of how the social context of cognitive experience relates to children's learning and development.
Characteristics of the Child

Many factors characteristic of the child may influence cognitive interaction. These include child age, individual cognitive skill, social competence, and emotionality. One or all of these may influence how cognitive interaction proceeds.

The question of whether children of different ages respond differently to adult assistance was taken up by Plumert and Nichols-Whitehead (1996) in a study examining children's spatial communication. This research concentrated on young children's ability to describe a spatial location in an unambiguous way—an important developmental achievement. Three- and 4-year-old children gave directions to parents about the location of a miniature toy mouse in a dollhouse. Parents were asked to respond to their children's directions by either asking for more explicit information about the location, a condition that was referred to as "direct prompts" (e.g., "Is it in the bag behind the TV?"), or by using more open-ended questions, called "nondirect prompts" (e.g., "Which bag do you mean?"), or by not questioning the child further. The researchers found age-related differences in how children benefited from these different forms of scaffolding, with 3-year-olds benefitting less than 4-year-olds from nondirect prompts. This suggests that there are important maturational contributions in early childhood, some that can emerge even in a 1-year period, that affect children's ability to benefit from social interaction with adults. Much of the research on scaffolding emphasizes the adult's contribution to the process. This study serves as a reminder of the importance of studying the children's contribution.

As another example of the role of child characteristics in social-cognitive activity, consider how child temperament, a measure of emotional adaptability and reactivity, may mediate parent-child joint problem solving. In a study involving 2½-year-old children and their mothers, children rated by their mothers as having more difficult temperaments when the children were 18 months old received more cognitive assistance and disapproval from their mothers during joint problem solving than children rated as having less difficult temperaments (Gauvain & Fagot, 1995). Mothers of children rated as temperamentally difficult assumed more responsibility for the more challenging aspects of the tasks, such as selecting which puzzle piece to insert next, than mothers of children rated as having an easier temperament (see Table 6.2). Although performance on the individual posttest was not directly related to child temperament, children who had more involvement in the more challenging aspects of the tasks during the interaction had better posttest performance. Such experience was more common among children rated as having an easier temperament. Apparently, children perceived by their mothers as easier or less difficult have more opportunity during joint activity to discover new strategies or to practice more complex actions under their mother's tutelage than children perceived by their mothers as more difficult.

These observations raise the question as to what information is used by adults during joint activity to help them regulate problem-solving interactions with their children. Usually in studies examining adult-child interaction, the assumption is that behaviors that arise during the interaction determine the guidance adults provide. However, research by Gauvain and Fagot (1995) discussed above suggests that other factors, such as parents' awareness of and sensitivity to their children's emotionality, may influence this process. Joint cognitive tasks may be especially likely to evoke parental sensitivity to children's temperament in that such tasks may exacerbate the behavior of children with difficult temperaments and thereby create a different learning context than that which occurs for dyads that include children who are perceived as having an easier temperament. These interpersonal experiences may leave traces later on in the child's development.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean (SD)</th>
<th>Correlation with temperament rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maternal guidance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive assistance</td>
<td>32.33 (14.4)</td>
<td>.38**</td>
</tr>
<tr>
<td>Behavioral directives</td>
<td>28.35 (15.6)</td>
<td>.33*</td>
</tr>
<tr>
<td>Positive support</td>
<td>19.61 (12.6)</td>
<td>.24</td>
</tr>
<tr>
<td>Disapproval</td>
<td>17.54 (10.1)</td>
<td>.38**</td>
</tr>
<tr>
<td>Mother's task involvementa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More challenging aspects</td>
<td>2.45 (0.4)</td>
<td>.40**</td>
</tr>
<tr>
<td>Less challenging aspects</td>
<td>1.23 (0.3)</td>
<td>.12</td>
</tr>
<tr>
<td>Children's task involvementa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More challenging aspects</td>
<td>2.49 (0.4)</td>
<td>.17</td>
</tr>
<tr>
<td>Less challenging aspects</td>
<td>2.95 (0.1)</td>
<td>.08</td>
</tr>
<tr>
<td>Task performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interaction</td>
<td>15.35 (1.6)</td>
<td>.04</td>
</tr>
<tr>
<td>Posttest</td>
<td>7.08 (4.2)</td>
<td>.11</td>
</tr>
</tbody>
</table>


*Average rating, using a 3-point scale (1 = never, 2 = sometimes, 3 = always) for each partner's active involvement in the more or less challenging aspects of the task.

*p < .10; **p < .05.
In a follow-up study involving these same children, both the mother's early perception of the child's temperament and her guidance during joint problem solving when the child was 2½ years of age were related to the child's problem-solving behavior at age 5 (Fagot & Gauvain, 1997). It is not possible to determine if the relations among the earlier maternal variables (child temperament rating, cognitive assistance) and the later child variables (child independent cognitive performance on two problem-solving tasks and class behavior as rated by the teacher) were due to initial differences in the child's abilities or whether the cumulative effects of parent-child interaction led to observed child behaviors at age 5. It is likely that both contributed to the patterns observed.

Characteristics of the Partner

Characteristics of the partner, whether an adult or a child, may also influence cognitive interaction. These include the relationship between the child and the partner, such as whether the adult is the child's parent or the peer is the child's friend. The expertise of the partner also matters, as I discussed above. Another important characteristic is the gender of the partner. Researchers who study the contribution of gender to joint cognitive activity have been especially interested in whether the cognitive guidance provided by mothers and fathers is similar or different.

In general, research that has compared the cognitive interactions of mothers and fathers with their children has found few differences in the behavior of mothers and fathers. Mothers and fathers are equally capable of identifying and using the child's region of sensitivity or zone of proximal development when instructing preschoolers (Conner, Knight, & Cross, 1997; Pratt, Kerig, Cowan, & Cowan, 1988) and school-age children (Gauvain, Fagot, Leve', & Kavanagh, 2000; Radziweiska & Rogoff, 1988, 1991). For example, Conner and colleagues (1997) observed 2-year-old children interacting with their mothers and fathers separately on two different occasions and on two different tasks. After the interactions, children worked on similar tasks on their own. One task involved problem solving (building a tower of blocks) and the other involved reading a book and having the child retell the story. Mothers' and fathers' behaviors were very similar during the problem-solving task. Both provided high levels of cognitive assistance and both were likely to shift their level of assistance appropriately when needed. Parental assistance during the interaction was related to the child's later individual performance, with more contingent, sensitive assistance by the parent related to better individual performance by the child on the posttest. This is the same type of pattern reported by Wood and colleagues (Wood et al., 1976, 1978; Wood & Middleton, 1975) in their research. A different pattern of results appeared for the reading task, however. Mothers' behaviors were more contingently related to the child's behaviors than were the fathers' behaviors during joint reading.

A study involving parents and children in middle childhood reported similar task-related results, but it added child gender to the picture. Parental assistance for their 6-year-old children on two cognitive tasks, a puzzle and a picture memory task, was observed (Frankel & Rollins, 1983). Fathers provided more feedback, positive and negative, on the puzzle task, and mothers provided more feedback, positive and negative, during the memory task. Child sex was influential in that both parents were more performance- and task-oriented with sons and more cooperative with daughters, regardless of task.

Although both parents show differences across tasks, some research suggests that fathers are more affected by task than mothers. Worden, Kee, and Ingle (1987) found that mothers were more consistent than fathers in terms of verbal style on two tasks: reading picture books and interacting with alphabet-learning software on a computer. Worden et al. speculated that fathers' inconsistency across tasks may lead to increased difficulties for children when interacting with them relative to mothers. Other research supports this claim in that children appear to experience more communicative breakdowns with fathers than with mothers (Laasko, 1995; Tomasello, Conti-Ramsden, & Ewet, 1990). Fathers seem less skilled than mothers at adjusting their communicative interaction to the child's level. This may reflect the differential experience of mothers versus fathers in playing and working on joint cognitive tasks with their children (Parke, 1996). To summarize the data on mothers' and fathers' contributions to cognitive interaction with their children, it appears that both mothers and fathers are able to provide support for their children's learning during joint cognitive activity (Gauvain et al., 2000). The differences between mothers and fathers are relatively small given the large number of behaviors that have been examined and, in most cases, the differences observed were task-related.

Other characteristics of the partner have also been studied in relation to joint problem solving. For instance, parenting style appears to influence parent-child cognitive interaction. Pratt and colleagues (1988) found the authoritative parenting style positively related to more effective use by the parent of the child's region of sensitivity in joint problem solving. This suggests some link between parenting style and scaffolding when parents interact with their children. More personal qualities of the partner also appear to influence the nature of
cognitive interaction. This includes factors like an individual's skill at teaching or working with young children (Rogoff & Gauvain, 1986). The partners' emotional state, such as whether he or she is depressed (Goldsmith & Rogoff, 1995) or has attention or compliance difficulties (Gauvain & DeMent, 1991), may also influence social interaction during joint problem solving. Essentially, child or adult behaviors that interfere with the sustained concentration, coordination, and support needed to make joint problem solving successful are likely candidates for influencing the nature of cognitive interaction.

Characteristics of the Dyad

Characteristics of the dyad may also lead to variation in social interaction during joint problem solving. Such characteristics may influence two aspects of the process. First, they may determine how the partners arrange the interaction. Second, they may influence the expectations partners have for each other's behavior during the interaction, which may, in turn, regulate one or both partner's participation during problem solving. In peer collaboration, many factors play a role. Several were discussed above, including the developmental status, relative expertise, and personal relationship of the partners. In parent–child interaction, dyadic characteristics like attachment and other descriptions of the dyad's shared social history are important to consider.

Patterns of mother–child problem solving have been found to be related to attachment classifications that were determined several months prior to a problem-solving interaction (Matas, Arend, & Stroufe, 1978). In this research, secure attachment was associated with more cognitive assistance and support by mother, as well as less off-task time, nay-saying, and aggression by children. Others have observed that mothers of insecure-avoidant and insecure-resistant babies provide a poorer quality of cognitive assistance during joint problem solving (Frankel & Bates, 1990). In other research, mothers of resistant children provided less task support and were more intrusive and disapproving during joint problem solving than mothers of children classified as securely attached (Fagot, Gauvain, & Kavanagh, 1996).

One study found that mothers and children in secure and insecure groups did not differ in terms of their general problem-solving approach, that is, the information they exchanged was comparable (Moss, 1992). However, in this research the affective tone of the interaction differed, with more mutual attention and coordination in the secure group. In the insecure group, the mutual attention that did occur was usually disapproving. The researchers also found that insecure children were less likely than secure children to comply with their mother's at-
during later individual problem solving on related tasks. The type of evidence needed to support this point conclusively, namely, precise assessment of whether these strategies were in place before the joint activity occurred, is unfortunately still rare in research (Ellis et al., 1993). However, when such assessments have been conducted, evidence is mounting that children's use of strategies is affected by experience solving problems with others (see, e.g., Ellis, 1995).

Research examining strategy development and use has also asked whether scaffolding must be face to face or whether other forms of instruction are equally effective. This has been studied by providing children with problem-solving assistance on computers and by placing feedback on children’s worksheets. The information provided to children during these "nonsocial interactions" aided their understanding and related to improved performance. However, it is important to emphasize that these types of nonsocial support were designed and staged by other people and not by the material artifact that conveyed the message. Like Piaget's experiments on knot tying described at the beginning of this chapter, the contribution of the social world is inherent even in these seemingly nonsocial performances. How these various types of social experiences can be mapped into a understanding of cognitive development in social context is on the agenda for the next decade of research on children's problem solving.

The third component of problem solving is the knowledge base. Clearly, joint problem solving enhances children's knowledge, especially when children interact with more experienced partners, either adult or child. The knowledge conveyed in joint activity is mostly domain-specific, and most of the research evidence described above illustrates this contribution to development. Adults are also active in children's early years in building conceptual structures that may be less tied to specific domains but help construct the foundation of knowledge that is used later in problem solving—for example, by pointing out to children that objects can belong to a group of objects with similar properties.

Cultural knowledge is also implicit in joint problem solving, most notably with adults, but this can also occur in child-child interaction. As Goodnow (1990) states, "The social environment does not take a neutral view toward the acquisition of knowledge and skill" (p. 280). When people solve problems together they convey lots of information in addition to task descriptions, procedures, and strategies. They also transmit a set of values about thinking in a particular domain in a particular cultural context. For example, adults may communicate information to children about the types of problems that are considered worth solving ("It is important for you to know this") and that some procedures are more valued than others ("This is the best way to do this"). In social context, children also learn about the categories of thinking that problems represent ("This is a math problem"), what solving a particular type of problem entails intellectually or emotionally ("Ooh, this is going to be hard to figure out"), and whether some problems are more suited to some individuals than others ("This is the kind of problem that mathematicians do"). Goodnow (1990) laments that there is far too little understood about this type of knowledge, how it is conveyed, and what difference it makes to children's learning. In her view, studying this will lead to a broader conception of what cognitive development is all about.

The next chapter continues this discussion by focusing on the development of one particular type of problem-solving skill: planning. We live our lives in good part in the future, and skills that support our passage there—like anticipating and determining future behaviors—are critical to social, cognitive, and emotional development.