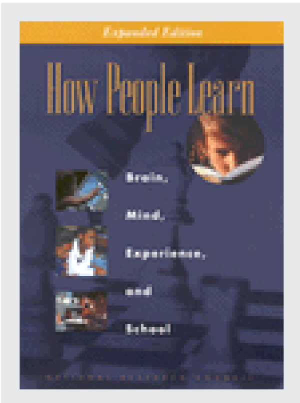

How People Learn: Brain, Mind, Experience, and School: Expanded Edition

DETAILS

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How Children Learn

Children differ from adult learners in many ways, but there are also surprising commonalities across learners of all ages. In this chapter we provide some insights into children as learners. A study of young children fulfills two purposes: it illustrates the strengths and weaknesses of the learners who populate the nation's schools, and it offers a window into the development of learning that cannot be seen if one considers only well-established learning patterns and expertise. In studying the development of children, an observer gets a dynamic picture of learning unfolding over time. A fresh understanding of infant cognition and of how young children from 2 to 5 years old build on that early start also sheds new light on how to ease their transition into formal school settings.

INFANTS' CAPABILITIES

Theories

It was once commonly thought that infants lack the ability to form complex ideas. For much of this century, most psychologists accepted the traditional thesis that a newborn's mind is a blank slate (*tabula rasa*) on which the record of experience is gradually impressed. It was further thought that language is an obvious prerequisite for abstract thought and that, in its absence, a baby could not have knowledge. Since babies are born with a limited repertoire of behaviors and spend most of their early months asleep, they certainly appear passive and unknowing. Until recently, there was no obvious way for them to demonstrate otherwise.

But challenges to this view arose. It became clear that with carefully designed methods, one could find ways to pose rather complex questions about what infants and young children know and can do. Armed with new methodologies, psychologists began to accumulate a substantial body of data about the remarkable abilities that young children possess that stands in stark contrast to the older emphases on what they lacked. It is now known that very young children are competent, active agents of their own conceptual development. In short, the mind of the young child has come to life (Bruner, 1972, 1981a, b; Carey and Gelman, 1991; Gardner, 1991; Gelman and Brown, 1986; Wellman and Gelman, 1992).

A major move away from the *tabula rasa* view of the infant mind was taken by the Swiss psychologist Jean Piaget. Beginning in the 1920s, Piaget argued that the young human mind can best be described in terms of complex cognitive structures. From close observations of infants and careful questioning of children, he concluded that cognitive development proceeds through certain stages, each involving radically different cognitive schemes.

While Piaget observed that infants actually seek environmental stimulation that promotes their intellectual development, he thought that their initial representations of objects, space, time, causality, and self are constructed only gradually during the first 2 years. He concluded that the world of young infants is an egocentric fusion of the internal and external worlds and that the development of an accurate representation of physical reality depends on the gradual coordination of schemes of looking, listening, and touching.

After Piaget, others studied how newborns begin to integrate sight and sound and explore their perceptual worlds. For perceptual learning theorists, learning was considered to proceed rapidly due to the initial availability of exploration patterns that infants use to obtain information about the objects and events of their perceptual worlds (Gibson, 1969). As information processing theories began to emerge, the metaphor of mind as computer, information processor, and problem solver came into wide usage (Newell et al., 1958) and was quickly applied to the study of cognitive development.

Although these theories differed in important ways, they shared an emphasis on considering children as active learners who are able to set goals, plan, and revise. Children are seen as learners who assemble and organize material. As such, cognitive development involves the acquisition of organized knowledge structures including, for example, biological concepts, early number sense, and early understanding of basic physics. In addition, cognitive development involves the gradual acquisition of strategies for remembering, understanding, and solving problems.

The active role of learners was also emphasized by Vygotsky (1978), who pointed to other supports for learning. Vygotsky was deeply interested in the role of the social environment, included tools and cultural objects, as well as people, as agents in developing thinking. Perhaps the most powerful idea from Vygotsky to influence developmental psychology was that of a *zone of proximal development* (Vygotsky, 1978), described in Box 4.1. It refers to a bandwidth of competence (Brown and Reeve, 1987) that learners can navigate with aid from a supportive context, including the assistance of others. (For modern treatments of this concept, see Newman et al., 1989;

BOX 4.1 Zone of Proximal Development

The zone of proximal development is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers (Vygotsky, 1978:86). What children can do with the assistance of others is even more indicative of their mental development than what they can do alone (Vygotsky, 1978:85).

The zone of proximal development embodies a concept of readiness to learn that emphasizes upper levels of competence. These upper boundaries are not immutable, however, but constantly changing with the learner's increasing independent competence. What a child can perform today with assistance she will be able to perform tomorrow independently, thus preparing her for entry into a new and more demanding collaboration. These functions could be called the "buds," rather than the fruits of development. The actual developmental level characterizes mental development retrospectively, while the zone of proximal development characterizes mental development prospectively (Vygotsky, 1978:86-87).

Moll and Whitmore, 1993; Rogoff and Wertsch, 1984; from a different theoretical perspective, see Bidell and Fischer, 1997.) This line of work has drawn attention to the roles of more capable peers, parents, and other partners in challenging and extending children's efforts to understand. It has also contributed to an understanding of the relationship between formal and informal teaching and learning situations (Lave and Wenger, 1991) and cognition distributed across people and tools (Salomon, 1993).

As a result of these theoretical and methodological developments, great strides have been made in studying young children's learning capacities. To summarize an enormous body of research, there have been dramatic increases in knowledge in four major areas of research, illustrated in this chapter:

1. *Early predisposition to learn about some things but not others* No evidence exists that infants come into the world as "blank slates" capable only of registering the ambient events that impinge on their senses in an undisciplined way. Young children show positive biases to learn types of information readily and early in life. These forms of knowledge, referred to as *privileged domains*, center on broadly defined categories, notably physi-

cal and biological concepts, causality, number, and language (Carey and Gelman, 1991).

2. *Strategies and metacognition* Outside of these privileged domains children, like all learners, must depend on will, ingenuity, and effort to enhance their learning. It was previously thought that young children lacked the strategic competence and knowledge about learning (metacognition) to learn intentionally, but the last 30 years have witnessed a great deal of research that reveals hitherto unrecognized strategic and metacognitive competence in the young (Brown and DeLoache, 1978; DeLoache et al., 1998).

3. *Theories of mind* As they mature, children develop theories of what it means to learn and understand that profoundly influence how they situate themselves in settings that demand effortful and intentional learning (Bereiter and Scardamalia, 1989). Children entertain various theories of mind and intelligence (Dweck and Legget, 1988). Indeed, not all learners in schools come ready to learn in exactly the same way. Some theorists argue that there is more than one way to learn, more than one way to be "intelligent." Understanding that there are multiple intelligences (Gardner, 1983) may suggest ways of helping children learn by supporting their strengths and working with their weakenesses.

4. *Children and community* Although a great deal of children's learning is self-motivated and self-directed, other people play major roles as guides in fostering the development of learning in children. Such guides include other children as well as adults (caretakers, parents, teachers, coaches, etc.). But not only people can serve as guides; so, too, can powerful tools and cultural artifacts, notably television, books, videos, and technological devices of many kinds (Wright and Huston, 1995). A great deal of research on such assisted learning has been influenced by Vygotsky's notion of zones of proximal development and the increasing popularity of the concept of "communities of learners," be they face-to-face or through electronic media and technologies (see Chapters 8 and 9).

Methodological Advances

The large increase in the number of studies that address early learning came about as a result of methodological advances in the field of developmental psychology. Much of what is now known about the human mind comes from the study of how infants learn. This work demonstrates that the human mind is a biologically prepared organism (Carey and Gelman, 1991). In order to study what babies know and can learn about readily, researchers needed to develop techniques of "asking" infants, who cannot speak, what they know. Because infants are so limited physically, experimenters interested in finding out how babies think had to find methods suitable to an infant's motor capabilities. New ways were developed for measuring what infants prefer to look at (Fantz, 1961) and detecting changes in events to which they are sensitive. Three such methods are non-nutritive sucking, habituation, and visual expectation.

Non-nutritive sucking is a way to use a physical capability that even the youngest infants have. In one experiment, the researchers (Kalnins and Bruner, 1973) showed 5- to 12-week-old infants a silent color film and gave the infants a pacifier to suck, the nipple of which was connected to a pressure switch that controlled the projector lens. The infants quickly learned to suck at a given rate to bring the movie into focus, showing not only that they were capable of and interested in learning how to control their own sensory environment, but also that they preferred a clear image to a blurry one.

The second method demonstrates an infant's thirst for novelty. The habituation paradigm involves presenting babies with an event (a stimulus)—a picture, sound, or series of sounds—to which the baby attends either by looking at it, turning to it, or doing something to keep the event continuing. Over a period of time infants stop responding to repeated presentations of the same event: that is, they *habituate*. They recover interest if a recognizably different event is presented. A combination of non-nutritive sucking and habituation was used in a study (Eimas et al., 1971) to show that 4-month-old infants will suck vigorously when first introduced to the phoneme (speech sound) "ba," then gradually lose interest and stop sucking. But when presented with a different phoneme, "pa," they resume sucking.

Because infants will look at things they find interesting, researchers developed the method of visual expectation to study infants' comprehension of events. It uses infants' gaze patterns to determine if they are comprehending patterns of visual events. For example, an experimenter establishes a pattern of flashing a picture two times on the left side of a screen and then three times on the right side. Once this alternating pattern has been established, the experimenter can watch an infant's gaze while the pictures continue to be flashed. If the baby continues to gaze at the left side of the screen after one flash, but then shifts its gaze to the right side after the second picture appears, then it is assumed that a distinction has been made between one, two, and three events. Using this procedure, infants as young as 5 months have shown that they can count up to three (Canfield and Smith, 1996).

Thus, using infants' capacities for looking, sucking, and interest in novelty, developmental psychologists devised methods for reliably studying early aspects of infant cognition. These studies have been refined for studying early infant memory development by using bodily actions, such as leg kicking and arm movements, for determining object recognition (Rovee-Collier, 1989).

Studies like these do more than simply show that infants actively select experiences; they also demonstrate what infants are capable of perceiving, knowing, and remembering. Recovery of interest in a novel speech sound could only occur if infants could recognize the rather subtle difference between "pa" and "ba." Discovering that very young infants can see, hear, smell, and be particular about what exactly they wish to explore led to an emboldened attitude about the kinds of experimental questions that could be asked. The answers about infant understanding of physical and biological causality, number, and language have been quite remarkable. These studies have profoundly altered scientific understanding of how and when humans begin to grasp the complexities of their worlds. In the next section, we present a few examples of infants' learning in these domains.

EARLY COMPETENCIES IN THE PRIVILEGED DOMAINS

Physical Concepts

How do infants learn about the physical world? Research studies have demonstrated that infants as early as 3-4 months of age have the beginnings of useful knowledge. Three examples from many: they understand that objects need support to prevent them from falling; that stationary objects are displaced when they come into contact with moving objects; and that inanimate objects need to be propelled into motion.

Consider the notion of support—that an object cannot be suspended in mid-air. In one study, infants are seated in front of a table that includes a platform. They see an experimenter's gloved hand reach out from a side window and put a box on top of the platform (possible event) and then withdraw her hand. Alternatively, when the experimenter reaches out from the side window, she places the box beyond the platform, leaving the impression that the box is suspended in mid-air when she withdraws her hand (impossible condition); see Figure 4.1.

Using the visual habituation methodology, studies have found that infants as young as 3 months old look reliably longer at the impossible events. This reaction indicates that infants *expect* that a box can be stable when a hand releases it onto a platform, but not when there is no supporting platform (Baillargeon et al., 1992; Needham and Baillargeon, 1993; Kolstad and Baillargeon, 1994); see Figure 4.2.

In a study of visual fixation on consistent and inconsistent events with light and heavy objects, Schilling and Clifton (1998) also showed that 9-month-old infants look longer at the physically inconsistent events than those that are consistent with their expectations; see Figure 4.3. Another well-documented example of infants' early understanding of physical causality is that stationary objects are displaced when hit by moving objects. Research studies have demonstrated that infants as young as 2-1/2 months understand

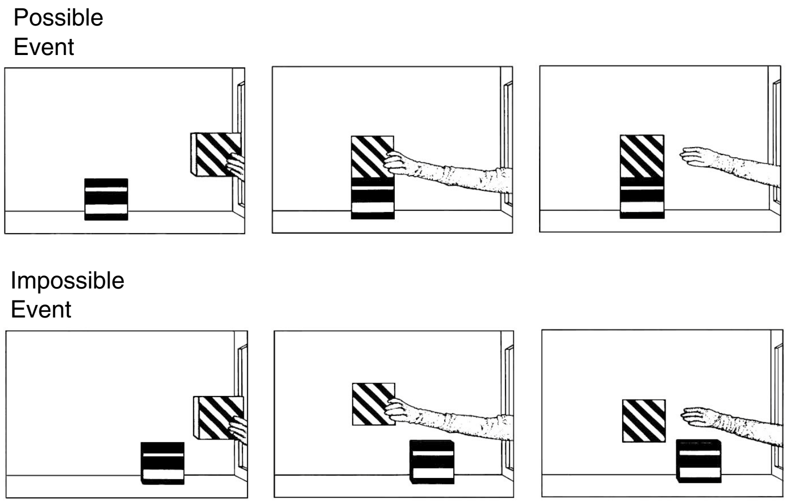

FIGURE 4.1 *Testing infants' understanding of possible and impossible physical events. SOURCE: Test events used in Needham and Baillargeon (1993).*

this concept, though it is not until about 6-1/2 months of age that they relate the size of the moving object and the distance of displacement of the stationary objects. "When looking at collision events between a moving and a stationary object, infants first form an initial concept centered on an impact/no-impact decision. With further experience, infants begin to identify variables that influence this initial concept" (Baillargeon, 1995:193).

In the first year of life, infants can understand that inanimate objects need to be propelled into action, that the objects cannot move themselves. For example, Leslie (1994a,b) showed that 4- to 7-month-old infants expect a point of contact to be involved in physical displacement. In one study, the infant watches a film in which a hand approaches a stationary doll and either appears to pick it up (contact condition) and moves away or the doll moves in tandem but without physical contact (no-contact condition). Using the habituation methodology, Leslie demonstrated that infants are highly sensitive to spatiotemporal discontinuities: they see the hand as an agent to cause movement in an inanimate object, but the no-contact conditions are seen as anomalous events—violations of causal principles.

The early understandings just described are soon reflected in children's spontaneous actions. In studies of his own young children's exploratory play, Piaget found that by 12 months of age they clearly understood the

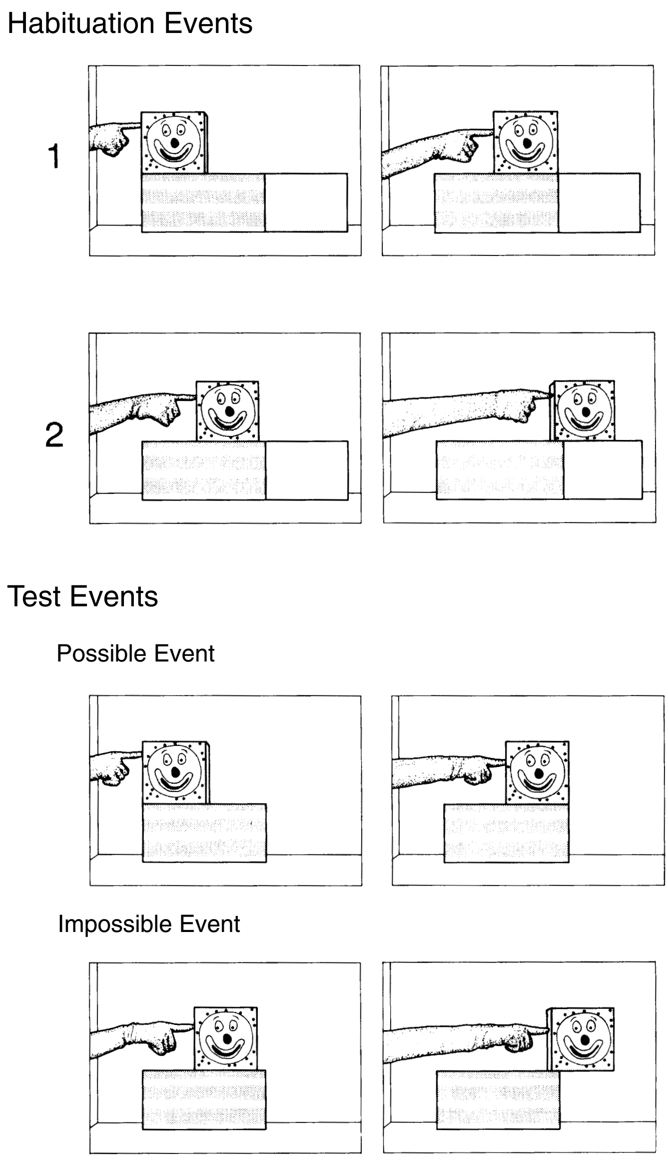

FIGURE 4.2 *Habituation and test for physical concepts. SOURCE: Test events used in Baillargeon, Needham, and Devos (1992).*

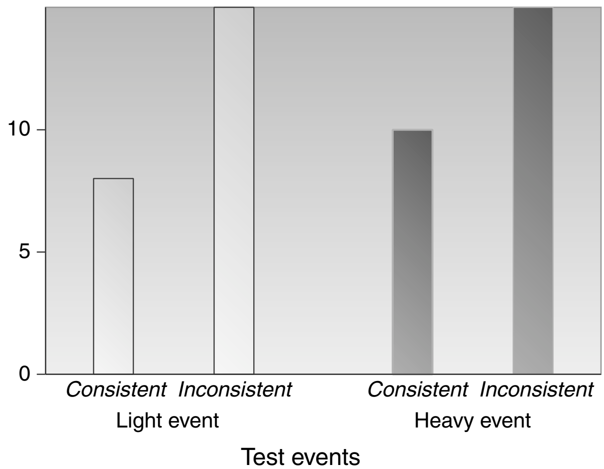

FIGURE 4.3 *Average visual fixation duration. SOURCE: Adapted from Schilling and Clifton (1998).*

need for a point of contact to bring inanimate objects into range. For example, Jacqueline (9 months) discovers that she can bring a toy within reach by pulling a blanket (support) on which it is placed. During the weeks that follow, she frequently uses this "schema" (Piaget, 1952:285). Lucienne (12 months), once having witnessed the action of the support, rapidly generalized the schema to sheets, handkerchiefs, table cloths, pillows, boxes, books, and so on. Once the baby understood the notion of the support, this knowledge transferred rapidly to a variety of potential supports. The same learning is true of stick-like things (push schema) and string-like objects (pull schema), as "means for bringing" (Piaget, 1952:295). Each new acquisition brings with it its own realm of generalization.

A series of laboratory studies has reaffirmed and extended Piaget's original naturalistic observations and provided a fairly detailed description of development of the push/pull schema from 4 to 24 months of age. As noted above, Leslie showed that 7-month-olds are sensitive to the need for point of contact in a pushing scenario. Bates et al. (1980) looked at infants' ability to reach a toy using various tools. And Brown and Slattery (described in Brown, 1990) looked at children's ability to choose the correct tool (with adequate length, rigidity, and pushing or pulling head) from an array of available tools. It was not until 24 months of age that children immediately selected the adequate tool, but by 14 months children could do so with some practice. Across the age range of 10-24 months, children first used tools effectively that were physically attached (unbreakable contact) in contrast to tools that could be unattached at the contact point (breakable contact) or when the point of contact needed to be imagined (no contact). Children showed distress or surprise at trick events—when a tool appeared to be attached but wasn't or vice versa, thus violating their pulling schema (Brown, 1990).

These studies, taken together, paint an interesting developmental scenario. Although children in habituation paradigms seem to understand the need for point of contact early (5-7 months), they cannot at 10 months apply that knowledge to tool use tasks *unless* the contact between the tool and the goal is provided in the physical layout of the task: the tool touches the object; the solution is physically situated in the environment itself. Several months later, infants can learn, with a demonstration, to envision the point of contact that is not specified in the visual array, but is invited by the pulling features of the tools. They can see that a hook would work in getting the tool if it is rigid and long enough. By 24 months, children readily note the pulling potential of unattached tools and can make a choice between available tools on the basis of their adequacy. The research shows that young children have the requisite knowledge in some sense very early on, but they need help in the form of demonstrations to prompt the application of what they know.

Biological Causality

During the past 30 years, a great deal has been learned about primitive concepts of biological causality. We concentrate here on the differences between animate and inanimate objects.

Infants learn rapidly about the differences between inanimate and animate: as we have seen, they know that inanimate objects need to be pushed or propelled into motion. Infants as young as 6 months can distinguish animate versus inanimate movements as patterns of lights attached to forces or people (Bertenthal, 1993). And Spelke (1990) has shown that if two people come close together and move away in tandem without touching, 7-months-olds show no surprise; but if two people-sized inanimate objects come together and move without a point of contact, they are perturbed (as measured by the habituation paradigm).

Young children show an early understanding that animate objects have the potential to move themselves because they are made of "biological stuff"—they obey what R. Gelman (1990) calls the "innards principle of mechanism." Inanimate objects, in contrast, obey the external-agent principle: they cannot move themselves, but must be propelled into action by an external force.

For example, Massey and Gelman (1988) reported that 3- and 4-year-old children correctly responded when asked if novel objects like an echidna and a statue can move themselves up and down a hill. Despite the fact that the echidna looked less like a familiar animal than did a statue, the children claimed that only the living object could move itself up and down a hill.

Similarly, young children in this age range can give sensible answers to questions about the difference between the insides and outsides of animals, machines, and natural inanimate objects; see Figure 4.4.

These are only a handful of findings from a large body of research that goes a long way to challenge the idea that young children are incapable of considering non-perceptual data in scientific areas. Given that there is a mounting body of evidence showing that youngsters are busy constructing coherent accounts of their physical and biological worlds, one needs to ask to what extent these early competencies serve as a bridge for further learning when they enter school.

Early Number Concepts

An ever-increasing body of evidence shows that the human mind is endowed with an implicit mental ability that facilitates attention to and use of representations of the number of items in a visual array, sequence of drumbeats, jumps of a toy bunny, numerical values represented in arrays, etc. For example, Starkey et al. (1990) showed 6- to 8-month-old infants a series of photographic slides of either 2- or 3-item displays. Each successive picture showed different household items, including combs, pipes, lemons, scissors, and corkscrews that varied in color, shape, size, and texture and spatial position. Half of the infants saw a series of two-item displays while the other half were shown a series of three-item displays. When they became bored, their looking times dropped by 50 percent (they habituated). At this point, they were then shown displays that alternated between two and three items, and if the displays showed a different number of items from what they had seen before, the infants began to show interest by looking again. The only common characteristic within the two-item and three-item displays was their numerical value, so one can say the infants habituated to the set of two or three things and then recovered interest when they were shown a different number of things. The infants could have focused on perceptual attributes of the items such as their shapes, motion, textural complexity, and so on, but they did not. This is an important clue that they are able to process information that represents number at a rather abstract level.

Other researchers have shown that infants pay attention to the number of times a toy rabbit jumps up and down, so long as the number of jumping events they have to keep track of is kept between two and four jumps (Wynn, 1996). An especially interesting demonstration of infants' ability to notice abstract number information in the environment was reported by Canfield and Smith (1996). They found that 5-month-old infants used visual expectation (see previous section) to show that infants are able to distinguish three pictures presented in one location from two pictures in another.

Young infants and toddlers also respond correctly to the effects of the

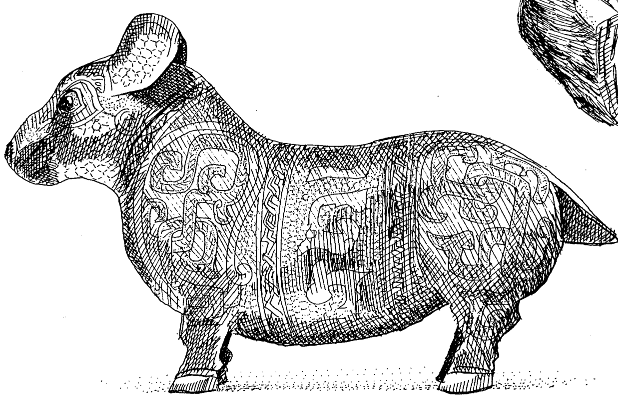

FIGURE 4.4 *Drawings used in studying preschoolers' reasoning about movement. SOURCE: Massey and Gelman (1988:309).*

arithmetic operations of adding and subtracting. Through their surprise or search reactions, young children are able to tell us when an item is added or subtracted from what they expected (Wynn, 1990, 1992a, b; Starkey, 1992). For example, 5-month-old infants first saw two objects repeatedly; then a screen covered the objects and they watched as an experimenter proceeded to add another object or remove one from the hidden display. The screen was then removed, revealing one more or one less item than before. In both the less and more conditions, infants looked longer at the numerically "incorrect" display—that is, the unexpected value that did not correspond to their initial training; if they saw one added, they expected three, not one, and vice versa (Wynn, 1992a, b).

Experimental evidence of this kind implies a psychological process that relates the effect of adding or removing items to a *numerical representation* of the initial display. A similar line of evidence with preschool children indicates that very young children are actively engaged in using their implicit knowledge of number to attend to and make sense of novel examples of numerical data in their environments; see Box 4.2.

There are many other demonstrations of young children's interpreting sets of objects in terms of number. Together, the findings indicate that even young children can actively participate in their own learning and problem solving about number. This ability is why children often deal with novel conditions rather well, as when they tell puppets who are "just learning to count" if they are correct and if they are wrong or even invent counting solutions (Groen and Resnick, 1977; Siegler and Robinson, 1982; Starkey and Gelman, 1982; Sophian, 1994).

But just because children have some knowledge of numbers before they enter school is not to say that there is little need for careful learning later. Early understanding of numbers can guide their entry into school-based learning about number concepts. Successful programs based on developmental psychology already exist, notably the Right Start Program (Griffin and Case, 1997). Although making the entry levels easier, these early number concepts can also be problematic when it comes to the transitions to higher-level mathematics. Rational numbers (fractions) do not behave like whole numbers, and attempting to treat them as such leads to serious problems. It is therefore noteworthy that many children experience just these sorts of problems in mathematics when they encounter "fractions": They believe the larger number always represents a bigger quantity or larger unit.

Early Attention to Language

We introduced the idea that children come equipped with the means necessary for understanding their worlds when considering physical and biological concepts. It should not be surprising that infants also possess

BOX 4.2 How Many?

How do 3- to 5-year old children react when they encounter unexpected changes in the number of items? Before the dialog below, children had been playing with five toy mice that were on a plate; the plate and mice were then covered and the experimenter surreptitiously took away two mice before uncovering the plate (Gelman and Gallistel, 1978:172). What follows is one child's attempts to reconcile the differences in the number of mice:

Child:	*Must have disappeared.*
Experimenter:	*What?*
Child:	*The other mousses?...*
Experimenter:	*How many now?*
Child:	*One, two, three.*
Experimenter:	*How many at the beginning of the game?*
Child:	*There was one there, one there, one there, one there, one there.*
Experimenter:	*How many?*
Child:	*Five—this one is three now but before it was five.*
Experimenter:	*What would you need to fix the game?*
Child:	*I'm not really sure because my brother is real big and he could tell.*
Experimenter:	*What do you think he would need?*
Child:	*Well I don't know...Some things have to come back.*
Experimenter:	[Hands the child some objects including four mice].
Child:	[Puts all four mice on the plate]. *There. Now there's one, two, three, four, five, six, seven! No...I'll take these* [points to two] *off and we'll see how many.*
Child:	[Removes one and counts]. *One, two, three, four, five; no—one, two, three, four. Uh...there were five, right?*
Experimenter:	*Right.*
Child:	*I'll take out this one here [on the table] and then we'll see how many there is now.*
Child:	[Takes one off and counts]. *One, two, three, four, five. Five! Five.*

such mechanisms for learning language. They begin at an early age to develop knowledge of their linguistic environments, using a set of specific mechanisms that guide language development.

Infants have to be able to distinguish linguistic information from nonlinguistic stimuli: they attribute meaning and linguistic function to words and not to dog barks or telephone rings (Mehler and Christophe, 1995). By 4 months of age, infants clearly show a preference for listening to words over other sounds (Colombo and Bundy, 1983). And they can distinguish changes in language. For example, after being habituated to English sentences, infants detected the shift to a different language, such as Spanish; they did not register shifts to different English utterances (Bahrick and Pickens, 1988), which indicates that they noticed the novel Spanish utterances. Figure 4.5 illustrates that American-born infants, at 2 months of age, start reacting to English utterances significantly faster than they do to French utterances. Young infants learn to pay attention to the features of speech, such as intonation and rhythm, that help them obtain critical information about language and meaning. As they get older, they concentrate on utterances that share a structure that corresponds to their maternal language, and they neglect utterances that do not.

By 6 months of age, infants distinguish some of the properties that characterize the language of their immediate environment (Kuhl et al., 1992). Around 8-10 months of age, infants stop treating speech as consisting of mere sounds and begin to represent only the linguistically *relevant* contrasts (Mehler and Christophe, 1995). For example, Kuhl et al. (1992) have shown that the contrasts "ra" and "la" can be learned by very young English and Japanese babies alike, but later on only the contrast relevant to the mother

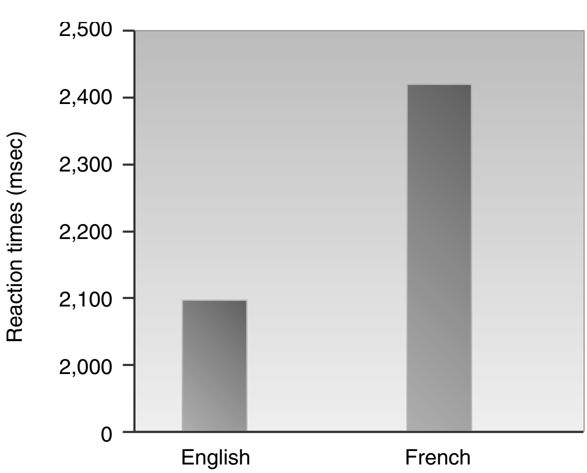

FIGURE 4.5 *Reaction time to French and English sentences for 2-month-old infants. Mean latencies of initiation of a visual saccade in the direction of the sound for American 2-month-olds listening to French and English sentences. SOURCE: Adapted from Mehler and Christophe (1995:947).*

language is retained as the other one drops out (e.g., "la" drops out for Japanese infants). Such studies illustrate that the learning environment is critical for determining what is learned even when the basic learning mechanisms do not vary.

Young infants are also predisposed to attend to the language spoken by others around them. They are attracted to human faces, and look especially often at the lips of the person speaking. They appear to expect certain types of coordination between mouth movements and speech. When shown videos of people talking, infants can detect the differences between lip movements that are synchronized with the sounds and those that are not.

Young children also actively attempt to understand the meaning of the language that is spoken around them. Roger Brown (1958) discussed "The Original Word Game" that children play with parents. Successful participation involves the child's making inferences about what someone must mean by paying attention to the surrounding context. Parents of 1-year-olds report that their children understand much of what is said to them, although there is obviously a great deal of information that children really do not understand (Chapman, 1978). For example, Lewis and Freedle (1973) analyzed the comprehension abilities of a 13-month-old child. When handed an apple while she was in her high chair and told "Eat the apple," the child bit it. When handed an apple while playing in her playpen and told "Throw the apple," the child threw it. Lewis and Freedle performed an experiment in order to test whether the child really understood words such as "eat" and "throw." They handed the child an apple while she was in her high chair and asked her to "throw the apple." The child bit it. Later, when the child was in her playpen she was handed an apple and told "eat the apple." She threw it. The child's strategy was basically to assume that she should "do what you usually do in this situation." This sound strategy is frequently correct.

In everyday settings, young children have rich opportunities for learning because they can use context to figure out what someone must mean by various sentence structures and words. Unless she was being tested by tricky experimenters, for example, the child discussed above could determine the general meanings of "apple," "eat," and "throw." Similarly, if a mother says "Get your shirt" while pointing to the only loose object (a shirt) on the rug, the child begins to understand the meaning of "get" and "shirt." Language acquisition cannot take place in the absence of shared social and situational contexts because the latter provide information about the meanings of words and sentence structures (Chapman, 1978). The child uses meaning as a clue to language rather than language as a clue to meaning (MacNamara, 1972). Parents and other caregivers take into account both context and children's emerging abilities as they help them extend their competencies. The extremely important guiding role that caregivers have in children's cognitive development is discussed further below.

Language development studies illustrate that children's biological capacities are set into motion by their environments. The biological underpinnings enable children to become fluent in language by about age three, but if they are not in a language-using environment, they will not develop this capacity. Experience is important; but the opportunity to use the skills—practice—is also important. Janellen Huttenlocher, for example, has shown that language has to be practiced as an ongoing and active process and not merely passively observed by watching television (Huttenlocher, cited in *Newsweek*, 1996).

STRATEGIES FOR LEARNING AND METACOGNITION

So far we have reviewed research that has tapped into infants' amazing competencies that biologically predispose them to learn. These predispositions help prepare human infants for the complex challenges of adaptive learning that come later in life. In order to thrive, children must still engage in self-directed and other-directed learning, even in areas of early competence. In this section we look at how children learn about things that they would not be predisposed to attend to, such as chess or the capital cities of countries. We discuss how children come to be able to learn almost anything through effort and will.

It has generally been assumed that in the arena of deliberate, intentional, mindful, and strategic learning, young children are woefully inadequate. But recent scientific studies have revealed hitherto unsuspected strategic competence and metacognitive knowledge in young children.

The Importance of Capacity, Strategies, Knowledge, and Metacognition

A traditional view of learning and development was that young children know and can do little, but with age (maturation) and experience (of any kind) they become increasingly competent. From this view, learning is development and development is learning. There is no need to postulate special forms of learning nor for learners to be particularly active (see Bijou and Baer, 1961; Skinner, 1950). Yet even in privileged domains, as described above, this passive view does not fully apply.

In addition, research in another major area began to show how learners process information, remember, and solve problems in nonprivileged domains. Known as information processing (Simon, 1972; Newell and Simon, 1972), this branch of psychology was quickly adopted to explain developments in children's learning. All human learners have limitations to their short-term memory for remembering and for solving problems. Simon (1972) and others (e.g., Chi, 1978; Siegler, 1978; Klahr and Wallace, 1973) argued that development means overcoming information-processing constraints, such as limited short-term memory capacity. The crucial argument for developmental psychologists is whether young learners are particularly hampered by memory limitations and whether, compared with adults, they are less able to overcome general limitations through the clever use of strategies or by lack of relevant knowledge factors.

One view of learning in children is that they have a less memory capacity than adults. While there is no doubt that, in general, children's learning and memory abilities increase with age, controversy surrounds the mechanisms that affect these changes. One view is that children's short-term memory capacity, or the amount of mental space they have (M-space), increases as children mature (Pascual-Leone, 1988). With more mental space, they can retain more information and perform more complex mental operations. A complementary view is that the mental operations of older children are more rapid, enabling them to make use of their limited capacity more effectively (Case, 1992). If one holds either of these positions, one would expect relatively uniform improvement in performance across domains of learning (Case, 1992; Piaget, 1970).

A second view is that children and adults have roughly the same mental capacity, but that with development children acquire knowledge and develop effective activities to use their minds well. Such activities are often called strategies. There are a variety of well-known strategies that increase remembering, such as rehearsal (repeating items over and over), which tends to improve rote recall (Belmont and Butterfield, 1971); elaboration (Reder and Anderson, 1980), which improves retention of more meaningful units such as sentences; and summarization (Brown and Day, 1984), which increases retention and comprehension. These are just three of many strategies.

Perhaps the most pervasive strategy used to improve memory performance is clustering: organizing disparate pieces of information into meaningful units. Clustering is a strategy that depends on organizing knowledge. In a classic paper, Miller (1956) described the persistence of a phenomenon he called the "magical number 7 ± 2" in human mental processing. Given a list of numbers to remember, sounds (phonemes) to distinguish from one another, or a set of unrelated facts to recall, there is a critical change in performance at around seven items. Up to seven items (between five and nine, actually, hence Miller's title), people can readily handle a variety of tasks; with more than seven, they simply cannot process them handily. People have developed ways around this memory constraint by organizing information, such as grouping together or "chunking" disparate elements into sets of letters, numbers, or pictures that make sense to them.

Known as the chunking effect, this memory strategy improves the performance of children, as well as adults. A prototype experiment would involve, for example, presenting 4- to 10-year-olds with long lists of pictures to remember, far more than they could if they simply tried to remember them individually. Such a list might consist of pictures of a cat, rose, train, hat, airplane, horse, tulip, boat, coat, etc. Given a 20-item list, older children remember more than younger children, but the factor responsible for better recall is not age per se, but whether the child notices that the list consists of four *categories* (animals, plants, means of transportation, and articles of clothing). If the categories are noticed, young children often recall the entire list. In the absence of category recognition, performance is poorer and shows the age effect. Younger children employ categorization strategies less often than older ones. However, the skill is knowledge related, not age related; the more complex the categories, the older the child is before noticing the structure. One has to know a structure before one can use it.

These varying views of children's learning have different implications for what one expects from children. If one believes that learning differences are determined by gradual increases in capacity or speed of processing, one would expect relatively uniform increases in learning across most domains. But if one believes that strategies and knowledge are important, one would expect different levels of learning, depending on the children's conceptual knowledge and their control over strategies that organize that knowledge for learning. For example, in a comparison of college students' and third graders' abilities to recall 30 items that included the names of Saturday morning television shows, children's cartoon characters, etc., the third graders clustered more and subsequently recalled more (Linberg, 1980). Similarly, a group of 8- to 12-year-old "slow learners" performed much better than "normal" adults on a task of recalling large numbers of pop stars because of a clustering strategy (Brown and Lawton, 1977). An outstanding example of the intertwining of capacity, knowledge, and strategies in children's chess performance is provided in Box 2.1 (see Chapter 2).

Metacognition is another important aspect of children's learning (see Brown, 1978; Flavell and Wellman, 1977). The importance of prior knowledge in determining performance, crucial to adults as well as children, includes knowledge about learning, knowledge of their own learning strengths and weaknesses, and the demands of the learning task at hand. Metacognition also includes self-regulation—the ability to orchestrate one's learning: to plan, monitor success, and correct errors when appropriate—all necessary for effective intentional learning (Bereiter and Scardamalia, 1989).

Metacognition also refers to the ability to reflect on one's own performance. Whereas self-regulation may appear quite early, reflection appears to be late developing. If children lack insight to their own learning abilities, they can hardly be expected to plan or self-regulate efficiently. But metacognition does not emerge full-blown in late childhood in some "now you have it, now you don't" manner. The evidence suggests that, like other forms of learning, metacognition develops gradually and is as dependent on knowledge as experience. It is difficult to engage in self-regulation and reflection in areas that one does not understand. However, on topics that children know, primitive forms of self-regulation and reflection appear early (Brown and DeLoache, 1978).

Attempts at deliberate remembering in preschool children provide glimpses of the early emergence of the ability to plan, orchestrate, and apply strategies. In a famous example, 3- and 4-year-old children were asked to watch while a small toy dog was hidden under one of three cups. The children were instructed to remember where the dog was. The children were anything but passive as they waited alone during a delay interval (Wellman et al., 1975). Some children displayed various behaviors that resemble well-known mnemonic strategies, including clear attempts at retrieval practice, such as looking at the target cup and nodding yes, looking at the non-target cups and nodding no, and retrieval cueing, such as marking the correct cup by resting a hand on it or moving it to a salient position. Both of these strategies are precursors to more mature rehearsal activities. These efforts were rewarded: children who prepared actively for retrieval in these ways more often remembered the location of the hidden dog. Box 4.3 shows a glimmer of even earlier emergence of "rehearsal."

These attempts to aid remembering involve a dawning awareness of metacognition—that without some effort, forgetting would occur. And the strategies involved resemble the more mature forms of strategic intervention, such as rehearsal, used by older school-aged children. Between 5 and 10 years of age, children's understanding of the need to use strategic effort in order to learn becomes increasingly sophisticated, and their ability to talk about and reflect on learning continues to grow throughout the school years (Brown et al., 1983). By recognizing this dawning understanding in children, one can begin to design learning activities in the early school years that build on and strengthen their understanding of what it means to learn and remember.

Multiple Strategies, Strategy Choices

The strategies that children use to memorize, conceptualize, reason, and solve problems grow increasingly effective and flexible, and are applied more broadly, with age and experience. But different strategies are not solely related to age. To demonstrate the variety, we consider the specific case of the addition of single-digit numbers, which has been the subject of a great deal of cognitive research.

Given a problem such as 3 + 5, it was initially believed that preschool children add up from 1 (i.e., 1,2,3|4,5,6,7,8), that 6- to 8-year-olds add by

BOX 4.3 Remembering Where Big Bird Is

For a group of 18- and 24-month-old children, an attractive toy, Big Bird, was hidden in a variety of locations in a playroom, such as behind a pillow, on a couch, or under a chair. The children were told that "Big Bird is going to hide, and when the bell rings, you can find him." While waiting to retrieve the toy, even though they were engaged by an adult in play and conversation, the children did not wait passively. Instead, they often interrupted their play with a variety of activities that showed they were still preoccupied with the memory task. They talked about the toy, saying, "Big Bird"; the fact that it was hidden, "Big Bird hiding"; where it was hidden, "Big Bird, chair"; or about their plan to retrieve it later, "Me find Big Bird." Other rehearsal-like behaviors included looking or pointing at the hiding place, hovering near it, and attempting to peek at the toy. Although less systematic and well formed than an older person's rehearsal strategies, the young children's activities similarly function to keep alive the information to be remembered, the hidden toy and its location (DeLoache et al., 1985a).

counting from the larger number ("5, then 6, 7, 8,"), and that from 9 years on, children retrieve answers from memory because they know the answer (Ashcraft, 1985; Resnick and Ford, 1981). More recently, however, a more complex and interesting picture has emerged (Siegler, 1996). On a problem-by-problem basis, children of the same age often use a wide variety of strategies. This finding has emerged in domains as diverse as arithmetic (Cooney et al., 1988; Geary and Burlingham-Dubree, 1989; Goldman et al., 1988; Siegler and Robinson, 1982), causal and scientific reasoning (Lehrer and Schauble, 1996; Kuhn, 1995; Schauble, 1990; Shultz, 1982), spatial reasoning (Ohlsson, 1991); referential communications (Kahan and Richards, 1986), recall from memory (Coyle and Bjorklund, 1997), reading and spelling (Jorm and Share, 1983), and judgments of plausibility (Kuhara-Kojima and Hatano, 1989). Even the same child presented the same problem on two successive days often uses different strategies (Siegler and McGilly, 1989). For example, when 5-year-olds add numbers, they sometimes count from 1, as noted above, but they also sometimes retrieve answers from memory, and sometimes they count from the larger number (Siegler, 1988).

The fact that children use diverse strategies is not a mere idiosyncrasy of human cognition. Good reasons exist for people to know and use multiple strategies. Strategies differ in their accuracy, in the amounts of time their execution requires, in their processing demands, and in the range of problems to which they apply. Strategy choices involve tradeoffs among these properties. The broader the range of strategies that children know and can appreciate where they apply, the more precisely they can shape their approaches to the demands of particular circumstances.

Even young children can capitalize on the strengths of different strategies and use each one for the problems for which its advantages are greatest. For example, for an easy addition problem such as 4+1, first graders are likely to retrieve the answer; for problems with large differences between the numbers, such as 2+9, they are likely to count from the larger number ("9,10,11"); for problems excluding both of these cases, such as 6+7, they are likely to count from one (Geary, 1994; Siegler, 1988). The adaptiveness of these strategy choices increases as children gain experience with the domain, though it is obvious even in early years (Lemaire and Siegler, 1995).

Once it is recognized that children know multiple strategies and choose among them, the question arises: How do they construct such strategies in the first place? This question is answered through studies in which individual children who do not yet know a strategy are given prolonged experiences (weeks or months) in the subject matter; in this way, researchers can study how children devise their various strategies (Kuhn, 1995; Siegler and Crowley, 1991; see also DeLoache et al., 1985a). These are referred to as "microgenetic" studies, meaning small-scale studies of the development of a concept. In this approach, one can identify when a new strategy is first used, which in turn allows examination of what the experience of discovery was like, what led to the discovery, and how the discovery was generalized beyond its initial use.

Three key findings have emerged from these studies: (1) discoveries are often made not in response to impasses or failures but rather in the context of successful performance; (2) short-lived transition strategies often precede more enduring approaches; and (3) generalization of new approaches often occurs very slowly, even when children can provide compelling rationales for their usefulness (Karmiloff-Smith, 1992; Kuhn, 1995; Siegler and Crowley, 1991). Children often generate useful new strategies without ever having generated conceptually flawed ones. They seem to seek conceptual understanding of the requisites of appropriate strategies in a domain. On such tasks as single-digit addition, multidigit subtraction, and the game of tic-tac-toe, children possess such understanding, which allows them to recognize the usefulness of new, more advanced strategies before they generate them spontaneously (Hatano and Inagaki, 1996; Siegler and Crowley, 1994).

The new understanding of children's strategic development has led to instructional initiatives. A common feature of such innovations as reciprocal teaching (Palincsar and Brown, 1984), communities of learners (Brown and Campione, 1994, 1996; Cognition and Technology Group at Vanderbilt, 1994), the ideal student (Pressley et al., 1992), and Project Rightstart (Griffin et al., 1992) is that they recognize the importance of students' knowing and using diverse strategies. These programs differ, but all are aimed at helping students to understand how strategies can help them solve problems, to recognize when each strategy is likely to be most useful, and to transfer strategies to novel situations. The considerable success that these instructional programs have enjoyed, with young as well as older children and with low-income as well as middle-income children, attests to the fact that the development of a repertoire of flexible strategies has practical significance for learning.

Multiple Intelligences

Just as the concept of multiple strategies has improved understanding of children's learning and influenced approaches to education, so, too, has the growing interest in multiple forms of intelligence. In his theory of multiple intelligences, Gardner (1983, 1991) proposed the existence of seven relatively autonomous intelligences: linguistic, logical, musical, spatial, bodily kinesthetic, interpersonal, and intrapersonal. Recently, Gardner (1997) proposed an eighth intelligence, "naturalistic." The first two intelligences are those typically tapped on tests and most valued in schools.

The theory of multiple intelligences was developed as a psychological theory, but it sparked a great deal of interest among educators, in this country and abroad, in its implications for teaching and learning. The experimental educational programs based on the theory have focused generally in two ways. Some educators believe that all children should have each intelligence nurtured; on this basis, they have devised curricula that address each intelligence directly. Others educators have focused on the development of specific intelligences, like the personal ones, because they believe these intelligences receive short shrift in American education. There are strengths and weaknesses to each approach.

The application of multiple intelligences to education is a grass roots movement among teachers that is only just beginning. An interesting development is the attempt to modify traditional curricula: whether one is teaching history, science, or the arts, the theory of multiple intelligences offers a teacher a number of different approaches to the topic, several modes of representing key concepts, and a variety of ways in which students can demonstrate their understandings (Gardner, 1997).

CHILDREN'S VIEWS OF INTELLIGENCE AND THEIR LEARNING: MOTIVATION TO LEARN AND UNDERSTAND

Children, like their elders, have their own conceptions about their minds and those of others and how humans learn and are "intelligent" (see Wellman, 1990; Wellman and Hickey, 1994; Gelman, 1988; Gopnik, 1990). Children are said to have one of two main classes of beliefs: entity theories and incremental theories (Dweck, 1989; Dweck and Elliot, 1983; Dweck and Leggett, 1988). Children with entity theories believe that intelligence is a fixed property of individuals; children with incremental theories believe that intelligence is malleable (see also Resnick and Nelson-LeGall, 1998). Children who are entity theorists tend to hold performance goals in learning situations: they strive to perform well or appear to perform well, attain positive judgments of their competence, and avoid assessments. They avoid challenges that will reflect them in poor light. They show little persistence in the face of failure. Their aim is to perform well. In contrast, children who are incremental theorists have learning goals: they believe that intelligence can be improved by effort and will. They regard their own increasing competence as their goal. They seek challenges and show high persistence. It is clear that children's theories about learning affect how they learn and how they think about learning. Although most children probably fall on the continuum between the two theories and may simultaneously be incremental theorists in mathematics and entity theorists in art, the motivational factors affect their persistence, learning goals, sense of failure, and striving for success. Teachers can guide children to a more healthy conceptualization of their learning potential if they understand the beliefs that children bring to school.

Self-Directed and Other-Directed Learning

Just as children are often self-directed learners in privileged domains, such as those of language and physical causality, young children exhibit a strong desire to apply themselves in intentional learning situations. They also learn in situations where there is no external pressure to improve and no feedback or reward other than pure satisfaction—sometimes called achievement or competence motivation (White, 1959; Yarrow and Messer, 1983; Dichter-Blancher et al., 1997). Children are both problem solvers and problem generators; they not only attempt to solve problems presented to them, but they also seek and create novel challenges. An adult struggling to solve a crossword puzzle has much in common with a young child trying to assemble a jigsaw puzzle. Why do they bother? It seems that humans have a need to solve problems; see Box 4.4. One of the challenges of schools is to build on children's motivation to explore, succeed, understand (Piaget, 1978) and harness it in the service of learning.

GUIDING CHILDREN'S LEARNING

Along with children's natural curiosity and their persistence as self-motivated learners, what they learn during their first 4 or 5 years is not learned

BOX 4.4 Solving a Problem

Children 18 to 36 months of age are given nesting cups to play with (DeLoache et al., 1985b; see also Karmiloff-Smith and Inhelder, 1974, on children balancing blocks). Five plastic cups are dumped on a table in front of a child, who is simply told, "These are for you to play with." Although the children have previously seen the cups nested together, there was no real need for them to attempt to nest the cups themselves; they could easily have stacked them, made an imaginary train, pretended to drink from them, etc. However, the children immediately started trying to fit the cups together, often working long and hard in the process.

Overall, in their spontaneous manipulations of a set of nesting cups, very young children progress from trying to correct their errors by exerting physical force without changing any of the relations among the elements, to making limited changes in a part of the problem set, to considering and operating on the problem as a whole. This "developmental" trend is observed not only across age, but also in the same children of the same age (30 months) given extensive time to play with the cups.

Most important, the children persist, not because they have to, or are guided to, or even because they are responding to failure; they persist because success and understanding are motivating in their own right.

in isolation. Infants' activities are complemented by adult-child relationships that encourage the gradual involvement of children in the skilled and valued activities of the society in which they live. Research has shown that learning is strongly influenced by these social interactions. In fact, studies of interactions of drug-abusing mothers and their infants show how the absence of these critical learning interactions depresses 3- and 6-month-old infants' learning (Mayes et al., 1998).

Parents and others who care for children arrange their activities and facilitate learning by regulating the difficulty of the tasks and by modeling mature performance during joint participation in activities. A substantial body of observational research has provided detailed accounts of the learning interactions between mothers and their young children. As an illustration, watch a mother with a 1-year-old sitting on her knees in front of a collection of toys. A large part of her time is devoted to such quietly facilitative and scene-setting activities as holding a toy that seems to require three hands to manipulate, retrieving things that have been pushed out of range, clearing away those things that are not at present being used in order to provide the child with a sharper focus for the main activity, turning toys so that they become more easily grasped, demonstrating their less obvious properties, and all along molding her body in such a way as to provide maximal physical support and access to the play materials (Schaffer, 1977:73).

In addition to the research showing how adults arrange the environment to promote children's learning, a great deal of research has also been conducted on how adults guide children's understanding of how to act in new situations through their emotional cues regarding the nature of the situation, nonverbal models of how to behave, verbal and nonverbal interpretations of events, and verbal labels to classify objects and events (Rogoff, 1990; Walden and Ogan, 1988). Parents frame their language and behavior in ways that facilitate learning by young children (Bruner, 1981a, b, 1983; Edwards, 1987; Hoff-Ginsberg and Shatz, 1982). For example, in the earliest months, the restrictions of parental baby talk to a small number of melodic contours may enable infants to abstract vocal prototypes (Papousek et al., 1985). Parental labeling of objects and categories may assist children in understanding category hierarchies and learning appropriate labels (Callanan, 1985; Mervis, 1984). Communication with caregivers to accomplish everyday goals is the groundwork for children's early learning of the language and other cognitive tools of their community; see Box 4.5.

An extremely important role of caregivers involves efforts to help children connect new situations to more familiar ones. In our discussion of competent performance and transfer (see Chapter 3), we noted that knowledge appropriate to a particular situation is not necessarily accessed despite being relevant. Effective teachers help people of all ages make connections among different aspects of their knowledge.

Caregivers attempt to build on what children know and extend their competencies by providing supporting structures or scaffolds for the child's performance (Wood et al., 1976). Scaffolding involves several activities and tasks, such as:

- interesting the child in the task;
- reducing the number of steps required to solve a problem by simplifying the task, so that a child can manage components of the process and recognize when a fit with task requirements is achieved;
- maintaining the pursuit of the goal, through motivation of the child and direction of the activity;
- marking critical features of discrepancies between what a child has produced and the ideal solution;
- controlling frustration and risk in problem solving; and
- demonstrating an idealized version of the act to be performed.

Scaffolding can be characterized as acting on a motto of "Where before there was a spectator, let there now be a participant" (Bruner, 1983:60).

BOX 4.5 Which Toy?

Consider the efforts to reach an understanding between an adult and a 14-month-old about which toy the infant wants to play with. The adult is looking for a toy in the toy box. When he touches the tower of rings, the baby exclaims, "Aa!" The adult responds, "Aa?" picking up the tower. The infant continues looking at the toy box and ignores the tower, so the adult shows the baby the tower and again asks "Aa?" The baby points at something in the toy box grunting, "Aa . . . aa . . . " The adult reaches toward the toy box again, and the infant exclaims, "Tue!" The adult exclaimed "Aa!" as he picks up the peekaboo cloth and shows it to the infant. But the infant ignores the cloth and points again at something in the toy box, then, impatiently, waves his arm. The adult responds, "Aa?" But the baby points down to the side of the toy box. They repeat the cycle with another toy, and the baby waves his arm impatiently. The adult says "You show me!" and lifts the baby to his lap from the high chair. The adult then picks up the jack-in-the-box, asking, "This?"—the baby opens his hand toward the toy, and they began to play (Rogoff et al., 1984:42-43).

Learning to Read and Tell Stories

The importance of adult support of children's learning can be demonstrated by considering the question: How is it that children, born with no language, can develop most of the rudiments of story telling in the first three years of life? (Engle, 1995). A variety of literacy experiences prepare children for this prowess. Providing children with practice at telling or "reading" stories is an impetus to the growth of language skills and is related to early independent reading; see Box 4.6. For many years some parents and scholars have known about the importance of early reading, through picture book "reading" that is connected to personal experiences. Recently, the efficacy of this process has been scientifically validated—it has been shown to work (see National Research Council, 1998).

In the late nineteenth century, C. L. Dodgson—Lewis Carroll—prepared a nursery version of his famous *Alice in Wonderland/Through the Looking Glass* books. The majority of the book consisted of reprints of the famous Tenniel woodcut illustrations. The book was to stimulate "reading" in the sense that contemporary children's wordless picture books do. This was a first of its kind, and we quote Lewis Carroll (cited in Cohen, 1995:440).

> I have reason to believe that "Alice's Adventures in Wonderland" has been read by some hundreds of English Children, aged from Five to Fifteen: also by Children aged from Fifteen to Twenty-five: yet again by Children aged

BOX 4.6 Baby Reading

Sixteenth-month-old Julie is left alone temporarily with a visiting grandfather. Wishing to distract the child from her mother's absence, he starts "reading" a picture book to her. On each page is an animal and its "baby." Julie shows interest as a spectator until they came to a picture of a kangaroo and its "joey." She quickly says "Kanga, baby." Pointing to a shirt with Kanga and Roo (from *Winnie the Pooh*), she says again, "Kanga" "baby." Grandfather repeats each utterance. Then he says: "Where's Julie's Kanga?" knowing that she has recently received a large stuffed animal from Australia. With great excitement, Julie pulls the stuffed animal over to her grandfather and, pointing to the book, says "Kanga, baby," then points to the stuffed toy, "Kanga" and to the joey in the pouch, "baby." Communication had been reached with much laughter and repetition of the Kanga/baby routine. Even at the one-word utterance stage, children can "read," "refer," and "represent" across settings (Brown, personal communication).

> from Twenty-five to Thirty-five . . . And my ambition now (is it a vain one?) is that it will be read by Children aged from Nought to Five. To be read? Nay, not so! Say rather to be thumbed, to be cooed over, to be dogs'-eared, to be rumpled, to be kissed, by the illiterate, ungrammatical.

A preeminent educator, Dodgson had a pedagogical creed about how "Nursery Alice" should be approached. The subtext of the book is aimed at adults, almost in the fashion of a contemporary teacher's guide; they were asked to bring the book to life. The pictures were the primary focus; much of the original tale is left unspecified. For example, when looking at the famous Tenniel picture of Alice swimming with mouse in a pool of her own tears, Carroll tells the adult to read to the child as follows (cited in Cohen, 1995:441):

> Now look at the picture, and you'll soon guess what happened next. It looks just like the sea, doesn't it? But it really is the Pool of Tears—all made of Alice's tears, you know!
>
> And Alice has tumbled into the Pool: and the Mouse has tumbled in: and there they are swimming about together.
>
> Doesn't Alice look pretty, as she swims across the picture? You can just see her blue stockings, far away under the water.
>
> But Why is the Mouse swimming away from Alice is such a hurry? Well, the reason is, that Alice began talking about cats and dogs: and a Mouse always hates talking about cats and dogs!
>
> Suppose you were swimming about, in a Pool of your own Tears: and suppose somebody began talking to you about lesson-books and bottles of medicine, wouldn't you swim as hard as you could go?

Carroll, a natural teacher, guides caretakers through the task of concentrating the child's attention on the picture, prodding the child's curiosity by asking questions, and engaging the child in a dialogue—even if the child's contribution is initially limited. Carroll asks the adult to lead the child through literacy events by developing "habits of close observation." He cleverly suggests certain truths about human and animal nature, and he opens up a realm of fun and nonsense that the child can share with the adult reading the story (Cohen, 1995:442).

When caregivers engage in picture book "reading," they can structure children's developing narrative skills by asking questions to organize children's stories or accounts (Eisenberg, 1985; McNamee, 1980). If the child stops short or leaves out crucial information, adults may prompt, "What happened next?" or "Who else was there?" Such questions implicitly provide children with cues to the desired structure of narratives in their environment.

For example, one mother began reading with her child, Richard, when he was only 8 months old (Ninio and Bruner, 1978). The mother initially did all the "reading," but at the same time she was engaged in "teaching" Richard the ritual dialogue for picture book reading. At first she appeared to be content with any vocalization from the baby, but as soon as he produced actual words, she increased her demands and asked for a label with the query, "What's that?" The mother seemed to increase her level of expectation, first coaxing the child to substitute a vocalization for a nonvocal sign and later a well-formed word for a babbled vocalization. Initially, the mother did all the labeling because she assumed that the child could not; later, the mother labeled only when she believed that the child would not or could not label for himself. Responsibility for labeling was thereby transferred from the mother to the child in response to his increasing store of knowledge, finely monitored by the mother. During the course of the study the mother constantly updated her inventory of the words the child had previously understood and repeatedly attempted to make contact with his growing knowledge base.

Middle-class children between 1-1/2 and 3 years often provide labels spontaneously. One group of children did such labeling as "There's a horsie" or asked the mothers for information "What's this?" (DeLoache, 1984). With the 3-year-olds, the mothers went far beyond labeling; they talked about the relation among the objects in the picture, related them to the children's experiences, and questioned the children about their outside experience. For example, "That's right, that's a beehive. Do you know what bees make? They make honey. They get nectar from flowers and use it to make honey, and then they put the honey in the beehive." The mothers use the situation and the material to provide the children with a great deal of background information. They continually elaborate and question information, which are comprehension-fostering activities that must later be applied to "real" reading tasks.

In these reading activities, mothers are attempting to function in what psychologists call a child's zone of proximal development—to stretch what the child can do with a little assistance (see Box 4.1 above). As the child advances, so does the level of collaboration demanded by the mother. The mother systematically shapes their joint experiences in such a way that the child will be drawn into taking more and more responsibility for their joint work. In so doing, she not only provides an excellent learning environment, she also models appropriate comprehension-fostering activities; crucial regulatory activities are thereby made overt and explicit.

Story telling is a powerful way to organize lived and listened-to experiences, and it provides an entry into the ability to construe narrative from text. By the time children are 3 or 4, they are beginning narrators; they can tell many kinds of stories, including relating autobiographical events, retelling fiction, and recalling stories they have heard. The everyday experiences of children foster this story telling. Children like to talk and learn about familiar activities, scripts or schemes, the "going to bed" script or the "going to McDonald's" script (Nelson, 1986; Mandler, 1996). Children like to listen to and retell personal experiences. These reminiscences are stepping stones to more mature narratives. As they get older, children increase their levels of participation by adding elements to the story and taking on greater pieces of the authorial responsibility. By 3 years of age, children in families in which joint story telling is common can take over the leadership role in constructing personal narratives.

Reminiscing also enables children to relate upsetting experiences; such narratives act as "cooling vessels" (Bruner, 1972), distancing the experience and confirming the safe haven of homes and other supportive environments. This early interest in sharing experience, joint picture book reading, and narrative, in general, have obvious implications for literary appreciation in preschool and early grades. Indeed, the KEEP (Au, 1981; Au and Jordan, 1981) program in Hawaii and the Reciprocal Teaching Program (Palinscar and Brown, 1984) in urban U.S. cities were both explicitly modeled after the natural interactions; they attempted to build on them and model the style. Connection-making and scaffolding by parents to support children's mathematical learning has also proved a successful intervention (Saxe et al., 1984; Byrnes, 1996) that has been mimicked in school settings.

Cultural Variations in Communication

There are great cultural variations in the ways in which adults and children communicate, and there are wide individual differences in communication styles within any cultural community. All cultural variations provide strong supports for children's development. However, some variations are more likely than others to encourage development of the specific kinds of knowledge and interaction styles that are expected in typical U.S. school environments. It is extremely important for educators—and parents—to take these differences into account.

Conversing, Observing, or Eavesdropping

In some communities, children are seldom direct conversational partners with adults, but rather engage with adults by participating in adult activities. In such situations, children's learning occurs through observing adults and from the pointers and support provided by adults in the contexts of ongoing activities. Such engagements contrast sharply with patterns common in other communities, in which adults take the role of directly instructing young children in language and other skills through explicit lessons that are not embedded in the contexts of ongoing activities (Ochs and Schieffelin, 1984; Rogoff, 1990; Rogoff et al., 1993).

For example, Pueblo Indian children are provided access to many aspects of adult life and are free to choose how and with whom to participate (John-Steiner, 1984). Their reports of their own learning stress their role as "apprentices" to more experienced members of the community (Suina and Smolkin, 1994). Observation and verbal explanation occur in the contexts of involvement in the processes as they are being learned.

In an African-American community of Louisiana, in which children are expected to be "seen and not heard," language learning occurs by eavesdropping. "The silent absorption in community life, the participation in the daily commercial rituals, and the hours spent overhearing adults' conversations should not be underestimated in their impact on a child's language growth" (Ward, 1971:37). "Nothing is censored for children's ears; they go everywhere in the community except Saturday-night parties." Older children teach social and intellectual skills: "Alphabets, colors, numbers, rhymes, word games, pen and pencil games are learned . . . from older children. No child, even the firstborn, is without such tutelage, since cousins, aunts, and uncles of their own age and older are always on hand" (Ward, 1971:25).

In this community, small children are not conversational partners with adults, as in the sense of other people with whom one converses. If children have something important to say, parents will listen, and children had better listen when their parents speak to them. But for conversation, adults talk to adults. Questions between older children and adults involve straightforward requests for information, not questions asked for the sake of conversation or for parents to drill children on topics to which the parents already know the answers. Mothers' speech to children, while not taking the form of a dialogue, is carefully regularized, providing precise, workable models of the language used in the community (Ward, 1971).

Schooling and the Role of Questioning

Detailed ethnographic research studies have shown striking differences in how adults and children interact verbally. Because of the prevalence of the use of questions in classrooms, one particularly important difference is how people treat questions and answers. One classic study, a comparison between the questioning behavior of white middle-class teachers in their own homes and the home question interaction of their working-class African-American pupils, showed dramatic differences (Heath, 1981, 1983). The middle-class mothers began the questioning game almost from birth and well before a child could be expected to answer. For example, a mother questions her 8-week-old infant, "You want your teddy bear?" and responds for the child, "Yes, you want your bear" (see Box 4.6 above). These rituals set the stage for a general reliance on questioning and pseudo-questioning interactions that serve a variety of social functions. Children exposed to these interaction patterns seem compelled to provide an answer and are quite happy to provide information that they know perfectly well an adult already possesses.

Such "known-answer" questions, where the interrogator has the information being requested, occur frequently in classroom dialogues (Mehan, 1979). Teachers routinely call on children to answer questions that serve to display and practice their knowledge, rather than to provide information that the teacher does not know. Similarly, in middle-class homes, known-answer questions predominate. For example, in one 48-hour period, almost half the utterances (48% of 215) addressed to 27-month-old Missy were questions; of these questions, almost half (46%) were known-answer questions (Heath, 1981, 1983).

In general, questions played a less central role in the home social interaction patterns of the African-American children; in particular, there was a notable lack of known-answer rituals (Heath, 1981, 1983). The verbal interactions served a different function, and they were embedded within different communicative and interpersonal contexts. Common questioning forms were analogy, story-starting, and accusatory; these forms rarely occurred in the white homes. For example, the African-American children were commonly asked to engage in the sophisticated use of metaphors by responding to questions that asked for analogical comparisons. The children were more likely to be asked "What's that like?" or "Who's he acting like?" rather than "What's that?" Such questions reflected the African-American adults' assumptions that preschool children are adept at noting likenesses between things, assumptions that are also revealed in speech forms other than questioning, such as frequent use of similes and metaphors. The adults were asked about and value metaphorical thinking and narrative exposition initiated by a storytelling question: one participant indicated a willingness to tell a story using the question form, "Did you see Maggie's dog yesterday?" The appropriate answer to such a query is not "yes" or "no," but another question, "No, what happened to Maggie's dog yesterday?" that sets the stage for the initiator's narrative. Both adults and older preschool children were totally familiar with these questioning rituals and played them enthusiastically.

These examples emphasize the systematic differences between the form and function of questioning behaviors in the working-class black and middle-class white communities that were studied. Neither approach is "deficient," but the match between the activities that predominate in classrooms at the early grades is much greater with middle-class homes than with working-class ones in that community. As the middle-class teachers practiced their familiar questioning routines with their pupils, it is not surprising that the middle-class pupils, who shared the teacher's background, successfully fulfilled the answerer role, while the working-class African-American children were often perplexed (Heath, 1981, 1983). Moreover, teachers were sometimes bewildered by what they regarded as the lack of responsible answering behavior on the part of their black pupils. They commented (Heath, 1981:108):

> They don't seem to be able to answer even the simplest questions.
>
> I would almost think some of them have a hearing problem; it is as though they don't hear me ask a question. I get blank stares to my question. When I am making statements or telling stories which interest them, they always seem to hear me.
>
> The simplest questions are the ones they can't answer in the classroom; yet on the playground, they can explain a rule for a ballgame, etc. They can't be as dumb as they seem in my class.
>
> I sometimes feel that when I look at them and ask a question I'm staring at a wall I can't break through.

However, as the teachers learned about the types of metaphoric and narrative question sequences with which the children are familiar, they were able to gradually introduce the unfamiliar known-answer routines. This is an excellent example of the "two-way path, from school to the community and from the community to school" (Heath, 1981:125) that is needed if the transition to formal schooling is to be made less traumatic for ethnically diverse groups. Not only can interventions be devised to help minority-culture parents prepare children for school, but the schools themselves can be sensitive to the problems of cultural mismatches. The answer is not to concentrate exclusively on changing children or changing schools, but to encourage adaptive flexibility in both directions.

CONCLUSION

The concept of "development" is critical to understanding the changes in children's thinking, such as the development of language, causal reasoning, and rudimentary mathematical concepts.

Young children are actively engaged in making sense of their worlds. In some particular domains, such as biological and physical causality, number, and language, they have strong predispositions to learn rapidly and readily. These predispositions support and may even make possible early learning and pave the way for competence in early schooling. Yet even in these domains, children still have a great deal of learning to do.

Children's early understanding of the perceptual and physical world may jump-start the learning process, even making learning possible, but one should look with caution for ways in which early knowledge may impede later learning. For example, children who treat rational numbers as they had treated whole numbers will experience trouble ahead. Awareness of these roadblocks to learning could help teachers anticipate the difficulty.

Although children learn readily in some domains, they can learn practically anything by sheer will and effort. When required to learn about nonprivileged domains they need to develop strategies of intentional learning. In order to develop strategic competence in learning, children need to understand what it means to learn, who they are as learners, and how to go about planning, monitoring, revising, and reflecting upon their learning and that of others. Children lack knowledge and experience but not reasoning ability. Although young children are inexperienced, they reason facilely with the knowledge they have.

Children are both problem solvers and problem generators: children attempt to solve problems presented to them, and they also seek novel challenges. They refine and improve their problem-solving strategies not only in the face of failure, but also by building on prior success. They persist because success and understanding are motivating in their own right.

Adults help make connections between new situations and familiar ones for children. Children's curiosity and persistence are supported by adults who direct their attention, structure their experiences, support their learning attempts, and regulate the complexity and difficulty levels of information for them.

Children, thus, exhibit capacities that are shaped by environmental experiences and the individuals who care for them. Caregivers provide supports, such as directing children's attention to critical aspects of events, commenting on features that should be noticed, and in many other ways providing structure to the information. Structure is critical for learning and for moving toward understanding information. Development and learning are not two parallel processes. Early biological underpinnings enable certain types of interactions, and through various environmental supports from caregivers and other cultural and social supports, a child's experiences for learning are expanded. Learning is promoted and regulated both by children's biology and ecology, and learning produces development.