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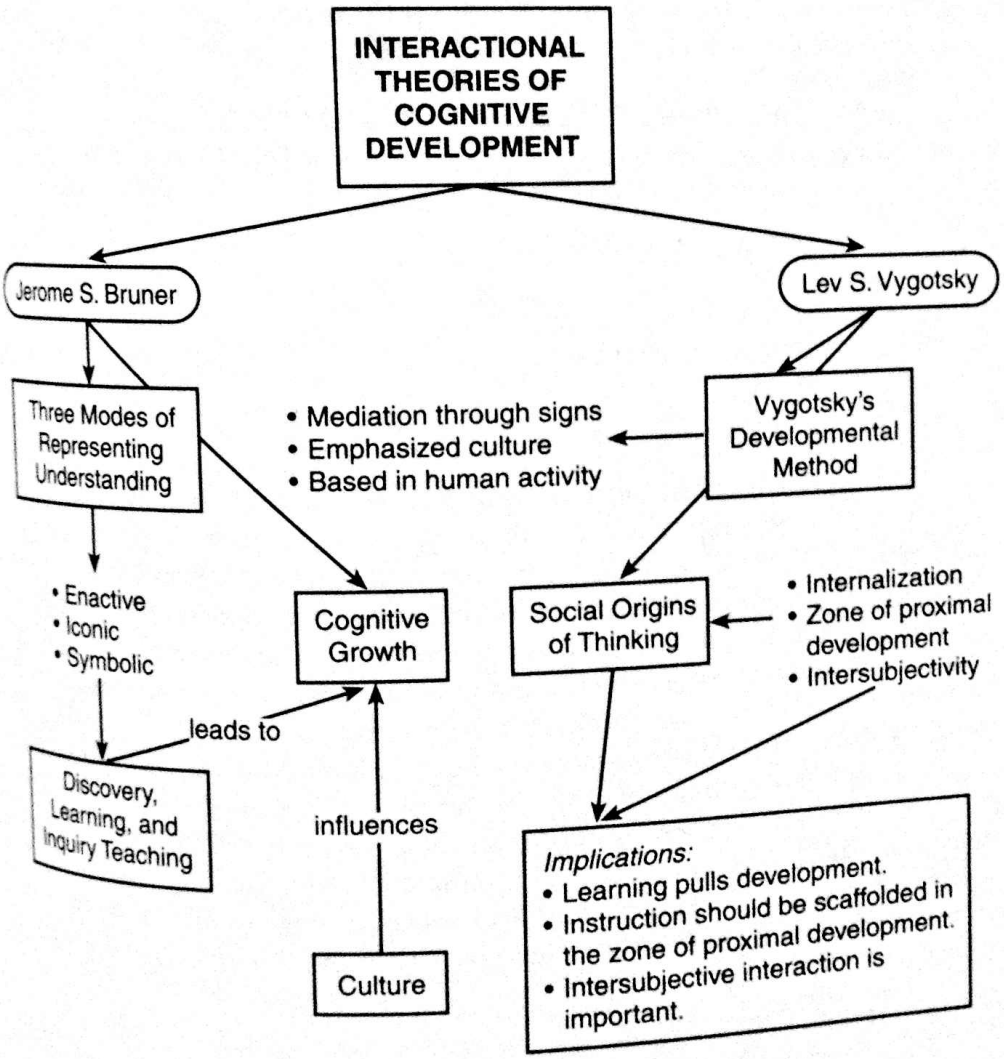
Interactional Theories of Cognitive Development



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Consider the following scenarios.

• *Pet Monkey*[1]

Mrs. Bell teaches kindergarten in a school district zoned to increase integration of underrepresented minority children into its predominantly white schools. She has a class of nineteen and begins a lesson with eight students on the concepts of animals with four legs and pets. She draws two overlapping circles on the chalkboard, and says, "The blue circle is for all animals that have four legs. The red circle is for pets. Now I want you to think of some animals and what circle they belong in."

As the children clamor to make suggestions, Mrs. Bell questions them about where the animals belong (in the blue circle, in the red circle, or in both, and thus in their intersection). She also asks the children to justify their selection. Then, with each correct classification, Mrs. Bell hands her chalk to someone, who comes to the board and makes a mark in one of the circles or in the intersection. During the course of the lesson, the following scene takes place.

[1]This scenario was inspired by Ennihovich (1981), who studied interaction patterns among kindergarten children as a function of their race and gender.

Mrs. B: Shannon, have you thought of another animal? (She calls on a petite girl, who has been waving her hand madly.)

Shannon: Yes, a monkey.

Mrs. B: And where does your monkey belong?

Shannon: (Softly) In the red circle.

Mrs. B: In the red circle? Why does it belong there? Is a monkey a pet?

Darren: (A boy who has been clowning around, paying no apparent attention to the lesson) I know someone who had a monkey for a pet!

Mrs. B: (Ignores Darren, paces in front of the board holding the chalk close to her chest) But where do you find monkeys?

Chorus: In the circus!

Mrs. B: So, is a monkey a pet if it's in the circus? Shannon?

Shannon: (Softly) Maybe.

Mrs. B: (Tries again) But don't people usually keep pets in their homes? (Shannon nods) Monkeys aren't usually kept at home, because they don't make very good pets. So where does your monkey belong?

Shannon: In the blue circle. (Mrs. B hands Shannon the chalk to put a mark in the blue circle.)

• *Beginning Spanish*[2]

Pete and Richard are high school students in a third-year Spanish class. The teacher has put students in pairs for an "information gap" activity in which the two participants sit opposite one another with a wooden barrier between them. Both have a diagram of puzzle pieces, and the task is to work together in Spanish to find out and draw what each other one has in front of him. When finished, the partners should have a representation of the same diagram.

Pete begins the activity.

Pete: Oh, un momento. El semicircula *faire*...um...no, not *faire*, that's French (general laughter)...um...el semicircula derecha de el...um ...de el botóm...which way does it face? Down, right?

Richard: Arriba.

Pete: ¿Arriba?

Richard: Sí.

[2]The conversation in this scenario is taken from Brooks and Donato (1994), who argued for a Vygotskian approach to understanding the discourse of foreign language learners.

Pete: Oh, we're all screwed up!

Richard: Okay, hold it...um...no dere—no arriba.

What is going on in these scenarios? How might we explain the events described in terms of the learning theories discussed so far? From a behaviorist perspective, we might say that Mrs. Bell in Pet Monkey rewards correct responses with the chalk and opportunity to write on the chalkboard. Thus, Shannon is rewarded only when she acknowledges that a monkey is not a pet and so belongs in the blue circle instead of the red circle. Darren, on the other hand, is ignored by the teacher. This prompts a logical hypothesis that Mrs. Bell considers his behavior disruptive and hopes to extinguish it.

An information-processing perspective on Beginning Spanish would suggest that Pete and Richard are engaged in decoding and encoding messages about the task at hand. Pete experiences interference when he retrieves the French word *faire* from memory instead of the Spanish word he is trying to remember.

But have we now understood all the events related to learning in the two scenarios? Some researchers have argued that current theories of learning and development overlook the social and cultural context within which cognitive development and learning occur. In other words, the events in Pet Monkey and Beginning Spanish do not take place in a vacuum, and so they must be infused with expectations and patterns of interaction that are culturally based.

In Pet Monkey, for example, the teacher might be viewed as perpetuating a metaphor of teacher as authority figure. She, after all, has knowledge and power, and it is her agenda that prevails in the classroom. Children soon learn, as Shannon appears to in Pet Monkey, that there *are* right answers and it is the teacher who has them, not other students. In Beginning Spanish, Pete and Richard use English (their first language, or L1) to help them control the problem-solving task. This metatalk, once seen by second language researchers as nonrelevant task talk, plays an important role in the participants' establishing mutual goals and control over the learning task.

In this chapter, the cultural context of cognitive development and learning is examined. Of central importance is viewing education as more than curriculum and instructional strategies. Rather, one must consider the broader context in how culture shapes the mind and provides the toolkit by which individuals construct worlds and their conceptions of themselves and their powers (Bruner, 1996a). It is important to note that social and cultural factors have not been entirely ignored by the theorists discussed in other chapters.

Piaget, in particular, included social knowledge as a kind of knowledge that children acquire, and he placed great store on the actions of a child in developing all knowledge. But, Bruner and Bornstein (1989) contended,

> It is our view that developmental psychology [has] been dominated for a decade or two by theories that [seek] primarily to formulate explanations of growth and development in terms of intra-individual factors: processes of accommodation and assimilation, of impulse control, of learning, of genetic predisposition, of cognitive representation, and so forth. When issues of interaction [are] treated in these theoretical accounts, it [is] usually in the spirit of taming them by showing how they [are] simply sources of variance that affect such processes as those just mentioned. (p. 1)

Interaction is therefore important to consider in its own right (Bruner & Bornstein, 1989), and it is this focus on interaction that distinguishes the theories discussed in this chapter.

The work of Jerome S. Bruner is presented first. Although his approach to cognition has changed over the years, Bruner retains a belief that a theory of development should go hand in hand with a theory of instruction. He reflected recently about his career. "I never felt I was going into education. If you didn't take into account this most powerful institution—schooling—how could you talk about cognitive development?" [conversation with Jerome Bruner, October, 2000, as cited in (Lutkehaus & Greenfield, 2003, p. 409)]. Therefore, implications of his views for instruction will be discussed as his theory of development unfolds.

In the second half of the chapter, the ideas of Lev Semenovich Vygotsky (1896–1934) are examined. There has been a resurgence of interest in the theories of Vygotsky, a Russian psychologist whose writings were originally published in the late 1920s and early 1930s. Wertsch (1985) described Vygotsky as a brilliant scholar whose interdisciplinary ideas preclude one from considering him only a psychologist. Today, these ideas provide information for theory development in both developmental and educational psychology.

Bruner: Going Beyond the Information Given

Recall from Chapter 6 that one of the hallmarks of developmental theory is the idea of an endpoint to which all children are assumed to develop. In order to explain how this endpoint is reached, developmental theory must account for the states through which children pass as they develop and the mechanisms by which transition occurs from state to state. Like the theorists discussed in the previous chapter, Bruner proposed answers to these questions.

First and foremost, the outcome of cognitive development, for Bruner, is thinking. That is, the well-developed mind, the intelligent mind, creates from experience "generic coding systems that permit one to go beyond the data to new and possibly fruitful predictions" (Bruner, 1957/1973, p. 234). Moreover, the aim of education is to make the learner "as autonomous and self-propelled a thinker" as possible (Bruner, 1961, p. 23).

Jerome Bruner

The attempt to understand both what it means to know and how one comes to know led Bruner through several phases in his early empirical and conceptual work. When Bruner was a student in psychology during the 1930s (he did his undergraduate work at Duke University and his graduate study at Harvard), "the mainstream world of psychology...was dominated by sensationalism, empiricism, objectivism, and physicalism. But...my heroes and mentors were almost to a man swimming against that mainstream" (Bruner, 1983, p. 59). He was interested in the work of Gestalt psychologists and cultural anthropologists, and cultural factors later came to play a significant role in his theory of cognitive development.

Taking together the bulk of Bruner's work reveals two major themes. The first concerns the sequence of representational systems children acquire through which they understand their worlds. The second pertains to the role of culture in the course of cognitive growth and of schooling as an instrument of culture in the "amplification of human intellectual powers" (Bruner, 1964, p. 13). Let us consider each in some detail.

Three Modes of Representation

"Children, as they grow, must acquire ways of representing the recurrent regularities in their environment" (Bruner, 1964, p. 13). This involves, according to Bruner, an interaction between basic human capabilities that have evolved over a long period of years and culturally invented technologies

that serve as amplifiers of these capabilities. "Cognitive growth, then, is in a major way from the outside in as well as from the inside out" (Bruner, 1964, p. 1). Although it is almost impossible to entirely separate discussion of these two aspects of cognitive development, this section focuses on the inside out and the next section discusses the outside in.

Based on his study of human evolution, Bruner proposed three systems by which people structure their understanding of the world. In particular, he suggested that humans respond to their environment through action or patterned motor acts, through conventionalized imagery and perception, and through language and reason. These capabilities formed the basis for the modes of representation that Bruner called enactive representation, iconic representation, and symbolic representation.

Enactive representation refers to *"a mode of representing past events through appropriate motor responses"* (Bruner, 1964, p. 2). Young children, for example, may not be able to tell you directions to the store from their house, but they can take you there by way of a route previously traveled. Similarly, many adults may not be able to adequately describe or picture the layout of their office complex, but they negotiate its corridors with ease every day. Likewise, pianists have described the need to play a chord on an imaginary piano in order to know how it will sound; their fingers seem to carry the meaning of the chord. Some types of understanding, then, appear to be represented solely within our muscles.

Iconic representation enables the perceiver to *"summarize events by the selective organization of percepts and of images,* by the spatial, temporal, and qualitative structures of the perceptual field and their transformed images" (Bruner, 1964, p. 2). A child who can draw a map depicting the route from her house to the store now represents her experience and understanding of that route in an iconic mode. Likewise, a person who has experienced a fire might represent his understanding of the experience in images of red-hot flames, black smoke, and charred remains.

Finally, **symbolic representation** comes about with the acquisition of *"a symbol system [which] represents things by design features that include removeness and arbitrariness"* (Bruner, 1964, p. 2). Language, for example, is the primary symbol system by which humans can encode and represent experience. Not only do words stand as arbitrary designates for objects, events, and ideas, they can be combined to produce "far beyond what can be done with images or acts" (Bruner, 1964, p. 2). The same is true, of course, for other symbol systems, such as the numeric codes used by mathematicians. Table 7.1 provides a summary of Bruner's three modes of representation.

The Sequence of Representational Stages. Although Bruner believed that "the usual course of intellectual development moves from enactive through iconic to symbolic representation of the world" (1966, p. 49), he is also famous for the statement that "any subject can be taught effectively in some

TABLE 7.1 *Bruner's Three Modes of Cognitive Representation*

Mode	*Definition*	*Implication for Instruction*
Enactive	Representing one's understanding through motor responses	Use manipulables and tactile instructional strategies with young children to teach concepts with which learners have no prior experience.
Iconic	Using images to represent understanding	Accompany instruction with diagrams and other strategies that appeal to the imagination.
Symbolic	Using symbol systems such as language, musical notation, and mathematical notation to represent understanding	Use familiar symbol systems when teaching new concepts in a subject with the learner already has prior experience.

intellectually honest form to any child at any stage of development" (Bruner, 1960, p. 33). How do we reconcile the two?

Stage theories like Piaget's (see Chapter 6) hold that developmental stages proceed in a fixed sequence, transitions among stages occur at certain approximate ages, and certain logical operations develop at each stage. In addition, the operations of each stage are both more complex and adaptive than those of the preceding stage. A Piagetian would consider it futile, therefore, to teach any subject requiring logical operations to a child in a stage where these operations had not yet developed.

Bruner, in contrast to Piaget, believed in the invariant sequence of stages through which children pass but not in their age dependency. He argued instead that influences from the environment play a significant role in amplifying the internal capabilities that learners possess. In other words, the fact that children acquire enactive, iconic, and symbolic modes of representation, in that order, supplies the inside out part of the developmental story. The outside in aspect of development is explained through an examination of how the environment specifically influences the acquisition of these modes. These influences are discussed more fully in the next section.

There are at least two important implications of this distinction in theory between Bruner and Piaget. First is that it redefines what is meant by readiness for learning. Whereas Piaget might speak of the cognitive readiness of the learner to understand the logical operations inherent in a subject matter, Bruner would ask whether the subject matter is ready for the learner to which it is to be taught. In other words, has the subject matter been structured so as to match the internal, cognitive structure of the learner (Lutkehaus & Greenfield, 2003)? "Any idea can be represented honestly and usefully in the thought forms of children of school age" (Bruner, 1960, p. 33). The task, in Bruner's view, is one of translation, and the challenge is to provide problems in instruction that both fit the manner of children's thinking and tempt them into more powerful modes.

Bruner (1960) described an experienced teacher of elementary mathematics, for example, who recognized the need for presenting material to students in terms they can understand. In the words of the teacher,

> Given particular subject matter or a particular concept, it is easy to ask trivial questions or to lead the child to ask trivial questions. It is also easy to ask impossibly difficult questions. The trick is to find the medium questions that can be answered and that take you somewhere. This is the big job of teachers and textbooks. (Bruner, 1960, p. 40)

Consider how this view of readiness compares with that of Ausubel (see Chapter 4). Like Bruner, Ausubel believed that instructional materials should be appropriate for the child. But Ausubel defined appropriateness in terms of the child's prior knowledge—i.e., what she knows and how she structures that knowledge in memory—whereas Bruner considers the child's dominant mode of thinking as the basis for appropriateness. As we have seen, the two are certainly related in that more knowledge of a subject correlates with the ability to think symbolically about that subject.

Assuming an invariant sequence of developmental stages and considering learning difficulty to be a function of the interaction between child and subject matter together raise a second important implication. Might not adults, as well as children, pass through the same sequence of enactive to symbolic representation when they learn a subject for which they have no prior experience? "We know little about the conditions necessary for the growth of imagery and iconic representation," wrote Bruner (1964, p. 3). He noted, however, that adults typically require a certain amount of motoric skill and practice before they are able to develop an image representing their actions.

In other cases, as well, adults may require practice with iconic forms before they can understand and use a symbolic mode of representation. For example, in a course taught by a colleague of mine, adults were being introduced for the first time to how a computer works. They became frustrated when they experienced difficulty in comprehending what the instructor thought were simple operations. Even diagrams of a computer's functions proved difficult for the class to understand. Finally, the instructor built a board with slots representing addresses in computer memory and removable cards representing bits of information. Actually moving the cards through input, storage, and output met the students' requirement for learning—they understood through action. Whereas symbolic representation is likely to be

used for learning something new in a familiar topic, then, learners of all ages may resort to enactive or iconic representation when they encounter unfamiliar material. Indeed, Bruner (1985) recognized this possibility when he called his theory a "bogus stage theory"; a true stage theory assumes a relationship between age and stage of development.

Sequence and Instruction. The enactive through iconic to symbolic representational sequence of intellectual development implies an optimum sequence for instruction, namely, one that progresses in the same direction (Bruner, 1966). Any domain of knowledge, Bruner contended, can be represented in each of those three modes. "When the learner has a well-developed symbolic system, it may be possible to by-pass the first two stages. But one does so with the risk that the learner may not possess the imagery to fall back on when his symbolic transformations fail to achieve a goal in problem solving" (Bruner, 1966, p. 49). This seems to be precisely what occurred in the computer class described above. Although adults presumably have well-developed symbolic systems (i.e., they read and understand language, and they undoubtedly have had the rudiments of mathematics), these systems failed when the instruction was entirely symbolic in nature. Because the students also failed to have corresponding imagery to fall back on, the instructor was forced to begin instruction in the enactive mode.

To determine what mode of representation will be optimal for instruction, then, requires knowing something about the learners' prior knowledge and dominant modes of thinking. Are they capable of symbolically representing the to-be-learned material? Or should the conservative course be followed and instruction developed that follows an enactive to iconic to symbolic sequence?

A second factor should also be considered when this decision is made. Bruner (1966) argued that "optimal sequences...cannot be specified independently of the criterion in terms of which final learning is to be judged" (p. 50). In other words, whether speed of learning or transfer of learning is the desirable goal may dictate what representation modes should be included in the instruction. And these, he noted, are sometimes antithetical goals. The ability to transfer what has been learned to new situations may require considerable time to achieve and may depend upon symbolic representation. Conversely, if learning time is short, of necessity, and the to-be-learned material relatively complex, learners may only be able to achieve iconic representation of what they understand.

Let us consider two hypothetical examples. In the learning of mathematics, desirable goals frequently include that learners can apply mathematical concepts to solve a variety of problems. Transferability of knowledge is important and depends upon a true understanding of the concepts. So, for example, suppose the skill of multiplying fractions is being taught. Students are asked to solve word problems such as:

> By the end of the day, Mr. Green had sold 2/3 of the onions he brought to market. He exchanges half of his remaining 1/3 for some corn from the merchant in the stall next to his. What proportion of the onions he brought to sell does he take home?

This problem can certainly be represented symbolically (i.e., $1/2 \times 1/3 = ?$; the correct answer is 1/6), and students can be taught the procedures for solving this type of problem (multiply the numerators to get the numerator of the answer, multiply the denominators to get the denominator of the answer, then reduce if necessary). However, learning the mathematical procedures does not alone guarantee students an understanding of the concept of fraction. If a computational mistake is made, students may not immediately recognize the error or be able to correct it. Suppose, for example, a student decodes the problem to mean he should divide by 1/2, instead of multiplying, and arrives at an answer of 2/3 by following the procedure invert and multiply. Without understanding that taking 1/2 of something means the result will be smaller than the original amount, he will simply not realize he has made a mistake.

Instead of teaching only mathematical procedures in a symbolic mode, Bruner would recommend that instruction include activities in the enactive and iconic modes for establishing the concept of fractions. These might take the form of games in which students act the part of grocers and customers, buying and selling portions of their wares. Actually making exchanges, such as "I'll take 3/8 of your layer cake," facilitates enactive representation. Similarly, using pie charts and other diagrams to picture fractions will serve to facilitate iconic representation. Although it is time consuming, having students solve many such problems, from enactive to symbolic modes, will ensure a deep understanding of the concept and the ability to apply it appropriately in many contexts.

Now consider an alternative situation in which speed of learning, rather than transfer, is a goal of instruction. Students in a vocational center are learning skills that will enable them to acquire jobs as automobile mechanics. Initially at least, it is more important for them to be able to successfully carry out such procedures as replace spark plugs than to understand the physics underlying what a spark plug does. In this case, then, instruction may never progress beyond the enactive or iconic modes. And the criterion for judging learning may be exclusively enactive, i.e., can the student successfully change a spark plug on an actual engine?

Finally, Bruner (1960) proposed the spiral curriculum as a strategy for translating material into children's modes of thought. It is in this proposal that we see Bruner's beliefs concerning the relations among the three representational modes. Not only can ideas be honestly represented in any mode, but also "these first representations can later be made more powerful and precise the more easily by virtue of this early learning" (Bruner, 1960, p. 33). It makes good instructional sense, then, claimed Bruner, to introduce students "at an early age to the ideas and styles that in later life make an

educated man" (1960, p. 52). To accomplish this requires presenting topics consistent with children's forms of thought at an early age and then reintroducing those topics again later in a different form.

The Course of Cognitive Growth

Except to acknowledge the influence of environment on children's acquisition of the three representational systems, little has yet been said about how the transition occurs from stage to stage. In other words, what enables learners to develop the capacity for symbolic thinking when they have been thinking in iconic modes?

It is in answer to this question that we see Bruner's increasing emphasis on interaction. There is interaction between genetic predispositions and experience. Learners may be predisposed, for example, to representing their experience in iconic modes, but with appropriate medium-level questions from a tutor, be brought to a symbolic understanding of some idea. There is also interpersonal interaction; learning is a social enterprise. And there is interaction of the individual with the cultural. Indeed, culture provides the backdrop against which all forms of interaction play (Bruner & Bornstein, 1989). "The growth of intellect," then, "...moves forward in spurts as innovations are adopted. Most of the innovations are transmitted to the child in some prototypic form by agents of the culture: ways of responding, ways of looking and imaging, and most important, ways of translating what one has encountered into language" (Bruner, 1964, p. 13).

Just what interactions best transmit innovations that will promote cognitive development? Here we will see how Bruner's proposals for development are interwoven with his ideas about education and schooling.

Learning by Discovery. Bruner defined *discovery* as "all forms of obtaining knowledge for oneself by the use of one's own mind" (1961, p. 22). In essence, this is a matter of "rearranging or transforming evidence in such a way that one is enabled to go beyond the evidence so assembled to additional new insights" (1961, p. 22). Bruner believed that the process of discovery contributes significantly to intellectual development and that the heuristics of discovery can only be learned through the exercise of problem solving. That being so, he proposed discovery learning as a pedagogic strategy with such important human implications that it must be tested in schools. Before we examine the results of such testing, however, it is important to understand what Bruner had in mind when he proposed discovery learning.

A true act of discovery, Bruner contended, is not a random event. It involves an expectation of finding regularities and relationships in the environment. With this expectation, learners devise strategies for searching and finding out what the regularities and relationships are. Characterizing this searching and finding, however, should also be an attitude of constructionism. In other words, it is not enough to seek information and generate hypotheses without regard to constraints. Bruner (1961) described children who did this (i.e., generated random hypotheses for what information to seek) as "potshotters." Their information gathering lacked connectivity and organization and, as a result, their ability to solve problems was deficient. By contrast, those who demonstrated a connectionist approach were systematic and organized in collecting information that would help solve the problem.

What conditions, then, promote true discovery? For one thing, "discovery, like surprise, favors the well prepared mind" (Bruner, 1961, p. 22). In order to solve any problem, learners must determine what variables are relevant, what information should be sought about those variables, and, when the information is obtained, what should be done with it. In large measure, doing this easily depends on prior knowledge of a range of phenomena, or in Bruner's words, sheer "knowing the stuff"! Learners without such prior knowledge will undoubtedly face frustration and failure in a discovery learning environment.

A second, equally important, condition for discovery concerns the provision of models to help guide discovery. After the publication of "The Act of Discovery" in 1961, the concept of discovery became the basis of a "school of pedagogy" by some educators. Bruner (1973a) wrote,

> As so frequently happens, the concept of discovery, originally formulated to highlight the importance of self-direction and intentionality, had become detached from its context and made into an end in itself. Discovery was being treated by some educators as if it were valuable in and of itself, no matter what it was a discovery of or in whose service. (p. xv)

In response to this pedagogical movement, Bruner attempted to clarify "some elements of discovery" in a convention address and later published essay. In particular, he reemphasized that discovery is not haphazard; it proceeds systematically toward a model which is there all the time. "The constant provision of a model, the constant response to the individual's response after response, back and forth between two people, constitute 'invention' learning guided by an accessible model" (Bruner, 1973b, p. 70). Moreover, "Discovery teaching generally involves not so much the process of leading students to discover what is 'out there', but rather, their discovering what is in their own heads" (Bruner, 1973b, p. 72).

Bruner, Goodnow, and Austin (1956) proposed a concept attainment model that exemplifies this notion of discovery teaching. Concepts, in essence, are rules for organizing the regularities of experience, and as such, stand as models of the world to be constructed and internalized. In Bruner's view, learners acquire concepts by setting forth tentative hypotheses about the attributes that seem to define a concept and then testing specific

instances against these hypotheses (Bruner et al., 1956). Discovery of a concept, then, proceeds from a systematic comparison of instances for what distinguishes examples from nonexamples. To promote concept discovery, the teacher presents the set of instances that will best help learners to develop an appropriate model of the concept.

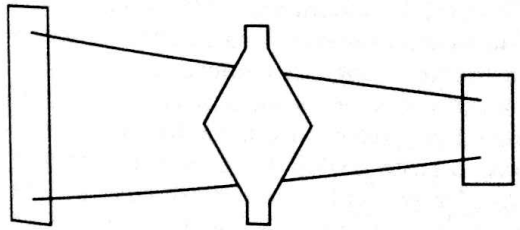
Note the similarity between the concept attainment model and the discovery teaching demonstrated by Mrs. Bell in the scenario, Pet Monkey. In asking for examples and questioning students about those they suggest, Mrs. Bell systematically guides them toward discovery of relationships between animals (a concrete concept) and pets (an abstract concept). She herself is guided by her own mental models of the relationships she hopes they will discover. That is, some four-legged animals are pets, some pets have four legs, and some animals are neither pets nor have four legs. Specific examples also raise issues regarding category definition and who is doing the defining. Mrs. Bell obviously excludes monkeys from her concept of pet, yet people have been known to keep monkeys as pets. Instead of leading Shannon to accept her concept of pet, Mrs. Bell might better have used the opportunity to explore how concepts come to be known. For example, only through the experience of living with the 10-foot Burmese python owned by my husband did my concept of pet come to include snakes.

The provision of models is important for discovery in another aspect. By asking certain kinds of questions or by prompting certain hypotheses during problem solving, the teacher also models the conduct of inquiry. It is necessary, according to Bruner, to teach children how to cut their losses, to pose good testable guesses, to persist in seeking appropriate evidence, and to be concise. In regard to the latter, for example, he described a fifth grader who, when asked what a particular movie was about, responded with a blow-by-blow account instead of giving a synopsis of it. Similarly, Duffield (1990) observed children play a computer game designed to teach problem solving. They were to locate an animal hidden behind "magic squares" by opening one square at a time and posing hypotheses based on the information presented behind each square. Instead of posing guesses that would minimize the number of squares they opened, some children systematically opened every square until they found the animal. The twin goals of hypothesis testing and conciseness were clearly not met in this instance.

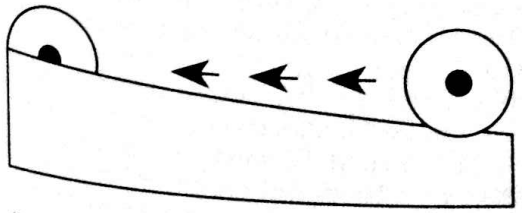
Guided practice in inquiry and sufficient prior knowledge, then, constitute minimum conditions for discovery learning to be successful. To these, Bruner later added reflection and contrast (1966, 1973b). The need for reflection occurs when children can accomplish some task but are not able to represent to themselves what they did. In other words, they may successfully solve a problem but have little clue as to why they were successful. Reflecting back on the problem and recasting what occurred in a mode of thought understood by learners may help them to figure it out, to make the knowledge their own.

Finally, contrasts that lead to cognitive conflicts can set the stage for discovery. That is, "readiness to explore contrasts provides a choice among the alternatives that might be relevant" in a discovery learning situation (Bruner, 1973b, p. 81). In science lessons, for example, surprising events can provide an effective venue for discovery. As part of a unit on space science, seventh grade science teachers conducted the following demonstration. As shown in Figure 7.1, two funnels connected together at their wide openings are placed in the middle of a sloped, triangular ramp. The ramp has been constructed of two wires such that one end is higher and wider than the other end. Students are asked to predict which direction the funnels will roll. Without question, they all indicate that the funnels will roll downhill, toward the narrow end. When the funnels instead appear to roll uphill, the students are mystified and ask to see the demonstration done several more times. To the question of whether this might be an antigravity machine, most of the students are even willing to say yes.

Eventually, they discover that they have overlooked two important factors: The incline of the funnels is greater than the slope of the ramp, and the



(a) A top view of the funnels as they are set upon the ramp



(b) The funnels appear to roll uphill when they sink toward the wider end of the ramp

FIGURE 7.1 *The "Anti-Gravity" Demonstration: A Surprising Event for Seventh Grade Students in Science Class*

ramp is wider at one end. Taken together, these cause the funnels to sink downward into the opening of the ramp. They in fact go downhill, but they appear to go uphill (S. Edwards and R. Driscoll, personal communication, March, 1992; Friedl, 1991, p. 169).

Bruner's recommendation for contrasts that cause cognitive conflict parallels that made by Piaget and other developmental theorists who have focused on restructuring as the major developmental process. Although they have all offered different explanations for why the strategy works, the important point is that it does and can be reliably used in instruction.

Bruner noted in 1973 that by the mid-1960s, educational pedagogy based on discovery learning seemed to have moved far from his intended course. During this time, discovery teaching came to imply providing a rich environment for learning with an accompanying freedom for learners to set their own learning agenda, and there was a surge of popularity for open, unstructured classrooms. The 1970s, however, brought criticism to this pedagogic movement, a new wave of back-to-basics adherents, and a second look at what inquiry teaching was really about.

Out of this arose a model of inquiry teaching that Collins and Stevens (1982, 1983; see also Collins, Warnock, & Passafiume, 1975; Stevens & Collins, 1980) inductively derived from their observations of effective inquiry teachers. Although no claim is made regarding this model and its relation to Bruner's discovery learning, it nevertheless represents a means by which his ideas may be systematically carried out. According to Collins and Stevens (1983), inquiry teachers pursue two basic goals. The most common is for their students to derive a particular concept, rule, or principle that the teacher has in mind. The second, no less important, is for students to derive general rules or theories, or in other words, learn the conduct of inquiry.

In their model, Collins and Stevens (1983) presented ten of what they considered to be the most important instructional strategies used by inquiry teachers in service of their goals. These strategies are thought to be useful for concept learning and problem solving in any subject matter with any age learner, and numerous and diverse examples are offered to support this claim. For the most part, the examples come from teacher-student dialogues collected by Collins and Stevens during the course of their research. However, other researchers have also conducted studies that demonstrate the effectiveness of these strategies. Moreover, it is important to note that students' more advanced peers, or a well-designed computer-based tutor, may serve in the role of inquiry teacher as effectively as an adult instructor. Listed in Table 7.2, then, are the ten strategies together with examples of how each might be implemented in instruction.

In addition to the strategies themselves, teachers must have some means for making decisions about which ones to employ and at what point in the instructional dialogue to employ them. Indeed, "the control structure that the teacher uses to allocate time between different goals and subgoals

TABLE 7.2 ***Collins and Stevens's (1983) Model of Inquiry Teaching: Instructional Strategies Used by Inquiry Teachers***

Strategy	*Example in Use*
1. Selecting positive and negative exemplars	A teacher presents dog (example), whale (example), and shark (non-example) in a dialogue about mammals.
2. Varying cases systematically	To consider factors that influence average temperature, the teacher offers places that vary in latitude (e.g., Amazon jungle, North Dakota) but not in other factors, such as distance from the ocean.
3. Selecting counterexamples	In a discussion on birds, ostrich is suggested as a counterexample for the attribute "flying."
4. Generating hypothetical cases	To illustrate the unfairness of boys dominating the classroom computer, a teacher asks, "How about a rule that boys can use anything in class except the computer? Would you like that?" (hypothetical case)
5. Forming hypotheses	After considering places where rice is grown, the teacher asks students to suggest what factors influence rice-growing.
6. Testing hypotheses	Students have generated a rule for how sets of 3 numbers (e.g., 2–4–6) relate to one another (e.g., all even numbers, or a + b = c). They are asked for sets to be used to test the rule.
7. Considering alternative predictions	In criminology, students piece together evidence to determine what must have happened at a crime scene. The instructor suggests an alternate explanation that could account for the available evidence.
8. Entrapping students	Students have suggested that a critical feature of fish is that they live in water. The instructor leads them to an incorrect prediction by suggesting that a whale must be a fish.
9. Tracing consequences to a contradiction	In a math lesson, a student suggests doubling the length of a side to double the area of a square. The teacher does what the student suggests, with the result being 4 times the square's area.
10. Questioning authority	An instructor refuses to accept examples of learning theory applications that came from the students' textbooks. She asks students for their own examples, and questions, "Do these principles ever work in practice?"

may be the most crucial aspect for effective teaching" (Collins & Stevens, 1983, p. 274).

Based on their analyses, Collins and Stevens proposed four basic parts to this control structure. First is a set of strategies for systematically selecting cases that will facilitate student achievement of a particular, top-level goal. These strategies help to determine the beginning of an instructional dialogue. As it proceeds, however, teachers adjust their questioning according to their model of the student. Students continually reveal errors in reasoning or misconceptions when they respond to the teacher's questions. As teachers identify specific problems, then, they add subgoals to their instructional agenda, using a set of priority rules. Summarized in Table 7.3 are the four parts of an inquiry dialogue control structure. Figure 7.2 provides a visual representation of the strategies involved in inquiry teaching.

"By turning learning into problem solving..., teachers challenge the students more than by any other teaching method. The students come out of the experience able to attack novel problems by applying these strategies themselves" (Collins & Stevens, 1983, p. 276). Bruner could hardly have said it better.

Culture and Cognitive Growth. "What does it mean, intellectually, to grow up in one cultural milieu and not another?" (Bruner, 1973c, p. 20). Developmental theorists discussed in the previous chapter of this book might reply,

TABLE 7.3 ***Collins and Stevens's (1983) Model of Inquiry Teaching: A Dialogue Control Structure***

1. Strategies for selecting cases	Select cases to illustrate more important factors before less important ones.
	Select cases to move from concrete to abstract factors.
	Select more frequent cases over less frequent ones.
2. A student model	Ask questions to reveal both what students know as well as what gaps exist in their knowledge or reasoning.
3. A teacher's agenda	Begin inquiry according to a top-level goal. Add subgoals as necessary.
4. Priority rules for adding subgoals	Correct errors before omissions.
	Correct prior steps before later steps.
	Implement shorter fixes before longer ones.
	Deal with more important factors than less important factors in correcting errors.

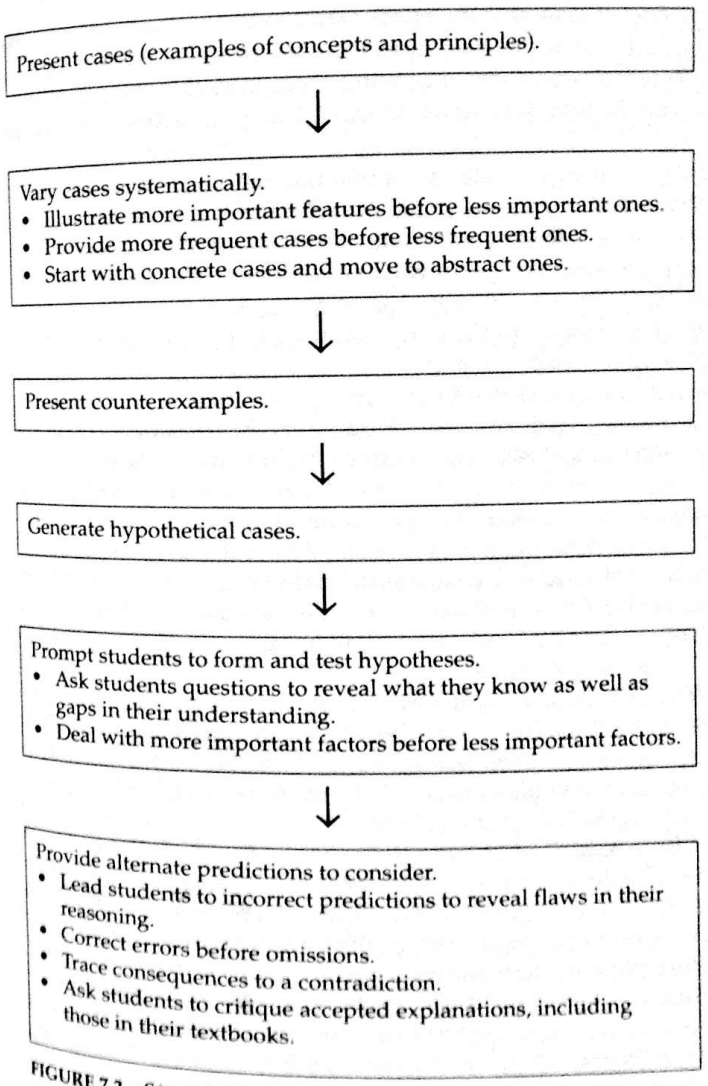


FIGURE 7.2 ***Strategies for Inquiry Teaching***

"Not much." Their focus has been largely on the search for universal structures of the mind that are presumably unaffected by cultural differences. Bruner, however, found "intrinsic anticulturalism" to be a weakness of context-free approaches to cognitive development. He alluded to the Geneva dilemma (in reference to Piaget): "If the child only takes in what he is 'ready to

assimilate,' why bother to teach before he is ready, and since he takes it in naturally when he is ready, why bother afterwards?" (Bruner, 1973d, pp. 153–154). The reason to bother, for Bruner, comes from understanding how culture interacts with human development and biology to define the human condition.

"Intelligence is to a great extent the internalization of 'tools' provided by a given culture" (Bruner, 1973c, p. 22). Members of different cultures, because of the specific and unique demands of living in their societies, make sense of their experiences in different ways. This is similar to the concepts as tools view promulgated by the situated learning theorists discussed in Chapter 5. But what determines the particular use or application of concepts is the cultural environment of the user.

Eskimos, for example, depend upon group cooperation to hunt seal or fish in order to subsist. Their children, as an apparent consequence, do not exhibit the egocentrism that is characteristic of American and European children (Bruner, Olver, & Greenfield, 1966). Recall that Piaget proposed egocentrism as a universal characteristic of all preoperational children, but he based this proposal on observations of mostly European and American children. Other observations of schooled versus unschooled children in a region of Africa also showed differences in cognitive development that suggested Piaget's descriptions may be "neither 'natural' nor universal" (Lutkehaus & Greenfield, 2003, p. 417). A student of Bruner's, Patricia Greenfield, found that unschooled children had no awareness of their thoughts as separate from what they were thinking about. Thus, they did not understand questions such as "Why do you *think* X is the case?" whereas they had no difficulty answering questions phrased as "Why *is* X the case?" (Greenfield, 1966, cited in Lutkehaus & Greenfield, 2003).

Cole and Bruner (1971) cited another example in which the ability to make estimates of volume or distance was compared between nonliterate rice farmers from Central Africa and Yale University sophomores. Whereas the Yale students were superior in judging distance, the rice farmers were far more accurate in estimating how much rice was contained in different sized bowls. What these results suggest, Cole and Bruner believed, is a cultural influence on the manifestation of inherent competence. Inherently, there must be no difference between the two groups in their ability to make estimates. But demands of their respective cultures have made it more likely for them to develop different manifestations of this ability.

The same argument can be seen in studies of children selling candy in northeastern Brazil (Saxe, 1990). Although all the children studied were from the same culture (in the sense of all being Brazilian), the candy sellers developed different mathematical understandings from their non-candy-selling agemates. Whereas the non-candy sellers learned standard number orthography for manipulating numbers on paper, the candy sellers developed alternative procedures linked to currency exchanges. The candy sellers' understandings were "interwoven with the mathematical and economic problems linked to the practice" of candy selling (Saxe, 1990, p. 99). As in the research discussed in Chapter 5, culture here begins to take on a broader meaning.

So what does this influence of culture mean for instruction? For one thing, Bruner sees schooling as an instrument of culture. What goes on in schools should equip students with the cognitive skills required for control and utilization of the resources of the culture (Cole & Bruner, 1971; Bruner, 1992, 1996a). This implies further that

> To instruct someone in [the] disciplines is not a matter of getting him to commit results to mind. Rather, it is to teach him to participate in the process that makes possible the establishment of knowledge. We teach a subject not to produce living libraries on that subject, but rather to get a student to think mathematically for himself, to consider matters as an historian does, to take part in the process of knowledge-getting. Knowing is a process, not a product. (Bruner, 1966, p. 72)

Moreover, children should be accepted as members and participants in the culture and provided opportunities to make and remake the culture in each generation (Bruner, 1996b). This suggests that thinking like a mathematician or historian also means working on problems relevant to the student's own particular culture.

Bruner also called for a change in the way in which competence and performance are viewed. If performance is treated only as a shallow expression of underlying competence, then achievement differences between, for example, black ghetto children and white middle class children become evidence of underlying capability differences. The black child is then seen as having a deficit in learning caused by cultural deprivation.

Instead, Bruner argued, performance differences evident in the classroom should be viewed in the context of situational differences in how the children have learned to apply their skills outside of school. Surviving in the ghetto, for example, may require verbal negotiation and a show of bravado, but these same skills may be seen by a middle class white teacher as disruptive and counterproductive to learning in the classroom. By understanding how skills are influenced by culture, however, teachers will be in a better position to capitalize on the performances students do exhibit. In other words, teaching new intellectual structures may not be required so much as getting students to transfer skills they already possess to other situations relevant to the school context (Cole & Bruner, 1971).

Cross-cultural differences also appear to manifest themselves in what Bruner refers to as two cognitive cultures—logical scientific thinking and narrative thinking. Narrative thinking is the use of story telling to affirm connections with family members, and it is often a dominant mode of interaction in immigrant families. When children of these families express their

understanding using stories at school, however, they are ignored in favor of children who express themselves in the more customary and privileged logical scientific ways (Lutkehaus & Greenfield, 2003). A teacher training project called Bridging Cultures is designed to help teachers learn to value the stories of immigrant and minority children and to use them effectively in the educational process.

Summary: Toward a Theory of Instruction

As mentioned earlier, Bruner believed that theories of development and instruction should go hand in hand. Cognitive growth, in his view, is a matter of growing from the outside in as much as from the inside out. Whereas inherent biological predispositions provide direction to the inside out aspect of cognitive development, the outside in depends upon the mastering of techniques and cognitive tools passed on by agents of the learner's culture. As such, cognitive development can be facilitated and even accelerated through effective instruction. Cross-cultural studies provide evidence that "some environments 'push' cognitive growth better, earlier, and longer than others" (Bruner, 1973c, p. 50). To hold as a goal then, in Bruner's words, "an intellectually more evolved man" is ultimately a question of values.

Assuming that one's curriculum goals stem from a desire to develop self-propelled thinking in learners, Bruner suggested that an adequate theory of instruction must bring together the nature of knowledge, the nature of the knower, and the nature of the knowledge-getting process (Bruner, 1966). Interaction of the first two components influences decisions about what mode of representation should be emphasized in instruction. These decisions affect whether learning proceeds economically or whether learners experience cognitive strain.

Economy relates to how much information must be kept in mind at one time in order to achieve comprehension (Bruner, 1966). It is a function of both the content structure of the material to be learned and the preferred processing mode of the learner. Characterizing the Allied Forces' war against Iraq, for example, as a "battle over oil" is an economical means of representing the conflict. But it also overlooks many other factors that are equally important for understanding the event, such as the long history of strife in the Middle East, Iraq's invasion and occupation of Kuwait, and Saddam Hussein's aim to acquire nuclear weapons. Summarizing the conflict in a long sentence which alludes to all these factors, however, is likely to overload a learner's processing capacity, causing cognitive strain. The aim for effective instruction, therefore, is to tread the fine line between economy of representation and power of representation to convey important meanings.

An example where meaning has been sacrificed for economy can be seen in some corporate logos. In the effort to be concise, images or abbreviations are used that fail to convey appropriate or enough information about the organization for which they stand.

The knowledge-getting process dictates the types of instructional strategies that should be employed for instruction to be optimally effective. For reasons already discussed, Bruner recommended strategies that promote discovery in the exercise of problem solving. The activity of problem solving, furthermore, is influenced by the culture in which it is embedded. Because of this, instructors should foster cognitive strategies that will have the greatest likelihood of solving the particular problems faced by the culture.

An illustration of this principle might be seen in a third grade class where students are working in teams to produce instructional videos designed to teach various science concepts to their classmates (G. Stier, personal communication, October, 1992). The teams are multiculturally diverse, as is the overall class (which includes whites, blacks, Native Americans, and Hispanics). The students, with help from their teacher, have selected concepts to investigate such as air pollution (which is a significant problem in this urban area). They must research the concept/problem and then determine how their results might be conveyed most effectively through video in order for their classmates to learn what they have discovered.

To accomplish all this, the students must engage in multifaceted problem solving. They must work out differences among team members in order to work collaboratively. They must acquire research skills in order to locate and make use of information related to their topic. They must learn specific roles involved in video production. And they must decide how to illustrate what they have learned in ways to help others learn it as well. All of these are important aspects of learning within a cultural context.

Finally, Bruner spoke to the instructional issues of reinforcement and motivation (1961, 1966, 1973b). Although feedback which can be used for correction is obviously important, Bruner contended that it must be provided in a mode that is both meaningful and within the information-processing capacity of the learner. In the example above, for instance, the students can find satisfaction not only in the product of their videotapes but in how well their tapes promote learning in their classmates. Extrinsic reinforcement, on the other hand, can develop a pattern in which children look for cues to the right answer or right way of doing things. Exposing children to discovery learning can therefore promote a sense of self-reward in which students become motivated to learn because of the intrinsic pleasure of discovery.

Vygotsky: The Social Formation of Mind

"If life illustrates science, Vygotsky's own life can best be understood with reference to the very things that he came to argue were essential to understanding development: the interrelations of the individual, the interpersonal, and the cultural-historical" (Tudge & Scrimsher, 2003, p. 208). Lev S. Vygotsky was born in 1896 into a Jewish family in Russia. He attended Moscow University and graduated with a degree in law just before the start

Lev S. Vygotsky

of the Russian revolution in 1917, having studied also philosophy, linguistics, sociology, psychology, and the arts. At the end of the German occupation and after the small town in which he lived came under Soviet control, Vygotsky began a career teaching literature and psychology, founding a psychological laboratory at a regional teacher training institute.

On delivering a paper at the Second All-Russian Psychoneurological Congress in 1924, however, Vygotsky's life changed. His brilliant performance led to an invitation to join the Psychological Institute of Moscow University, where he completed a dissertation, "The Psychology of Art," in 1925. Thereafter, he helped to found an institute for studying handicapped children and became its director in 1929.

In this postrevolutionary era, there was a "zeal to create new ways of doing things, transform ideas on education, and develop a 'new' psychology that would be based on Marxist-Leninist dialectical materialism" (Tudge & Scrimsher, 2003, p. 209). Vygotsky participated in this movement and published a book about psychology in 1926 that was "the most ideology-related of his writings, seen not simply in the frequent citations of Marx, but in the apparent acceptance of the Marxist-Leninist perspective" (p. 210). Heavily influenced at first by Pavlov's ideas about reflexology and conditioning, Vygotsky moved away from these ideas in the late 1920s and began developing his cultural-historical theory. By the time he died in 1934 of tuberculosis, Vygotsky had written extensively of "pedology," or the "science of child development" (van der Veer & Valsiner, 1991, as cited in Tudge & Scrimsher, 2003). His writings were attacked on political grounds even before his death; afterward, Vygotsky's theory was banned in the Soviet Union and not published again until 1956—a wide-ranging impact on psychological theory (Cole & Scribner, 1978; Wertsch, 1985).

Bruner (1962) wrote in an introduction to Vygotsky's *Thought and Language* that "Vygotsky is an original" (p. vi). He "represents still another step forward in the growing effort to understand cognitive processes" (Bruner, 1962, of Vygotsky, p. ix). Like Bruner, Vygotsky attempted to understand the formation of intellect by focusing on its process of development. Also like Bruner, he believed that individual development could not be understood without reference to the social and cultural context within which such development is embedded. But unlike Bruner or Piaget, Vygotsky focused on the mechanisms of development to the exclusion of specific, distinguishable developmental stages. He rejected the idea that a single principle, such as Piaget's equilibration, could account for development. Instead, he suggested that development is much more complex, its very nature changing as it unfolds.

In criticizing developmental stage theories, Vygotsky (1962) wrote,

> These schemes do not take into account the reorganization of the process of development itself, by virtue of which the importance and significance of any characteristic is continually changing in the transition from one age to another. This excludes the possibility of breaking childhood down into separate epochs by using a single criterion for all ages. Child development is a very complex process which cannot be fully defined in any of its stages solely on the basis of one characteristic. (p. 115)

Bruner (1997), discussing differences in Vygotsky's and Piaget's theories, suggested that their views are probably incommensurate. He noted that the incommensurability highlights two ways human beings can make sense of their world: by means of logical necessity (Piaget) or by means of interpretive reconstruction of circumstances (Vygotsky).

So how does Vygotsky's notions about "interpretive reconstruction of circumstances" function as an explanation of intellectual development? And what implications does his theory suggest for learning and instruction? These questions provide the focus for the remainder of this chapter. Wertsch (1985; see also Wertsch & Tulviste, 1992; and Wertsch & Sohmer, 1995) described three themes which appear to form the core of Vygotsky's theoretical framework: "(1) a reliance on a genetic or developmental method; (2) the claim that higher mental processes in the individual have their origin in social processes; and (3) the claim that mental processes can be understood only if we understand the tools and signs that mediate them" (pp. 14–15). Let us begin by examining the first of these three themes. This will provide a foundation for considering the social origins of mental processes, together with the function of signs in mediating their development.

Vygotsky's Developmental Method

Vygotsky took a fundamentally different approach toward development than is typical of other developmental theorists. As we have seen in Chapter 6, most researchers interested in cognitive development assume the existence of some endpoint toward which the developmental process is aimed. They frame investigatory questions such as, "By what mechanism does a child become an adult?" or "How are the cognitive abilities of the child transformed into those of the adult?" Vygotsky, on the other hand, maintained a broader perspective. He posed research questions about the process of intellectual development "in all its phases and changes—from birth to death" (Vygotsky, 1978, p. 65). Thus, "by a developmental study of a problem, [Vygotsky meant] the disclosure of its genesis, its causal dynamic basis" (1978, p. 62).

The larger question for Vygotsky, then, had to do with how human beings came to develop higher psychological processes in the first place. A part of this question concerns how individuals, through childhood, come to possess the cognitive functions they exhibit later in life. The answers to either question, in Vygotsky's view, must emanate from a triangulation of multiple sources. He believed it important to study the natural development of cognitive skills in humans, to make cross-species comparisons, and to consider sociohistorical factors that mediate development.

The Natural Process of Development. In order to examine the origin of intellectual skills and their changes through the course of learning and development, Vygotsky believed that experiments should be conducted which provide "maximum opportunity for the subject to engage in a variety of activities that can be observed, not just rigidly controlled" (Cole & Scribner, 1978, p. 12). To achieve this, Vygotsky employed three techniques in his experiments with children. The first involves introducing obstacles that will disrupt normal problem solving. In studying egocentric speech, for example, Vygotsky asked children who spoke different languages to complete a cooperative activity. A second technique is to provide external aids to problem solving that can be used in various ways. Under varying task conditions, children of different ages would be expected to use the materials in systematically different ways. Finally, children may be asked to solve problems that exceed their current knowledge and skills. In this way, Vygotsky sought to discover the rudimentary beginnings of new abilities (Cole & Scribner, 1978).

What all three techniques have in common is their emphasis on illuminating process, rather than product. In other words, the question of interest is not how well did the children perform, but rather, what did they do under varying task conditions? How did they seek to meet task demands? The findings from his experiments utilizing these techniques provided Vygotsky with evidence supporting a mediational view of development. By **mediation,** Vygotsky meant that "in higher forms of human behavior, *the individual actively modifies the stimulus situation as a part of the process of responding to it*" (Cole & Scribner, 1978, p. 14). The implications of this view will be explored shortly.

Phylogenetic Comparisons. According to Wertsch (1985), Vygotsky drew heavily from Kohler's research on insight (see Chapter 1) to propose the use of tools as a prerequisite for the evolution of human cognitive functioning. Recall that Kohler's chimpanzees were observed to use a stick as a tool to reach bananas dangled out of arm's reach. Vygotsky also believed, however, that tool invention and use, although prerequisites to human cognition, were not sufficient conditions. To account for the differences in mental functioning between humans and other animals, then, Vygotsky adopted the Marxian position that socially organized labor activity, which is founded on the use of technical tools, is the basic condition of human existence. In other words, the structure and practices of socially organized labor provide the context for how people act, and subsequently, how they think. But Vygotsky also went beyond this position to consider the emergence of speech to be equally important in distinguishing humans from other animals.

From these phylogenetic comparisons, then, Vygotsky derived a belief very similar to Bruner's, discussed earlier. That is, biological and cultural development do not occur in isolation. It is therefore important to consider social and cultural factors as they mediate the development of human intellectual capabilities.

Sociocultural History. Like Bruner, Vygotsky considered the development of intelligence to be the internalization of the tools of one's culture. But tools emerge and change as cultures develop and change. This suggested to Vygotsky that an historical perspective is as important as a cultural perspective in understanding human mental functions. As an example, witness how the concepts that we use to represent and understand the mind have changed through history. Among the tools of Aristotle's day were wax tablets, and he likened memories in the mind to impressions made in the wax on these tablets. Today, however, computers function in many aspects of our lives, and the increasing sophistication of their technology is reflected in increasingly complex computer models of the mind (see Chapter 3).

To Vygotsky, cultural and historical perspectives are almost one and the same, because different cultures can be viewed along a continuum of social evolution. For example, Wertsch (1985) wrote of research conducted by Vygotsky and a colleague in which they investigated subjects' performance on several reasoning tasks. The subjects who participated came from societies in Soviet Central Asia that differed in the degree to which they were literate. Vygotsky argued, in other words, that the literate society represented a later point in social evolution than the nonliterate society, and therefore, should have evolved higher psychological functions.

The results of the research were interesting. On a task requiring them to group familiar objects, nonliterate subjects tended to categorize on the basis of how the objects might go together in a concrete setting. So, for example, *hammer, saw, hatchet,* and *log* were thought to be related. Literate subjects, by contrast, tended to categorize objects by their relationship independent of context. Thus, *hammer, saw,* and *hatchet* were grouped as *tools* (Wertsch, 1985).

Analogous results can be seen in research reported by Lakoff (1987) concerning the categorization schemes of Dyirbal-speaking aborigines in Australia. Glance at the concepts listed in Box 7.1. How would you categorize them? Now examine the categories shown in Box 7.2. The categories of the aborigines reflect their society—what things go together in their world. Your categories, by contrast, are less likely to be context-bound and more likely to reflect abstract concepts, such as things related to romance, for example, males, females, moon, wine, figs (S. Aljabari, personal communication, November 1992). The degree to which thinking is context-bound came to represent, for Vygotsky, an important indicator of intellectual development.

In the section that follows, then, we will see how Vygotsky's developmental method led him to a theory of the social formation of mind.

The Social Origins of Higher Mental Processes

One of the important characteristics distinguishing Vygotsky's theory from the theories of other developmentalists is his premise that "individual development cannot be understood without reference to the social milieu...in which the child is embedded" (Tudge & Rogoff, 1989). Social milieu, however, is not just another variable to be explained in the equation of human development (Bruner & Bornstein, 1989). Rather, it causes a shift in how that explanation is derived. The cognitive theorists of Chapter 6, for example, focused on the individual as the unit of analysis, but Vygotsky contended that a more appropriate focus is social activity. Development "does not proceed toward socialization"; it is "the conversion of social relations into mental functions" (Vygotsky, 1981, p. 165).

BOX 7.1 • *Sociocultural Influence on Cognition*

Sort the following words into whatever categories make sense to you, and provide a label or rationale for each category.

males, females, figs, kangaroo, mean, dogs, honey, bees, the moon, cigarettes, water, sun, spear, wine, wind, fish, mud, fire, birds, rainbow.

Now compare your categories to those shown in Box 7.2.

BOX 7.2 • *Classification of Concepts Made by Aboriginal Dyirbal Speakers in Australia*

Research reported in Lakoff (1987) reveals that Dyirbal aborigines possess four basic concept classifications. They are listed below, along with the words presented in Box 7.1.

Bayi: *males, kangaroo, the moon, rainbow, fish, spear*
Balan: *females, dogs, birds, fire, water, sun*
Balam: *figs, honey, wine, cigarettes*
Bala: *meat, bees, wind, mud*

Proposed explanations for these classifications include (1) domain of experience (e.g., wine is made from fruit; water extinguishes fire); (2) myths and beliefs (e.g., rainbows are believed to be mythical men; birds are believed to be female spirits); and (3) dangerous and exceptional things are marked by special classification, that is, put in minimally contrasting category (e.g., dogs are considered to be exceptional animals and so they appear in the second class instead of with men). Consider how different these classifications are from typical Western thinking.

This perspective "highlights the *bi*directional nature of individual and context.... Neither organism nor context constitutes the unit of analysis, but rather their interaction does" (Bruner & Bornstein, 1989, p. 9). This refers again to the essentially Marxist-based dialectical nature of Vygotsky's theory (Tudge & Scrimsher, 2003, p. 216). Bruner and Bornstein go on to suggest that such a view of development is not readily grasped nor easily investigated, but is "decisive to the next step in comprehending human development" (p. 13).

From this interactional perspective, how does the child convert social relations into psychological functions? The answer lies in mediation. We already know that mediation means changing a stimulus situation in the process of responding to it. What this implies is that the conversion from the social to the psychological is not direct. Instead, it is accomplished through some kind of link—a tool, or "sign," as Vygotsky terms it. This can be understood by thinking of what is meant by tool and sign. A tool, for example, is something that can be used in the service of something else; a sign is something that stands for something else. In order to solve the problem of the bananas being out of reach, then, the chimpanzee had to change the situation by using the stick, not as a stick, but as a banana-reaching implement. It used the stick as a tool. Similarly, students learn that an economical way to solve complex word problems is to "let x stand for the unknown quantity which is to be found." They transform the problem into mathematical signs in order to find its solution.

Recall from Chapter 5 that the science of signs, or semiotics, concerns how people develop signs and systems of signs (or codes) to interpret and explain their experience. Three types of signs are possible. Indexical signs are those that bear a cause-effect relationship to the objects for which they stand. For example, smoke is a sign of fire; it is caused by fire. Likewise, the reading on a thermometer is an index of temperature, because heat causes it to rise whereas cold causes it to fall.

Iconic signs are images or pictures of the objects for which they stand. Examples of icons can be seen in many computer applications. The trash can on the Macintosh screen, for example, stands for its function; it is used for throwing out or deleting files. Finally, signs that are symbolic in nature bear an abstract relationship with the objects or events for which they stand. Language and mathematics are two examples of symbolic sign systems. (Notice the similarity between these three types of signs and the modes of cognitive representation proposed by Bruner.)

So how do children learn to use signs in the first place? Vygotsky (1978) argued that sign use arises from something that was originally not a sign operation. He gave the example of a child stretching out her hand for an object she cannot quite reach. An adult interprets the gesture as pointing and responds accordingly. Gradually, as the child apprehends the same meaning as the adult, she will deliberately use the gesture as a sign for pointing.

It is also possible to apprehend different meanings from signs than those they are intended to convey. It is unlikely that Mrs. Bell in Pet Monkey, for example, thought about what her possession and use of the chalk might come to mean for her students other than "writing on the board during an activity." Yet the gesture of holding the piece of chalk close to her chest and giving it up only when the student said the "right" answer could easily become a symbol (sign) of her authority in the classroom.

Higher mental processes are created, then, when mediation becomes increasingly internal and symbolic. Two concepts proposed by Vygotsky for understanding this process are internalization and the zone of proximal development.

Internalization. "Any higher mental function necessarily goes through an external stage in its development because it is initially a social function" (Vygotsky, 1981, p. 162). The gesture of pointing, for example, could not have been established as a sign without the reaction of the other person. Until the adult responds, the child is simply grasping, on her own volition, for an object out of reach. With the adult's response, however, the situation has changed to one of social exchange, and it is in that exchange that the act of grasping takes on a shared meaning of pointing. When the child internalizes this meaning and subsequently uses the gesture as pointing, the interpersonal activity has been transformed into an intrapersonal one.

Vygotsky (1962) argued that internalization provides a good explanation for the egocentric speech observed by Piaget in preoperational children. In Piaget's theory, egocentric speech reflects the egocentric thought and reasoning patterns of the preoperational child. It disappears when the logical operations of the next stage are acquired. Vygotsky believed, however, that egocentric speech evolves into inner speech and denotes "a developing abstraction from sound, the child's new faculty to 'think words' instead of pronouncing them" (1962, p. 135). "From the child's own point of view," Vygotsky (1962) argued further, "egocentric speech is not yet separated from social speech" (p. 136). He conducted experiments to test this belief and concluded that when children have made the transition of isolating their own consciousness from the social world around them, their egocentric speech will be entirely subvocal and inner-directed.

Similar logic has been applied to second language learning in characterizing the role that the first language (L1) plays as the second language (L2) is being learned. Just as egocentric speech helps the child to regulate his or her thinking, so metatalk in L1 can help learners regulate and structure their responses to task demands in L2 (cf. Brooks & Donato, 1994; Donato, 1994). This can readily be seen in the scenario, Beginning Spanish, in which Pete and Richard are clearly focused on the task, which they are supposed to conduct entirely in Spanish. Because Spanish is not yet entirely internalized, however, they rely on English to help orient themselves as they attempt to solve the problem.

The Zone of Proximal Development. Consistent with his emphasis on the process of development, Vygotsky sought to understand the beginnings of skill development. As such, he looked for a means to examine "those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. These functions could be termed the 'buds' or 'flowers' of development rather than the 'fruits' of development" (Vygotsky, 1978, p. 86). The means he discovered consisted of assigning tasks to children that went beyond their current capabilities. This technique enabled Vygotsky to reveal a gap between a child's "*actual developmental level as determined by independent problem solving*" and the higher level of "*potential development as determined through problem solving under adult guidance or in collaboration with more capable peers*" (1978, p. 86). This gap he called the **zone of proximal development** (see Figure 7.3).

Vygotsky argued that the standard way of assessing a child's mental age reveals only what abilities have developed and provides no information about what will yet develop. To illustrate, he described a hypothetical example:

> Suppose I investigate two children upon entrance into school, both of whom are ten years old chronologically and eight years old in terms of mental development. Can I say that they are the same age mentally? Of course. What does

this mean? It means that they can independently deal with tasks up to the degree of difficulty that has been standardized for the eight-year-old level. If I stop at this point, people would imagine that the subsequent course of mental development and of school learning for these children will be the same, because it depends on their intellect.... Now imagine that I do not terminate my study at this point, but only begin it. These children seem to be capable of handling problems up to an eight-year-old's level, but not beyond that. Suppose that I show them various ways of dealing with the problem. Different experimenters might employ different modes of demonstration in different cases: some might run through an entire demonstration and ask the children to repeat it, others might initiate the solution and ask the children to finish it, or offer leading questions. In short, in some way or another I propose that the children solve the problem with my assistance. Under these circumstances it turns out that the first child can deal with problems up to a twelve-year-old's level, the second up to a nine-year-old's. Now, are these children mentally the same? (Vygotsky, 1978, pp. 85–86)

According to Vygotsky (1978), "the zone of proximal development defines those functions that have not yet matured but are in the process of maturation" (p. 86). In this hypothetical example, then, the first child shows evidence of skills that will develop beyond those of which the second child will be capable.

The zone of proximal development, in separating actual development from potential development, suggests rather revolutionary implications for assessment of children's intellectual abilities. It is likely, for example, that children's learning potential is masked by standard IQ or problem-solving tests that measure only independent, or intrapsychological, performance. To test this possibility, A. Brown and her colleagues (e.g., Brown & Ferrara, 1985; Campione et al., 1984) developed a measure of interpsychological performance. Specifically, they observed the number of standardized prompts children required in order to reach a preset performance criterion on a letter sequencing task.

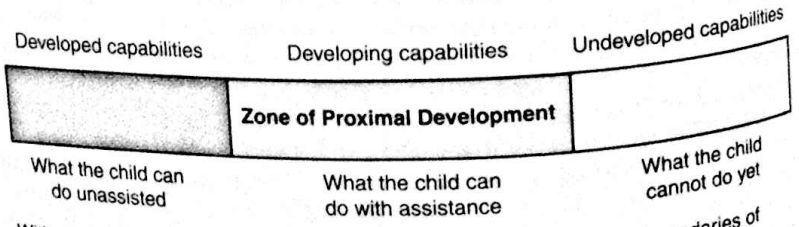


FIGURE 7.3 *A Conceptualization of Vygotsky's Zone of Proximal Development*

This index of learning potential, while correlated with IQ and grade level, provided information about students' cognitive levels that went beyond what could be explained by IQ or grade level. For instance, Brown and Ferrara (1985) reported:

> Overall, the IQ of almost 50 percent of the children did not predict learning speed and/or degree of transfer. Thus, from this wide range of "normal"-ability children (IQ range 88–150) a number of different learning profiles have emerged, including (1) slow learners, narrow transferrers, low IQ (slow); (2) fast learners, wide transferrers, high IQ (fast); (3) fast learners, narrow transferrers (context-bound); (4) slow learners, wide transferrers (reflective); and (5) fast learners, wide transferrers, low IQ (somewhat analogous to Budof's high scorers). All of these profiles are hidden when one considers only the child's initial unaided performance. (p. 293)

A second, equally important, implication of the zone of proximal development concerns the role of social interaction in determining its precise boundaries. Its lower limit is obviously fixed by the actual level of development that a child demonstrates. But what about its upper limit? This, Vygotsky believed, is set by processes of instruction that can occur in play, in formal instruction, or in work (Vygotsky, 1978; Wertsch, 1985). What is essential, regardless of the setting, is that "the child is interacting with people in his environment and in cooperation with his peers" (Vygotsky, 1978, p. 90). When we consider the nature of this interaction, we encounter Vygotsky's views on learning and instruction.

Learning, Instruction, and Development

"The only good kind of instruction is that which marches ahead of development and leads it" (Vygotsky, 1962, p. 104). "The only 'good learning' is that which is in advance of development" (Vygotsky, 1978, p. 89). From these statements, it is clear that Vygotsky viewed the processes of learning and development to be separate, in that learning is not the same thing as development, but linked, in that learning can set developmental processes in motion. The lagging behind of development from learning is what results in zones of proximal development. Moreover, "each school subject has its own specific relation to the course of child development, a relation that varies as the child goes from one stage to another" (Vygotsky, 1978, p. 91). When we also take into consideration the impact of social interaction on zones of proximal development, a rather complex picture emerges of just what "good instruction" should be. Let us examine some possibilities.

Teaching Thinking Versus Content-Specific Skills. Vygotsky (1978) considered and rejected three views of how development and learning may interact. The first, that development is a precondition for learning, he attributed primarily to Piaget. The logical implication for instruction based on this view is that concepts or problems in any subject should not be taught until children have developed the necessary logical operations to understand them. Furthermore, since logical operations cut across subject matter areas, "instruction in certain subjects [should] develop[s] the mental faculties in general" (Vygotsky, 1962, p. 96). This is the basic idea behind instruction in formal disciplines and amounts to instruction in how to think.

The second perspective, that development is learning, is more characteristic of behaviorist and cognitive information-processing theories. In describing this view, Vygotsky wrote, "Learning is more than the acquisition of the ability to think; it is the acquisition of many specialized abilities for thinking about a variety of things" (1978, p. 83). For the design of instruction, this suggests attention to specific prerequisites within content domains. And only to the extent that content domains have skills and knowledge in common should we expect a transfer of abilities developed in one to problems in the other.

A third view merely combines the first two, and Vygotsky found it equally unsatisfactory. Instead, he proposed a more complex view of the interaction between learning and development, which Wertsch (1985) criticized as being unclear in its implications for instruction. On the one hand, learning—and therefore, instruction—precedes development and, in fact, draws it along. As such, demonstrated ability within a subject area must necessarily depend upon organized instruction within that area. On the other hand, development must also occur in part because of its own internal dynamic. How else can we explain differences among children's zones of proximal development when their learning histories are similar? How else can we account for the changing relation that Vygotsky proposed between the subject and the child during development? Unfortunately, it is not entirely clear what this means for instruction.

Perhaps we may draw a parallel between Vygotsky's views of learning and development and Bruner's. Acquiring specific prerequisite skills and knowledge within a content discipline is obviously important. But so is solving problems that require learners to go beyond their current skill and knowledge levels. As Vygotsky noted, "Learning which is oriented toward developmental levels that have already been reached is ineffective from the viewpoint of the child's overall development. It does not aim for a new stage of the developmental process but rather lags behind this process" (1978, p. 89). We may conclude from his statement that Vygotsky agrees with Bruner about the need for those "medium-level questions" in instruction, the ones that will "take you somewhere."

Vygotsky's acceptance of Marxian philosophy offers another clue to what he regarded as effective instruction. If socially organized labor activity provides the context for how people act and think, it also provides an appropriate context for learning. That is, "cognition is constituted in dialectical relations among people acting, the contexts of their activity, and the activity itself" (Lave, 1988, p. 148; cf. Leontiev, 1981). And learning involves solving problems that arise out of conflict-generating dilemmas in everyday situations. Shoppers learn certain arithmetic practices, for example, because living within a limited budget requires that they calculate the best buys. This suggests that instruction should supply similarly relevant situations in which students are called upon to resolve dilemmas. We have seen the same argument expressed in Chapter 5, and it will come up again as a driving force in constructivist learning environments (Chapter 11).

Interaction in the Zone of Proximal Development. For instruction to precede development implies that certain types of interaction will be more effective than others in the child's zone of proximal development. In other words, "children learn to use the tools and skills they practice with their social partners" (Tudge & Rogoff, 1989, p. 25). This means that the social interactions they encounter could lead to developmental delays or abnormal development as well as to normal or accelerated development. Contrast this position to Piaget's, whose theory assumes that development is unidirectional, with all normal children expected to reach the last stage at approximately the same time.

Given that the role of a child's social partner is critical to the zone of proximal development, what can be said about it? For one thing, Vygotsky's theory "requires not only a difference in level of expertise but an understanding on the part of the more advanced partner of the requirements of the less advanced child, for information presented at a level too far in advance of the child would not be helpful" (Tudge & Rogoff, 1989, p. 24). Ideal partners in an instructional enterprise, then, should not be equal in terms of their present level of knowledge and skill. The more advanced partner, whether adult or peer, will function to bring about cognitive development in the less advanced partner.

This is consistent with the notion of scaffolding, where the instructor or more advanced peer operates as a supportive tool for learners as they construct knowledge (Greenfield, 1984; Wood, Bruner, & Ross, 1976). "The scaffold, as it is known in building construction, has five characteristics: It provides a support; it functions as a tool; it extends the range of the worker; it allows the worker to accomplish a task not otherwise possible; and it is used selectively to aid the worker where needed…a scaffold would not be used, for example, when a carpenter is working five feet from the ground" (Greenfield, 1984, p. 118).

The characteristics of a scaffold define the characteristics of an ideal instructor. An instructor should neither present information in a one-sided way nor shape successive approximations to some goal behavior. Rather, an

instructor should provide the guidance required for learners to bridge the gap between their current skill levels and a desired skill level. As learners become more proficient, able to complete tasks on their own that they could not initially do without assistance, the guidance can be withdrawn (Greenfield, 1984).

A second requirement of the social interaction between partners is that their relationship be one of intersubjectivity. By this, Vygotsky meant that partners must come to some degree of joint understanding about the task at hand (Wertsch, 1984). It is not enough, in other words, for the partners to simply work together or for one partner to dominate and demonstrate solutions to the other. They must co-construct the solution to a problem or share in joint decision making about the activities to be coordinated in solving the problem. It should be apparent that the requirement of intersubjectivity denotes a different relationship between social partners in instruction than is typical between a teacher and student or between a tutor and tutee. Intersubjectivity implies shared power and shared authority, where inequality between partners resides only in their respective levels of understanding.

Think back to the two scenarios with which this chapter began, Pet Monkey and Beginning Spanish, and consider the extent to which scaffolding or intersubjectivity has been established. In Pet Monkey, there are clear signs that the teacher and students are *not* partners in the instruction. She is evidently standing near the board, the children are seated, and they can come to the board only when she gives them permission by handing them her piece of chalk. By contrast, Pete and Richard are partners in the instructional enterprise by design of the teacher who instigated the activity. Between them, they must construct a shared understanding of the task and of the means to accomplish it.

Social interaction among partners during instruction (whether the partners are peers or one is an adult or teacher) has been investigated for its effect on learning, and several conclusions have resulted. First, it is useful to distinguish between the learning of skills and adopting new perspectives as the goal of instruction (Tudge & Rogoff, 1989).

In the learning of skills, adults were more effective as partners than children's peers. They tended to promote more advanced planning strategies (e.g., Radziszewska & Rogoff, 1988), provide more verbal instruction, and elicit greater participation (e.g., Ellis & Rogoff, 1982) than did the child partners. By contrast, "the child teachers appeared relatively unskilled at guiding instruction within the learner's region of sensitivity to instruction" (Ellis & Rogoff, 1982, p. 323).

In learning to consider another's perspective, however, child partners were more effective than were adult partners, provided there was a free and active exchange of ideas without one child dominating the conversation. It is likely that peer interaction may provide for a more open forum for discussing issues than is available in adult-child interaction (Tudge & Rogoff, 1989).

Finally, research findings seem to converge in support of the requirement for intersubjectivity between social partners during instruction. Advances in development occurred when partners collaborated to arrive at a solution to a problem (e.g., Forman, 1987). But interaction was less successful when one partner dominated, or when partners argued or engaged in off-task behavior (e.g., Glachan & Light, 1982; Russell, 1982).

An instructional strategy in which intersubjectivity comes together with scaffolding is reciprocal teaching. Developed for reading instruction by Palincsar and Brown (1984; see also Brown & Palincsar, 1982; Palincsar, 1986), reciprocal teaching is designed to improve comprehension of poor readers. In this program, poor readers engage in dialogue among themselves and with the teacher, during which they jointly construct meaning from whatever text they are reading. The dialogue is structured to emphasize four comprehension strategies: questioning about the main points in the passage, clarifying to resolve difficulties in understanding, summarizing to capture the gist of the text, and predicting to forecast what might happen next.

Initially, the teacher leads and sustains the discussion, modeling the four comprehension strategies. But as the instruction proceeds, the teacher transfers more and more control of the dialogue to students, who assume the role of instructor. Evaluations of this program have consistently shown significant gains in students' reading comprehension. In addition, they appear to use their newly acquired skills in reading texts in content domains, such as science and social studies.

The Role of Language and Other Sign Systems. A consequence of internalization is the ability to use signs in increasingly elaborative ways that extend the boundaries of children's understanding. In play, for example, young children use whatever resources are available to them to "project themselves into the adult activities of their culture and rehearse their future roles and values" (John-Steiner & Souberman, 1978, p. 129). Although the tools at hand may include sophisticated, prefabricated toys, children are equally successful at creating imaginary situations with sticks and other common objects in their environment. In play, Vygotsky argued, children stretch their conceptual abilities and begin to develop a capacity for abstract thought. The signs they establish in their imaginations, in other words, can make up a very complex symbol system, which they communicate through verbal and nonverbal gestures.

The development of language, however, was thought by Vygotsky to have the greatest impact on children's acquisition of higher psychological processes. Vygotsky believed that language constitutes the most important sign-using behavior to occur during cognitive development, because it frees children from the constraints of their immediate environment. It provides for decontextualization, wherein signs (or words, in this case) become more and more removed from a concrete context (Wertsch, 1985; Wertsch & Sohmer,

1995). In learning concepts, for example, children initially associate the concept name, such as horse, with a specific animal they have encountered. With experience, however, they learn to abstract the concept from a particular concrete context and so generalize it to other situations and instances of horses.

This process of decontextualization must occur with any symbol system if it is to serve higher mental functions such as reasoning. To illustrate, Wertsch (1985) described the results of Saxe (1977, 1982), who investigated children's understanding of numeration (counting) systems. The children Saxe studied came from New Guinea and counted by employing their body parts in a particular order. Young children, he discovered, focused on the physical characteristics of the body parts, rather than their role in the counting process. Imagine, for example, counting up to four on your fingers, by starting either from the right or left of your hand. The fact that a different finger is reached would mean to the young children of this study that two different numbers must have been counted. Older children, however, were able to abstract the body part from its role in numeration and so would respond that four had been counted in each case.

Although Vygotsky did not address specific implications for instruction of language and other sign systems, other than to suggest that play is important for learning in young children (Vygotsky, 1978), other researchers have begun to pick up the slack. Lemke (1985, 1988) suggested that mastery of a subject entails mastery of its specialized language structures. In one study of a high school class in earth science, for example, Lemke (1988) illustrated how a teacher and his students, with different understandings of what light and heat mean, talked at cross-purposes. He concluded that "meaning relations, in particular, need to be frequently glossed, paraphrased, and made explicit, and students need to be explicitly alerted to the genres of paraphrase and semantic clarification, so that they can use them actively in asking questions, posing problems, and refining their mastery of the thematics of a subject" (Lemke, 1988, p. 97).

Similarly, Emihovich (1981) has demonstrated gender and race differences in discourse structure, not only in teacher-student interactions, but in student-student interactions as well. This reinforces the need for teachers to realize that children's misbehavior may simply stem from misunderstanding rather than willful disobedience. In addition, misunderstanding may be a problem of translation, or differences in language structure, rather than a problem of misconception.

Conclusion

In this chapter and the preceding one, the concept of human cognitive development has been explored as it relates to learning and instruction. In some respects, the theorists discussed in Chapter 6 represent opposing positions.

Despite an apparent common focus on interaction between children's native capabilities and their environment to explain development, Piagetian and cognitive information-processing theorists diverged in their explanatory emphases. With its proposal of age-based stages and a single developmental mechanism (equilibration), Piaget's theory is more nativistic. By contrast, information-processing theorists put more emphasis on environmental factors in development.

In this chapter, Bruner and Vygotsky might be said to offer intermediary positions, with their explicit focus on the role of interaction in development. As John-Steiner and Souberman (1978) suggested, Vygotsky "offers a model for new psychological thought and research to those who are dissatisfied with the tension between traditional behaviorists and nativists" (p. 121). Finally, perhaps recent cognitive developmentalists, and most certainly Bruner and Vygotsky, now recognize a complexity in human development that belies the sufficiency of a single model or theory of development. "The age of global claims appears to be at an end" (Bruner & Bornstein, 1989, p. 13). Instead, many theories may each provide insight into some aspect of learning and development. As we have seen throughout this book, what one theory conceals, another illuminates.

"Kermit and the Keyboard" from the Perspective of Interactional Theories of Cognitive Development

Like Piaget's theory, the interactional theories of Bruner and Vygotsky are focused on cognitive development as it relates to learning, not on learning itself per se. Because Kermit is an adult learner, we would expect these theories to have relatively little to contribute toward understanding what and how he is learning in this story. However, Bruner himself pointed out that his "bogus stage theory" did not put age limits on the modes of understanding that children develop, and I suggested in the chapter that adults might well exhibit the same progression through the three modes of understanding as they are learning subject matter that is new and unfamiliar.

Because Kermit had prior training in music, the task of learning to play the keyboard is not entirely new or unfamiliar. Reading music is a skill that is already in his repertoire, and we can see that he easily understands the music symbol system involved in being able to do this. Thus, he may be learning specific songs at the symbolic level. Enactive understanding can perhaps be seen in Kermit's trial-and-error playing, as he attempts to connect particular notes on the keyboard with the notes represented on the musical score.

Vygotsky's ideas about the interaction of an individual with his cultural milieu might be implicated in Kermit's decision to study the keyboard in the

first place. After all, why not take up the instruments that he learned to play years ago? Surely, it would be easier to become proficient on those a second time than to become as well skilled on the keyboard. However, the computer is ubiquitous in the modern age, and today's computer-based keyboard is truly an incredible tool for making music. It enables the performer to sound like almost any instrument, to play with many different accompaniments, and to compose and record his or her own arrangements. The versatility of this tool is a powerful incentive because the player can sound nearly professional on simple compositions in a relatively short period of time.

Theory Matrix

Theory	Interactional Theories of Cognitive Development
Prominent Theorists	J. S. Bruner; L. S. Vygotsky
Learning Outcome(s)	Thinking, conceptual knowledge, ability to use the tools of one's culture, awareness of one's own thinking
Role of the Learner	Interact with the instructor, peers, and sociocultural environment to solve problems
Role of the Instructor	Involve learners in a process of inquiry and problem-solving Ask medium-level questions to provoke cognitive conflict Engage learners in socially organized labor activities relevant to their culture with learning partners appropriate for the desired goals of instruction.
Inputs or Preconditions to Learning	A "well-prepared mind", culturally relevant tools, and prior knowledge
Process of Development/ Learning	For Bruner, a progression through successively more sophisticated modes of thinking (enactive to iconic to symbolic) For Vygotsky, mediation to apprehend tools of the culture, internalization of socially-mediated understanding to become personal knowledge For both, learning serves to pull development along

Suggested Readings

Bruner, J. S. (1986). *Actual minds, possible worlds.* Cambridge, MA: Harvard University Press.
Bruner, J. S. (1996). *The culture of education.* Cambridge, MA: Harvard University Press.
Wertsch, J. V. (1998). *Mind as action.* New York: Oxford University Press.
Wertsch, J. V., del Rio, P., and Alvarez, A., Eds. (1995). *Sociocultural studies of mind.* New York: Cambridge University Press.
Zimmerman, B. J. & Schunk, D. H. (2003). *Educational Psychology: A century of contributions.* Mahwah, NJ: Erlbaum.

Reflective Questions and Activities

1. Consider the underlying assumptions that Bruner and Vygotsky appear to make about knowledge and its development. With what epistemological position would they most closely align? How are their assumptions similar to or different from those of Piaget or the cognitive information-processing theorists?
2. At the end of the last chapter, you took a preliminary position on which comes first, learning or development. Reflect upon your answer and decide whether your opinion has changed or remained the same. In either case, indicate why.
3. Describe an instructional program (hypothetical or actual) that makes use of Vygotsky's "zone of proximal development." What is being taught and learned? By whom? And utilizing what instructional strategies?
4. Although Bruner and Vygotsky concerned themselves with the development of knowledge among children, their ideas have been used to apply to adults. What, in your opinion, might be the most likely concepts from their theories to apply to adult learning? Why? Illustrate your answer with specific examples.