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Images of childhood and their reflection in teaching

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In this chapter, I describe, in outline, four ways of thinking about the nature of learning and thinking. I try to present and discuss these views in terms of the way in which they invite us to think about the nature of the intellectual abilities of five- to eleven-year-old children. Theories that offer very different accounts of the way in which children think and learn also lead to alternative views on what is involved in teaching them. So, this chapter also revolves around a discussion of what roles the three images of childhood etch out for teachers.

The chapter is also designed to provide a guide to the rest of the book. Some of the ideas involved are difficult and they are often expressed in unfamiliar language. I have tried to keep jargon to a minimum. Where I have felt obliged to introduce uncommon terms, I have provided concrete examples and illustrations to try to convey their meaning. The main themes explored are discussed several times in later chapters, so it is not necessary to grasp or to remember all that is said here. I suggest a quick read to obtain a general sense of what is to come later in the book, rather than a close study of the contents of this chapter. Details come later.

Learning and schooling

About thirty years ago, I read my first book on psychology and education. It was Bruner's (1966b) influential *Toward a Theory of Instruction*. One of the observations he made in that book was that schools and the social roles they have created (such as 'teacher' and

'pupil') are relatively modern inventions. There are non-technological cultures in which schools do not exist. Indeed, a number of languages have no verb meaning 'to teach' in their vocabulary. The notion that children must be taught in order to learn, let alone the expectation that they will do so in classrooms, is by no means a universal one. Rather, it seems to have been an invention of technological, schooled and literate societies. Another of Bruner's arguments is that the widespread availability of schooling involves far more than a change in the place where (some) learning and development take place. Rather, schools engender new and distinct *forms* of learning and lead to new *ways* of thinking. These contentions will be a major focus of the present book. We will be exploring the impact of formal education and, more specifically, teaching, on the development of children's powers of attention, concentration, memory, thinking, learning and language. I hope to show how a consideration of these topics bears directly on a range of practical issues having to do with children's adjustment to and, for some, problems in school. These concerns, in turn, will lead us to discussions about 'readiness' for learning, 'relevance' in the curriculum, 'discovery' methods in learning and factors that help to shape children's capacities for disciplined, self-directed learning and sustained, rational thinking.

Although I do not subscribe to the view that children are, in any simple sense, directly taught how to learn and think, I do believe that the development of certain ways of reasoning and learning about things is a direct product of both spontaneous and contrived social interactions between the developing child and more mature members of his or her community. By 'contrived encounters' I mean social interactions that come about as a result of *explicit* educational goals. Many interactions in school are, of course, of this nature. However, learning is obviously not synonymous with schooling. A great deal of what children learn occurs spontaneously outside the school walls as they play, observe, ask questions, experiment and make sense of the world around them. Similarly, many spontaneous encounters between children and their parents, relatives and peers involve an element of *informal* teaching. Suggestions, hints and warnings, conversation, practical tasks shared, family reminiscences and the like, all provide contexts within which the developing child's learning and understanding are orchestrated and extended through social interaction. Often, as we shall see, the formative influences of such interactions on the child's mentality are not *intentional* outcomes of what we seek to communicate to the child. Rather, they are products of implicit features of the

social *practices* within which communication and attempts to teach take place. We are usually unaware of such things. They are, so to speak, like water to the fish, 'transparent' to the participants.

The child is not a passive nor always a compliant partner in such encounters. I share with Piaget and most contemporary theorists of child development the view that children actively 'construct' their knowledge of the world. I will discuss and illustrate this proposition in some detail. But I will depart from Piagetian theory in a number of important directions. I believe that adults, social interaction and communication play a far more formative role in the development of children's thinking and learning than his theory allows. Although Piaget accepts that social experiences and inter-personal behaviour are an important part of development, they play a rather limited and secondary role in his theory. The child's intercourse with the physical world provides the main constraints on and contributions to intelligence. Children construct their own knowledge by acting upon objects in space and time. Social interactions (particularly those which take place between children themselves) may facilitate the course of development by exposing a child to other points of view and to conflicting ideas which may encourage him to re-think or review his ideas. However, for Piaget, any social facilitation of development only works when the child's own understanding, based on his commerce with nature, is in an appropriate state of readiness for change. I will be arguing that social interaction plays a more important role than this view permits. Children's knowledge, I suggest, is often a product of the 'joint construction' of understanding by the child and more expert members of his culture.

I will also examine alternatives to Piaget's concept of knowledge, of what it is the child is learning about. These alternative views, we will find, question his account of young school children's ability to learn and think. Bruner and the Soviet psychologists, such as Vygotsky and his colleague, Luria, place far more emphasis than Piaget does on the role played by culture and its systems of symbols (e.g. its languages, sciences, books, diagrams, pictures and other artefacts) in forming the child's intelligence. Such systems have a dynamic, structuring effect on learning and development. They are not to be viewed as the mere 'content' of thinking but seen as part of its structure and its activity. When the child learns a language, for example, he does not simply discover labels to describe and remember significant objects or features of his social and physical environment but ways of *construing* and *constructing* the world. When he watches television or examines pictures in books, he

is not merely experiencing another way of depicting things but is involved in medium-specific activities which, in time, generate mental 'operations' that become part of the fabric of his intellect. But I move on too fast.

From five to eleven

Theories of development and the evidence they have generated provide the framework for this book. The main *subject* explored is the study of learning and thinking in children aged between five and eleven years. It is not an easy topic. What we mean by 'thinking' and what is entailed by the term 'learning' are not easily expressed. Indeed, the meaning of such terms varies, often radically so, across theories of development. Similarly, our everyday usage of such terms also betrays a multitude of different attitudes towards, and implicit theories about, what thinking and learning involve and how they are fostered or nurtured. I do not think it would be useful to try here to outline and discuss definitions of thinking, learning and related aspects of our intellect. This, I suggest, is best achieved through a detailed consideration of concrete examples and illustrations. When we begin to weigh up the various interpretations offered to explain why, for instance, seven-year-olds are able to do many things that five-year-olds cannot do, we will, I hope, see how different theories offer us several ways of viewing and thinking about our own intelligence and its development.

Debates about the nature of development are inescapably and necessarily bound up with concepts of teaching. A book about the development of children's cognitive abilities, their powers of perception, attention, learning, memory, thinking and language, is also a book about teachers and teaching. Some theories afford only a supporting role for adults in the drama of development whilst others cast them into starring parts. What it means to be a 'teacher' rests, amongst other considerations, on how we construe children-as-learners. And how should we go about the task of creating the conditions under which teachers and learners are enabled to fulfil their roles? Do schools provide contexts within which anything approaching 'optimum' conditions for teaching and learning arise? What 'optimum' means depends upon how we choose to view the developmental process. At one level, then, it is impossible to divorce the academic study of children's thinking and learning from moral, political and economic issues concerning the resources we allocate to education and the way in which

we train our teachers. Although it is not my intention to bring such issues to the forefront of attention, they will, inescapably, lurk in the background of many discussions.

Metaphors of mind: how do we talk about how we think?

When we think about what goes on in our minds and try to describe what takes place there, what terms do we use? How do we try to capture and describe the content and structure of thought? Well, we resort to metaphor; to phrases like 'in our minds'. If we are asked to describe what we are doing as we try to remember something, for instance, we often talk about 'searching', as though our memory is a 'place' or a 'store'. What we are 'looking' for is in a 'location', 'somewhere'. By talking about searching our memories, we invite comparisons with the processes involved in physical activities like searching a room, looking for a mislaid object. As we search our memories, we may know that something that we can't yet recall, but that we know we know, is 'at the back of our mind' and that we will recognize it when we 'find' it. Meanwhile, perhaps, another place or word that we have already thought about and rejected keeps coming to the 'forefront' of our thinking and, despite all our rejections, will not 'go away'.

When we talk about our reasoning, we often use expressions like 'imagining what would happen if. . .', 'picturing', or, particularly if one is a cognitive psychologist, 'making a mental model of . . .'. We may on other occasions be aware of a process that resembles 'talking to oneself' or hearing an imaginary other talking to us. If during the course of our imaginings we think about a serious mistake, we might 'cringe' at its effect and feel the ghost of whatever feeling it would entail if we 'really did' what we 'thought to do'. As we reason, we reach decisions and make judgements, deciding, perhaps, that something 'will not work','doesn't fit', leads to a 'dead end' or that it takes us a 'step forward' and a 'stage further on'. We may chide ourselves for stupidity or praise our own ingenuity. If we are lucky, we may decide that we have 'made a discovery', 'got there', 'thought it out', 'found out' or 'done it'. Often, as many innovative thinkers have commented, following the feeling that an insight or solution has been 'grasped', 'seen' or 'felt' comes another period of often hard and protracted work as one sets out to *prove* or *explain* or *demonstrate* the fact that a solution has been 'worked out'. Reasoning, then, is often described in terms also used to talk about physical activity, discussion and inter-personal evaluations.

But we are not always 'in control' of our mental activity. When we are supposed to be thinking about one thing we may suddenly 'find ourselves' considering something else that we should not be thinking about and, probably, be unsure or mystified as to why and how we found ourselves doing so, or when we 'went off course'. Our concentration may lapse or we might 'lose hold' of what we were supposed to be 'working on'. On the other hand, a sudden idea, insight or solution may seem to 'come to us' in a 'flash of insight'.

The metaphors that we employ to talk about, describe and explain the invisible, often fleeting, processes that go on as we think are, not surprisingly perhaps, derived from the visible, talked-about aspects of our directed *physical* activities and our experiences in the real world. But are our descriptions and explanations anything *more* than metaphorical? Are they an adequate starting place for a psychological analysis of mind? Are there any fundamental and demonstrable connections between the spatial, temporal and corporeal aspects of practical activities and mental processes that we often describe in similar terms? One theory of human development which suggests that there are more than metaphorical relationships between the language used to describe mental processes and that used to talk about activities in the physical world is that of Vygotsky. Although, as we shall see, he did not claim that mental activities are direct 'enactments', 'copies' or 'recordings' of external activities, he did argue that their *nature and their structure* are derived from them. He explored the theory that activity in what he termed the external, social plane is gradually 'internalized' by the child as he develops until it *forms* his intellectual processes. When we speak, say, of creating a 'mental model', there is a real sense in which the 'imaged' actions that we perform and their 'imagined' consequences are derived from physical actions that have previously been done to real objects and whose consequences have been directly felt or observed.

Of course, we often make errors and misjudgements in reasoning. Our models of the world are never perfect replicas. We may find, when we try to 'really' act out what we previously thought of doing, that the world resists the enactment of our imagined actions, or that the result of our actions surprises us. Thought, thus viewed, is a *substitute* for overt action and permits 'trials' whose 'errors' are only imagined. Viewed in evolutionary terms, thought (up to now at least) has proved its survival value. Though not immune to error, it has, on balance, conferred evolutionary advantage. Thinking before acting must have proved sufficiently reliable and valid to enable energy to be saved (mental activity consumes less time and food than overt action) and

dangers to be avoided. Perhaps, then, the use of words to refer to mental actions *as though* they are related to similar or analogous physical actions involves more than metaphor. However, as I have already warned and will argue later, establishing the *nature* of the relations between actions and thoughts is no simple matter.

Thought as internalized action

Piaget shared with Vygotsky a similar conception of the relations between action and thought. He also argued that the foundations of mental processes lie in action-in-the-world. His often cited, deceptively simple, statement that 'Thought is internalized action' declares his view that the analysis of human knowledge and intelligence must begin with a consideration of motor activity and practical problem-solving. It also alerts us to one of his important educational messages, which is that children have to be active and constructive in order to develop their understanding of the world.

Although this book is focused on the development of children aged between five and eleven years, I think it is important when trying to grasp the significance of Piaget's analysis of the relation between acting and thinking to consider, albeit briefly, his observations of infants in the first year of their lives. The many examples he gave of babies' activities, play, imitation and problem-solving provide a concrete sense of the way in which he charted the beginnings of a transition from physical to mental activity.

Initially, the newborn's movements are reflex responses to internal and external stimulation. The infant may grasp a finger placed in his palm, respond to a light touch on the cheek by 'rooting' around, or blink in response to a puff of air. At first babies do not *anticipate* the impact of such stimulations, even when, so to speak, they can 'see them coming'. Things just happen to them. With experience, however, the infant starts to discover some of the *predictable* patterns in his experience. For instance, if a baby notices that a mobile placed over his cot moves when he happens to strike the cot side, he may well repeat the movement in order to maintain the interesting sight of the mobile in motion. At this stage, however, the infant is not aware of the fact that it is 'his' hand that has produced the effects on an object (i.e. the mobile). Both his actions and their consequences are part of a continuous flow; an undifferentiated experience or 'scheme'. However, this soon changes. When the infant starts to show evidence that he is *intending* to produce

anticipated end results through his own actions, then true 'practical intelligence' has emerged. The infant's activity displays such intelligence when he begins to use different *means* towards a common *goal*. So, for example, an infant, having failed to reach up and touch the mobile, might push his mother's hand towards it, which is most likely to happen if both the mobile and her hand are in view at the same time. It is when the infant exhibits a *sequence* of different actions to achieve the same purpose that Piaget endows him with the beginnings of a practical intelligence. This intelligence takes the form of *anticipating* or desiring a state of affairs, being able to hold or represent what is sought 'in mind' and trying out various actions that, *in the past* have accomplished desired ends. Eventually, the child will come to 'reject' certain actions on the basis of mental activity alone as he imagines their consequences and mentally evaluates their desirability without actually performing them. Thus, interiorized or internalized *mental actions* start to substitute for (represent) physical actions; action is being internalized to form thought.

Several other theories of learning also offer explanations for such phenomena, and some of these (explicitly) proceed without making any reference to 'minds', infantile or otherwise. What is distinctive and original about Piaget's analysis is the fact that such 'elementary' learning is only one aspect of a much more elaborate theory of development. Sensory–motor schemes, the learned co-ordinations between actions and their sensory consequences, provide the bedrock of all knowledge, but the biology of human beings dictates that such sensory–motor learning is *structured* in the infant to form not only 'internalized actions' but, ultimately, *mental operations*.

I do not intend to go into detail here about Piaget's account of the operations of mind since this is best achieved after we have looked at some of the other observations that he used to illustrate the nature of children's thinking. These, I hope, will help to make his ideas more graspable. However, I do need to say a little about the distinction between mental actions and mental operations, both to explore Piaget's hypothesis that thought is internalized action and to help to show how his theory leads to a very different view of intellectual development from those provided by theories of learning that predated his.

Some actions in the world have rather special properties in that, for instance, their effects can be reversed (and observed). Imagine a child playing with a set of bricks. He has five of them, say. Each time he moves one, he changes the configuration and, hence, the *appearance* of the set of blocks. He may pile them so that they get higher. He may then take

the pile down and lay the bricks side by side so that they cover a larger surface area. Each of these actions leads to a perceptible change. To an adult eye, of course, whilst the appearance of the set of blocks changes, their *number* remains invariant. The adult appreciates the fact that any action can be 'reversed' to recreate an earlier configuration, for instance. Configurations are interchangeable and appearances are ephemeral but number is an invariant *property* of the set of blocks. Only if blocks are added or taken away, we realize, is their number changed. As we shall see in chapters 3 and 8, Piaget argues that young children (aged below seven years or so) do not appreciate the fact that actions which change the appearance of things do not also affect their number, because they can't grasp the concept of invariance itself. Recognizing the fact that certain actions are also *operations* which form logical groups and can be *reversed* or which may be 'offset' by other actions is a prerequisite for the ability to *understand* invariant properties like number. Whilst such mental operations are 'abstracted' from physical and mental actions, they have a special status. Although they are derived from practical experience, they are not a direct product of 'learning' (or teaching) in any simple sense. One may observe an action but not an operation. Operations are 'mental constructions' which the child creates to make sense of his or her experience of the world. The transition in human development from an intelligence restricted to a capacity to perform single mental actions to one structured as systems of mental operations marks an intellectual *revolution* that occurs at about seven years of age (although Piaget himself was not over-concerned with 'dating' his stages). How and why the development of operations takes place is considered in chapter 3.

Piaget's analysis of the stages of human intellectual development emerged from a more over-arching endeavour, which was to understand the nature, structure and evolution of knowledge. Piaget was a 'genetic epistemologist', one who studies the origins and evolution of knowledge. He based his analysis of knowledge and his observations and interpretations of children's knowing and understanding on a theoretical framework derived from logic and mathematics (hence, he employed a 'logical-mathematical' approach). This framework led him to analyse and interpret children's development in terms of systems of logical operations that are taken to be the basis for rational understanding of the physical world and of mathematical systems for representing reality. Although it makes life difficult, we have to bear Piaget's main quest and his theoretical approach in mind. It is not possible to separate either an evaluation of his theory of development or its educational

implications from a consideration of the value of using logic as a framework for thinking about thinking and learning. One consequence of Piaget's theory is the prediction that logical reasoning, described in terms of operations of mind, represents the culmination of intellectual development. As we shall see, the implication that mature thinking is adequately or even properly described in terms of logic has aroused a great deal of debate. If we decide that Piaget's view of logic does *not* offer an appropriate description of mature thinking, then we must question his interpretations of young children's abilities and, with them, the educational implications of his theory. Such questions are part of the agenda for this book.

Piaget's approach to language and cognition

Perception and thought

If Piaget places action at the foundation of thought, where do perceptual 'images' and verbal thinking come on the scene? Although there has been and continues to be much debate about the role of 'imagery' in thinking, many people report that they 'use' images when they think in order to represent or 'picture' a situation, object or event. How does Piaget's theory tackle the notion of mental images and what implications does his view have for teaching and learning?

Part of the answer is that Piaget 'relegates' perception to action. For instance, when the infant sees an object, what he perceives, recognizes and knows about it depends upon his past actions. An object is, so to speak, defined by the past actions that have been done to it. The 'sensory' aspects of experiences, such as what an object looked, smelled, felt, tasted and sounded like, are consequences of what was *done* to that object. Thus, the sensory aspects of experience are 'classified' in terms of actions. Some objects can be sucked and others cannot. Some can be grasped and picked up whilst others resist such actions. Some materials can be stretched, others are not so malleable, and so on. A child's intuitive knowledge of the world is based on the actions that he performs on it, and an object is 'known' in terms of the repertoire of actions to which it can and cannot be 'assimilated'. This is one sense in which (past) actions dictate how children perceive the world.

Perception, for Piaget, also involves *activity*. One example of such activity is the movement of the eyes as a situation is inspected and

observed. What we see is determined, in part, by where we look. What we remember is largely dictated by what we attend to. As we shall see in chapter 4, Piaget argues that a child's ability to *control* where and how he looks at things is itself determined by his stage of development. Pre-operational children, he argues (those who have yet to develop mental operations), cannot inspect situations *logically*. Thus, what they perceive is more unreliable and idiosyncratic than what is perceived by an 'operational' thinker, whose inspection of the world is guided by a logical understanding of it. The educational implications of this view of perception, as a process under the control of action and, eventually, mental operations, are profound and far-reaching. If Piaget's theory is sound, then it follows that young children are logically incapable of seeing the world as adults do. Any attempt to 'teach' them by demonstrating how things work is bound to fail if children do not possess the necessary mental operations to *make sense*, in logical terms, of what they are shown.

Language and thought

Piagetian views on the role of *language* in thinking are similar to those on visual perception. Language, for Piaget, is a system of symbols for *representing* the world, as distinct from actions and operations which form the *processes* of reasoning. So, for example, if we had asked the five-year-old child playing with the blocks 'How many?' he had, he would not have *understood* what we asked (at least, in our terms) because he lacks the operations that endow questions like 'How many?' with logical meaning. Suppose we *told* him that he had five blocks, taught him how to count them and managed to obtain from him the answer 'five' when we asked him how many blocks he had. Does the child understand what we said and did? Not according to Piaget – at least, not in the sense that the child shares our understanding of things. It is not the case that he now understands and has been 'taught' the *concept* of number. What the child has learned is simply a *procedure* (making certain sounds) in response to a question ('How many?'). He has not developed a *conceptual* understanding of number. Such an understanding demands that the child comes to the realization that many actions which change appearances have no effect on the abstract, invariant property that we call number. He will not understand such abstract concepts until he has reached operational thinking.

Thus, Piaget's theoretical arguments about the nature of thinking and of the relationships between what is seen, heard and understood

have direct implications for teaching and its effectiveness (or lack of it). Attempts to question, show or explain things to children before they are mentally 'ready' cannot foster *development*, though the child may *learn* some 'empty' procedures. Indeed, premature teaching and questioning may demoralize or frustrate a child who can't begin to understand what he is being 'taught'.

A teacher can provide appropriate *materials* and contexts for development, and organize time and space so that children are free to act upon the world with objects and tasks that serve to foster the emergence of operations and an understanding of invariance. But the basis for such an understanding is constructed by the child through his own, self-selected problem-solving; not through any direct efforts of his teachers.

Vygotsky: instruction and intelligence

Children who are unable to perform tasks, solve problems, memorize things or recall experiences when they are left to their own devices often succeed when they are helped by an adult. Piaget, as we have just seen, takes a somewhat negative view of such apparent successes, claiming that they involve the teaching and learning of procedures and not the development of understanding. He views 'genuine' intellectual competence as a manifestation of a child's largely unassisted activities. Vygotsky, on the other hand, argues that the capacity to *learn through instruction* is itself a fundamental feature of human intelligence. When adults help children to accomplish things that they are unable to achieve alone, they are fostering the development of knowledge and ability. Without a natural ability for teaching, as well as learning, human *cultures* would never have developed since they can only be perpetuated if the immature learn and the mature teach (though not in the narrow sense of these terms, of course). From this perspective, which places instruction at the heart of development, a child's *potential* for learning is revealed and indeed is often *realized* in interactions with more knowledgeable others.

One of Vygotsky's main contributions to educational theory is a concept termed the 'zone of proximal development'. This he used to refer to the 'gap' that exists for an individual (child or adult) between what he is able to do alone and what he can achieve with help from one more knowledgeable or skilled than himself. This concept leads to a very different view of 'readiness' for learning from that offered by Piagetian theory. Readiness, in Vygotskian terms, involves not only the state of the child's existing knowledge but also his capacity to learn with

help. Two children at nominally the 'same' level of (unassisted) performance in a given task or discipline may differ in how much they are able to learn given similar amounts of instruction. A child's current level of performance must be distinguished from his *aptitude* to learn with further instruction. Some children have larger zones of proximal development than others, even when their existing levels of performance are similar. Such children are able to learn more from instruction (though not necessarily in every domain of learning). Vygotsky's theory, then, offers a way of conceptualizing individual differences in 'educability' where Piaget's theory has little or nothing to say about the issue. Note, however, that this is not intended as a criticism of Piaget's theory. Piaget never set out to explore individual differences in rates of development so it is hardly surprising that he said little about the issue. Perhaps this explains why he wrote little about the educational implications of his theory, and even then apparently with some reluctance and late in life (Elkind, 1974). In chapter 4, we will see how Vygotsky's concept of differing zones of proximal development has led to important new techniques for diagnosing children's learning needs and for tailoring instructional methods to meet these.

For Vygotsky, then, *co-operatively achieved success* lies at the foundations of learning and development. Instruction – both formal and informal, in many social contexts, performed by more knowledgeable peers or siblings, parents, grandparents, friends, acquaintances and teachers – is the main vehicle for the cultural transmission of knowledge. Knowledge is embodied in the actions, work, play, technology, literature, art and talk of members of a society. Only through interaction with the living representatives of culture, what Bruner terms the 'vicars of culture', can a child come to acquire, embody and further develop that knowledge. Children's development thus reflects their *cultural* experiences and their opportunities for access to the more mature who already *practise* specific areas of knowledge.

In order to provide a flavour of Vygotsky's analysis of development and a sense of how it resembles Piaget's theory in some respects but differs from it in others, let me compare and contrast their views on the relation between language and thought.

Piaget and Vygotsky on talking and thinking

The most widely reported difference of opinion between Vygotsky and Piaget, about which they argued in print, concerns the nature of

language and its effect on intellectual development. Piaget, as we have seen, argues that language exerts no formative effects on the structure of thinking. It is a 'medium', a method of representation, within which thought takes place. Mental actions and operations, the processes of thought, are derived from action, not talk.

Piaget's position is more subtle than this statement suggests, however. Although language does not create the structure of thinking, it does facilitate its *emergence*. He suggests, for example, that it is through talking to others, particularly other children, that the child's thinking becomes socialized. What another child says about some event or happening may provoke thought, discussion or argument. It may lead both children to re-view and re-think their points of view. But it is the structure of the child's intelligence, based on activity, that determines when such collaborative exchanges come about. When Piaget analysed conversations between young children, for example, he found no evidence that they were able to discuss things rationally. Piaget writes, 'if, before the age of 7 or 8, children have no conversation bearing upon logical or causal relations, the reason is that at that age they hardly understand one another when they approach these questions' (Piaget, 1967).

What can be talked *about* is determined by children's stages of development. The pre-school child's thinking (and talk) is largely 'egocentric', reflecting the child's own thinking, activity and point of view. At this stage, the child may respond to what another person says, but he cannot stand in their shoes nor understand what they are saying from *their* perspective. Piaget writes, 'Clearly . . . one must start from the child's activity in order to understand his thought; and his activity is unquestionably egocentric and egotistic. The social instinct in well-defined form develops late. The first critical period in this respect occurs towards the age of 7 or 8.'

One line of evidence that Piaget used to illustrate his views on language arose from observations of pre-school children at play. Although children talk as they play together, they do not, according to Piaget, really *converse*. The pre-operational child cannot think about what the world is like from another person's viewpoint. To do this, he must be capable of ignoring his own physical and mental position and be able to 'construct' situations as they appear from other perspectives. For various reasons discussed later, children can only perform such constructions when they have developed mental operations. Before this stage is reached, they assimilate what is said by another person, adult or child, to their own point of view, often 'distorting' the meaning of

much that is said to them. The impact of language on the child, then, is limited to what he can assimilate, and this is determined by the structure of the child's thinking. True 'reciprocity' and attempts at mutual understanding only emerge with the development of concrete operations, at around age seven. This is why young children playing and talking in each other's company are usually involved in 'collective monologues' rather than true dialogue.

Vygotsky's theory shares a number of similarities with Piaget's but differs radically in its treatment of language and its influence on thinking. He agreed with Piaget's view that children do not think like adults and applauded the fact that, unlike most child psychologists before him, Piaget did not simply set out to discover what children could *not* do in comparison with adults, but sought to find out what they could do and what they actually did. However, childhood speech, in Vygotsky's view, is not a personal, egocentric affair but the reverse: it is *social* and communicative in both origin and intent. Vygotsky also observed what Piaget termed 'collective monologues' by young children but he gave them a different interpretation. For Vygotsky, they represent an important stage of transition between two quite different *functions* of language. In the beginning, speech serves a regulative, communicative function. Later, it also serves other functions and transforms the way in which children learn, think and understand. It becomes an instrument or *tool* of thought, not only providing a 'code' or system for representing the world but also the means by which *self-regulation* comes about. The initial motivation for gesture and speech is to control the world through the agency of other people. The infant is weak and cannot sustain himself. Consequently, many of the things he wants or needs have to be met with the help of others. Gestures and speech serve this role, giving the infant a way of influencing the course of his immediate future which he could not achieve otherwise. Speech, like any system of movement, is a physical *activity*, a way of controlling one's own body in order to achieve goals and avoid discomfort. The overt activity of speaking provides the basis for 'inner speech', that rather mysterious covert activity that often forms the process of thinking. For Vygotsky, then, not only do physical actions that serve to manipulate and organize the world get internalized to become (non-verbal) thinking: the physical activity of speaking, which serves to regulate the actions of others, also becomes internalized to create verbal thinking. All forms of thought, then, are *activities*.

The 'monologues' produced by pre-school children, such as those observed by Piaget, lie midway between the social and intellectual

functions of speech. For Vygotsky, the child who is talking to himself is *regulating* and planning his own activities in ways that foreshadow verbal thinking. As the child discovers how to control the actions of others through speech, his developing knowledge of language 'acts back' on him in that others can also regulate his actions through speech. As he discovers how to gain people's attention by speaking and learns how to direct their attention to features of the shared physical world – to solicit specific actions and services, inhibit, refuse and so forth – he becomes subject to the same regulative forces through the speech of others. They can begin to control and direct his attention, solicit his services and inhibit his activities. Alongside 'other-control' by verbal means comes verbal 'self-control-by-others'.

As such developments are taking place on the linguistic front, the child is also developing his non-verbal knowledge of the world through his own activities. In relation to this aspect of early development, the Soviet emphasis on activity is similar to Piaget's concept of sensory–motor development. At around three years of age, a merging and integration of the two streams of development, non-verbal and verbal, begins. The pre-school child's verbal commentaries on his own activities are evidence of the emergence of *linguistic control* over his own non-verbal activities. In 'talking to himself' the child is playing two roles: the regulated and the regulator. In the past, other people played one of these roles. Sometimes the child regulated their actions; at other times they regulated his. The pre-school child is beginning to play both parts before 'internalizing' the process to become a verbal thinker.

Children's monologues, for Piaget, reflect the egocentric nature of their thinking. When, at around age seven or eight, genuine discourse is made possible by the development of logical operations, language starts to become rational and social (though egocentric thinking does not disappear entirely). Egocentric speech disappears from the scene because the child is now aware of the need to make what he says accessible to his listener and has the intellectual competence to start to learn how to make himself intelligible.

Vygotsky argues, however, that egocentric speech serves an intellectual purpose for children and does not 'disappear' at age seven but is internalized to form 'inner speech' and verbal thinking. When Vygotsky and his colleagues observed pre-school children, they also found evidence of egocentric speech, but noted that this was most likely to occur when some *frustration* or difficulty arose. For example, when a child discovered that he did not have a blue pencil to colour a drawing he said 'Where's the pencil? I need a blue pencil. Never mind, I'll draw

with the red one and wet it with water; it will become dark and look blue' (Vygotsky, 1962, p. 17). So, egocentric speech often serves a *planning* and *self-regulating* function and is stimulated by problems and frustrations.

In this way, speech comes to form what Vygotsky referred to as the higher mental processes. These include the ability to plan, evaluate, memorize and reason. Note that these processes are *culturally* formed in social interaction. Looked at in this way, language does not simply *reflect* or represent concepts already formed on a non-verbal level. Rather, it structures and directs the processes of thinking and concept formation themselves. Where Piaget views young children's play and talk as a manifestation of a natural desire to manipulate and assimilate the physical world, laying down the sensory–motor and intuitive foundations for mathematical and logical operations, Vygotsky sees it as a product of social experience and evidence for the emergence of intellectual self-control.

Processing information: on becoming an expert

One of the influences that helped to shape the development of Piaget's theory was a discipline called 'cybernetics'. This arose in the 1940s, fathered by a mathematician, Norbert Wiener, and a physician, Arturo Rosenbluth. It is defined, in modern terms, as 'the science of effective organization' (Beer, 1977). The initial aim of cyberneticians (the term is derived from the Greek word for 'steersman') was to identify the fundamental and universal principles governing the development and functioning of all complex systems, be they organic, physical or mechanical. Are there universal laws which govern how such systems must be organized and structured in order to work effectively in any environment?

The concepts of *information* and information *control* are employed by cyberneticians to analyse the workings of natural systems such as the human brain, and to design efficient and workable manufactured systems such as computers, large industrial organizations and so on. How should information be distributed, processed and controlled in order for such systems to work? In company with another set of concepts, derived initially from electronic engineering and called information theory, the ideas and terminology of cybernetics have been absorbed into psychology to provide a theoretical *language* for the study and analysis of human intelligence.

Piaget's interest in cybernetics stemmed from his desire to create a field of study, genetic epistemology, that would cross the traditional boundaries separating several disciplines (biology, psychology, philosophy, the natural sciences, mathematics and logic). Like the cyberneticians, he wanted to discover general principles of *organization* that applied to all living systems and which would establish theoretical connections between biology and knowledge: how has the evolution and structure of biological systems led to the emergence of rational intelligence? The study of 'self-organizing systems' that develop towards stable and efficient functioning, governed by universal principles of structure and function, was of central relevance to his endeavour, so it is no surprise that he should have been attracted to the ideas of cybernetics.

Other psychologists also adopted the concepts and the language of cybernetics and information theory. Although, as we shall see, they put them to uses that are different from Piaget's, their main motivation was also to explore the nature of human cognition viewed as a system organized to process information in order to adapt, learn and understand.

In engineering, information theory has been used to study, design and evaluate ways of transmitting information between two points without distortion, loss or degradation. No information-processing system, be it telephone, radio, television or whatever, is perfect. Information may be lost during the encoding phase (consider, for example, how a voice over a telephone compares with the 'real thing'), or it may 'leak' or be distorted by noise (like the 'crackle' on a telephone line). The role of the information theorist is to provide the means to measure and improve the performance of systems that transmit, process and store information and the engineer's task is to design and make systems that minimize distortion, loss and noise and which work fast.

The term 'information' used in this sense has a more precise, technical meaning than that implied by its use in everyday talk. Imagine, for instance, that I have drawn a single card from a normal deck of playing cards. I ask you to discover what card I am holding. You ask if it is a red card. I inform you that it is not. You have been given an item of information that rules out one-half of the set that the card was drawn from. More formally, I have given you one 'bit' of information (short for 'binary digit'). You next ask if the card is a club. I say that it is not. You can now rule out from the set of candidates for the card I am holding a further 50 per cent of the possibilities (i.e. you now know it must be one of the thirteen spades). I have now given you two bits of

information overall. In short, any item of information that reduces uncertainty about an event by a half conveys one bit of information. Of course, when an electronics engineer calculates the amount of information being conveyed in a complex system, the maths become somewhat difficult!

What has all this got to do with the psychology of learning and thinking? Well, do we discover anything by thinking about human beings as 'information processors'? Is it useful, for example, to look at human speech as a system for transmitting information? Can the workings of the brain be analysed usefully as an information processing device like a computer? Do children become better at 'processing information' as they develop? Can learning usefully be viewed as information processing, memory as information storage and knowledge as information structures?

These are, in fact, controversial questions in psychology and I will not attempt to answer them in detail here. I list them to provide some sense of how and why information processing theory has been embraced by many psychologists. An important paper, written by George Miller in 1956, paved the way for many insights into the nature of human intelligence based on the image of 'man the information processor'. Let me say a little about the background to and content of this paper before discussing what it might have to tell us about the nature of learning and thinking.

If adults are asked to remember random strings of digits (i.e. to transmit information about them from one moment in time to another) they usually manage to handle sets of six or seven items without making many errors. Increase the number of digits and they begin to make mistakes (they lose information and introduce 'noise'). Imagine tasting two drinks which vary in saltiness. You are presented with each in turn and asked to describe them to someone or, perhaps, to press one of two keys to signal which you have just sampled. Adults find this task easy. Increase the number of drinks to three (high, middle and low in saltiness). Then move on to four, five, six, seven, and so on. Here too, we find that adults can usually 'transmit information' without error in situations where they are exposed to six or seven different degrees of saltiness, but once the set exceeds seven then errors, information loss and noise creep in. Miller, who drew attention to these and many similar phenomena, suggested that whatever the nature of the stimuli used in such situations (they may be sounds, tastes, degrees of brightness, colour saturation and so on), provided that they are 'random' and that the sequences used have no meaning (e.g. tones that do not form

a recognized tune), we find that mature people can 'transmit', without loss or distortion, information about sets of stimuli that number somewhere between five and nine. The title of his paper was 'The magical number seven, plus or minus two'.

Why is this interesting? Well, described in the language of information theory, it demonstrates that adults have a limited and relatively fixed *channel capacity*. We are only able to transmit information, without loss or distortion, about a specific number of (unstructured) items. It follows that if people are put into unfamiliar situations and expected to take note of and react to (i.e. to process) more than a relatively small number of elements, they will be overwhelmed by information and uncertainty ('What do I attend to next?','What should I do about it?'). They will make mistakes. In such situations, *training* and/or *experience* will be needed before anything approaching error-free performance can be achieved.

The analysis becomes more interesting when we consider the answers to two questions. The first asks if children have the *same* channel capacity and information-processing limits as adults. The second concerns the nature of *expertise*. What happens with training or experience that enables people to *overcome* their information-processing limitations? Why is it, for example, that a concert pianist may be able to sight-read a piece of music that involves, say, sequences of eight-note chords in a novel combination? The pianist is transmitting far more information than subjects in the experiments just outlined, but how? How is practice and experience translated into expert performance? What is being *learned* and how is it remembered?

First consider the question about children. If three-year-olds are asked to remember strings of digits, they begin to falter when the set exceeds three items. By five, children can handle about five items. By age eight or so, mature levels of performance are reached. There is debate about exactly what happens during development to explain this phenomenon, and I will discuss both the arguments and their educational implications in chapter 3 when I explore the view that children have to learn *how* to memorize such things. For the moment, the important point is that children have a smaller 'channel capacity' than adults do. Consequently, in unfamiliar, uncertain situations, they are less able than the mature person is to attend to, memorize and respond to events. Perhaps we should explore the view that five-year-olds (but not seven-year-olds) fail to solve many problems because they lack the *information-processing capacities* needed to do such tasks. This I also do in chapter 3.

In thinking about the nature of expertise and how it is learned or acquired, consider an example. We find a chess Grand Master willing to take part in an experiment. We show him or her a chess board on which pieces are arranged in a 'state of play'. We show them the board for a few moments and then ask them to turn away and then to recall the positions of the pieces they were shown. They are likely to perform this feat without error even when the board has on it most or all of the pieces. Ask a novice at chess to do the same task and he or she is unlikely to remember more than a handful of pieces (De Groot, 1965). Does the chess Grand Master have a phenomenal memory? Is this why he or she was able to achieve Grand Mastership? No: outside their area of special expertise, the Grand Master suffers from the same information-processing limitations as the rest of us. Their feats of perception and memory are *specific* to chess boards and pieces.

More detailed studies of how they manage this feat illustrate the important and far-reaching connections between what may appear to be 'fixed' or 'natural' capacities – like the ability to see and memorize – and 'higher mental processes'– such as learning and thinking. What the expert, but not the novice, 'sees' when he or she inspects the chess board are *configurations* of pieces, or in Miller's term, 'chunks'. These configurations, in turn, represent familiar, recurrent patterns that occur as an outcome of particular strategies of play, or some pattern that shows an 'interesting' departure from such prototypical configurations. Experiments designed to analyse the way in which experts perceive the structure of chess games (Chase and Simon, 1973) show that they have memorized a huge repertoire of such configurations. In other words, the chess Grand Master can recognize a very large number of different patterns that are typical or interpretable states of play. Whereas the novice 'perceives' isolated pieces which, perhaps, he or she can barely recognize or identify, the Master recognizes individual pieces as parts of larger configurations. Put in information-processing terms, the expert and novice share the same channel capacity, but the six or seven chunks that the expert encodes are meaningful configurations, not isolated chess pieces. Through playing chess, and the observation of others at play, the expert has not only discovered clever strategies and good tactics of play but also developed an *organized memory* which enables them to assimilate much more of what they see than the novice. This also means that they are better able to *plan* and think ahead because their representation or model of the chess board is robust, accurate and enduring. So they are also able to think more clearly and in greater depth.

The differences exposed in such studies between experts and novices are found in many other contexts. Indeed, there is a fair case to be made for the assertion that they are typical of differences found between experts and novices in *any* field. The expert reader, for example, perceives and processes larger units of text than the beginning reader. An adult can look at an array of objects and 'subitize' them – perceive them in groups of a certain size (e.g. as sets of three) – whilst a young child cannot. Thus, the speed with which we are able to 'encode' what we see, the *organization* of what we see and the amount of information that we can memorize are related to and symptomatic of the *structure* of our knowledge.

Children are novices at life in general and find many of the tasks and demands they face in school novel and full of uncertainty. They are more limited than adults in how much they can attend to and memorize in unfamiliar situations. Perhaps, then, it should not be surprising to find differences between the mature and immature in the ability to profit by a specific experience or to solve an unfamiliar problem. It may be that what is at stake in such situations is not young children's inability to perform *logical operations* but their general lack of *expertise* which leads them to perceive situations in different ways from the adult.

An informal, but telling, finding that emerged from studies of chess players was their inability to identify, describe or articulate how they were 'seeing' chess boards. Surely, much of our expertise is like this. Our knowledge is 'tacit', locked into the way we act and perform and not easily articulated or described to others. Experts may find the problems of the novice puzzling or even infuriating if they do not recognize that novices do not perceive situations in the same way as they themselves do. It should come as no surprise, for example, to find that even when the expert *points out* things to be attended to, the novice may not be able to 'take in' what they are shown because they lack the prerequisite *knowledge* which would enable them to perceive and memorize configurations. If so, it is also not surprising that the expert's ability to *act* and *think* is surer, smoother and more accurate than that of the novice.

Viewing children as limited information processors who have yet to learn or acquire expertise offers a third image of the child as learner and thinker. This makes no recourse to 'large-scale' concepts like logical operations, but suggests that knowing how and what we are about is far more *domain-* or task-specific. Children's ability in one area, be it chess, arithmetic, reading or whatever, may not reflect their abilities in

others if their *expertise* in different subjects and activities varies. This view makes no use of concepts of *stages* of development: however, it does agree with Piaget's view that perception, memory, knowledge and understanding are all deeply related and change with learning and development.

Piaget, Vygotsky and Bruner: a brief comparison and summary

Before moving on to the next chapter, I will summarize some of the main ideas we have just considered. Rather than simply repeat myself, I will try to re-examine these ideas whilst exploring a little more of the biography of the three main characters I have introduced.

I have outlined three main perspectives on the development of learning and thinking. These will be explored in more detail in the following pages. One view, which stems from Piaget's theory, holds that all children pass through a series of stages before they construct the ability to perceive, reason and understand in mature, rational terms. In this view, teaching, whether through demonstration, explanation or asking questions, can only influence the course of intellectual development if the child is able to assimilate what is said and done. Assimilation, in turn, is constrained by the child's stage of development. This leads to a specific concept of learning 'readiness' and, as we shall see, holds out many implications for the design of curricula and the timing of formal instruction.

A second perspective, introduced by Vygotsky, shares some important areas of agreement with Piagetian theory, particularly an emphasis on *activity* as the basis for learning and for the development of thinking. However, it involves different assumptions about the relationship between talking and thinking. It entails a far greater emphasis on the role of communication, social interaction and instruction in determining the path of development. Vygotsky died in his late thirties in 1934. His death came after ten years of illness from tuberculosis. In that ten-year period, Vygotsky wrote about a hundred books and papers, many of which have only recently been published and translated into English. Many psychologists, including some of his own former students and colleagues, recognize that much of what he wrote was speculative and, in places, self-contradicting. Unlike Piaget, who worked on into his eighties and lived to see a dramatic expansion in the field of developmental psychology, Vygotsky did not have access to what has become

a vast literature on child development. Consequently, whilst many of the ideas we will explore later in this book are consistent with his general position and were sometimes stimulated directly by it, we are left to guess at what Vygotsky himself might have had to say about them.

Bruner, influenced as I have already said by Vygotsky, was constructing the foundations of his theory of instruction in the 1960s when the assimilation of information theory into psychology was under way. Unlike both Vygotsky and Piaget, Bruner came to the study of child development after extensive research into adult thinking and problem-solving. Although sharing with Vygotsky a stress on the importance of culture and cultural history in the formation of mind, his background provided him with a more detailed sense of the *processes* involved in mature, socialized cognition. His theory, unlike either Piaget's or Vygotsky's, is grounded in the language of information theory. For instance, he entitled one of his early papers 'Going beyond the information given' (Bruner, 1957). In this, he explored the nature of creative thinking and originality in terms of our ability not only to acquire information but also to 'go beyond' it by inventing codes and rules. Learning involves the search for pattern, regularity and predictability. Instruction serves to assist children in the formation and discovery of such patterns and rules. We return to a fuller discussion of these ideas in chapter 8.

Like Vygotsky, Bruner was convinced that social experience plays a major part in mental development, though his theory of the way in which social experience is involved in development differs from Vygotsky's account in a number of ways (not least by being informed by research findings that Vygotsky did not live to study). For example, throughout his writings on human development, Bruner laid considerable stress on the importance of acknowledging not only the role of culture and social interaction but also the influences of biology and evolution. He often drew parallels between the abilities of humans and other species when he theorized about the formation of mind: 'I take it as a working premise that growth cannot be understood without reference to human culture and primate evolution' (1968, p. 2). Vygotsky also acknowledged the importance of biological study in the creation of psychological theory. He distinguished between what he called the 'natural line' and the 'cultural line' in development. But he did not live to provide a synthesis of the two streams of growth. Indeed, unlike Bruner, he largely 'ignored' the natural, biological line in his desire to establish the importance of historical, social and cultural

influences on human development (Wertsch, 1985, p. 8). You will find that discussions of the interplay between biology and social experience pervade this book. As we shall see, the last decade has seen a dramatic upsurge of interest in, and knowledge about, the innate capacities of the human infant and this has led to far more emphasis on the role of biological influences on human growth and development in recent theorizing about how children think and learn.

Looked at in one way, Bruner's theory stands between those of Piaget and Vygotsky. Like Piaget, Bruner emphasized the importance of biological and evolutionary constraints on human intelligence. At the same time, and more in sympathy with Vygotsky, he laid stress on the way in which culture forms and transforms the child's development, and he gave a more central role than Piaget did to social interaction, language and instruction in the formation of mind. Bruner employed the language of information processing in formulating his ideas and, in so doing, offered us an opportunity to integrate the findings from work on adult cognition with those arising from the study of children. All too often, cognitive psychologists who study adult intelligence ignore the process of development and education. They often leave one with the impression that mental activity springs, fully formed, out of a developmental vacuum. Bruner, however, sought to ground his account of the 'processes of mind' in a theory of culture and growth, often drawing and building upon insights delivered by both Piaget and Vygotsky.

Piaget's theory, with its emphasis on the active, constructive nature of human development, is often referred to as a 'constructivist' approach. Whilst Bruner also accepted the image of children as active architects of their own understanding he, in company with Vygotsky, stressed the role of social interaction and cultural practices in shaping the course of human development. Their approach is often referred to as 'social constructivism'. As we shall see in the next chapter, both of these theoretical perspectives have been extended and modified over the past decade. They have also come under critical scrutiny from those who hold that nature and biology play a far more crucial role in shaping human destiny than either of these approaches allow.