Chapter 1

The Invention of Language by Children: Environmental and Biological Influences on the Acquisition of Language

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Human children grow up in cultural settings of enormous diversity. This differentiation sometimes leads us to overlook those aspects of development that are highly similar, even universal to our species. For example, under widely varying environmental circumstances, while learning different languages within different cultures and under different conditions of child rearing, with different motivations and talents, all normal children acquire their native tongue to a high level of proficiency within a narrow developmental time frame. Evidence from the study of the language learning process suggests that this constancy of outcome, despite variation in environment, has its explanation in biology. Language is universal in the species just because the capacity to learn it is innately given. In Descartes's (1662/1911) words: "It is a very remarkable fact that there are none ... without even excepting idiots, that they cannot arrange different words together, forming of them a statement by which they make known their thoughts; while on the other hand, there is no other animal, however perfect and fortunately circumstanced it may be, which can do the same."

In other words, some part of the capacity to learn languages must be "innate." At the same time, it is equally clear that language is "learned." There are about five thousand different languages now in use on the earth, and the speakers of one cannot understand the speakers of the next. Moreover, specific exposure conditions strikingly influence how each of these is acquired: there is a massive correlation between being born in England and coming to speak English and being born in France and speaking French. This immediately shows that the language function is heavily affected by specific environmental stimulation.

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How can both of these claims (language is innate, and it is learned from the environment) be true? Like many developmental processes that have been studied in animals, *language acquisition in humans seems to involve a type of learning that is heavily constrained, or predisposed to follow certain limited courses, by our biology*. Clearly, no specific language is innate; the particular languages we come to speak must be learned. Yet, the commonalities among human languages are, upon careful study, far more striking than the differences among them. Every human language is organized in terms of a hierarchy of structures, composed of speech sounds that lawfully combine into morphemes and words, which in turn combine into phrases and sentences. Every human language has the wherewithal to express approximately the same meanings (that is, they are intertranslatable). Apparently, human children are in some sense prepared by nature to learn only languages that have just these formal and substantive properties, and to learn such languages relatively effortlessly during the natural course of maturation.

This chapter reviews two kinds of evidence for the claim that there is an important biological endowment in humans that supports and shapes language acquisition: (1) language learning proceeds uniformly within and across linguistic communities despite extensive variability of the input provided to individuals; (2) the child acquires many linguistic generalizations that experience could not have made available.

1.1 Uniformity of Learning

1.1.1 Milestones of Normal Development

Language learning follows the same course in all of the many languages that have been investigated. Isolated words appear at about one year of age. These are mainly nouns that describe simple objects and a few social words such as "bye-bye". Sometime during the second year of life, there is a sudden spurt of vocabulary growth accompanied by the appearance of rudimentary sentences. At first these are limited to two or three words; for example, "Throw ball," "Kiss teddy," and the like. These early sentences display considerable structure despite their brevity. Roughly speaking, there is a place for the noun and a place for the verb; moreover, the subject and object noun are positioned differently within the sentence. Thus, though the young learner never says long sentences like "Mommy should promptly throw that ball," the distinction between subject and object will show up in such foreshortened attempts as "Mommy throw" (the subject precedes the verb) versus "Throw ball" (the direct object follows the verb). As soon as children begin to combine words at all, they reserve structurally determined positions for subjects and direct objects.

This ability to hone in on such a crucial and fundamentally linguistic distinction forms a kind of skeletal base of language learning; this shows up early and in much the same way in two-year-olds all over the world.

Language use by the child in normal learning settings undergoes considerable elaboration between the ages of 2 and 5. Complex (multiclausal) sentences appear, and the function morphemes (prepositions, articles, bound morphemes like *-ed*, and so forth) make their appearance. By age 5 or before, youngsters sound essentially adult.

Lenneberg (1967) argued that these uniformities in the course of learning for children exposed to different languages are indicators that language learning has a significant biological basis. Like the regularities of physical and motor development (the appearance of teeth, or of walking), they suggest that language learning is controlled, at least in part, by some underlying maturational timetable. He provided some normative evidence that the achievement of basic milestones in language learning can be predicted from the child's age and seem, in fact, to be intercalated tightly with the aspects of physical development that are known to be maturationally dependent. For instance, youngsters utter first words just when they stand, two-word sentences just when they walk, and elaborate sentence structures just when they jump.

These findings alone, however, cannot prove the position that Lenneberg proposed, for they are consistent as well with other quite different conjectures about the processes that underlie language learning. Possibly, children move from talking childishly to speaking with great sophistication because of the maturation of their brains; but, on the other hand, they may go through these regular stages because such stages are the only logical way to learn, through time and exposure, all the detailed facts about the language that they are hearing from adults around them. (After all, foreign adults first arriving in a new linguistic community will also say things like "Throw ball" and later speak in longer and more complex sentences; but this is surely not because they are biologically changing from a primitive to a more advanced maturational state.)

A stronger way to test this view is somehow to disentangle the environmental exposure from the maturation of the learner. We will therefore next consider these two aspects separately, looking first at how language learning proceeds when the learning environment is changed, and second at how language learning proceeds when the maturational status of the learners themselves is changed. As we will show, while languages are in some sense certainly learned from the environment, alterations in the environment over a very large range do not change the fundamental character of acquisition. In contrast, changing the learner's maturational status has substantial effects on the nature and success of acquisition.

1.1.2 Altering the Learning Environment

There are several ways in which one might examine alterations in the linguistic environment to observe the consequences for acquisition. We will consider three: first, the modest natural variations in the degree to which mothers adjust the complexity of their speech to children; second, a much more radical change, in the presence versus absence of any conventional linguistic input; and third, a similarly radical change, in the presence versus absence of the visual nonlinguistic world during language learning. In each case, we will argue, young children proceed on a remarkably stable course of early acquisition.

Variation in Motherese

It is obvious that mothers talk differently to their young children than they do to other adults. This natural simplification is clearly an adaptation both to the fact that children are cognitively immature and to the fact that their understanding of the language is primitive. But it has sometimes been asserted that this simple kind of speech does more than serve the immediate communicative needs of caretakers and infants. Simplified speech (often fondly called Motherese; Newport, Gleitman, and Gleitman 1977) may play a causal role in the language-learning process itself. The idea would be that the caretaker first teaches the child some easy structures and contents, and then moves on to more advanced lessons—essentially, provides smallest sentences to littlest ears. For instance, perhaps the fact that the child learns nouns before verbs and declarative sentences before interrogative sentences is a straightforward consequence of caretakers' natural behavior toward infants.

This hypothesis, though plausible, turns out to be false. By and large, mothers speak in whole sentences even to youngest learners. Nouns, verbs, prepositions, and so forth occur in speech even to the youngest learners, and yet the children all select the nouns as the first items to utter. Worse, contrary to intuition, maternal speech is not characterized by simple declarative sentences of the kind that children utter first, such as "Mommy throw ball." In fact, these apparently simplest declarative formats occur in speech to youngest learners only about 25 percent of the time. Instead, the mother's speech is replete with questions ("Where is your nose?") and commands ("Get your foot out of the laundry!"), while the child's own first sentences are mostly declaratives.

Most interestingly, variations in maternal speech forms have been investigated to see if they are predictive of the child's learning: perhaps some mothers know just how to talk to help their children learn; other mothers may not be inclined to speak in ways that facilitate the learning process, in which case their children should progress more slowly in language knowledge. One method for studying this (Newport et al. 1977) is to select a group of young children who are at the same stage of language knowledge (for example, 15-month-olds who speak only in single isolated words) and to collect samples of their caretakers' speech. If learning is a function of the caretaker's speech style, then variation among the mothers at this time should predict the further progress of these children. To study this, the children's speech was sampled again six months later. Analyzing the children's speech at these two times (ages 15 months, then 21 months), one can compute growth scores for each child on various linguistic dimensions (the length and structure of the sentences, the size of the vocabulary, and so forth). The question is whether properties of the mother's speech (in the first measurement, at age 15 months) predict the child's rate of growth on each measured dimension and explain the child's language status at the second measurement six months later.

The outcome of these studies was that, while the details of mothers' use of a few particular constructions of English predicted the children's rate of acquiring these same few constructions, the mothers' overall simplicity did not predict the rate at which their children progressed through the stages of acquisition. In this sense, then, the children's learning rate was largely unaffected by differences in their mothers' speech. Each child seemed to develop according to a maturational schedule that was essentially indifferent to maternal variation.

While such studies preclude certain strong versions of the view that language is learned just because it is taught, they also unfortunately leave almost all details unresolved. This is because the absence of measurable environmental effects may be attributable to threshold effects of various sorts. After all, though the mothers differed in their speech styles to some degree, presumably they all uttered speech that fell into some "normal range" for talking to children. This complaint is quite fair. To find out how the environment causes (or does not cause) a child to learn its native tongue, we would need to look at cases in which the environment is much more radically altered. The most straightforward technique would be to maroon some infants on a desert island, rearing them totally apart from adult language users. If they could and would invent a human language on their own hook, and if this invented language developed just as it developed in infants acquiring English or Urdu, this would constitute a stronger argument for a biological basis for language learning.

Classical cognoscenti will recall that, according to Herodotus (ca. 410 B.C./1942), this ultimate language-learning experiment has been performed. A certain Egyptian king, Psammetichus, placed two infants ("of the ordinary sort") in an isolated cabin. Herdsmen were assigned to feed them but were not to speak to them, on pain of death. Psammetichus's experimental intent was to resolve the question of which (Egyptian or

Phrygian!) was the first of all languages on earth. Appropriately enough for a king, he appears to have been a radical innatist, for he never considered the possibility that untutored children would fail to speak at all. Herodotus tells us that two years later ("after the indistinct babblings of infancy were over") these children began to speak Phrygian, whereupon "the Egyptians yielded their claims, and admitted the greater antiquity of the Phrygians."

In effect, if Herodotus is to be believed, these children reinvented Phrygian rather than merely learning it: though the children were isolated from input, Phrygian emerged as the pure reflection of the language of the soul, the original innate language.

Of course, modern scientists have reason to doubt the reliability of these particular findings, but the concept of Psammetichus's experiment (modified by our increased concern for the possibility that the children might require more kindly environments) is still highly pertinent to the questions of languages and language acquisition. While we would no longer conduct this experiment on purpose, it has been possible, surprisingly enough, to observe natural circumstances that reproduce some of the essentials of Psammetichus's experiment in modern times. In the sections below, we will discuss several examples of language learning in environmentally deprived circumstances. As we will see, the outcome is not Phrygian. All the same, we will apply the same reasoning to the findings as did Psammetichus: those aspects of language that appear in children without environmental stimulation or support must reflect preprogrammed tendencies of the human brain.

Language Invention by the Isolated Deaf Child

Extensive study over the past thirty years has shown that the sign languages used among the deaf differ but little from the spoken languages of the world (Klima, Bellugi et al. 1982; Supalla and Newport 1978). Their vocabularies are the same, and their organizational principles are the same; that is, they are composed of a small set of primitive gestural parts (analogous to speech sounds), organized into morphemes and words, which in turn are organized into meaningful phrases and sentences. Moreover, deaf or hearing children who acquire a sign language from their deaf parents follow the learning course typical of spoken-language learning (Newport and Meier 1985).

Most deaf infants, though, are born into hearing families in which the parents know no sign language. In many cases the parents make the decision not to allow the children access to sign language at all. They believe that the children can come to know a spoken language by formal "oralist" training in which the children are taught to lip-read and utter English. (This method has at best mixed results; few totally deaf children ever come to control spoken English adequately.) Because the children are not exposed to a sign language and, at the same time, are not able to hear a spoken language, they are effectively deprived of linguistic stimulation during their early years. They cannot learn the language around them (spoken English) just because they cannot hear it. And they cannot learn an alternative—one of the sign languages of the deaf—because they have not been exposed to it. The question is whether, like the Psammetichus children, these youngsters will invent a language in circumstances that provide no opportunity to learn one.

Goldin-Meadow and her colleagues (Feldman, Goldin-Meadow, and Gleitman 1978; Goldin-Meadow and Mylander 1984) have studied the development of language in ten of these language-isolated, congenitally deaf children, from the ages 1–4 years (the period during which they would ordinarily be acquiring an environmental language). The findings were quite startling. As mentioned earlier, normally circumstanced learners acquiring English or Urdu from their caretakers produce isolated words starting around their first birthday. The deaf isolates in this same time period began to produce single manual gestures, much like the single words of the youngsters next door who were learning English "from" their caretakers. These gestures were understandable because of their iconicity; for example, the deaf children would flutter their fingers for "snow," and they would cup their hands behind their ears to render "Mickey Mouse." The hearing parents much more rarely produced such gestures; instead, they more frequently simply pointed at objects or pantomimed an action using a nearby object, hoping that their oral speech would itself thereby be comprehensible enough. Nevertheless, the size and content of the children's gestural vocabulary approximated that of their hearing peers even though they had to invent their own "words."

At about age 2, again in common with their hearing peers, the deaf children began to sequence their gestures in rudimentary two- and three-sign sentences, with occasional examples of yet further complexity. For example, a child would point to a chicken on the table and then extend his open palm ("give"), or point at himself ("me") and then produce a gesture at his mouth ("eat"). Most surprising of all, when these signed sentences were analyzed like sentences of hearing children, it was discovered that they were structurally organized, with distinct structural positions assigned to the verb and nouns in each utterance. For instance, just like the youngest English speakers, the deaf children had structurally distinctive ways of expressing "Chicken eat" and "Eat chicken." This syntactic structuring of signed sentences was not observed in their hearing caretakers.

Evidently, where the environment provides no language samples, children have the internal wherewithal to invent their own forms to render the same meanings. What is more, the timing of language development—at least at the early stages investigated here—is approximately the same whether one is exposed to a fully elaborated natural language or not: first words at age 1, rudimentary sentences at age 2, and elaborations beginning to appear at age $2\frac{1}{2}$ to 3. The appearance of the skeletal base of a language is thus part of the biology of normally developing children; it appears on the maturationally appropriate timetable even when a normal linguistic environment is absent.

At the same time, it is important to point out that the development of this homemade system does not appear to advance to anywhere near the level of full natural languages, whether signed or spoken. In particular, the function morphemes, such as articles, verbal auxiliaries, and bound morphemes marking tense and case, are virtually nonexistent in these children's signing. As we stressed at the beginning, languages are not fully innate, but instead are acquired as a product of both linguistic input and biology. Many complex aspects of linguistic structure do not therefore appear in full without linguistic input; in a later section (see "Pidgins and Creoles") we will discuss more about the circumstances of input and maturation in which these more complex elements appear. The important point to notice for now is the rather remarkable achievement of the early parts of language development, which the isolated learners can produce without an environmental language at all.

Language Development in the Blind Child

The case just considered involved children who were cut off from opportunities to observe a language. Evidently, they could invent something like a skeletal human language all the same, demonstrating that there is something within the human child that makes it "natural" to develop a language of a certain type—one that has words, phrases, and so forth. But a little reflection reveals that, in some ways, language invention seems an easier task than ordinary language learning. After all, the inventors of a new language are free to choose their own instantiations of each item that is dictated by the internal predispositions for language. Those who want a word for Mickey Mouse can just make one up, say, by mimicking Mickey's big ears through an iconic gesture. The learners of English or Greek have no such freedom. They must learn just which sound (such as the sound "snow") is used to express the concept *snow* in the linguistic community around them.

How is this done? Clearly, learners observe the real world contexts in which words are uttered; thus, presumably, they will notice that "cup" is uttered in the presence of cups, "jump" is uttered in the presence of jumping, and so forth. But if this is the whole story of vocabulary learning, then we should expect delays and perhaps distortions in the language learning of the blind. After all, some words refer to things that are too large, distant, or gossamer for the blind child to apprehend through tactile means—such as mountains, birds, and clouds. Overall, the restrictions on blind children's access to contextual information ought to pose acquisitional problems. Yet study of their progress demonstrates that there is neither delay nor distortion in their language growth (Landau and Gleitman 1985). They acquire approximately the same words at the same maturational moments as do sighted children, and their syntactic development is unexceptional, with phrases and sentences occurring at the ordinary time.

A particularly surprising aspect of blind children's learning has to do with their acquisition of terms that (seem to) describe the visual experience in particular—words like *look* and *see* (Landau and Gleitman 1985). Because blind children cannot experience visual looking and seeing, one would think that these terms would be absent from their early spoken vocabularies. Yet, in fact, these are among the very first verbs to appear in blind (as well as sighted) children's spontaneous speech. And these words are meaningful to their blind users. For instance, sighted 3-year-olds (even if blindfolded) will tilt their faces upward in response to the command "Look up!", presumably because they understand that *look* has to do with visual-perceptual inspection. Blind children raise their hands instead, keeping the head immobile, as though they too realize that *look* has to do with perceptual inspection—but in the absence of a working visual system, this perceptual inspection must necessarily be by hand. This interpretation is reinforced by the finding that blind youngsters distinguish between the perceptual term *look* and the contact term *touch*. Thus, if told "You can touch that table but don't look at it!", the blind 3-year-old responds by gingerly tapping the table. And then if told "Now you can look at it," the child systematically explores all the surfaces of the table with her hands. Despite radical differences in the observational opportunities offered to blind and sighted babies, both populations come up with interpretations of quite abstract words in a way that is fitting to their own perceptual lives.

Let us now try to organize these facts. Clearly, learning a language is a matter of discovering the relations between the sounds (or gestures) and the meanings that language can express. Thus, the novice English speaker must learn that there is a relation between the sound "see" and the meaning *inspect by eye* (or *by hand*, if the learner is blind), while the Spanish novice must discover that the sound "see" means *yes*. The deaf isolates were deprived of the sound side of this equation. They neither heard sounds nor saw formal gestures; as a result, they could not learn any of the languages of the community around them. All the same, they were capable of inventing the rudiments of such a system, assigning distinct, spontaneously invented gestures to particular objects and events that they could observe in the world around them. In contrast, the blind children had access to all the sounds and structures of English, for they could hear. Their deprivation had to do with simultaneous observation of some of the things in the world to which their parents' speech referred, and which could provide the clues to the meanings of the various words. For instance, when the blind child's mother asks her to "look at the pumpkin," the child decidedly cannot look, in the visual sense of this term. All the same, blind learners come up with a perceptual interpretation of the word—a haptic-perceptual interpretation, to be sure—that is relevant to their perceptual functioning. In content as well as in form, properties of mind appear to legislate the development and character of human language.

To summarize the effects of altering the learning environment: While language may not be quite as innate as Psammetichus reported (none of the subjects of these studies spoke Phrygian), there is a remarkable range of environments in which the normal milestones of language structure and content appear. Apparently, then, significant aspects of language development are dictated by our biology. In the next section we will examine the opposite manipulation, in which normal environments are presented to learners who vary in their maturational status (that is, who vary in their biology). If what we have said thus far is correct, it should be the case that changes in the biology of learners have far more dramatic effects on the process of learning a language.

1.1.3 Changing the Learner's Mental Endowment

Deprivation of First Language Exposure Until Late in Life

Thus far, we have argued that language learning is the natural product of the developing human mind and brain, that linguistic-learning events in the child's life are the natural consequences of maturation rather than rote outcomes of what children hear and see in the world around them. After all, various children hear different sentences in different contexts, but they all learn the language of their communities in just the same way. But if maturation is a serious limiting factor in acquisition, learning should look different if it takes place later in life than in the usual case: Presentation of a full and complete environment for language learning, but at a time after the usual maturational sequence should have been completed, would on this view not result in normal acquisition. Where can one find cases in which learners are exposed to normal linguistic input only late in life?

One such case is the (fortunately) occasional situation in which children have been reared, like Romulus and Remus, by wolves or bears, and then attempts are made to rehabilitate them into human society. Unfortunately such "pure" cases of isolation defy interpretation, owing to the collateral physical, nutritional, and other deprivations that accompany such individuals' language deprivations (Brown 1958).

More interpretable cases involve children raised by humans under conditions that are almost unimaginably inhumane. "Isabelle" (a code name) was hidden away in an attic by a deranged mother, apparently never spoken to at all, and provided with only the minimal attention necessary to sustain her life. She was discovered at age 6. Unsurprisingly, she had learned no language, and her cognitive development was below that of a normal 2-year-old. But within a year Isabelle learned to speak at the level of her 7-year-old peers. Her tested intelligence was normal, and she took her place in an ordinary school (Davis 1947).

The first lesson from this case is that a 7-year-old child, with one year of language practice, can speak about as well as her second-grade peers, all of whom had seven years of practice. Relatedly, bilingual children (who presumably hear only half as much of each language they are learning as do monolingual children, unless they sleep less) acquire both languages in about the same time that it takes the monolingual child to learn one language. That is, bilinguals speak at the level appropriate to their age, not the level appropriate to their exposure time. Such findings argue that maturational level, not extent of opportunities for practice, is the chief limiting factor in language growth. But the second inference from Isabelle's case seems to be that learning can begin late in maturational time and yet have the normal outcome: native-level fluency.

However, any such conclusion would be premature. Rehabilitation from isolation does seem to depend on maturational state. A child, "Genie," discovered in California about twenty years ago, was 13 years old when she was removed from the hideous circumstances of her early life. From the age of about 20 months, she had lived tied to a chair in a darkened room, was frequently beaten, and never was spoken to—in fact, she was barked at because her deranged father said she was no more than a dog. But despite intensive long-term rehabilitation attempts by a team of sophisticated psychologists and linguists, Genie's language learning never approached normality (Fromkin et al. 1974; Curtiss 1977). She did rapidly pass through the stages we have discussed thus far and identified as the skeletal base of the language-learning capacity: she acquired vocabulary items and put them together in meaningful propositions much as 2-year-olds do—for example, "Another house have dog," "No more take wax." But she never progressed beyond this stage to complex sentences or acquisition of the function words that characterize normal 3- and 4-year-olds' speech.

Another case of late language learning, but without the extreme abuse suffered by Genie, has been reported in a study of a woman called "Chelsea" (Curtiss 1989). Born deaf, Chelsea was mistakenly diagnosed by a series of doctors as retarded or emotionally disturbed. Her family did not believe that she was retarded, but, because of these diagnoses, she was raised at home and never exposed to either sign language or speech training. She was, however, otherwise healthy and emotionally and neurologically normal. At age 31 she was referred to a neurologist, who recognized that she was merely deaf. When she was provided with hearing aids, her hearing tested at near-normal levels. Intensive rehabilitation, along with several years of this radically improved hearing, has led to her acquisition of a sizable vocabulary, as well the production of multiword utterances. However, her sentences do not have even the rudimentary aspects of grammatical structure found in Genie's. For example, Chelsea says such things as "Breakfast eating girl" and "Banana the eat."

Why did Genie and Chelsea not progress to full language knowledge while Isabelle did? The best guess is that the crucial factor is the age at which exposure to linguistic stimulation began. Age 6 (as in Isabelle's case) is late, but evidently not too late. Age 13 or 31 is too late by far. There appears to be a critical or sensitive period for language acquisition, a consequence of maturational changes in the developing human brain.

The notion of a critical period for learning has been studied primarily in animals. Acquisition of a number of important animal behavior patterns seems to be governed by the timing of environmental stimulation. One example is the attachment of the young of various species to their mothers, which generally can be formed only in early childhood (Hess 1973; Suomi and Harlow 1971). Another is bird song. Male birds of many species have a song that is characteristic of their own kind. In some species this song is entirely innate, but in other species the song is partially acquired or modified through exposure. They learn this song by listening to adult males of their own species. However, this exposure will be effective only if it occurs at a certain period in the fledgling's life. This has been documented for the white-crowned sparrow (Marler 1970). To learn the white-crowned sparrow song in all its glory (complete with special trills and grace notes), the baby birds must hear an adult song sometime between the seventh and sixtieth days of life. The next forty days are a marginal period. If the fledgling is exposed to an adult male's song during that period but not before, he will acquire only some skeletal basics of the sparrow song, without the full elaborations heard in normal adults. If the exposure comes still later, it has no effect at all: the bird will never sing normally.

It is tempting to extend such findings to the cases of Isabelle, Genie, and Chelsea. Though Isabelle's exposure to language was relatively late, it might have fallen full square within the critical period. Genie's later exposure might have been at the "marginal" time, allowing her to achieve only the skeletal base of a human language. Chelsea's even later exposure might have been entirely too late. But in order to draw any such grand conclusions, it is necessary to look beyond such complex and tragic individual cases at a more organized body of evidence to examine the effects of brain state on the capacity to learn a language.

Second Language Learning

Much of the literature on this topic has traditionally come from studies of second-language learning, for the obvious reason that it is hard to find adults who have not been exposed to a first language early in life. But individuals acquire second—and third, and fifth—languages throughout their life spans. Do they acquire these differently as a consequence of differences in their degree of brain maturation?

The facts are these. In the first stages of learning a second language, adults appear to be more efficient than children (Snow and Hoefnagel-Hohle 1978). The adult second-language learners produce primitive sentences almost immediately, whereas the young child displaced into a new language community is often shocked into total silence and emotional distress. But the long-range outcome is just the reverse. After a few years very young children speak the new language fluently and sound just like natives. This is highly uncommon in adults.

This point has been made by investigators who studied the long-run outcome of second-language learning as a function of the age at first exposure to it (Johnson and Newport 1989; Oyama 1978; Patkowski 1980). In the study by Johnson and Newport, the subjects were native Chinese and Korean speakers who came to the United States and were immersed in English at varying ages. The East Asian languages were chosen because they are maximally dissimilar to English. The subjects were tested for English-language knowledge after they had been in the United States for at least five years; therefore, they had ample exposure and practice time. Finally, all of them were students and faculty members at a large midwestern university, so they shared some social background and presumably were about equally motivated to learn the new language so as to succeed in their jobs and social roles.

These subjects listened to English sentences, half of which were clearly ungrammatical ("The farmer bought two pig at the market, The little boy is speak to a policeman"); the other half were the grammatical counterparts of the ungrammatical sentences. The task was to identify the grammatical and ungrammatical sentences. The results were clear-cut. Those learners who (like Isabelle) had been exposed to English before age 7 performed just like native speakers. Thereafter, there was an increasing decrement in performance as a function of age at first exposure. The later they were exposed to English, the worse they performed.

Late Exposure to a First Language

Immediate objections can be raised to the outcomes just described as bearing on the critical period hypothesis. The first is anecdotal. All of us know, or know of, individuals (such as Joseph Conrad or Vladimir Nabokov) who learned English late in life and controlled it extraordinarily well. But the point of the studies just mentioned has to do with population characteristics, not extraordinary individuals. Every child of normal mentality exposed to a (first or second) language before age 6 or 7 learns it at native level. It is a rarity, the subject of considerable admiration and awe, if anyone does as well when exposure begins in adulthood.

The second objection is more substantive. Perhaps the difficulties of the learners just discussed had to do specifically with second-language learning. Maybe older individuals are not worse at learning language but rather are troubled by their sophisticated knowledge of the first language. One body of language knowledge may interfere with the other.

For this reason, it is of interest to look at acquisition of a first language late in life. The best available line of evidence comes from work on the acquisition of sign language. As we saw earlier (see the section "Language Invention by the Isolated Deaf Child"), most deaf children are born into hearing families and are therefore not exposed to a gestural language from birth. These individuals invent a skeletal communication system that compares quite well with language in the normally circumstanced 2-year-old (Feldman et al. 1978; Goldin-Meadow and Mylander 1984). Yet they do not advance to an elaborate language system containing function morphemes and other very complex linguistic devices. In some ways their spontaneous development seems akin to Genie's; early in life these isolates control no elaborate linguistic system. At varying points in life, as accidents of personal history, most of these individuals do come in contact with a formal language of the deaf, such as American Sign Language (ASL), which they then learn and use for all their everyday communicative needs. Sometimes contact with a formal sign language comes relatively early in life but sometimes as late as 15 or 20 years of age. These individuals are essentially learning a first language at an unusually late point in maturational time.

Does this late start matter? Newport (1990) studied the production and comprehension of ASL in three groups of congenitally deaf people. All of them had been using ASL as their primary means of communication for at least thirty years, a virtual guarantee that they were as expert in this language as they would ever be. The only difference among them was the age at which they had first been exposed to ASL. The first group consisted of deaf children of deaf parents who had been exposed to ASL from birth. The second consisted of early learners, those who had been exposed to ASL between ages 4 and 6. The third group had come into contact with ASL after the age of 12. All subjects were at least 50 years of age when tested. The findings were dramatic. After thirty years or more of exposure and constant use, only those who had been exposed to ASL before age

6 showed native-level fluency. There were subtle defects in the middle group, and those whose exposure occurred after the age of 12 evinced significant deficits. Their particular problems (as usual) were with the ASL equivalents of the function morphemes and with complex sentences.

Pidgins and Creoles

A fascinating line of research concerns the process of language formation among linguistically heterogeneous adults who are thrown together for limited times or purposes (Bickerton 1975, 1981; Sankoff and LaBerge 1973). They may be occasional trading partners of different language backgrounds who have to communicate about the costs of fish and vegetables, or foreign coworkers who come to a new country to earn money and then return to their native land, or citizens of a region in which there are too many languages for everyone to learn them all. In order to communicate across language barriers, these individuals often develop a rough-and-ready contact language, a lingua franca, or *pidgin*. Not surprisingly from what we have discussed so far, these pidgin languages are rudimentary in form, perhaps because all their speakers are late learners. Thus, there are interesting overlaps between the pidgins and the first attempts of young children learning an elaborated natural language (Slobin 1977). For example, at the first stages of both, the sentences are one clause long and have a rigid simple structure and few if any function words.

Very often, a pidgin will develop into a full language. An example is Tok Pisin ("Talk Pidgin"), a language of Papua, New Guinea, with pidgin origins. When the speakers of different language groups began to marry, they used this pidgin as the only means of linguistic communication. Most important, they had babies whose only language input was the pidgin itself. Once a pidgin language has native speakers (and thus by definition is called a *creole*), it undergoes rapid change and expansion of just the sort one might expect based on the learning data we have presented so far: Multiclausal sentences and a variety of function morphemes appeared in the users who heard the pidgin from birth rather than acquiring it during adulthood. Sankoff and LaBerge 1973 (see also Bickerton 1975, 1981) showed that this elaboration of structure was carried out primarily by the child learners who, between the ages of about 4 and 7 years, refined and expanded upon the formal resources available in the pidgin.

Singleton and Newport (1994) have shown a related effect for the children of late learners of ASL. Recall that the late learners, even after thirty years of exposure and practice, have substantial problems with the complex parts of ASL: While they may have good control over the basic vocabulary and simple clauses of ASL, they use more complex structures of ASL inconsistently, and they often omit multiclausal sentences and function morphemes altogether. In this sense, then, their late-learned language is somewhat like a pidgin (see Schumann 1978 for a similar analogy between late-acquired second languages and pidgins). When two late learners marry, their children (learning ASL in the family home from their parents) are therefore like creole speakers. Singleton and Newport observed such a child, "Simon," from the time he was about 2 years old until he was 9, and recorded both his parents' and his own use of ASL. Simon's parents provided his only input to ASL; as is common for deaf children, no one at Simon's school knew ASL at all. His parents showed the characteristic restrictions of late learners of ASL described above. In contrast, however, Simon's own ASL surpassed his parents'. At the appropriate maturational time (ages 4 to 7), he refined, expanded, and grammaticized the resources of his input, creating an elaborated language complete with complex sentences and function elements.

In a nutshell, both for the spoken creole of Sankoff and LaBerge and the gestural creole of Singleton and Newport, the first language-learning situation, carried out at the correct maturational moment, creates new resources that are not properties of the input pidgin, are highly abstract, and are the very hallmarks of full natural languages.

1.2 Every Learner Is an Isolate

Most of our discussion so far has focused on language learning in unusual and apparently especially difficult conditions—when the learner was blocked from getting information of various kinds by accidents of nature or circumstance, or even when there was no full language out there in the world for the learner to observe. Rising above these inadequacies in the data provided, children learned language even so. These findings point to a human "linguistic nature" that rescues learners from inadequacies in relevant nurture.

In one sense, these populations provide the most solid and dramatic evidence for our understanding of language learning because they extensively remove or reduce the contributions from one of the components of the nature/nurture equation and thereby reveal the effects of the other. But in an important sense, it was not really necessary to look at special populations to conclude that language learning must be largely "from the inside out" rather than being "outside in." The special cases serve only to dramatize what are actually the ordinary conditions for language acquisition. For every learner of a human language, no matter how fortunately circumstanced, is really in the same boat as, say, the blind child or the learner exposed to a rudimentary contact language: isolated from much of the information required to learn a language from mere exposure. At best, the child's environment offers some fragmentary and inconclusive clues, with human nature left to fill in the rest. In short, children are able to acquire English or German or Tlingit just because in some sense they know, from their biological predispositions, the essence of language.

We can document this point with a few examples. Consider the information children are given for learning that the sound "dog" means *dog*. No one tells the child the meaning of the word (perhaps, *cute, furry, tame, four-legged, midsized mammal of the canine variety*). Instead, the child will see a few dogs—say, a chihuahua and a Great Dane—and in their presence the caretaker will utter, "That's a dog," "Be careful; that dog bites!", "I'm glad we don't have a dirty dog like that at home," or something of the sort. From such adventitious encounters with dogs along with sentences about dogs, rather than from any direct encounters with the meaning of *dog*, novices must deduce that there is a category *dog*, labeled "dog" in English, that can be applied to certain kinds of creatures in the world. Though their observations may include only the chihuahua and the Great Dane, they must be able to apply the word to future terriers and poodles as well, but not to cats or elephants. That is, the use of even the homeliest words is creative. Once learned, they are applicable to instances never previously observed, so long as they fit the category. But just what the appropriate extensions are, from the particular examples they have seen to new things in the world, is left to the children to figure out on their own.

Such are the real conditions for vocabulary acquisition. The category (or *concept*) is never directly encountered, for there are no categories indicated directly in the world; there are only individual things, complex events, and so forth. Learners are thrown upon their own internal resources to discover the category itself. Yet the most ordinary child by age 6 has acquired about ten thousand words, hardly any of them ever directly defined by the adult community.

To see the real dimensions of this vocabulary acquisition task, consider now the acquisition of *know*, a vocabulary item within the range of every self-respecting 4-year-old. In certain conversational contexts the novice will hear, "Do you know where your blocks are?", "I don't know what you're crying about," "You know Aunt Mary, don't you? You met her at Bobby's house last week." In consequence of such contacts with the world and the word, children come to understand the meaning of *know*. How do they manage to do this? What is the meaning of *know*, such that it refers truly and relevantly to the (infinitely many) new knowing situations but not to the infinitely many other new situations that involve no knowing? Just what are the situations that license uttering "know"?

All in all, it seems that the word learner is "isolated" from direct information about word meanings, even under optimal environmental conditions. The instances offered by experience are insufficient to warrant discovery of these meanings, but the child does so anyway, and for a formidably large set of words.

Lay observers are often impressed with the fact that very young children may sometimes overextend some term—for example, calling the dog in the street "Fido" if that is the name of the child's own dog, or calling the man in the street "Daddy." But these errors are quite rare, even in the toddler (perhaps that is why they are so treasured), and have largely disappeared by age 2. More important, the rare errors in applying a word are highly constrained: no child uses the word *dog* for an onion or jumping or redness. Even when toddlers are slightly off the mark in using first words, they are admirably close to correct, despite the fact that the information presented in the environment is ludicrously impoverished. It must be that the categories in which language traffics are lavishly prefigured in the human mind.

Similar arguments for the poverty of the stimulus information (and thus the need to look to nature to understand the emergence of language in children) can be made by looking at almost any property of syntactic structure. No mother explains English grammar to her child. One reason is that no one knows the grammar in any conscious way and so could not explain it if they tried. Another is that the babies would not understand the explanations. Just as in the case of vocabulary, acquisition of syntactic structure proceeds on the basis of examples rather than explanations. One can thus ask, for syntax as well as vocabulary, whether the example utterances that children hear are really sufficient to account for what they come to know about the structure of their language. The structures we will use for illustration come from a discussion by Chomsky (1975).

In simple English declarative sentences, the verb occurs after the subject noun phrase: for example, *The man is a fool.* To form the interrogative, the *is* "moves" into initial position preceding the subject (*Is the man a fool?*). But can any *is* in a declarative sentence be moved to form an interrogative? It is impossible to judge from one-clause sentences alone. The issue is resolved by looking at more complex sentences, which can contain more than one instance of *is*, for example:

(1) The man who is a fool is amusing.

(2) The man is a fool who is amusing.

Which of the two *is*'s in each of these sentences can move to initial position to form an interrogative? Suppose we say that it is the first of the two *is*'s that can move. This will yield:

(1′) Is the man who a fool is amusing?

(2′) Is the man a fool who is amusing?

Sentence (2′) is fine, but (1′) is clearly ungrammatical. No one talks that way. Therefore, the "rule" for forming an interrogative cannot be anything like "move the first *is*." But a new trouble results if we try to move the second *is* instead. This would yield:

(1″) Is the man who is a fool amusing?

(2″) Is the man is a fool who amusing?

Now sentence (2″) has come out wrong. Thus *no* rule that alludes to the serial order of the two *is*'s will correctly account for what is and what is not a grammatical interrogative. The only generalization that will work is that the *is* in the *main clause* (rather than the subordinate clause, the one introduced by *who*) moves. The problem with (1′) and with (2″) is that we tried to move the *is* in the subordinate clause, a violation of English syntactic structure.

English speakers by age 4 are capable of uttering complex interrogatives like those we have just looked at. No one has ever observed a youngster to err along the way, producing sentences like (1′) or (2″). But how could they have learned the appropriate generalization? No one whispers in a child's ear, "It's the *is* in the main clause that moves." And even such a whispered hint would be insufficient, for the task would still be to identify these clauses. Sentences uttered to children are not marked off into clauses such as:

(3) The man [who is a fool] is amusing.

nor are clauses marked "main" and "subordinate" anywhere in the speech stream. No one hears sentences like:

(4) beginning-of-main clause: "The man," subordinate clause: "who is a fool," end-of-main clause: "is amusing."

In short, the analysis of utterances required for forming the correct generalization is not offered in the language input that the child receives. Even so, every child forms this generalization, which operates in terms of structures (such as "the main clause") rather than according to the serial order of items (such as "the first *is*").

The distinction between main and subordinate clauses—or, in modern linguistic parlance, "higher" and "lower" clauses—is no arcane byway of English grammar. Consider as one more instance the interpretation of pronouns. Very often, pronouns follow their antecedent, as in:

(5) When John arrived home, he ate dinner.

But we cannot account for the antecedent/pronoun relation simply by alluding to their serial order in the sentence (just as we could not account for the movement of *is* by alluding to its serial position in a sentence). This is because a pronoun can sometimes precede its antecedent noun as in:

(6) When he arrived home, John ate dinner.

But this is not always possible, as shown by:

(7) He arrived home when John ate dinner.

Sentence (7) is perfectly grammatical, but its *he* cannot be John, while the *he* in sentence (6) can be John.

What is the generalization that accounts for the distinction in the interpretation of (6) and (7)? It is (very roughly) that the pronoun in the main (higher) clause cannot corefer with a noun in the subordinate (lower) clause. Again, it is necessary to invoke structures within sentences, rather than the serial order of words (here, nouns and pronouns), to understand how to interpret the sentences.

How could a child learn that the principles of English syntax are—always, as it turns out—*structure-dependent* rather than serial-order-dependent? Why are errors not made on the way to this generalization? The problem is that sentences spoken and heard by children in no way transparently provide the structural information . The "stimulus information" (the utterances) is too impoverished—just a bunch of words strung in a row—to sustain the correct generalizations. And yet these generalizations are formed anyway.

The solution seems to be that learners are innately biased to assume that generalizations in natural languages will always be structure-dependent rather than serial-order-dependent. Indeed, extensive linguistic investigation shows this to be true of all languages, not just English. With this principle in hand, children have a crucial leg up in acquiring any natural language to which they are exposed.

To summarize this discussion, every real learner is isolated from many of the kinds of elaborate information that would be necessary for discovering the word meanings and grammatical forms of a human language. Children use neither dictionaries nor grammar texts to redress this paucity of the information base. It follows that innate principles must be guiding their linguistic development. Children can learn language because they are disposed by nature to represent and manipulate linguistic data in highly circumscribed ways.

1.3 Conclusions

In the preceding sections we have presented some of the complex facts about language and language learning. We have suggested that these facts support the notion that there are biologically given dispositions toward certain types of language structure and toward a particular maturationally based sequence in which these structures appear. We have given evidence that, to a surprising degree, language is the product of the young human brain, such that virtually any exposure conditions short of total isolation and vicious mistreatment will suffice to bring it forth in every child. In retrospect, this is scarcely surprising. It would be just as foolish for evolution to have created human bodies without human "programs" to run these bodies as to have created giraffe bodies without giraffe programs or white-crowned-sparrow bodies without white-crowned-sparrow programs. It is owing to such biological programming that language is universal in our species and utterly closed to other species—including even college-educated chimpanzees.

The universality of language is, moreover, no quirk or back corner of human mentality but rather one of the central cognitive properties whose possession makes us truly human. If we humans ever get to another planet and find organisms who speak like us, it is likely that we will feel some strong impetus to get to know them and understand them—rather than trying to herd them or milk them—even if they look like cows.

While we have emphasized the biological underpinnings of language acquisition, we must also repeat that part of the normal acquisition process clearly involves learning from the environment as well: English children learn English, not Greek or Urdu. The surface manifestations of human languages are marvelously variable, and children learn whichever of these manifestations they are presented with (as long as what they hear is organized in accord with the general principles of human language, and as long as it is presented at the proper maturational moment). Language acquisition is therefore a complex interaction between the child's innate capacities and the social, cognitive, and linguistic supports provided in the environment. What we have tried to emphasize, however, is that acknowledgment of significant environmentally caused variation should not blind us to the pervasive commonalities among all languages and among all their learners. Specific languages are apparently acquired within the constraints of a specialized and highly evolved biological endowment, which learns languages only in particular ways and only at particular moments of life.

Perhaps it would repay serious inquiry to investigate other complex human functions in ways similar to those that have been exploited in the study of language learning. There are vast differences in human artifacts and social functions in different times and places, with some humans riding on camels while others rocket to the moon. All the same, it may well be that—as is the case for language—human individuals and cultures do not differ from one another without limit. There may be more human universals than are visible to the naked eye. Beneath the kaleidoscopic variation in human behavior that we easily observe, there may be many universal organizing principles that constrain us and contribute to the definition of what it is to be a human.

Suggestions for Further Reading

Noam Chomsky (1959) initiated modern debate on the nature-nurture questions for language acquisition in a review article that contrasted his view with that of the great learning theorist B. F. Skinner. This classic article is still timely today, nearly forty years after its publication.

When considering problem 1.2, you may want further information on language learning and retardation that can be found in the following: Fowler, Gelman, and Gleitman 1994, Johnston 1988, and Nadel 1988.

The study of brain state and organization and how this affects language learning is in its infancy. Two entirely different approaches can be seen in Borer and Wexler 1992 and in Landau and Jackendoff 1993. The first article argues for a maturational schedule in language development by comparing formal properties of child and adult language organization. The second article relates differences in language categories (such as noun, preposition) to the storage of information concerning objects and places in the brain.

Some of the same kinds of empirical and logical evidence that have been adduced in favor of biological supports for language learning have also been raised for other abilities, for example, the acquisition of numerical abilities by young children. For this, see Starkey, Spelke, and Gelman 1990.

A view that is strongly opposed to the one taken by Gleitman and Newport in the present chapter is that language substantially affects how we think, rather than language being essentially the natural product of human thought. For this different view, see its original formulation in Whorf 1956.

The debate about whether specifics of a language truly affect thought has been carried out extensively by examining color terminology, to discover whether linguistic communities that have different color terminologies perceive hues in the world differently (the "Whorfian" position) or whether perception is independent of language. See, for example, Berlin and Kay 1969, Brown and Lenneberg 1954, and Heider and Oliver 1972.

Problems

1.1 As an example of examining language learning "with changed mental endowment," our article discussed learners of different ages. Mentally handicapped children (for instance, with Down Syndrome) offer another kind of opportunity to examine the effects of brain status on language learning. Describe a study you might do of language acquisition in Down Syndrome children, describing the factors that would have to be controlled or manipulated to understand their learning.

1.2 Suppose an adult and child human arrive on Mars and discover that there are Martians who seem to speak a language to one another. If the adult and child human stay on Mars for several years and try to learn this language, what do you think will be the outcome?

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