EVOLUTION OF THE HUMAN CAPACITY FOR BELIEFS

by Ward H. Goodenough

Abstract. Evolution of the human capacity for beliefs is considered in relation to the emergence in human phylogeny of the ability to formulate propositions, evaluate their worth as bases for action, and make emotional attachments to them. Most of the relevant capabilities had appeared in primate evolution before the emergence of the Hominidae. The combination of capabilities peculiar to evolving hominines was that involved in the development of language, which ontogenetic evidence suggests began as a tool for implementing intentionality in social interaction and whose subsequent elaboration was associated with later reportorial and narrative uses.

Keywords: beliefs; cognition; human evolution; language.

Beliefs are propositions about the relations among things to which those who believe have made some kind of commitment.[1] Commitment may be for pragmatic or emotional reasons. A proposition's credibility may appear obvious from experience, or a proposition may seem to be the most prudent assumption on which to act. In either case, the commitment has a pragmatic basis. Emotional commitment to a proposition occurs when a person wants or feels a need for it to be true because of what its truth implies about things that matter.

Consideration of the evolution of the human capacity for beliefs, therefore, requires that we consider the emergence in hominine phylogeny of the ability to formulate propositions, to evaluate their worth as bases for action, and to make emotional attachments to them.

Ward H. Goodenough is University Professor Emeritus, University of Pennsylvania, University Museum, Philadelphia, PA 19104-6398.

[*Zygon*, vol. 28, no. 1 (March 1993).]
 ISSN 0591-2385

PROPOSITIONS

Propositions are statements about relations among things and events, including how people feel. They may be descriptive or they may be expressions of opinion. In any case, they are ultimately rooted in people's experiences of their environment and of the effects of their responses to those experiences.

As here defined, propositions involve language, but experience of environment and neural organization of that experience go back a long way in mammalian phylogeny. If every sensory input were registered as new and phenomenally unlike any previous one, it would be impossible for an organism to develop the associations needed to learn adaptive responses to its environment. An organism's sensory equipment, moreover, is incapable of discriminating among the infinite variety of actual inputs. The senses necessarily serve as a filter. What the inputs are phenomenally for the organism is limited by what the organism is capable of discriminating and by what it has learned to discriminate in the course of experience.

We humans certainly do not learn to make all of the discriminations of which we are capable. When we learn a second language, we discover that there are discriminations we must make that we had not had to make before—discriminations of both sound and meaning. Years ago I was told by a student who had lost his sight in World War II how it was that blind persons knew they were coming to a street intersection. He told me that the air pressure on a person's face is different on the side where there are buildings from what it is on the open side where the street lies (actually a difference in sound). On coming to a break in the row of buildings, one can feel the air pressure change. As routes become familiar, a blind person learns when these changes in air pressure indicate intersections as distinct from vacant lots.

It is evident, then, that we ignore some sensory inputs entirely, we lump others together as the same when they are actually different, and we become habituated to making those discriminations we need to make in order to accomplish our purposes in the physical and social arenas in which we live. In this, humans are not alone, for we know that many animals can be trained to discriminate cues and perform in ways that differ from what they do in the wild.

So we conclude that the materials from which propositions are made are categorizations of experience, whatever the cognitive processes of categorization may be.[2] The phenomenal world in which we live is necessarily a cognitively structured world; and fundamental to this cognitive structuring is categorization. This is so not only for

humans, but for all animals that have to *learn* to respond to things and events in their environment in ways appropriate to survival. Nonhuman primates often behave as if they are seeking conscious goals with "mental maps" of how to reach them (Oates 1986, 206); chimpanzees, at least, are capable of planning ahead in relation to fairly immediate goals (Cheney, Seyfarth, and Smuts 1986, 1364). The ability to categorize both objects and relationships between objects is necessary to such behavior. This ability, associated with intentionality, appears to be manifested in humans very early in infancy (Bower, Broughton, and Moore 1970; Gelman 1983; also Bower 1974, Fantz 1961). The many parallels in the development of young chimpanzees raised in human homes with that of human infants testifies eloquently to their having many similar cognitive abilities (Premack 1976).

Categorization, essential to perceiving things as alike—and essential, therefore, to the development of learned responses—does not ordinarily involve discriminations along only one sensory dimension. Usually, several such discriminations are made simultaneously, or nearly so. In language, for example, we respond to words and short phrases as wholes rather than to their constituent categories of sound separately. Similarly, most other things that have stimulus value for us are complex structures of elementary categories. They are, in short, configurations or *gestalts*.[3] Such configurations can in turn be perceived as components of larger structures, as in our perceptions of spatial arrangements. We popularly associate the word *intuition* with the grasping of complex arrangements of arrangements; but we should note that the cognitive processes to which we give this blanket term are involved in perception generally. These processes are as essential to the successful life of monkeys as they are to the life of humans.

The ability to perceive structural arrangements, whole gestalts, as similar is essential to analogy. In making analogies, we equate gestalts on the basis of the similarity of their arrangement alone when we perceive their constituent components as unlike. Many of the propositions humans formulate are based on analogy, especially in the bodies of linked propositions we call belief systems (Jardine and Morgan 1987). In this regard, it is reported that laboratory experiments with chimpanzees indicate that they can be trained to "solve problems of transitivity, use analogical reasoning, and develop deliberate deception of others" (Cheney, Seyfarth, and Smuts 1986, 1363). Evidence suggesting the perception of analogous social relationships among monkeys and apes in the wild is provided by the observation that adult females among vervet monkeys tend to

respond actively to the screams of their own juvenile offspring, but when another female's offspring screams they tend to look at its mother. Even more suggestive is the observation that when two vervet monkeys fight, a close kin (associate) of one may attack a close kin (associate) of the other.[4]

We must distinguish, however, between the ability to perceive analogous structures in basic social relationships and the ability to analogize more freely. It is noteworthy that the analogical reasoning observed in chimpanzees occurred after they had learned to use a number of fairly arbitrary signs to represent things and to use these signs in communication with human experimenters. Also relevant is the ontogenetic process of becoming able to perceive relationships to which a child is not a party as analogous to those in which the child actually participates.[5] Is there a similar ontogeny among monkeys and apes? The evidence just cited about fighting behavior suggests that there may be. How far it is possible to analogize without the use of a system of representational signs remains an open question, but it is clear that the ability to discriminate among gestalts is prerequisite to that process and that some primates, monkeys and apes certainly, are capable of making such discriminations and of classifying and responding to phenomena accordingly.

What remains a question has to do with the extent of their ability to perceive structures as analogous when the similarity of constituent elements decreases and the similarity of arrangement is increasingly all that remains as a basis for such perception. There is also the question of the ability of monkeys and apes to perceive analogous structures involving relations among inanimate objects as distinct from analogous relationships among conspecifics or relations of conspecifics to objects. In my own view, such ability is greatly facilitated by the kinds of mental operations that language (or a comparable system of representational signs) makes possible and must remain largely undeveloped without it.

To perceive similarities of arrangement when the component elements are perceived as dissimilar is to make an abstraction. Abstraction makes higher-order categories out of lower-order categories on the basis of some shared characteristics, including shared structural arrangements. I have just indicated that there is some question as to the ability of monkeys and apes, in the absence of language, to make abstractions based on shared structural arrangements alone, the components of the gestalts under comparison being otherwise entirely different. What about abstractions based upon other shared characteristics, such as in discriminating between red and blue poker chips in some tasks but discriminating chips, as such, from other

things, regardless of color, in other situations? Here one is ignoring the single feature that distinguishes two otherwise similar gestalts. The result is a higher-order classification that is not based on analogy. The capacity to abstract in this way seems also to be attested in the performance of monkeys in the wild, for they respond to strange monkeys in a way that differs from their response to fellow members of their troop, while at the same time their behavior toward monkeys within their troop differs consistently from individual to individual (Cheney, Seyfarth, and Smuts 1986).

In the evolution of the capacity for belief systems, then, we may conclude that a number of the necessary capabilities were already in place before the emergence of the earliest hominids. Some of them, moreover, were already in place further back in mammalian and vertebrate phylogeny.[6]

These capabilities are: (1) categorization of experience; (2) perception and categorization of things in structural arrangements; (3) abstraction of higher-order categories from lower-order ones on the basis of common features, while overlooking a perceived difference; (4) potential for analogizing, largely undeveloped in the absence of language; (5) intuitive grasping or perceiving of relationships that would, if expressed in language, constitute propositions; and (6) the ability to act on these perceptions in the definition and pursuit of goals.

These capabilities have presumably become more highly developed in some animal species than in others; but they seem to have already achieved considerable development among the higher primates prior to the beginning of the hominid line. They are all prerequisite to the emergence of beliefs. What language allows us to objectify as propositions, however, can be no more than subjective or intuitive understandings in the absence of language. An additional prerequisite for the emergence of beliefs, one that is peculiar to humans, is a system of manipulable signs capable of representing categories of thing (including self and other), and categories of feeling, quality, act, and relationship.

LANGUAGE

The most significant development that set the hominid line on a course different from that of the ancestors of the modern apes seems to have been bipedalism and upright posture. The earliest fossil hominids of the genus *Australopithecus* show this major anatomic change to have occurred before any discernible increase in relative size and complexity of the brain. Upright posture promoted a

restructuring of the oral passage that made possible the development of the articulations necessary to produce the number and kinds of distinctive sounds found in human speech (Hill 1972). Later on, with the emergence of *Homo erectus,* roughly 1.6 million years ago, we find a significant increase in the size and complexity of the brain. It is still a matter of disagreement among paleontologists and paleolithic archaeologists as to whether language began to emerge with *Homo erectus* or with *Homo sapiens.* Important in this regard is the finding that the structural organization of the vocal tract or upper respiratory region in *Australopithecus,* especially the position of the larynx, is like that of monkeys and apes, whereas that of *Homo erectus* is intermediate between that of *Australopithecus* and *Homo sapiens* (Laitman 1983).

There are those who argue that even within what is recognized as *Homo sapiens,* language cannot be attributed to the Neanderthal subspecies, but only to *Homo sapiens sapiens* (as represented by types like Cro-Magnon), whose appearance is associated with the elaboration of stone technology and with cave art and other material evidence of symbolic representation (e.g., Davidson and Noble 1989). The apparent elaboration of tool types in the Mousterian or Middle Paleolithic, associated in Europe with *Homo sapiens neanderthalensis* and previously taken as evidence of language use, has recently been shown to be a result of resharpening, each reduction in size and shape in the process automatically producing the range of what had been presumed to be an intentionally differentiated and specialized tool kit (Dibble 1987, 1988, 1989). While this finding eliminates Mousterian tool differentiation as evidence of the presence of language, it cannot be taken as evidence of its absence.

Those who argue the position that language first appeared with *Homo sapiens sapiens* confuse the first material evidence of a behavioral capability with the earliest emergence of that capability. We take it for granted, for example, that the genetic capacity for composing music of the kind that developed in Europe in the last few hundred years was present in humans long before the realization of that capacity under historical and social circumstances favorable to it. Indeed, there is reason to think that the elaboration of technology reflected in tools and art represents a relatively late application of the possibilities inherent in language to purposes quite different from the social and expressive ones with which language was probably originally associated. The proper inference is that language—in the grammatically developed form we find among all living peoples today—must have been in place by the beginning of the Upper Paleolithic, about thirty thousand years ago, *at the latest.* How much earlier it was in place, and how long it was in process of development

and elaboration before that time, remains, on the basis of only the evidence of tool complexity and art, entirely unknown. The fact that language is found in fully developed form among all Amerindians and Australian aborigines, who were isolated from other humans from the late Pleistocene until fairly recent times, is another fact to be reckoned with, but this does not necessarily take the emergence of language back before *Homo sapiens sapiens.*[7]

Circumstantial evidence of another kind, however, allows us to push back the time for the presence of language in a developed form to the latter part of the Middle Pleistocene, prior to 125,000 years ago, when archaeology indicates that human penetration of temperate and possibly subarctic climatic zones by archaic *Homo sapiens* had occurred. Early hominids, like their nearest primate relatives, were adapted to life in the tropics and subtropics, and through most of their existence were confined to these climatic zones in the old world. For hominids to survive the winters of the temperate zone, to say nothing of the subarctic zone, required two things. One was an appropriate technology that would provide clothing (however simple in design), shelter, and the making and husbanding of fire for warmth. The other was the ability to plan ahead for changes in seasonal conditions. To begin preparing the skins (or other means) needed to protect the body from the cold only after the cold weather arrives is to act too late. Response must be made not to the weather as it is changing, but to what one anticipates the weather to be. This requires planning for the future and a sharing of understanding about unseen, not-yet-present conditions.

Humans have been using language to accomplish such things from as far back as we have record. To argue that they were managing these preparations for the changing seasons the way squirrels do—presumably because they are genetically programmed for it—flies in the face of everything we understand about biological evolution. Such genetic programming would not have been selected for in the tropical environment in which hominids evolved. Once humans had made a successful adjustment to living in temperate or even colder climatic zones, natural selection would then have begun to operate in favor of such things as body-builds more efficient for heat retention. But the initial human adjustment to living in temperate zones took place in too short a time for natural selection to account for it. We must presume that the means by which humans have adapted socially and technologically to radically changing circumstances in recorded history, means which rely heavily on the use of language, are the same means that humans have been using for as long as we have evidence of such adaptation. Evidence of successful adaptation

for survival in temperate and subarctic zones is, for this reason, presumptive indication of the existence of language with developed syntax as of that time. Moreover, language in such form had already to be in existence to make this adaptation possible. I conclude, therefore, that grammatically elaborated language goes back at least to the time when archaic *Homo sapiens* began to emerge from *Homo erectus*. The evidence from Chou-k'ou-tien in China suggests the possibility of an even earlier date, approximately 460,000 years ago (Chiang 1986, 42).[8]

The foregoing is consistent with the view that language did not evolve in connection with toolmaking—contrary to what has long been assumed by many anthropologists—but in social interaction within familial and coresidential groups and the planning and coordination of activities by members of such groups. Simple toolmaking, even to a clearly conceived pattern, can be learned by imitation and, when instruction is necessary, can be taught by example and positive and negative indicators. It does not need syntactically developed language. From this point of view, while language and symbolic behavior played an important role in the adaptive and social behavior of Middle Paleolithic hominids, it did not yet reflect itself in the stone tools they made, which constitute the major part of the archaeological record for that period, as observed by Chase and Dibble (1987). Consistent with this view is growing evidence that nonhuman primates, like human infants, are more sensitive and responsive to social than to nonsocial stimuli (Essock-Vitale and Seyfarth 1986, 459).

Relevant is the recent report that *Paranthropus robustus,* an early hominid that developed in parallel to the line leading to the genus *Homo,* may have had hands adapted for precision grasping, and might therefore have made and used the crude stone tools that were contemporaneous with its remains (Susman 1988). Existing about 1.8 million years ago, with a small brain and large jaw and teeth that are not consistent with the presence of language even in its early stages, *Paranthropus* provides evidence—if this report is verified—that language did not develop in association with making and using simple stone tools. On the contrary, making and using such tools appears to have developed independently, a conclusion that is consistent with the evidence of even more rudimentary toolmaking and tool use by chimpanzees in the wild (Goodall 1986, 535–64).

It follows from what I have been arguing that the Middle Paleolithic Neanderthals are better considered to have been language users than not. It has been suggested that they could not have had language because their vocal tracts were so structured that they could not readily make distinctive vowel sounds (Lieberman, Crelin, and Klatt

1972). The argument assumes that vowel distinctions are necessary to spoken language, whereas, in fact, they are not. All that is needed is an undifferentiated continuant between differently articulated consonants, as some modern languages with very few distinctive vowel phonemes attest. Furthermore, many languages, including spoken English, use nasal and liquid consonants like *m, n, l,* and *r* as continuants, as if they were vowels. There is, in short, no convincing anatomical evidence to support the idea that Neanderthals were incapable of language.

We must note, however, that the shape of the human vocal tract has changed in the course of hominid evolution, including the evolution of *Homo sapiens.* This change has included a considerable reduction in the size of the palate and, perhaps, a change in the articulation of the front teeth (Hockett 1985). We must infer that the range of easily made and even possible speech sounds was not the same one hundred thousand years ago as it is today. There must have been considerable overlap in the earlier and later ranges, but they were clearly not identical. Such difference, however, is not pertinent to the existence of language, however pertinent it may be to the phonological evolution of languages after language, as such, came into being.

The argument that Neanderthals were probably language users is not controverted by increasing evidence that *Homo sapiens sapiens* emerged in Africa perhaps as early as 90,000 years ago, while still using stone tools of Middle Paleolithic type, and coexisted with Neanderthals for a long time (Stringer and Andrews 1988; Stringer 1988; Valladas et al. 1988). The coexistence of geographic races of the same species must have emerged much earlier, following the spread of *Homo erectus* out of Africa. That *Homo sapiens sapiens* subsequently spread into areas formerly occupied by Neanderthals (thanks to new developments in technology) does not imply that the latter were replaced without any input into the later European gene pool any more than the disappearance of Native Americans as a recognizable racial type in most of New England in the past 350 years means that they made no contributions to the gene pool of New England's present population. A number of "white" New England families claim a Native American in their ancestry. Sackett (1988) has pointed out that there is not a sharp break, even in western Europe, between Middle and Upper Paleolithic archaeological remains, but a phasing of one into the other. It may not be a coincidence that the genetic allele for Rh negative blood is statistically most heavily concentrated in the region of Europe that was occupied for so long in apparent isolation during the last glacial period by the "classic" Neanderthals.

The position taken here is not controverted by widely publicized inferences from recent work relating to mitochondrial DNA (mtDNA), which is transmitted only through women (Cann, Stoneking, and Wilson 1987; Mahler 1973). Mutations accumulate in this DNA faster than in the DNA of a cell nucleus and give rise to different maternal "lineages" based on their shared mutations.[9] Comparison of the mtDNA of a small sample drawn from widely scattered parts of the world has revealed a number of these lineages, whose similarities and differences allow them to be ordered in a genealogical tree. The date for the convergence of these lineages in an ancestral population has been roughly estimated at 140,000 to 225,000 years ago, about the time of the emergence of early forms of *Homo sapiens.* It has been inferred from this that all modern humans derive from a dispersal of *Homo sapiens* out of Africa that in time replaced other hominid forms (Cann, Stoneking, and Wilson 1987; Foley 1987; Stringer and Andrews 1988).

This inference is at variance with the paleontological evidence, which supports the view that the several geographic races of *Homo erectus* contributed to the ancestry of *Homo sapiens* (Wolpoff 1989), although it would be erroneous to assume that they all did so equally. In a cogent review, Spuhler (1988) points out that the dating evidence suggests an earlier time of divergence and that the distribution of the oldest branches in the lineage tree is more consistent with the view that the major continental races of *Homo sapiens* had their origin in transitions from *Homo erectus* in at least three different regions than with the view that there was a global replacement of the latter by *Homo sapiens* through a migration from a single region.

From this perspective, the apparent spread of technologically superior modern forms in the late Pleistocene out of Africa into areas inhabited by Neanderthals and other technologically less developed races of *Homo sapiens,* as argued by Stringer and Andrews (1988), can be compared with more recent spreads of technologically or militarily advantaged peoples into areas occupied by less advantaged peoples in many parts of the world. Such spreads are well attested in recorded history and also in the prehistoric record of the past ten thousand years. These spreads did not involve the total replacement of one local gene pool by another. Moreover, in none of them, either historic or prehistoric, have we had reason to assume that the presence or absence of language in a fully developed form was a factor. It need not have been a factor in the spread of people with Upper Paleolithic tool assemblages, either. Indeed, there is increasing archaeological evidence of the coexistence and social interaction of

Middle and Upper Paleolithic tool users in Europe and elsewhere (Mellars 1989).

The Evolutionary Development of Language and Its Uses

It is highly unlikely that language in its developed form, with grammatical markers and syntactic structure, emerged from nothing in a sudden, great evolutionary leap. Language, moreover, is more than just a communicative system. It has pragmatic, expressive, referential, narrative, task-rehearsing, and reflective uses. As Derek Bickerton (1981, 217) has observed, "it must consist of a number of interacting systems." We must posit at least two major stages of development, each based on the crossing of a threshold that led to subsequent elaboration of the possible uses of language thus opened up, as circumstances and human (as well as primate) propensities for play and exploration stimulated them.

Some things necessary to language were already in place before language emerged at all. Experimental studies reveal that monkeys can discriminate auditorily among the same phonologically different speech sounds that human infants can (Kuhl 1978; Stebbins 1970, 1973). We must infer, therefore, that the ability to make the kinds of auditory discriminations involved in human languages is older evolutionarily than the ability to produce them vocally, having arisen in connection with the advantages of being able to respond selectively to a wide range of sounds generally. We must similarly assume that the ability to produce vocal sounds that were distinct intonationally—involving prosodic as distinct from segmentary phonological features—was already in place before the first threshold to spoken language was crossed. Human infants learn to reproduce short intonation sequences characterizing utterances they hear before they can reproduce these utterances phonologically (Crystal 1978). Such abilities were already involved in the kinds of calls and other vocalizations that characterize communication among nonhuman primates. Finally, studies of these primates indicate that vocalizations were already used to some degree in ways that required learning before language emerged. Their use was presumably pragmatic: to communicate and implement intentions in social interaction. Such vocalizations, especially in conjunction with eye movements and gestures, could have referential meaning as well, but were not used for purely referential communication. This inference is consistent with the observed priority of pragmatic over purely referential usage of words in human ontogeny (de Villers and de Villers 1978; Nelson 1978).

The first threshold to human language, then, involved the development of phonologically segmented verbal signs that were used referentially as well as pragmatically to represent objects, persons, acts, and feeling states. I assume that these signs served mainly to enable speakers to identify things of social importance for one another more precisely and to allow them to make utterances of one or two words of the kind manifested by human children in early stages of language learning. A limited vocabulary of arbitrary signs that can be freely combined in two-word utterances allows for a great deal of communication (Schaerlaekens 1973). It enables individuals to make wants clear to others and to communicate intentions and internal feeling states. Some intentions and feeling states are communicable without such rudimentary language, as is clearly shown in the behavior of chimpanzees.[10] Nevertheless, the possibilities for such communication are expanded considerably by a very limited set of verbal symbols. Wants for things that are not in view and that cannot be pointed to cannot be communicated without such symbols, for example. Two-word utterances do not require grammatical rules other than to make clear, when not contextually evident, what is topic and what is comment, as in the "pregrammatical rules" discussed by Givón (1989, 247–49).

Noteworthy in this regard is the apparent separation of function in different areas of the brain of memory for lexicon (words and their meanings) and memory for how to construct grammatically acceptable sentences (Goodglass and Kaplan 1983). Aphasia affecting the latter leaves a person able to use lexicon but having to do so "telegraphically" in the kind of pregrammatical, two-word mode just referred to. Aphasia affecting the lexical memory leaves a person able to construct grammatically well-formed sentences, but with words largely divorced from their referential meanings. This separation of function is consistent with an evolutionary priority of the kind posited here, the development of lexicon for pragmatic and referential purposes taking place before the emergence of elaborated grammatical organization (Danziger 1988).

What such a level of language development greatly facilitates, especially combined with the use of gestures, is communication of a kind relevant to social interaction within a domestic group, such as a mother and her several not-yet-mature offspring. Given the prolonged dependence of human children on mothers and the bonding with both mother and siblings that results, we can expect that language first emerged within such familial groups.[11] Its advantages must have given such groups a definite survival edge over those that lacked it. Again this inference accords well with what is being learned

about the development of language competence in children. Such competence, it is now clear, is developed in familiar social contexts, where situational and behavioral cues are plentiful as aids to learning meaning and syntax (Nelson 1978).

This view sees language as having emerged as a tool, a means to helping accomplish purposes with others in much the same way that gestures do. It accords well with recent work in the ontogeny of language acquisition, which shows that in its early stages children use language primarily instrumentally, as a tool, and only later in purely referential and propositional modes (Moore and Meltzoff 1978). Ontogenetic evidence is relevant not because "ontogeny repeats phylogeny," but because ontogeny gives indication of what kinds of things have to be in place before other things can build developmentally and, by inference, evolutionarily upon them.[12]

Paleoneurological evidence of lateralization of the brain has been used to infer that the development of language at this level, at least, may have occurred with the emergence of an early form of the genus *Homo:*

> By roughly 1.8–2.0 million years ago, there is clear evidence for a *Homo* lineage showing brain endocast patterns suggestive of a more modern and enlarged third inferior frontal convolutional complex, expanded brain size (e.g., 750 + ml), and cerebral asymmetries that are strong and seemingly identical to those known for modern *Homo sapiens* (i.e., left-occipital-right-frontal petalias). In so far as these patterns correlate with right-handedness and a left-right asymmetry of cognitive functioning regarding symbolic language behavior (left) and visual-spatial integration (right), it is possible to speculate that early *Homo* cognitive patterns were similar, albeit less advanced. (Holloway 1983, 113)

Right and left hemisphere lateralization is found in other primates and even in birds (Kuhl 1978, 229–30). This finding suggests that it is associated not so specifically with speech behavior as with performance functions on the one hand (left hemisphere) and monitoring functions on the other (right hemisphere). Performance involves putting acts together sequentially in relation to an intended goal. Speech is just such a behavior. Monitoring involves the grasping of situational gestalts and of where the self is in relation to other elements of the situation from moment to moment. Such differentiation of function would seem to have obvious adaptive advantages for arboreal creatures, whether primates or birds.

Of interest are the observations that monkeys in the wild use calls not only expressively, but denotatively to indicate the presence of different kinds of things (Seyfarth 1986). Research is now under way to see to what extent specific denotative usages are transmitted by

learning (Cheney, personal communication). If learning is significantly involved, it will mean that the capacity to use vocal calls as arbitrary signs for denotative purposes is already present in rudimentary form in monkeys. The step to achieving the first level of language development may have required only increasing articulatory facility within the vocal tract. I presume that it had occurred by the time *Homo erectus* had emerged. More significant in this regard than evidence of lateralization is the considerable enlargement of the brain in *Homo erectus* to a size intermediate between that of modern humans and that of *Australopithecus.*

It may have taken a long time, once this first threshold had been crossed, for language use to be developed to the extent of its possibilities at this level. Even with two-word utterances, simple propositions can be verbally expressed. "Baby hurt" can be offered as a descriptive statement of fact or, with altered intonation, turned into a question. One can say the words "baby hurt" at some other time in connection with recall, or in anxious or even pleasurable anticipation. But if one wishes to communicate to someone else who was not present that the baby has been hurt, something more is needed. When, where, how, and perhaps by whom become things to be indicated.

Efforts to inform others about events to which they were not a party, I am presuming therefore, were what led to the kind of elaboration that marked the second important threshold in the evolution of language, in which constructions could be made that marked subject and object (or agent and patient, as in ergative languages) and allowed for indications of such things as time, place, reality and unreality, beneficiary, and different kinds of relations among things. To do these things, a language must have organizational conventions that use some combination of lexical markers and word order—conventions of the kind that constitute grammar and syntax. The development of these conventions, I am suggesting, occurred in connection with reportorial and narrative uses of language, in which it is necessary to provide contextual information for hearers. (For a similar view see Givón 1979, 303–8.)

We cannot rule out pragmatic uses as providing impetus for the beginning of grammatical marking, however. Cross-linguistic studies of language acquisition by small children show that, regardless of grammatical differences in language, children begin to use grammatical markers to indicate the object or patient of an action in connection with verbs meaning such things as give, grab, take, and hit, which are said to have apparent salience for small children (Slobin 1985, 6). They are indeed prominent in the interactions

of small children with mothers and older siblings.

The development of grammar and syntax (whose advent I am assuming coincided roughly with the emergence of *Homo sapiens,* circa 250,000 to 300,000 years ago) provided the tools with which beliefs could be developed and elaborated into systems of belief. This development and elaboration, I presume, did not take place overnight. It takes time to realize possibilities, but all of the necessary capabilities were then in place. What remained for their realization was for them to be explored and used so that possibilities could be discovered and played with. What remained, in short, was the learning that comes from the cumulative, shared experience that language makes possible. Whatever genetic modifications may have been required for hominids to be able to cross the two thresholds I have postulated, once the capacity for developing grammar and syntax was in place, no further genetic changes were needed.

At the phonological level, as I have indicated, it is probable that languages have undergone some further modification as a result of genetic changes affecting the size and shape of the vocal tract. Aside from this, however, once the second threshold was crossed, the way languages and their uses evolved can be seen as the product of change other than genetic, however much the course of evolution was constrained by such human cognitive abilities and predilections as were already present. If there have been genetic changes affecting human cognitive capacities since the emergence of *Homo sapiens,* they have, like those involving the oral cavity, been diffused through the species generally. Natural selection has worked in these matters in much the same way panspecifically. Since any human infant from anywhere in the world readily learns whatever language is spoken where he or she happens to be reared, it is clear that differences in existing languages are a result of differences among human populations that are other than biological. Such must have been the case ever since the threshold to grammatically developed language was effectively crossed.

The use of language reflectively and for task rehearsal purposes must have come in the wake of its syntactic elaboration in relation to reportorial and narrative uses. Recent studies are providing support for the thesis of Vygotsky (1962) that "private" speech, as in reflection and task rehearsal, arises ontogenetically as a development out of "social" speech (Diaz 1986). There is a dramatic rise in the use of audible private speech between the ages of three and five and then a tapering off into whispered and "inner" speech by age seven. The earliest use of private speech is associated with activity and comes after the action with which it is associated. Later, it is used

to accompany action, and only later still to precede action, thus gradually developing the task-rehearsing uses by which people plan and guide their activity. It is in this latter context that beliefs are especially significant; and it is in this context, also, I have suggested, that language came to be applied to the elaboration of toolmaking and technology. Private speech is also inextricably involved in the reflective use of language, a use in which speech is divorced from activity. Reflective use is presumably indispensable to the elaboration of beliefs and belief systems.

The Evolutionary Development of Beliefs

The evidence is increasingly clear that monkeys and apes have understandings about relationships between things, and actions and expectations deriving from those understandings. Whether or not we are prepared to call such subjective understandings and expectations beliefs, we must accept that they are the stuff of which beliefs are made. Beliefs, in a more formal sense, come into being when these understandings are mapped into words and expressed as propositions. Thus, what is otherwise subjective is objectified. It can be communicated to others and can be an object of scrutiny and critical examination. With the calculus of language, its implications can be explored.

At what I am supposing to be the earlier stage of language evolution, the capability for such objectification in the form of propositions remained severely limited. Two-word utterances are not readily up to it. They facilitate interaction within the framework of subjective understandings that are shared on the basis of similar or shared experiences; and in the family units within which language presumably first emerged, much experience was shared. With the emergence of grammar and syntax in the later stage of language evolution came also the capability for stating propositions easily and for articulating beliefs. With these developments, moreover, came a number of other capabilities that allowed for propositions about things that were totally outside of experience. Let me review briefly some of these most pertinent capabilities.

Without language, categorizations of experience are entirely subjective. Even with language, many categories, like those of color, for example, remain so. We cannot define *red* to our children except by pointing to something we perceive as red. We similarly define what is hot and what is cold by having examples demonstrated to us. Categories of this kind are perceptual. We assign new stimuli to one or another category according to which it seems to be most like in

overall gestalt, having reference to stereotypes based on past experience, now evoked in memory in acts of recognition. Use of the words that encode perceptual categories serves also as a stimulus to recall and recognition. Thus it greatly facilitates vicarious experience and thereby increases the rehearsals of experience that seem to contribute importantly to the consolidation of long-term memory (Squire 1986, 1616). Language not only encodes and objectifies perceptual categories, but it also opens up the possibility of developing conceptual categories, such as *aunt* and *uncle* or *right* and *wrong*.

Conceptualization draws heavily on the use of analogy. With the advent of language, the ability to analogize, already present in limited form, was enormously enhanced. Once there are names for things, qualities, relationships, and actions, and once these can be put together in statements that describe arrangements and events in actual experience, it becomes possible to play with these statements by substituting other words of similar grammatical type into the same grammatical slot in a propositional frame. "George is eating carrots" can be played with by substituting the name of any other kind of object for the word *carrots* in the sentence. The absurd, the statement as fact of what is contrary to experience or what is abhorred, immediately becomes possible. We are all familiar with how children of four and five play with words in just this way. Imagination is thus given enormously increased range. We can imagine purple cows. Statements such as "George is roaring because George is angry," deriving from experience of human behavior, may well evoke the inference when it thunders that "the sky is roaring because the sky is angry." Such anthropomorphisms follow naturally out of analogy. In science most theory derives from using what we understand about one phenomenon as an analogue for helping us understand another. For example, what we understand about human intentionality from the ways humans behave leads us to attribute similar kinds of intentionality to animals when they seem to behave in similar ways. Analogy also underlies metaphor, and it plays a major role in logical inference.

Logic begins with the mapping of our experiences of things and relationships into words and with generalizations about relationships that can be rendered into propositions. There was, for example, a great debate among Europeans after the discovery of the New World as to whether its native inhabitants were fully human. The proposition that humans had been endowed with immortal souls by God logically implied that if Native Americans were human, they, too, had immortal souls; and the proposition that it was the duty of the Church to save all human souls through proselytizing implied that

the Church had a duty to proselytize Native Americans. Such reasoning is not peculiar to the European cultural tradition. My own experience and that of others who have lived and worked intimately with what used inappropriately to be called "primitive" people, learning to speak their language and to communicate with them in their terms, is that these people draw analogies and make deductive inferences in ways thoroughly familiar to us. For this to become apparent, however, one needs to know the limits of experience within which others are operating and the premises from which they are reasoning.

My favorite example illustrating the point comes from a comment before World War I by a Micronesian navigator in defense of his belief that the sun goes around the earth:

> I am well aware of the foreigner's claim that the earth moves and the sun stands still, as someone once told us; but this we cannot believe, for how else could it happen that in the morning and evening the sun burns less hot than in the day? It must be because the sun has been cooled when it emerges from the water and when toward setting it again approaches the water. And furthermore, how can it be possible that the sun remains still when we are yet able to observe that in the course of the year it changes its position in relation to the stars? (Girschner 1912, 173, my translation)

With the ability to imagine things comes the ability to think about the future, to consider alternative possibilities. The development of expressions or grammatical markers for "what if?" "suppose," "maybe," "make believe that," and the like, follows inevitably. We are now fully into the linguistic tools from which human belief systems—and also our scientific theories—have been and continue to be made.

COMMITMENT

Beliefs, we have noted, involve more than simply the statement of propositions. Minimally, belief involves a commitment to accepting a proposition as a basis for decision and action. A decision has to be made as to the proposition's fit with reality, as reality is understood. Beyond this, moreover, a decision has to be made as to whether to take seriously the individual stating the proposition. One might do so if it comes from one person but not if it comes from another. In this regard, it is noteworthy that vervet monkeys will take cover in response to a call indicating the presence of a predator if it comes from an adult, but may have a look first and not take cover if the same call is made by a juvenile that is still learning the system of calls. In short, the monkeys appear to be making credibility judgments (Nishida 1986, 473).

Over and above pragmatic commitment is emotional commitment. "True believers" are people who have an emotional commitment to a proposition's absolute "truth." There are many reasons for such emotional commitment; they need not concern us here.[13] The question we must consider is whether or not the capacity for such emotional commitment is peculiarly human or is, like so many other things we have considered, also present in monkeys and apes and presumably, therefore, prehuman in evolutionary time.

Emotional attachments to one's fellows are clearly manifested in the behavior of chimpanzees. Emotional attachments—indeed fixations—to objects by monkeys have been evoked experimentally, as in the well-known experiments with "terry-cloth mothers" (Harlow and Zimmerman 1959; Harlow 1971). Emotional fixations are also found in chimpanzees in the wild as exemplified by one young male's apparently obsessive attachment to his mother and his pining away and dying shortly after his mother's death (Goodall 1986, 66).

Among monkeys and apes there are no propositions to be emotionally attached to. But the capacity for emotional attachment to things within their cognizance similar to that displayed by humans seems clearly to be present. With language, propositions become things within human cognizance and thus objects available for such attachment.

CONCLUSION

I conclude, then, with the observation that there is increasing evidence that most of the capabilities necessary for human belief systems were already in place in primate evolution before the emergence of the hominid line.[14] The major new capabilities peculiar to hominids were those that made possible the emergence of language. With the advent of language, new selective pressures may well have been exerted on the other, evolutionarily older capabilities, leading to their enhancement. Such development, along with enhancement of linguistic capability, presumably accompanied further specialization of function in the brain and an increase in complexity and number of neural pathways associated with increase in brain size in the genus *Homo* over the past 2 million years.

What has been involved in the evolution of language and the human capacity for beliefs has, necessarily, been equally involved in the human capacity for culture generally, of which beliefs are an integral part.

Our focus on belief provides evidence for the widely held view that

what sets humans apart cognitively from their primate relatives is what is involved in the use of language. An older generation of anthropologists saw the use of tools as the significant difference. In the view taken here, the use and manufacture of simple tools occurred prior to and independently of the emergence of language. Language began as a kind of tool for implementing intentionality in social interaction. Its expanded use increased the content of memory storage, and its elaboration made possible the formulation in words of propositions. This, in turn, made it possible to plan for contingencies in the future, to imagine things, to develop beliefs and systems of beliefs. An eventual by-product of these developments was the greatly elaborated tool kit and the materially attested symbolic behavior we associate with the Upper Paleolithic era. Thus language, in its grammatically elaborated form, became the prime tool on which most else that we think of as peculiarly human depends.

NOTES

Acknowledgments. This article is an expanded version of a paper presented at the annual meeting of the American Association for the Advancement of Science in 1986 in a symposium entitled "Genes and Culture," sponsored by the Institute on Religion in an Age of Science. For helpful discussion of issues and comments on earlier drafts, I am indebted to Dorothy Cheney, Eve Danziger, Harold Dibble, Simon Holdaway, Alan Mann, Robert Seyfarth, Michael Speirs, and colleagues in the PARSS Seminar on Human Nature, University of Pennsylvania.

1. For an extensive review of the study of belief systems by anthropologists, both theoretically and methodologically, see Black (1973).

2. See, for example, the important examinations of categories by Lakoff (1987) and Givón (1989).

3. Registering and organizing experience by small children takes place in terms of gestalts (Gelman 1983). Categorization of phenomena by single traits and the organization of phenomena into hierarchies based on such traits come in older children, apparently in conjunction with language use in the process of learning.

4. Cheney, Seyfarth, and Smuts (1986, 1364) conclude that if this observation is confirmed, "it would indicate that primates, in the recognition of social alliances, solve problems that are functionally equivalent to laboratory tests of analogical reasoning."

5. See the discussion of "decentration" in human children by Hy Van Luong (1986).

6. A similar conclusion, that many of the cognitive capabilities that characterize humans were already present before the hominid line emerged, is drawn by Hill (1972).

7. For a persuasive argument that Amerindians had entered the New World well before the end of the last glacial period and while still equipped with a Lower Paleolithic stone technology, see Gruhn (1988).

8. Laitman (1983) has indicated that the degree of basicranial flexion permits inference regarding the position of upper respiratory structures as they relate to speech functions. He infers that these structures were similar to those of modern humans in archaic *Homo sapiens* and were well on the way toward the modern condition in *Homo erectus*. Argument that the larynx had not yet descended in adults of *Homo erectus* and Neanderthal types as far as it has in modern humans, and that, therefore, these earlier hominids could not have had speech, fails when we consider that modern children are already speaking when the larynx is still in an intermediate position.

9. If 20 percent of the women in any generation who reach childbearing age have no

daughters who reach childbearing age, then only 11 percent of the women in a given generation will have descendants who carry their mtDNA ten generations later, and a fraction over 1 percent of these women will have such descendants twenty generations later. This reduction toward the asymptote, given the mode of inheritance of mtDNA, must exacerbate the effect of genetic drift in small populations. Moreover, it inevitably works in favor of reducing within-population variance in mtDNA over time in the absence of population mixing, while at the same time making for wide within-population variance when there is population mixing. (See Spuhler 1988.)

10. See, for example, the interaction that occurred when a young chimpanzee insisted on being carried by his mother in spite of his mother's efforts to terminate her carrying him, recorded by Goodall (1986, 66).

11. Holloway (1983, 113) concludes similarly that sexual dimorphism in the structure of the brain, as it evolved in the genus *Homo,* suggests that "natural selection favored an increased degree of cognitive task specialization relative to both social nurturance and parental investment of relatively immature offspring" in females, while it favored "relatively more skill in visuospatial integrative tasks" for males, and that, in consequence, females retain "a socially-sophisticated edge over males in communicative skills and social structural knowledge."

12. Givón (1979; 1989, 261) has proposed that the process of children's acquisition of grammar follows the same developmental path as the process by which grammar has evolved in human language.

13. For a review of such reasons, see Goodenough (1963, 157–71). See also Black (1973).

14. Bickerton (1981, 221) also has argued that such human mental attributes as consciousness and volition are present in animals as well as humans, and that theory regarding the origin and evolution of language must take account of this.

REFERENCES

Bickerton, Derek. 1981. *Roots of Language.* Ann Arbor: Karoma Publishers.

Black, Mary. 1973. "Belief Systems." In *Handbook of Social and Cultural Anthropology,* ed. John J. Honigmann. Chicago: Rand McNally.

Bower, T.R.G. 1974. *Development in Infancy.* San Francisco: W.H. Freeman.

Bower, T.R.G., J.M. Broughton, and M.K. Moore. 1970. "Demonstration of Intention in the Reaching Behaviour of Neonate Infants." *Nature* 228:679–80.

Cann, Rebecca L., Mark Stoneking, and Allan C. Wilson. 1987. "Mitochondrial DNA and Human Evolution." *Nature* 325:31–36.

Chase, Philip G., and Harold L. Dibble. 1987. "Middle Paleolithic Symbolism: A Review of Current Evidence and Interpretations." *Journal of Anthropological Archaeology* 6:263–96.

Cheney, Dorothy, Robert Seyfarth, and Barbara Smuts. 1986. "Social Relationships and Social Cognition in Nonhuman Primates." *Science* 234:1361–66.

Chiang, Kwang-chih. 1986. *The Archaeology of Ancient China.* 4th ed. New Haven: Yale Univ. Press.

Crystal, David. 1978. "The Analysis of Intonation in Young Children." In *Communicative and Cognitive Abilities—Early Behavioral Assessment,* ed. Fred D. Minifie and Lyle L. Lloyd. Baltimore: University Park Press.

Danziger, Eve. 1988. "Language and the Brain: Questions of Interest to Anthropology." Unpublished manuscript in author's possession.

Davidson, Iain, and William Noble. 1989. "The Archaeology of Perception: Traces of Depiction and Language." *Current Anthropology* 30:125–55.

de Villers, Jill G., and Peter A. de Villers. 1978. "Semantics and Syntax in the First Two Years: The Output of Form and the Form and Function of Input." In *Communicative and Cognitive Abilities. See* Crystal 1978.

Diaz, Rafael M. 1986. "The Union of Thought and Language in Childrens' Private Speech." *The Quarterly Newsletter of the Laboratory of Human Cognition* 8:90–97.

Dibble, Harold L. 1987. "The Interpretation of Middle Paleolithic Scraper Morphology." *American Antiquity* 52:109-17.

———. 1988. "Typological Aspects of Reduction and Intensity of Utilization of Lithic Resources in the French Mousterian." In *Upper Pleistocene Prehistory of Western Eurasia,* ed. Harold L. Dibble and Anta Montet-White. University Museum Symposium Series, vol. 1. Philadelphia: The University Museum, Univ. of Pennsylvania.

———. 1989. "The Implications of Stone Tool Types for the Presence of Language during the Middle Pleistocene." In *The Human Revolution,* ed. Paul Mellars and Chris Stringer. Princeton, N.J.: Princeton Univ. Press.

Essock-Vitale, Susan, and Robert M. Seyfarth. 1986. "Intelligence and Social Cognition." In *Primate Societies,* ed. Barbara B. Smuts et al. Chicago: Univ. of Chicago Press.

Fantz, Robert L. 1961. "The Origin of Form Perception." *Scientific American* 204(5): 66-72.

Foley, Robert. 1987. "Hominid Species and Stone-tool Assemblages: How They Are Related." *Antiquity* 61:380-92.

Gelman, Rochel. 1983. "Recent Trends in Cognitive Development." In *The G. Stanley Hall Lecture Series* Vol. 3, ed. C. J. Schierer and A. M. Rogers. Washington, D.C.: American Psychological Association.

Girschner, Max. 1912. "Die Karolineninsel Namoluk und ihre Bewohner." *Baessler-Archiv* 2:123-215.

Givón, T. 1979. *On Understanding Grammar.* New York: Academic Press.

———. 1989. *Mind, Code, and Context.* Hillsdale, N.J.: Lawrence Erlbaum Associates.

Goodall, Jane. 1986. *The Chimpanzees of Gombe.* Cambridge, Mass.: Harvard Univ. Press, Belknap Press.

Goodenough, Ward H. 1963. *Cooperation in Change.* New York: Russell Sage Foundation.

Goodglass, H., and E. Kaplan. 1983. *The Assessment of Aphasia and Related Disorders.* Philadelphia: Lea and Febiger.

Gruhn, Ruth. 1988. "Linguistic Evidence in Support of the Coastal Route of Earliest Entry into the New World." *Man* 23:77-100.

Harlow, H. F. 1971. *Learning to Love.* New York: Ballantine Books.

Harlow, H. F., and R. R. Zimmerman. 1959. "Affectional Responses in the Infant Monkey." *Science* 130:421-32.

Hill, Jane H. 1972. "On the Evolutionary Foundation of Language." *American Anthropologist* 74:308-17.

Hockett, Charles F. 1985. "Distinguished Lecture: F." *American Anthropologist* 87:263-81.

Holloway, R. L. 1983. "Human Paleontological Evidence Relevant to Language Behavior." *Human Neurobiology* 2:105-14.

Jardine, David W., and Griffith A. V. Morgan. 1987. "Analogical Thinking in Young Children and the Use of Logico-Mathematical Knowledge as a Paradigm in Jean Piaget's Genetic Epistemology." *The Quarterly Newsletter of the Laboratory of Comparative Human Cognition* 9:95-101.

Kuhl, Patricia. 1978. "Predispositions for the Perception of Speech-Sound Categories: A Species-Specific Phenomenon?" In *Communicative and Cognitive Abilities. See* Crystal 1978.

Laitman, Jeffrey T. 1983. "The Evolution of the Hominid Upper Respiratory System and Implications for the Origins of Speech." In *Glossogenetics: The Origin and Evolution of Language,* ed. Eric de Grolier. Models of Scientific Thought, vol. 1. Paris: Harwood Academic Publishers.

Lakoff, George. 1987. *Women, Fire, and Dangerous Things: What Categories Reveal about the Mind.* Chicago: Univ. of Chicago Press.

Lieberman, Philip, Edmund S. Crelin, and Dennis H. Klatt. 1972. "Phonetic Ability and Related Anatomy of the Newborn and Adult Human, Neanderthal Man, and the Chimpanzee." *American Anthropologist* 74:287-307.

Luong, Hy Van. 1986. "Language, Cognition, and Ontogenetic Development: A Reexamination of Piaget's Premises." *Ethos* 14:7-46.

Mahler, Henry R. 1973. *Mitochondria: Molecular Biology, Genetics, and Development.* Addison-Wesley Module in Biology, no. 1. Reading, Mass.: Addison-Wesley.

Mellars, Paul. 1989. "Major Issues in the Emergence of Modern Humans." *Current Anthropology* 30:349-85.

Moore, M. Keith, and Andrew M. Meltzoff. 1978. "Object Permanence, Imitation, and Language Development in Infancy." In *Communicative and Cognitive Abilities. See* Crystal 1978.

Nelson, Katherine. 1978. "Early Speech in Its Communicative Context." In *Communicative and Cognitive Abilities. See* Crystal 1978.

Nishida, Toshisada. 1986. "Local Traditions and Cultural Transmission." In *Primate Societies. See* Essock-Vitale 1986.

Oates, John F. 1986. "Food Distribution and Foraging Behavior." In *Primate Societies. See* Essock-Vitale 1986.

Premack, Ann J. 1976. *Why Chimps Can Read.* New York: Harper and Row.

Sackett, James B. 1988. "The Mousterian and its Aftermath: A View from the Upper Paleolithic." In *Upper Pleistocene Prehistory of Western Eurasia. See* Dibble 1988.

Schaerlaekens, A. M. 1973. *The Two-Word Sentence in Child Language Development.* The Hague: Mouton.

Seyfarth, Robert M. 1986. "Vocal Communication and Its Relation to Language." In *Primate Societies. See* Essock-Vitale 1986.

Slobin, Dan I. 1985. "Introduction: Why Study Acquisition Crosslinguistically?" In *The Crosslinguistic Study of Language Acquisition*, vol. 1, ed. by Dan I. Slobin. Hillsdale, N.J.: Lawrence Erlbaum Associates.

Spuhler, J. N. 1988. "Evolution of Mitchondrial DNA in Monkeys, Apes, and Humans." *Yearbook of Physical Anthropology.* Yearbook Series 31:15-48.

Squire, Larry R. 1986. "Mechanisms of Memory." *Science* 232:1612-19.

Stebbins, W. C. 1970. "Studies of Hearing and Hearing Loss in the Monkey." In *Animal Psychophysics: The Design and Conduct of Sensory Experiments,* ed. W. C. Stebbins. New York: Plenum Press.

———. 1973. "Hearing of Old World Monkeys." *American Journal of Physical Anthropology* 38:357-64.

Stringer, Chris. 1988. "The Dates of Eden." *Nature* 331:565-66.

Stringer, C. B., and P. Andrews. 1988. "Genetic and Fossil Evidence for the Origin of Modern Humans." *Science* 239:1263-68.

Susman, Randall L. 1988. "Hand of *Paranthropus robustus* from Member 1, Swartkrans: Fossil Evidence for Tool Behavior." *Science* 240:781-84.

Valladas, H., et al. 1988. "Thermoluminescence Dating of Mousterian 'Proto-Cro-Magnon' Remains from Israel and the Origin of Modern Man." *Nature* 331:614-16.

Vygotsky, L. S. 1962. *Thought and Language.* Boston: MIT Press.

Wolpoff, Milford H. 1989. "Multiregional Evolution: The Fossil Alternative to Eden." In *The Human Revolution. See* Dibble 1989.