

Nobuo Masataka (Ed.)

The Origins of Language

Unraveling Evolutionary Forces

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Springer

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Cover: "Man Meets Monkey" drawn by Motoko Masataka

ISBN 978-4-431-79101-0 Springer Tokyo Berlin Heidelberg New York
e-ISBN 978-4-431-79102-7

Library of Congress Control Number: 2008928680

Printed on acid-free paper

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Printed in Japan

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Springer is a part of Springer Science+Business Media
springer.com

Typesetting: SNP Best-set Typesetter Ltd., Hong Kong
Printing and binding: Hicom, Japan

Preface

Debate on the origins of language has a long—and primarily speculative—history. Perhaps its most significant milestone occurred in 1866, when the Société de Linguistique de Paris banned further papers on the subject, because fossil records could provide no evidence concerning linguistic competence. This view has persisted until recently, with investigators who deal with language empirically remaining largely on the sidelines.

Contemporary developments in cognitive science, however, indicate that human and nonhuman primates share a range of behavioral and physiological characteristics (e.g., perceptual and computational) that speak to this issue of language origins. Rather than indicating a discontinuity between humans and other animals, studies concerning communicative, neurological, and social aspects of language behavior suggest that the view of language as determined by biologically innate abilities in conjunction with exposure to language in an environment is amenable to both ontogenetic and phylogenetic levels of analysis. This cross-disciplinary book has been edited to review and integrate the latest research in this area. Various chapters examine which aspects of language (and its foundations) were directly inherited from the common ancestor of humans and nonhuman primates, which aspects have undergone minor change, and which are qualitatively new in *Homo sapiens sapiens*.

The volume has three major themes, woven throughout the chapters. First, it is argued that psychologists and scientists studying animal behaviors, along with researchers in relevant branches of anthropology, need to move beyond unproductive theoretical debate to a more collaborative, empirically focused, and comparative approach to language. Second, accepting this challenge, the contributors describe empirical and comparative methods that reveal some underpinnings of language that are shared by humans and other primates and others that are unique to humans. New insights into the origins of language are discussed, and several hypotheses emerge concerning the evolutionary forces that led to the “design” of language. Third, the volume considers evolutionary challenges (selection pressures) that led to adaptive changes in communication over time with an eye toward understanding the various constraints that channeled this process. Admittedly, this seems a major undertaking (and may even seem

preposterous to some), but the investigators involved in this project have the expertise and the data to accomplish it.

Finally, we acknowledge that the writing and publishing of this book was supported by the MEXT grant for the Global COE (Center of Excellence) Research Programme (A06 to Kyoto University).

Nobuo Masataka, Editor

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1 The Gestural Theory of and the Vocal Theory of Language Origins Are Not Incompatible with One Another

NOBUO MASATAKA

1 Introduction

This book as a whole outlines an approach to the origins of language as the evolution of expressive and communicative behavior of primates, especially until the emergence of single word utterances in *Homo sapiens sapiens* as it is observed currently. It argues that expressive and communicative actions evolved as a complex and cooperative system with other elements of the human's physiology, behavior and social environment.

Even humans, as children, do not produce linguistically meaningful sounds or signs until they are approximately one year old. The ability to produce them begins to develop in early infancy, and important developments in the production of language occur throughout the first year of life. There are a number of earliest major milestones in early interactional development, before the onset of true language, and the accomplishment of most of them requires the children's learning of motor and/or cognitive skills which were inherited by the human species from its evolutionary ancestors. No doubt these skills include both gestural ones and vocal ones. Thus, formulating the question of language origins as either gestural or vocal dichotomously appears irrelevant. Nonetheless scientists concerned with this issue have been preoccupied with determining which of these two hypotheses should be accepted and which should be rejected.

2 Brief History of the Debate about Language Origins

The notion that some animal sounds conveyed semantic information as the human languages did and that iconic visible gestures have something to do with the origin of language is a frequent element in speculation about this phenomenon and appeared early in its history. For example, Socrates hypothesized about the origins of Greek words in Plato's satirical dialogue *Cratylus*. Socrates's specu-

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lation includes a possible role for sound-based iconicity as well as for the kinds of visual gestures employed by the deaf. Plato's use of satire to broach this topic also points to the fine line between the sublime and the ridiculous that has continued to be a hallmark of this sort of speculation (see below).

Such speculation was provided with a somewhat scientific atmosphere when it became joined with the idea that the human species might have a long evolutionary history soon after the publication of Darwin's *Origin of Species* in 1859. Thereafter there was such an active, one might even use the term rampant, period of speculation that apparently developed into such an annoyance to the Linguistic Society of Paris that it banned the presentation of papers on the subject of the origin of language in 1866. The London Philological Society followed suit in 1872. Thus began a century during which speculation on the origin of language in general fell increasingly into disrepute among serious scholars. However, the historical fact should be noted that just a year before this ban in 1872, Darwin himself published a book called *The Descent of Man*, in which he devoted some pages to discussing this issue. As detailed in another chapter of mine in this book, he argued that the vocal origin hypothesis is more plausible than the gestural origin hypothesis.

The fact that this book of Darwin became controversial acted as a serious blow to the idea of a gestural origin for language. In 1880, partly as a consequence, at a congress in Milan, the education of the deaf adopted a recommendation that the instruction of deaf students in sign language be discontinued in favor of oral-only instruction. This was not only a watershed event in the education of deaf children, to be followed by a century in which sign languages were suppressed in schools in Europe and the Americas, but it also signaled a general devaluation of and decline in the intellectual status of the history of languages in general and an end to serious scholarly study of the characteristics of language origins.

Historically, we had to wait for the reawakening of serious scientific and scholarly study of the origin of language until the 1970s, when two seminal conferences were held: a symposium at the 1972 meeting of the American Anthropological Association and a subsequent conference hosted by the New York Academy of Sciences in 1975. Apparently, the impetus for this reawakening seems to have been the increasing evidence that could be brought to bear on the subject from paleoanthropology, primatology, neurology, and neurolinguistics (see Christiansen and Kirby 2003 for review).

What is perhaps most evident is that early speculation about language origins following Darwin was severely constrained by a lack of fossil evidence regarding human evolution. At the time of the Paris Society's ban, paleoanthropological knowledge was limited essentially to one skullcap, from the Neander valley (Neanderthal) of Germany, and a few other European fragments, of an extinct relatively recent hominid now thought probably not to have been an ancestor of modern humans. The first finds of the more ancient *Homo erectus* did not come until the 1890s in Java, and those of the still more ancient australopithecines of southern Africa not until the 1920s. Making matters of interpretation more difficult during the first half of the 20th century was the existence of the infamous Piltdown forgery, which presented a picture almost diametrically opposed to that

which could be inferred from the erectus and australopithecine material. The forgery was not completely exposed until 1953. Discoveries of fossil humans in Africa, Europe, Asia, and Indonesia have come with increasing frequency in the post World War II era, so that now a fairly coherent story of the course of human anatomical evolution can be pieced together.

During the same post-war period, especially beginning in the 1960s, primatologists from the English-speaking world and Japan were compiling a detailed body of information about the behavior, in the wild and in captivity, of various nonhuman primates, including apes: gorillas, chimpanzees, and gibbons, undoubtedly the closest living relatives of modern *Homo sapiens*, separated from us by what is now known to be a very modest genetic divide. Current attempts to make inferences about the possible language-like behavior of early hominids depend upon a sort of triangulation from the fossil evidence for anatomical characteristics of the various fossil hominids (especially what these might imply about behavior) and what is known about the anatomy and behavior of living nonhuman primates contrasted with the same characteristics of modern humans. Whatever can be inferred through this process of triangulation can be said to be legitimate empirical evidence bearing on the origin and evolution of the human capacity for language prior to the invention of writing, about 5000 years ago. Finally, beginning in the mid-1950s, there was a growing movement to recognize the signed languages of deaf people as bona fide human languages, something that had been generally denied since the late 19th century. Taking together such trends of research in addition to other significant early work on sign language linguistics that began in the early 1970s, Hewes in 1973 proposed that language may have originated in manual gestures rather than in animal calls.

3 Evidence for the Gestural Theory of Language Origins

Since Hewes (1973), scientists supporting this proposal have reported evidence for the notion. Its latest argument is summarized in Corballis' review in the next chapter of this book, in which an evolutionary scenario is documented. What is particularly noteworthy in his argument is, in my view, to understand human speech itself as composed of gestures rather than as elements of discrete sounds. Corballis provides this discussion with recent evidence from articulatory phonology and reaches the conclusion that speech may be part of the mirror system, in which the perception of actions is mapped onto the production of those actions.

This notion is extremely intriguing to me personally as a researcher who has investigated the language learning of preverbal infants. For, even at the very onset of articulated sounds (commonly termed as babbling), any infants, deaf or hearing, are unable to learn to produce them just by hearing alone. Since these units present in babbling are utilized later in natural spoken language, production of babbling of this sort, such as "bababa", "dadada", termed canonical babbling, became taken in 1990s as what marked the entrance of an infant into a developmental stage in which the syllabic foundations of meaningful speech are estab-

lished. Indeed there is agreement that the onset of canonical babbling is an important developmental precursor to spoken language and that some predictive relations exist between characteristics of the babbling and later speech and language development (see Masataka 2003, for a review).

The empirical evidence has consistently shown that onset of canonical babbling occurs in the latter half of the first year in typically-developing infants. Consequently this onset was previously speculated to be a deeply biological phenomenon, geared predominantly by maturation and virtually invulnerable to the effects of auditory experience or other environmental factors (Lenneberg 1967). Such findings reported recently apparently disagree with this argument. A longitudinal investigation revealed that, on the basis of the recording of babbling and other motor milestones in full-term and preterm infants of middle and low socioeconomic status, neither preterm infants whose ages were corrected for gestational age nor infants of low socioeconomic status were delayed in the onset of canonical babbling. That study also showed that hand banging was the only important indicator of a certain kind of readiness to reproduce reduplicated consonant-vowel syllables, and that other motor milestones showed neither delay nor acceleration of onset in the same infants.

Moreover, the onset of repetitive motor action involving the hands is chronologically related to the onset of canonical babbling. We pursued this issue further by conducting meticulous sound spectrographic analyses on all the multisyllabic utterances that were recorded from four infants of Japanese-speaking parents in our longitudinal study. The results of the analyses revealed that the average syllable length of the utterances that did not co-occur with hand banging was significantly longer than that of the utterances that did co-occur with the motor action during the same period. Similarly, the averaged format transition duration of the utterances that did not co-occur with hand banging was significantly longer than that of the utterances that did co-occur with this motor action. These results indicate that some acoustic modifications in multisyllabic utterances take place only when they are co-occurring with rhythmic manual activity. The modifications appear to facilitate infants' acquisition of the ability to produce canonical babbling, because the parameters that were modified when they co-occurred with motor activity concern those that essentially distinguish canonical babbling from earlier speech-like vocalizations. For instance, a vocalization that can be transcribed as /ta/ would be deemed canonical if articulated with a rapid transition duration in a relatively short syllable, but would remain "noncanonical" if articulated slowly. In the latter case, syllables are termed as just "marginal" babbling.

4 Role of Motherese in the Intermediate Stage of Language Evolution

Unless successful with learning to produce canonical babbling, infants are unable to proceed to the following stages of language learning, and failure to produce canonical babbling should eventually result in a considerable delay in reaching

those linguistic milestones that are essential for performing various kinds of cognitive learning in general. Such findings apparently constitute evidence for the gestural theory of language origins such as Corballis' hypothesis. Such theories commonly assume that there was a stage in the evolution of language when signs were simply iconic and pantomimic illustrations of the things they referred to. Then, one could imagine a stage during which incidental sounds, especially those that were also iconic or onomatopoeic themselves, came to be associated in a gestural complex with the visible sign and the objects in the world that was being referred to.

Subsequent to this stage, the visible sign could wither away or come to be used as a visual adjunct to the now predominant spoken word. Kita's chapter in this book is an attempt to reconstruct this hypothesized intermediate stage as empirically as possible, focusing his research upon the case of Japanese mimetics. Mazuka and her colleagues are also interested in Japanese mimetics. Cross-linguistically, Japanese language has a relatively rich vocabulary. Moreover, many of such vocabulary items are specifically observed in child-directed speech. Such usage is reported to actually serve as a basis on which young children are helped to learn the language effectively, in terms of its phonology, and is therefore taken to be a sort of "motherese". Their findings, in turn, indicate the existence of the children's perceptual basis for these characteristics of caregiver's speech.

According to the anthropological view (Falk 2004), on the other hand, the evolution of motherese is closely related to the high degree of helplessness in human infants, which is a result of structural constraints that were imposed on the morphology of the birth canal by selection for bipedalism in conjunction with an evolutionary trend for increased brain (and fetal head) size. Thus, unlike the human mother, the chimpanzee mother is able to go about her business with her tiny infant autonomously attached to her abdomen, and with her forelimbs free to forage for food or grasp branches. According to the "putting the baby down" hypothesis, before the invention of baby slings, early bipedal mothers must have spent a good deal of time carrying their helpless infants in their arms and would have routinely freed their hands to forage for food by putting their babies down nearby where they could be kept under close surveillance. Unlike chimpanzee infants, human babies cry excessively as an honest signal of the need for reestablishing physical contact with caregivers, and it is suggested that such crying evolved to compensate for the loss of infant-riding during the evolution of bipedalism. Similarly, unlike chimpanzees, human mothers universally engage in motherese that functions to soothe, calm, and reassure infants, and this, too, probably began evolving when infant-riding was lost and babies were periodically put down so that their mothers could forage nearby. Thus, for both mothers and babies, special vocalizations are hypothesized to have evolved in the wake of selection for bipedalism to compensate for the loss of direct physical contact that was previously achieved by grasping extremities.

In contrast to the relatively silent mother/infant interactions that characterize living chimpanzees (and presumably their ancestors), as human infants develop, motherese provides (among other functions) a scaffold for their eventual acquisi-

tion of language. Infant-directed speech varies cross-culturally in subtle ways that are tailored to the specific difficulties inherent in learning particular languages. As a general rule, infants' perception of the prosodic cues of motherese in association with linguistic categories is important for their acquisition of knowledge about phonology, the boundaries between words or phrases in their native languages, and, eventually, syntax. Prosodic cues also prime infants' eventual acquisition of semantics and morphology. The vocalizations with their special signaling properties that first emerged in early hominid mother/infant pairs continued to evolve and eventually formed the prelinguistic substrates from which protolanguage emerged. Therefore, even if language originated as a primarily manual system, its evolution must have occurred, at its very beginning, with the involvement of the auditory system. And once the auditory system was modified, it might have almost inevitably been associated with the modification of the vocal system, by which more effective acoustic transmission of information became possible.

Koda actually presents evidence confirming that possibility in his chapter in this book, reporting the results of detailed acoustic analyses on vocal exchanges of contact calls in free-ranging Japanese macaques. During group progression and foraging, they frequently utter so-called coos to maintain cohesiveness among group members. Usually one animal emits a coo, which is responded to antiphonally by someone. Moreover, unless the spontaneously given coo (designated "the first coo") is replied to, the animal is likely to produce another coo ("the second coo") within a brief interval. Koda made comparative acoustic measurements of such the first and the second coos, and found that when repeated, the second coo became higher in its fundamental-frequency (F0) element and more exaggerated in its frequency modulation, and concluded that these observed modifications should be the rudimentary form of the motherese phenomenon.

5 Implications of Music for Language Evolution

Taken together with the findings described in Yamaguichi and Izumi's, Ghanzafar and Lewkowicz's and Nishimura's chapters, recent studies of macaque coo communication reveal that their vocal behavior is much more flexible than had been assumed previously, and appears somewhat music-like. Moreover, once these characteristics of macaque vocal behavior are recognized as such, it becomes noticeable that the characteristics of interaction between preverbal human infants and their caregivers are also music-like to an almost identical degree. Indeed, we have to wait until the age of 8 months in order to hear truly speech-like vocalizations in infants, and before that time, the manner in which they vocalize closely parallels that in which macaques do, which is summarized in another chapter of my own.

The general consensus about the early interactional development of human infants is that its earliest major milestone is the skill of conversational turn-taking. The ability to participate co-operatively in shared discourse is fundamental to social development in general. When a group of three- to four-month-old

infants experienced either contingent conversational turn-taking or random responsiveness in interaction with their Japanese-speaking mothers, contingency was found to alter the temporal parameters of the infant's vocal pattern. Infants tended to produce more bursts or packets of vocalizations when the mother talked to the infant in a random way. When the infants were aged three months, such bursts of vocalization occurred most often at intervals of 0.5–1.5 s, whereas when they were aged 4 months they took place most frequently at significantly longer intervals, of 1.0–2.0 s. This difference corresponded to the difference between intervals with which the mother responded contingently to vocalizations of the infant at the age of three months and four months, respectively. While the intervals (between the onset of the infant's vocalization and the onset of the mother's vocalization) rarely exceeded 0.5 s when the infant was aged three months, they were mostly distributed between 0.5 s and 1.0 s when aged 4 months. After vocalizing spontaneously, the infant tended to pause as if to listen for a possible vocal response from the mother. In the absence of a response, he vocalized repeatedly. The intervals between the two consecutive vocalizations were changed flexibly by the infant according to his recent experience of turn-taking with the mother. Thus, proto-conversational abilities of infants at these ages may already be intentional.

A subsequent series of experiments of mine also demonstrated the fact that, when the adult maintains a give-and-take pattern of vocal interaction, the rate of nonspeech sounds decreases, and instead of such sounds infants produce a greater proportion of speech-like vocalizations. Since the infants are always responded to verbally by the adults, taking turns may facilitate in the infant an attempt to mimic speech-like characteristics of the adult's verbal response. Alternatively, the affective nature of turn-taking could increase positive arousal in the infant, thereby instigating, by contagion, the production of pitch contours contained in the adult's response. On the other hand, it has been shown that if infants receive turn-taking from adults nonverbally, that is, by receiving a nonverbal "tsk, tsk, tsk" sound, this does not affect the speech-like sound/nonspeech sound ratio of the infants.

The timing and quality of adult vocal responses affects the social vocalizations of three-to four-month-old infants. Moreover, once the infant becomes to be framed as a conversational partner, matching starts developing with respect to suprasegmental features of the infant's vocalizations. That is, pitch contours of maternal utterances are likely to be mimicked by the infants. In order to facilitate the infants matching, the caregivers make specific efforts when contingent on with the infants' spontaneous utterances of cooing. When they hear cooing, Japanese-speaking caregivers are more likely to respond nonverbally; they themselves produce cooings in response to the infants' cooing. Moreover, cooing produced by the caregivers is matched with respect to pitch contour with the preceding coo of the infant. Even when the caregivers respond verbally, the pitch pattern of the utterances often imitates that of the preceding infants' cooing (Masataka 2003). Such mimicry is performed by the caregivers without their awareness. Usually they are not conscious of engaging in mimicry. When between

three- and four-months old, infants seem not to be aware of the fact that their own vocal production and the following maternal utterance share common acoustic features. However, around the end of the fourth month of life, they acquire the ability to discriminate similarities and differences of pitch contour between their own vocal utterance and the following maternal response. Thereafter, the infants rapidly come to attempt the vocal matching by themselves in response to the preceding utterances of caregivers.

To analyze the developmental processes underlying vocal behavior in infants, a discriminant functional analysis was employed, which statistically distinguishes the infants' cooing following five different types of pitch contours of maternal speech. With this procedure, structural variability in infant vocalizations across variants of maternal speech is found to be characterized by a set of quantifiable physical parameters. The parameters are those that actually distinguish the five different types of maternal speech. Attempts at cross-validation, in which the discriminant profiles derived from one sample of vocalizations are used to classify a second set of vocalizations are totally successful, indicating that the results obtained are not an artifact of using the same data set to derive the profiles and then to test reclassification accuracy. More importantly, the proportion of cross-validated vocalizations that are misclassified decreases as the infant's age increases. Thus, this discriminant analysis is an effective tool to demonstrate that a statistically significant relation develops between the acoustic features of maternal speech and those of the following infant vocalizations as infants grow.

A falling pitch contour is the result of a decrease of subglottal air pressure towards the end of an infant vocalization, with a concomitant reduction in vocal fold tension and length. However, for a rising pitch contour to occur, an increase at the end of the vocalization in subglottal air pressure or vocal fold tension is needed, and thus different, purposeful laryngeal articulations are required. Between the age of four and six months, speech-motor control develops dramatically in infants, associated with changes of the tongue, mouth, jaw and respiratory patterns, to produce vocalizations with distinctively different types of pitch contour. These vocalizations are initially the result of the infants' accidental opening and closing of the mouth while phonating. Six-month-old infants are found to be able to display an obvious contrastive use of different type of pitch contour. The importance of motor learning for early vocal development is greater than has traditionally been assumed (Masataka 1992).

Finally, the problem of which partner is influencing the other is determined experimentally when the controlled prosodic feature of caregiver's vocal behavior is presented to infants. The results show six-month-old infants are able to alter the quality of their responding vocalization according to the quality of preceding maternal speech. Throughout the process of interaction between caregivers and infants it is the caregivers who first become adept at being influenced by what was emitted by the infants on the last turn. Such a behavioral tendency must, in turn, be leaned by the infants. It is on the basis of this learning that the skill of purposeful vocal utterance is considered to be first accomplished by infants.

The purposeful use of one suprasegmental feature of vocalizations, namely pitch contour, plays an important role as a means of signaling different communicative functions before the onset of single words (Halliday 1975). Given this evidence of early use of pitch contour by mothers as a means of interacting, early discrimination and production of pitch contour is the child's first association of language form with respects of meaning. Such early associations may lead the child to later inductions of lexico-grammatical means of cooing similar aspects of meaning. This phenomenon has been investigated in infants exposed to various languages so far. Studies based on naturalistic observations of mother-infant interactions at home, the studies consistently show the association of rising terminal contours with demanding behavior, or protest and of falling contours with "narratives". And it seems to be noteworthy that, around this period, speech-like vocalizations in infancy culminates in the sense that canonical babbling emerges.

6 Musical Origins of Language

Overall, human infants acquire phonology during their first year. However, the newborn has the ability to distinguish virtually all sounds used in all languages at birth in spite of producing no speech sounds. During most of early infancy, music and speech are not as differentiated for very young infants as they are for older children and adults. Early in infancy, caregivers use both speech and music to communicate emotionally on a basic level with their preverbal infants, and it may be that only with experience and cognitive maturation do speech and music become clearly differentiated. As the reason for the occurrence of such a peculiar developmental pattern, we can only note the fact that humans are provided with a finite set of specific behavior patterns, each of which is probably phylogenetically inherited by humans as a primate species. Unlike in nonhuman primates, however, the patterns are uniquely organized during human ontogeny and a coordinated structure emerges that eventually leads us to acquire spoken language. A number of elements can be assembled providing for the onset of language in the infant in a more fluid, task-specific manner determined equally by the maturational status and experiences of the infant and by the current context of the action. Nonetheless, this does not force us to rule out the possibility of either the vocal theory of language origins or the gestural theory of language origins.

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