

Gestural Communication in Nonhuman Species

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Abstract

The evolution of language remains one of science's greatest mysteries. Although first comparative investigations into language origins focused on vocal abilities of nonhuman animals, especially primates, the number of publications reporting new and fascinating results about gestural skills of nonhuman animals has notably increased. To get a better insight in this intriguing scientific field, the present essay will provide a brief overview of its history and will then pinpoint current trends and future avenues.

INTRODUCTION

Human language forms such an exception among the behaviors of animals that it has often been used to define what it means to “be human.” Although there is still an ongoing debate concerning the definition of language, many theorists would agree that it embodies several communicative modalities—the auditory, tactile, and visual one—and is used referentially to direct and influence the attentional and mental states of others. The earliest manifestations of the potent urge to engage in communicative activities can already be observed in human children around the age of 9–12 months, when they start to use gestures, sounds, and/or a combination of both to obtain objects, and affect the thinking and behavior of other individuals. This behavior is so different from the vocal and gestural languages of other animals that it calls for an evolutionary investigation (Botha & Knight, 2009). Why do only humans have language?

Theories of the origins of language must account for the extremely short phylogenetic time available for the evolution of this highly sophisticated behavior. Some suggest that our hominin ancestors did not possess the anatomical and neural prerequisites to produce spoken language, at least until very recently (Lieberman, 2002; although this view is challenged by Fitch (2009)). A recent study by Krause *et al.* (2007) shows that our

closest extinct relatives, the Neanderthals, share with modern humans two evolutionary changes in FOXP2, a gene that has been implicated in the development of speech and language (Lai, Fischer, Hurst, Vargha-Khadem, & Monaco, 2001). Diller and Cann (2009) suggest a gradual coevolution of language and the complex brain structures necessary for speech and fully modern language, with the mutations in FOXP2 occurring some 1.8 million years ago, when human brains doubled in size from the 450 cc brains of chimpanzee (*Pan troglodytes*) and australopithecines to the 1350 cc brains of modern humans. This time period is relatively short and clearly insufficient for the evolution of the entire cognitive apparatus required for normally developed linguistic behavior, suggesting that many of the neural, anatomical, and cognitive components required for language processing must be substantially older, having evolved in the primate lineage long before the advent of speech in modern humans.

THE COMPARATIVE APPROACH

A powerful approach to problems of language evolution is provided by the comparative method, which uses empirical data from living species to draw detailed inferences about the behavior of extinct ancestors. Although scholars interested in the evolution of language have often ignored comparative data altogether or focused narrowly on only data from nonhuman primates (hereafter primates), recent developments in neuroscience, molecular biology, and developmental biology indicate that many aspects of neural and developmental function are highly conserved, encouraging the extension of the comparative method to all vertebrates (and perhaps beyond, Hauser, Chomsky, & Fitch, 2002). Furthermore, recent archaeological evidence suggests, that early hominins and extant apes are remarkably divergent in many anatomical features (e.g., dentition and feet; Lovejoy, 2009). Thus, in order to reconstruct the changes that paved the way for language to evolve, we should consider the likely adaptations of early hominins generally, rather than only with specific reference to living chimpanzees (Lovejoy, 2009). Detailed insight into the communicative abilities of our closest phylogenetic relatives, the nonhuman primates, can thus by both homology and analogy, help in reconstructing the behavior of the last common ancestor of *Pan* and *Homo* and perhaps some aspect of early hominin behavior. Examples of convergent evolution in distant related species can provide clues to the types of problems that particular morphological or behavioral mechanisms are “designed” to solve (Gould, 1976).

Furthermore, in order to claim that particular components of human language are unique to humans, data indicating that no other animal has this particular trait is required.

As we tend to associate language first with sound rather than movement, the majority of comparative research in relation to language origins focused on vocalizations (Marler, 1970; Seyfarth, 2005). However, speech consists of over 100 acoustically unique phones, commonly combined into rapid sequences, which serve as the main carriers of meaning. Thus the ability to produce speech relies heavily on fine, rapid and voluntarily produced motor movements synchronized with cognitive activity. In addition, McNeill recently stated “that language could not have come into existence without gesture” (McNeill, 2012, p. 59). To understand the evolutionary precursors of human language and the linkage between speech and gesture, we therefore also need to gain a profound knowledge of gestural forms, their usage and their function in nonhuman animals. The present essay aims to provide a brief overview of the history of this scientific field and will then focus on current trends and future avenues in this exciting research domain.

BRIEF HISTORY OF COMPARATIVE GESTURAL RESEARCH

Earliest comparative studies on gestural skills were mainly descriptive and focused on our closest living relatives, the great apes. Ladygina-Kohts (1935) for instance compared the expressive behavior of a chimpanzee and a human child and concluded that the initial language of both species, consisting of gestures, facial expressions and vocalizations, is quite similar. Since attempts to teach human speech to chimpanzees had failed, researchers tried to overcome great apes’ difficulties in speech production by switching to the manual modality. The first language projects centered on three chimpanzee females, Sara, Lana, and Washoe, and used different methodologies to communicate: (i) three-dimensional plastic pieces; (ii) two-dimensional geometric designs; and (iii) manual signs (Gardner & Gardner, 1969; Premack & Premack, 1972; Rumbaugh, Gill, & von Glasersfeld, 1973). One of the most successful studies was the sign language project carried out by the Gardners (1969), who raised a chimpanzee female, Washoe, in a house trailer exposing her to human caretakers communicating via American Sign Language (ASL) only. Washoe learned to use over a hundred of signs in appropriate ways, invented new signs and was also able to modulate taught signs in new purposeful ways. In addition, she formed sequences of signs, which mainly followed two principles: (i) more urgency \Rightarrow more signs and (ii) Addressee–Action–Nonaddressee (McNeill, 2012). The Addressee (or “donor”)–Action–Nonaddressee (or “recipient” and always Washoe) sequence represents an iconic model by depicting the desired result. However, contrary to human language, which is most notably used to communicate and interact in bubbles and hallucinations of thought, about today but also yesterday and tomorrow, Washoe’s sequences

mainly concerned objects and events in the here and now and communicated specific demands to meet specific wants with herself as beneficiary (McNeill, 2012). Although this and other ape language projects seemed to suggest that apes are able to converse with human caretakers via true symbols, there were several criticisms: First, the apes may have only learned basic conditioned associations between various food items and symbols instead of true symbolic communication (Savage-Rumbaugh, 1979). Second, the methods applied in sign-language studies and all other ape language projects (e.g. Premack & Premack, 1972; Rumbaugh *et al.*, 1973) differed significantly from language acquisition in normally developing human children. Human children acquire linguistic symbols through joint attentional frames that involve the intertwining of both linguistic and gestural means and actions between two or more individuals, starting very early with simple rule-oriented turn-taking games such as peek-a-boo. Furthermore, in these social situations, children do not simply learn words concerning food or object names only or sentence structure, but also “how to be” and “how to interact” in a wide range of settings. Even more crucially, they start to understand caretakers’ specific communicative intentions as expressed in an utterance.

Contrary to this learning environment, language-trained apes were typically taught to produce a symbol when a food item or object was held up in front of them or when a desired activity was withheld, assuming that comprehension would follow production naturally. For instance, if Washoe wanted a drink from the experimenter, she was required to sign “drink” in order to obtain it; if she wanted to go outdoors she was required to sign “open” before she would be allowed to leave, and so on. Contrary, just using a pointing gesture to the drink or the door was not considered an acceptable means of communicating the same intent. Similarly, if Sarah wanted an apple that was in front of her, she was only allowed to use a very limited communicative mean: placing the proper plastic chip on the tray to “name” the apple. If Lana wanted M&Ms in the dispenser, she had to press the buttons on the keyboard “Please machine give M&M.” Terrace (1979) thus argued that the apes in these scenarios sign only as a “way out,” suggesting that their symbol production and comprehension are not reflective of comparable levels of cognitive comprehension in normally developing children. Furthermore, McNeill (2012) proposed that not only differences in nonhuman primates’ mouth-anatomy but the lack of a thought-language-hand link brain to orchestrate mouth-part movements are the reason why nonhuman primates have not developed language.

In response to these criticisms, Savage-Rumbaugh and colleagues aimed to develop succinct, systematic procedures to push apes past the initial stage of using associations instrumentally and to enable true symbolic

comprehension and usage (Savage-Rumbaugh, 1979). They used again the electronically activated, computer-interfaced keyboard invented for the Lana project. The keys represent noniconic graphic symbols of one of more elements of nine basic geometric patterns, analogous to letters of the alphabet. The first teaching sessions circled around continuous one-to-one contact of four chimpanzees with a human teacher, encouraging the communicative and cognitive abilities of the apes by presenting and naming single nonfood items. After 4 months however, not a single chimpanzee showed any sign of learning names for the training objects. Instead of focusing on the task itself, the apes directed their main efforts and attention toward the experimenter to influence his decision to hand out a reward AFTER the trial. Savage-Rumbaugh (1979) therefore adjusted their experimental procedure by removing the decision-making process from the experimenter and by giving him the role of a helper rather than a judge of individual's performance. Although two of the chimpanzees, Sherman and Austin, learned to use the keyboard's symbols to request food, trips out of doors, blankets, and behaviors such as grooming and tickling, the biggest success of this scientific adventure originated by unintentionally matching the language learning process in normally developing human children (Savage-Rumbaugh, Rumbaugh, & McDonald, 1985). At that time, Savage-Rumbaugh *et al.* (1985) had also started working with a wild-caught adult bonobo (*Pan paniscus*) female, Matata, exposing her to the same established experimental procedure and showing her to use the keyboard to request foods, objects and certain behaviors. Matata, however, while not very successful in symbol acquisition herself, had a 6 months old stepson Kanzi, who did not receive any particular training but was always with Matata during the training sessions. At the age of 12 months, he started to show a playful interest in the keyboard and at the age of 2.5 years he switched to selecting specific symbols. Even more surprising, however, he combined specific keys with gestures, for instance he would produce the lexigram for "ball" and then gesture toward his ball to request that the ball was brought to him. Alternatively, he pressed the lexigram for "tomatoes," which represented a distinct location in the enclosure and gestured in the direction of it.

Furthermore, Kanzi started to request food via lexigrams and was also able to name foods he had observed Matata learning. His behavior thus showed that he had acquired lexigrams spontaneously by observing his mother. In addition, he had learned many of the lexigrams his mother had not and was able to understand the symbols bidirectionally, which means that he was able to produce and to comprehend them without any specific training. The subsequent procedure used with Kanzi was therefore to keep the exposure of lexigrams as natural as possible. His human caretakers used symbols when

communicating, encouraged him to do so as well and thus functioned as communicative models. In addition, as the enclosure consisted of 55 acres of forest, Kanzi's food was dispersed daily throughout the forest, enabling him to search for and discover it in a more natural way. In many ways his early vocabulary matched the early vocabularies of human children, including names for individuals, labels for common objects, words for actions, locations and properties. It included even a few function words such as "no" and "yes." However, similar to the apes in the sign-language projects, Kanzi mainly communicated about objects and events (i) in the here and now and (ii) benefiting merely his own goals and desires.

In parallel, researchers also had started to investigate the behavior of primates in their natural environments, including detailed descriptions of communicative signals such as vocalizations, facial expressions, and gestures. However, the first step toward an understanding of the cognitive complexity underlying the natural communication abilities of great apes was done by Plooj (1978) studying the ontogeny of gestural signals in chimpanzees at Gombe, Tanzania. He applied methods of Speech Acts Theory and parameters used in analyses of intentional behavior in human prelinguistic human children. Plooj showed that gestures of chimpanzees resemble those of prelinguistic human children in some important ways: They are (i) characterized by their flexible relation between means and ends (means-ends dissociation) and (ii) used to attract and redirect attention. Means-ends dissociation suggests that individuals are able to use (i) synonymous signals/gestures to achieve a certain outcome/goal and (ii) ambiguous gestures for different outcomes/goals (Pika & Liebal, 2012b). Examples for synonymous gestures are the gestures TOUCH and REACH OUT ARM, which are both used by chimpanzee infants to communicate to the mother to be picked up and thus carry the same message. The gesture ARM RAISE however is an example for an ambiguous gesture because it is used to solicit grooming but also to calm and appease an anxious conspecific, thereby communicating and embodying different messages across contexts. This cognitive approach to gestural signaling was continued and expanded by Tomasello and his research group, who provided the first systematic evidence that gestural skills of apes are far more complex and sophisticated than their vocal abilities (Call & Tomasello, 2007). By creating the first comprehensive database on gestural signaling of the four great ape species and one smaller ape (siamangs), they showed that apes

- use open-ended, multifaceted gestural repertoires, including *species-distinctive* and *species-indistinctive* gestures, whose meaning and usage has to be learned;

- use gestures as flexibly produced intentional strategies such as (i) recipient specificity, (ii) persistence to the goal (e.g., repetition of a gestures or use of a different one until the goal has been achieved), (iii) means-ends dissociation (see paragraph above), and (iv) adjustment to audience effects such as (1) adaption of signal category to the attentional states of recipient and (2) locomoting in the visual field of the recipient before producing a visual gesture; and
- develop group-specific traditions of gesture, implying that underlying social learning processes are involved.

Tomasello recently emphasized the impact of these findings on scenarios of language evolution by noting: “In all, I personally do not see how anyone can doubt that ape gestures—in all of their flexibility and sensitivity to the attention of the other—and not ape vocalizations—in all of their inflexibility and ignoring of others—are the original font from which the richness and complexities of human communication and language have flowed” (Tomasello, 2008, p. 55).

CURRENT DEVELOPMENTS AND FUTURE AVENUES

In recent years, the number of publications reporting new and fascinating results about the gestural skills of primates has increased impressively (for an overview see Pika & Liebal, 2012a). Although scientific investigations still disproportionally concentrate on gestural skills of (i) common chimpanzees (*P. troglodytes*); (ii) primates living in captive environments; and (iii) signalers of gestural interactions rather than recipients or both, a considerable amount of research interest has now shifted toward the gestural abilities of species in natural environments (e.g., Genty, Breuer, Hobaiter, & Byrne, 2009; Pika & Mitani, 2006; Roberts, Vick, & Buchanan-Smith, 2012), as well as monkeys (e.g., Maestripieri, 2005; Meguerditchian & Vauclair, 2006).

In addition, current trends and debates concern

- the origins of gestures;
- gestural usage;
- the neural substrates of gestural signaling; and
- the application of new methods.

The most intriguing research avenue toward an in-depth understanding of the evolutionary pressures acting upon gestural systems, however, concerns systematic investigations into the cognitive complexity underlying the visual and tactile signals of nonprimate taxa (Pika & Bugnyar, 2011). Although in the past century, ethologists and ornithologists had been especially fascinated

with courtship and threat displays of birds (Huxley, 1923; Lorenz, 1939), and fish (Dominey, 1983), these signals were mainly interpreted as fixed action patterns rather than complex cognitive means.

Recently, however, Kaplan (2011) reported that Australian magpies (*Gymnorhina tibicen*), which are highly social and cooperative songbirds, use a distinct posture to “point out” the position of a predator to their conspecifics. In addition, Pika and Bugnyar (2011) investigated the gestural behavior of another cooperative songbird species, ravens (*Corvus corax*) in their natural communicative interactions in the wild. They showed that ravens use gestures to refer to outside entities and to share attention with conspecifics. Since referential gestural signals had so far been only described in humans and great apes (for an overview see Pika, 2012), it seems that our understanding of gestural systems is only at its beginning and that future research will provide a viable base from which we may draw informed inferences about gestures and its importance for language origins.

ACKNOWLEDGMENTS

I am grateful to Wolfgang Wickler for fruitful discussions and Sue Anne Zollinger for constructive help with editing the essay. This project was supported by a Sofja Kovalevskaja Award of the Alexander von Humboldt Foundation.

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