Evolution of Communicative Flexibility

Complexity, Creativity, and Adaptability in Human and Animal Communication

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1 Signal and Functional Flexibility in the Emergence of Communication Systems: The Editors' Introduction

D. Kimbrough Oller and Ulrike Griebel

This volume is founded on the supposition that evolution of complex communication systems, where human language offers the most extraordinary example, requires a foundation of flexibility in both the form and the usage of signals. Without the ability to voluntarily manipulate potential signals, and without the ability to utilize those signals adaptively in an ever-changing physical and social environment, potential communicators are reduced to producing actions limited in communicative power and very unlike language.

Of course some actions may *result* in communication even though the purpose of the actions is not communicative. For example, if an animal leaves a track in the snow, it may thus unintentionally leave the basis for another animal to pursue or avoid it. The track is an indicator (or "cue"; see chapter 2) of a path and so can inform a perceiver, even though walking, and thus leaving tracks in the snow, is not an action that was evolved to communicate. Similarly, the sound of a prey animal's breathing or the sound of its chewing may be audible and may betray its position to a predator, but in neither breathing nor chewing do we see examples of actions that were evolved to be communications.

Further, cues such as tracks in the snow and the sound of chewing yield communicated information because the *perceiver* makes it so—any flexibility in response to such a cue is attributable to flexibility of the perceiver. The producer of a cue, on the other hand, is not an intentional signaler, and consequently the structure of an action that serves as a cue is incidental to other functions (locomotion, ingestion, etc.) and possesses no flexibility for the purpose of communication.

Even in the case of actions that were evolved specifically to communicate, there exist abundant examples lacking the fundamental flexibility of language. For example, the newborn infant cry is communicative in that it inspires caregivers to offer sustenance or comfort. When a house cat hisses in the direction of a conspecific, arches its back, and shows piloerection, the display communicates threat. Both the human infant distress cry and the feline threat were evolved to communicate, but they are inflexible in important ways. Both possess a stereotyped form that is universal within the species, and the function that each can serve is predetermined within the members of the species by natural history. Thus, a newborn cry is a distress signal that cannot be restructured to act, for example, as a greeting, an exultation, or as a name for a household pet. Perhaps even more fundamentally, the cry has a stereotyped form that is itself not fundamentally modifiable by the infant—to serve its purpose, the cry must be produced largely as nature decrees. The same goes for the feline threat display. It *is* what it *is* and cannot be restructured, for example, to offer praise, to announce a resignation, or to say, "The earth is blue when viewed from the moon." And again, the human infant and the house cat do not need to learn how to perform cries and threat displays.

The great bulk of the evolved, specialized signaling that occurs in nonhumans, and some of the signaling that occurs in humans, is fixed in the way that cries and feline threat displays are fixed. Such displays have been termed "fixed signals" by the classical ethologists (Lorenz, 1951; Tinbergen, 1951), and the evidence suggests that at least among primates, communicative evolution has primarily consisted of processes yielding within each species a small class of fixed signals, stereotyped in form and each designed to serve a particular social function: threat, greeting, invitation, exultation, warning, and so on.

Fixed signals are believed to be evolved by a process termed "ritualization." Fixed signals can obviously be important to survival and reproduction, because most animal species, as far as we know, possess fixed signals of this sort, each signal stereotyped in form and each tied to a particular function.

This volume asks, How did some species, and particularly how did ancient hominins, break free of the stereotypy and fixedness that are so widespread in communicative systems? How did it come to be that birds in three broadly different taxa (oscines, parrots, and hummingbirds) can learn to produce a wide variety of vocalizations (see Lachlan, this volume), and how did it come to be that only humans are able to learn such complexities of vocal communication as to make it possible for them to deliver lectures about communication itself or to edit volumes on the topic? Fundamentally, the authors of the chapters in this volume ask, What *is* communicative flexibility and what evolutionary conditions can produce it? Of course, human language is a primary target of explanation, but the questions addressed by the authors are basic and draw upon interest in communicative flexibility in species ranging from humans to fireflies of the genus *Photuris* (see Griebel and Oller, this volume). The theoretical perspectives offered are intended to illuminate these questions through reviews and interpretations of a rapidly growing body of research in diverse disciplines.

It is notable that the perspectives offered in the chapters that follow this introduction contrast in important ways with a variety of previous efforts dedicated to the study of language evolution, specifically by attempting to take the questions of language origins back farther in evolutionary time than has occurred in much previous work; many of the chapters attempt to address the very earliest communicative break of the hominin line from the primate background, and others address the evolutionary origins of flexibility in birds and cetaceans. Previous writings, in contrast, have often focused on how relatively complex features of language were evolved: (1) syntax (Bickerton, 1990; Pinker and Bloom, 1990), (2) symbolism (Deacon, 1997), (3) articulations of the wide range of vowel sounds in natural languages (Lieberman, 1984), or (4) the articulatory complexities evidenced in canonical babbling (MacNeilage, 1998). Such features of language seem likely to have been relatively recent innovations in hominin communicative capability. The present work does not ignore such topics but focuses primarily on answering questions that can be deemed even more fundamental, because the emergence of basic flexibility in communication through primitive vocalizations and gestures must have preceded the evolution of any of the more complex types of capabilities (1)–(4).

The emphasis on the earliest steps of evolution toward language has led in recent research to emphasis on parallels between human communicative flexibility and flexibility found in a wide variety of additional species (see articles in our previous volume in the Vienna Series in Theoretical Biology, Oller and Griebel, 2004). Further, the recent approach has led to special interest in the earliest phases of human development and in the developmental history of humans (Locke and Bogin, 2006). Importantly, the roots of early changes in hominin communication are also being sought in development and evolution of gesture (Tomasello, 1996; Tomasello and Call, 2007) and in the origins of play (Špinka et al., 2001). Finally, there is an exciting growth occurring in mathematical modeling, where scholars are seeking to offer theoretical perspectives on the evolution of language and to simulate scenarios of communicative evolution, an approach that incorporates many new tools that are themselves rapidly evolving (Elman et al., 1996; Niyogi, 2006).

The present volume is organized around themes that are at the cutting edge of these efforts to illuminate the origins of communicative flexibility. The approach entails interest in communication and cognition in hominins as well as in other species.[1]

Note

1. As this volume was going to press, a report appeared in *Science* (Aronov et al., 2008) regarding the neural basis for flexible vocal learning in the zebra finch. The work indicates that the subsong, or "babbling," of the juvenile bird is controlled by a special "forebrain nucleus involved in learning but not in adult singing" (p. 630). The result contributes to the growing excitement in research seeking to reveal the concrete mechanisms of flexible vocal learning in a variety of species.

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