

MEDIA REVIEW

Roles of Feedback and Information in Primate Communication

Review of *The Dynamic Dance: Nonvocal Communication in African Great Apes* by Barbara J. King. Cambridge, Harvard University Press, 2004, 283 pages. ISBN 0-674-01515-0, \$29.95, hardcover.

An interesting question in the evolution of language debate concerns the origins of symbolic communication—that is, how individuals, through either evolutionary or learning processes, come to agree that the “meaning” or referent of a signal (where signal can be conceptualized quite broadly as the entire communicative interaction) is a particular object or concept when there is no obvious correlation between the object and the signal. This is less of a problem for indexical signals, where, to speak loosely, the information encoded in the signal by its sender is reflected in the signal form. For example, the roar of the stag deer is correlated with the stag’s vigor because the roar is energetically costly to produce. At some point during the course of language evolution, this indexical constraint on signaling systems was overcome, which allowed individuals to communicate about a much larger set of objects and concepts in their environments. The question that remains largely unanswered is how this transition occurred. What set of factors allowed individuals to begin communicating about events with no direct observables, such as social concepts like subordination (as opposed to submission) or the description of a predator that is not present? This is essentially the topic of Barbara King’s book *The Dynamic Dance*.

King argues that great ape communication is an inherently polyadic, multimodal dynamic process that involves continuous mutual adjustments by the sender and receiver in response to one another, others in the social environment, and the social context. The premise of the book is that “unpredictability, contingency, and joint creation of meaning occur commonly” (p. 39) over the course of signaling interactions. King describes this process as one of “co-regulation” and attempts to use a qualitative approach emphasizing verbal description to show that in great apes, joint meaning is created through continuous mutual reinforcement of gestures and vocalizations. King argues that this mutual reinforcement, which is basically an elaborate pointing system, is the mechanism by which nonlinguistic individuals can develop a shared vocabulary.

The Dynamic Dance raises a number of issues that in the primate literature present substantial puzzles. Broadly speaking, these issues concern questions about 1) the proper unit of analysis in systems characterized by feedback, and 2) the role of information in biology and, more specifically, animal signaling.

Much of *The Dynamic Dance* is devoted to arguing that great ape communication is marked by extensive co-regulation and, consequently, that the proper unit of analysis is the interaction itself. King believes that the internal dynamics of interactions so strongly shape how they unfold that individual characteristics, including experience, internal state, and motivation, can be ignored. This is an intriguing hypothesis (though perhaps overstated), but like all hypotheses, especially strong ones, it requires empirical justification. Interestingly, the underlying issue—how much nonindependence, or correlation, there is in dyadic interactions, and what implications this has for analysis—has arisen in many research areas. It is a central question in the levels of selection debate in evolutionary biology: how much correlation in component behavior is required before a transition occurs in which a new level of individuality arises from formally autonomous components? It is also a fundamental issue in the study of social behavior, which by definition involves multiple individuals interacting in a social context. Yet the default position in the behavioral sciences generally is to treat observations on interacting individuals independently, even though it is quite likely that there is some correlation among the measurements. The degree of correlation is an interesting empirical question for two reasons. First, it has implications for the choice of statistical model. Second, it provides insight into the role of feedback in shaping component behavior, and prompts questions such as how an observed level of correlation arose and whether the system contains constraints that prevent complete integration of the components. In the case of great ape communication, quantitatively evaluating how the correlation between vocal and/or gestural responses changes over the course of the interaction could be used to test the hypothesis that mutual reinforcement allows for a winnowing down of the set of possible referents.

Progress on the role of information in biology has proceeded slowly—especially in the animal-signaling community, in which the role of information has been discussed for some time. This is an intellectually challenging issue, and it is problematic that theory training in the animal-behavior/primatology community is particularly weak. Consequently, a number of misconceptions are prevalent in the literature. The most obvious of these is that the information-processing approach rests on the idea that information is transmitted, or carried, in a signal. This is a colloquial description that has resulted in much confusion. In reality, this description reflects a more elaborate computational process involving encoding and decoding mechanisms in both the sender and receiver that influence and interact with the signal vehicle (i.e., a vocalization, gesture, etc.) to produce “information.” The encoding and decoding processes, and the signal vehicle itself are influenced (amplified or distorted) by physical and social factors in the environment, including, for example, vegetation density and the presence of third parties or predators.

Another common misconception is that the information-processing perspective requires that the interests of the sender and receiver overlap, or that the intentions of the sender are to “share” knowledge with the receiver. This is not the case, however: the sender can use a signal to trigger a representation of a referent in a receiver that produces behavior in the receiver that is advantageous to the sender but is disadvantageous to the receiver. Nor does the information-processing approach assume that the representation of the referent encoded by the sender in the signal matches the representation decoded by the receiver. However, as discussed in the first part of this review, an interesting question is, how do high correlations arise? Furthermore, the information-processing approach and the sender-receiver framework make no assumptions about

linearity. The simple sender–receiver schematics (which might seem to imply linearity) present in any introductory text on the evolution of animal communication are only crude cartoons that serve as useful introductions to a very rich system. King rightly points out, citing the work of Tecumseh Fitch and others, that primate communication appears to be comprised of multimodal signals, vocalizations that are characterized by nonlinearities in their frequency spectra, affected by context, and, in some cases, characterized by highly correlated responses in the sender and receiver.

Despite the apparent implications of these crude cartoons, the complexity of great ape communication can be captured with the use of an information-processing approach. Doing so requires consideration of five issues: 1) the role of context in signal semantics; 2) how to cross-correlate behavior, spectral properties of vocalizations, contextual changes, and the occurrence of other signal components, such as gestures and facial expressions; 3) the role of nonlinear dynamics in encoding and decoding processes; 4) how social network structure may affect signaling dynamics; and 5) how network methods can be adapted to study the role of higher-order interactions (which occur when third parties influence the outcome of dyadic interactions) in the structure and function of communication networks.

What is also required, and this is perhaps the most difficult part, is a more sophisticated mapping between the concept of information in biology and information theory, which is often used to formally represent signaling problems. The most well-known information theoretic formalization in animal behavior is probably the concept of Shannon entropy, which was developed by Claude Shannon and Warren Weaver in the first half of the 20th century. For the purposes of this review, Shannon entropy can be defined as a measure used to quantify how much information is communicated between a sender and receiver, where information is defined as the number of bits required to specify a signal. Its purpose is not to capture the significance or meaning of the signal, but to capture the improbability or complexity of the string of bits that constitutes the signal. Most works on animal communication that have made use of information theory have considered only the role of the channel in influencing the complexity of the signal. There has been less consideration of the complexity of the encoding or decoding processes, or how these relate to the complexity of the signal.

King tries to address these issues and many others in *The Dynamic Dance*. It is a shame that the tools and perspectives, including nonlinear dynamics, information theory, and a solid understanding of evolutionary and learning theory that are required to really tackle them are never fully discussed. Instead, King's primary approach to the study of great ape communication is qualitative, relying on verbal descriptions of the behavioral sequences that occur over the course of signaling interactions. King argues that the qualitative approach provides insight that quantitative methods can not—a position I find premature given that the vast space of quantitative methods has barely been explored in the animal behavior and signaling literature. This latter theme appears throughout the book, and by the last chapter it is clear that it was partly motivated by a postmodernist perspective.

Jessica Flack
Santa Fe Institute
1399 Hyde Park Road
Santa Fe, NM 87501
E-mail: jflack@santafe.edu