

Bio 45 – Lect. II - 5 -- An Overview Of Communication

Communication is at the heart of all behavioral interactions -- predator/prey, competition, reproduction, and social behavior. Therefore, we need to define communication and determine how selection might shape it. We will explore these in lecture, section and your journals.

The new perspective that communication introduces is that of interaction among members of the same species. Some powerful selection is generated from such interactions. This means that the evolution of behavior, especially in social animals, is being subject to two "kinds of" biological selective factors -- those from other species and those from inside the species. These "kinds" or flavors of selection can act in rather different ways. But first, what is communication?

I. Definitions of Communication and some Questions

Organisms are always actively or passively sending out information about themselves. Is all the information sent communication or should communication only be information an organism intends to send? Let's look at the effects of all kinds of signals (information sent) on senders and receivers:

| SIGNALS | EFFECT OF TRANSMISSION ON | | TYPE OF |
|---------------------------|---------------------------|----------|---------------|
| | SENDER | RECEIVER | INTERACTION |
| Interspecific | | | |
| Flower-pollinator signals | positive | positive | mutualistic |
| Warning coloration | positive | positive | mutualistic |
| Müllerian mimicry | positive | positive | mutualistic |
| Batesian mimicry | positive | negative | exploitative |
| Camouflaged prey | positive | negative | exploitative? |
| Conspicuous prey | negative | positive | accidental ? |
| Intraspecific | | | |
| Hyp. 1 -- all signals | positive | positive | mutualistic |
| Hyp. 2 -- all signals | positive | negative | exploitative |

It doesn't take long to see some problems. Should our definition of communication include within species and between species information exchange, or just within? Should communication include both active (intended?) signaling and passive giving off of information? Can we use interspecific signaling to model how communication within species might evolve? Should we view communication as cooperative or exploitative? First, let's try to resolve the definition of communication.

We want a working definition that aids our study of communication without overly biasing how we study it. An older definition (**information exchange between organisms of the same species**) caused workers to focus on how the signaling system worked, what the units of signals were, and how efficient the information transfer was. Here the design goal was assumed to be efficiency of information transfer. The interaction was seen as cooperative, at least to the extent that the message should be clear to both parties. A newer definition is, "**signals designed to alter the behavior of the receiver**". This definition focuses attention on how selection might act on both sender and receiver but not just in the context of efficiency. But, this raises a problem: Can interactions between individuals in a population actually be the only selection that shapes the communication or is it also shaped by the external environment as well? The answer is, of course, both. We will focus mainly on the effects of sender-receiver interaction but we should pay some attention to the general design of communication systems.

II. Some Basic Features of Communication (see Alcock for details)

- A. Discrete vs. graded signals. Some signals are either "all or none" while others can differ in intensity with motivation or context. Discrete (all or none) signals obviously convey less information than graded ones, but they are easier to study.

- B. Functions of communication signals: - might these differ in evolutionary design?
- Informational signals - e.g., what species or sex, position
 - Directions - e.g., location of food, which way to go
 - Intention signals - e.g., signals that show probable actions or state
 - Advertisements - e.g., mate attraction, dominance displays
 - Deceptions - sending false information in one or more of the above contexts
- C. There are 5 major sensory modalities animals use to communicate: visual, acoustic, chemical, electrical and tactile. They differ in a number of ways relative to the distance, speed, specificity, and information content of signals. Think about the advantages and disadvantages of each modality (in a very general sense) relative to the following questions:.
- How far will the signal will carry?
 - How much control over direction, intensity and gradation?
 - Potential information content - "how big is the vocabulary?"
 - Can signal units be combined to make new units or language?
 - Can signal be temporally patterned (i.e., can you increase information flow or content by turning the signal on and off rapidly?)?

III. Optimality and Communication -- exploring the options

We can view the optimization of communication behavior from three perspectives:

A. Optimize efficiency and quality of information transfer for **sender and receiver**

Given the efficiencies and costs of different modes of communication, think about how optimal communication systems might evolve? What utility function is maximized: 1) information transferred per unit time, 2) accuracy, 3) what else?

B. Optimize the fitness gain to the **sender** from signaling

Now shift your perspective to how sender fitness could gain at the expense of receiver fitness – within species. Do your ideas about the evolution of communication systems change? Would the change be the same if sender and receiver were parent and offspring, or female and male?

C. Optimize the fitness gain to the **receiver** from signaling

Now shift your perspective to how receiver fitness could gain at the expense of receiver fitness – within species. All of a sudden we see the potential for an “arms race” between sender and receiver! Each is the selection on the other and each is an evolving entity.

You can begin to appreciate the complexity added by the realization that reproductive selfishness is going to be involved and yet moderated by who is interacting. Given the complexity just introduced, should we expect communication to evolve to be cooperative and "honest" or is deception and manipulation going to rule? We will explore this a bit using Game Theory. Game theory allows us to address the issue of costs and benefits for those involved communication whose interests may differ. We cannot consider receivers and senders as genetic variants in a population because in reality each individual is both. Instead, we will look at things as a contest among different tactics of communication within a population.