

Animal Communication

BSCI 338W/BIOL 708W

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Office hours: Tuesday 1-2:00 or by appointment

Lectures: Tuesday and Thursday, 11-12:15; 1130 PLS

Please turn off cell-phones during lectures and exams.



Prerequisites: Required: Biology 106; one semester of physics, one semester of organic chemistry. Highly recommended: A course in animal behavior or biopsychology

Text: *Principles of Animal Communication* by Jack Bradbury and Sandra Vehrencamp, Sinauer Press, 1998

Software: *Raven Pro v.1.3, Interactive Sound Analysis Software* available from the Cornell lab of ornithology at <http://www.birds.cornell.edu/brp/raven/RavenVersions.html>

Why study animal communication?

- Central to the study of animal behavior and societies
- Tool for elucidating general evolutionary principles
 - Taxonomy, reproductive isolation, speciation, natural selection
- Has practical and conservation importance
 - Censusing populations and communities
 - Insect pest control via mate attraction signals
 - Welfare of captive and wild animals
- Broad and integrative field
 - Physics, physiology, psychology and ecology for signal design
 - Economics, behavioral ecology and evolution for signal use

Goals

- Acquaint you with the diversity of ways in which animals communicate
- Reinforce evolutionary thinking
- Improve your ability to read and write synthetically and critically
- Illustrate how computers have revolutionized sound analysis
- Give you experience in preparing and delivering scientific presentations

Course outline

- Mechanics of communication
 - production, transmission and reception of signals
 - treated by modality
- Optimizing information transfer
 - Information and signal detection
 - Signal evolution and design rules
 - Assume coincident interests of senders and receivers
- Conflicts and cooperation in communication
 - Signal exchange as an economic game
 - Examined in context of different categories of signals

Assignments

- Exams
 - Midterm - March 10 25%
 - Final - May 14, 8 AM 30%
- Papers
 - Literature summaries (five) 15%
 - Project proposal (< 5 pp) 10%
- Group Project
 - Group presentation 20%

Exams

- All exams will be short answer with some problem solving
- Questions will integrate material from lectures and the textbook
- You will be given list of questions to study. Group study is encouraged.
- I will select a subset of those questions for the exam
- Make-up exams permitted only with a doctor's note

Literature summaries

- Five required, approx one every other week
- See Schedule of Classes for topics
- Summarize the content of a recent article and explain how the methods and results are relevant to lecture topics.
 - Articles must have been published between 2005-2009
 - BSCI 338W – read 1 primary reference, write 1 page
 - BIOL 708W – read 2 primary reference, write 2 page
- Each summary will count 20 points and together will constitute 15% of your grade.

Bioacoustic research project

- Goals
 - Become familiar with sound analysis methods
 - Practice the scientific method and collaborate
- Group composition
 - 1 graduate and 2-3 undergraduate students
 - You are welcome to request group members, but I will assign groups after the drop/add period ends.
- Assignment
 - select an organism and question
 - use sounds from a researcher or from recordings you make or download
 - use Raven software to digitize and extract measurements
 - analyze and present results

Group project II

- Proposal – due March 26
 - Should describe the project the group intends to complete.
 - A problem must be stated and put in context, source of the sounds and species name identified, and the analysis planned should be described.
 - Each project must include at least one each of the following types of analyses: amplitude measurement from a power spectrum, frequency measurement from a spectrogram, and a duration or rate measurement from a waveform.
 - Each project should plan to include measurements from 50-100 calls
 - Students in a group are encouraged to work together to develop their hypotheses and experimental methods. However, each person must write their own proposal
 - The methods can be the same for all members of a group, but the introduction and discussion should be different for each person.
 - The project proposal will constitute 10% of your grade.

Group project III

- Group project presentations - May 5, 7 or 12
 - Each group is responsible for preparing their results for presentation to the class using Powerpoint or alternative presentation software
 - The last three class periods will be run like a scientific meeting, i.e. presentations should be no more than 15 minutes with an additional 5 minutes for questions.
 - All members of the group are encouraged to participate in the presentation.
 - Presentations will be reviewed by the class and by me.
 - Presentations will constitute 20% of your grade.

Grading policy

- All assignments will be graded on a curve
 - “A” = understands and can apply all concepts, papers indicate ability to synthesize material creatively
 - “B” = understands most concepts, papers are well-organized and carefully prepared
 - “C” = has difficulty with some concepts, papers could use improvement with content and style

Suggestions for success

- In my experience, a strong predictor of success in any class is attendance. I urge you to always come to class.
- If you miss class, ask a neighbor for their notes and/or see me. I will be happy to review material covered in class with you.
- If you have any questions or comments during the course, please ask or tell me. I am most easily reached by email, but I am also available during office hours and by appointment.

Academic code of conduct

Definitions of academic dishonesty include:

CHEATING

Intentionally using or attempting to use unauthorized materials, information or study aids in any academic exercise.

FABRICATION

Intentional and unauthorized falsification or invention of any information or citation in an academic exercise.

FACILITATION

Intentionally or knowingly helping or attempting to help another to violate any provision of the Code of Academic Integrity.

PLAGIARISM

Intentionally or knowingly representing the words or ideas of another as one's own in any academic exercise. You will be asked to sign an honor pledge on all exams and papers.

How would you define animal
communication?

i.e., what is necessary for animal
communication to occur?

Definitions of communication

- Wilson (1975) {sociobiology}
“..communication occurs when the action of or cue given by one organism is perceived by and thus alters the probability pattern of behavior in another organism in a fashion adaptive to either one or both of the participants.”

Definitions of communication

- Hailman (1977) {ethology} “Communication is the transfer of information via signals sent in a channel between sender and a receiver. The occurrence of communication is recognized by a difference in the behavior of the reputed receiver in two situations that differ only in the presence or absence of the reputed signal... the effect of a signal may be to prevent a change in the receiver’s output, or to maintain a specific internal behavioral state of readiness.

Definitions of communication

- Dusenbery (1992) {sensory ecology} “The term ‘true communication’ is restricted to cases in which the transmitting organism engages in behavior that is adaptive principally because it generates a signal and the interaction mediated by the signal is adaptive to the receiving organism as well.”

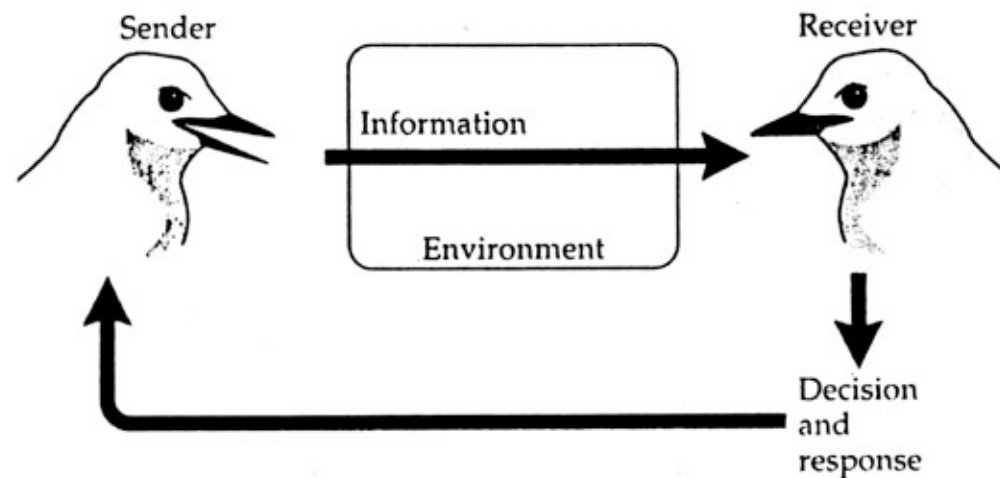
Definitions of communication

- Krebs and Davies (1993) {behavioral ecology} “..the process in which actors use specially designed signals or displays to modify the behavior of reactors.”
- Kimura (1993) {neuropsychology} “The term is used here in a narrower sense, to refer to behaviors by which one member of a species conveys information to another member of the species.”

Definitions of communication

- Johnson-Laird (1990) {cognitive psychology}
“Communication is a matter of causal influence...the communicator (must) construct an internal representation of the external world, and then..carry out some symbolic behavior that conveys the content of that representation. The recipient must first perceive the symbolic behavior, i.e. construct its internal representation, and then from it recover a further internal representation of the state that it signifies. This final step depends on access to the arbitrary conventions governing the interpretation of the symbolic behavior.

What is communication?



- Sender intentionally produces signal to convey information to a receiver

How is information transferred?

- Signal must be perceived by receiver despite attenuation or degradation caused by transmission through the environment
- Receiver must discriminate among signal variants and infer meaning as appropriate
- Signal transmission depends on sensory modality used

Sensory modalities and signals

- Sound - hearing
- Light - vision
- Chemicals - olfaction
- Electric field - electro-reception
- Tactile - mechanosensation

Transmission of signals in different sensory modalities

FEATURE	TYPE OF SIGNAL				
	VISUAL	AUDITORY	CHEMICAL	TACTILE	ELECTRIC
Effective distance	Medium	Long	Long	Short	Short
Localization	High	Medium	Variable	High	High
Ability to go around obstacles	Poor	Good	Good	Good	Good
Rapid exchange	Fast	Fast	Slow	Fast	Fast
Complexity	High	High	Low	Medium	Low
Durability	Variable	Low	High	Low	Low

Who benefits?

Receiver

Benefits

Possible detriment

Sender

Benefits

True
communication

Manipulation

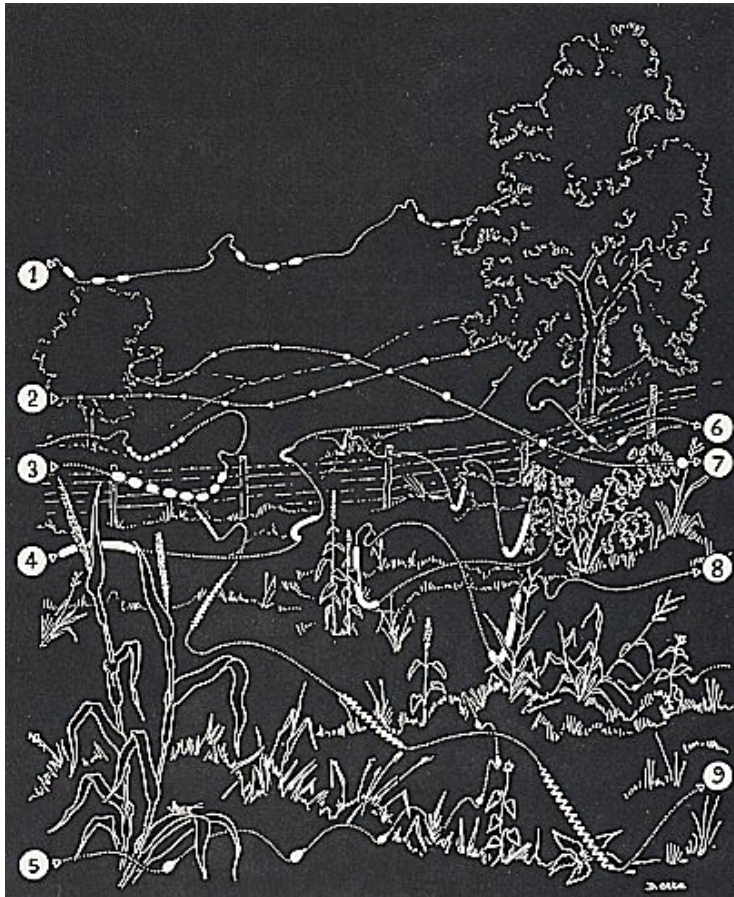
Possible
detriment

Eavesdropping

Ignore

Benefits	True communication	Manipulation
Possible detriment	Eavesdropping	Ignore

Manipulation: Female *Photuris* fireflies mimic *Photinus* males



Above are shown the flashes and flight paths of different species as they would appear in a time-lapse photograph (From: Lloyd, J. E. (1966). Univ. of Michigan Museum of Zoology, Misc. Pub. 130, 1-93)



Female *Photuris* firefly devours a male *Photinus* to obtain defensive compounds called lucibufagins.
Copyright © 1997 by Thomas Eisner

Firefly mimicry provides antipredator chemical



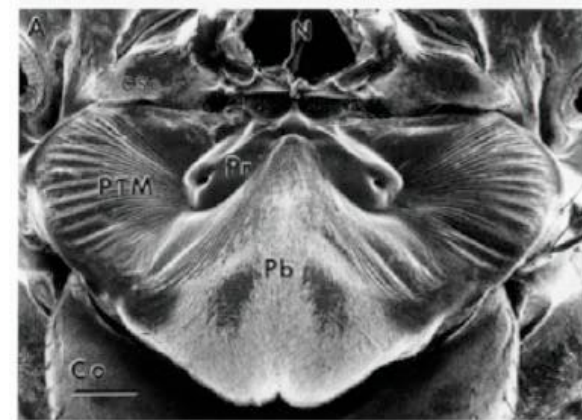
When disturbed, a firefly (*Photuris versicolor*) begins "reflex bleeding" and exudes a fluid that contains the defensive compound lucibufagin.



Left: without lucibufagans from a *Photinus* firefly, the *Photuris* firefly is attacked and eaten by a *Phidippus* jumping spider. Right: But a *Photuris* firefly with lucibufagans can repel the spider. Copyright © 1997 by Thomas Eisner



Exploitation: *Ormia* flies parasitize male crickets



True communication: food signalling



When are signals honest?

- Sender is closely related to receiver
- Signal production is condition dependent, i.e. costs of signalling can only be borne by some individuals
- Signal production is constrained

Why do animals communicate?

- Parental care
 - Recognition
 - Begging
- Sexual advertisement
- Transfer environmental information
 - Predator alarms
 - Food location
- Territory defense and conflict resolution
- Social integration - contact calls