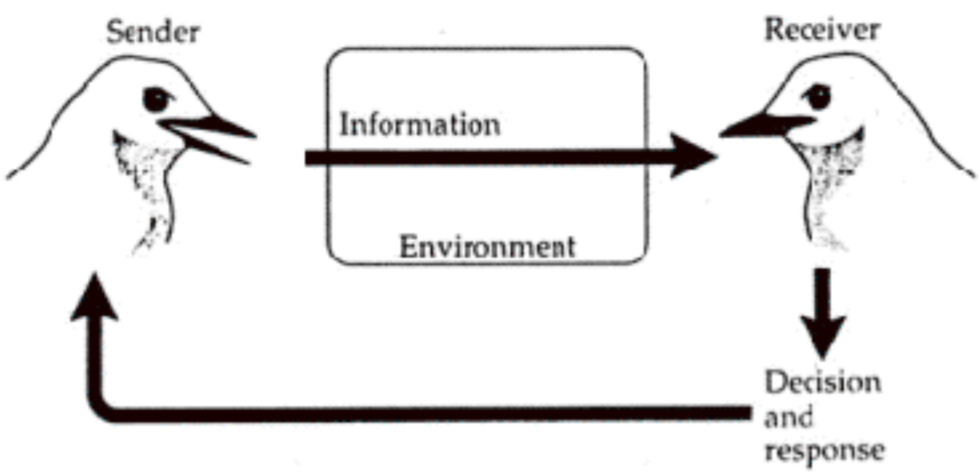
What is communication?

- Signaling: The process in which a sender/ signaler uses a specially evolved "signal" to modify the behavior of the receiver
    - Response, on average, benefits sender
    - Neutrality with respect to receiver's fitness
- "Cue": modifies the behavior of the receiver, but is not an evolved adaptation of sender/emitter



Who benefits?

Change in receiver's fitness

Change in sender's fitness

	+	**-/ nuetral**
+	mutually beneficial	manipulation, deceit
-/ nuetral	localization, eavesdropping	

Who benefits?

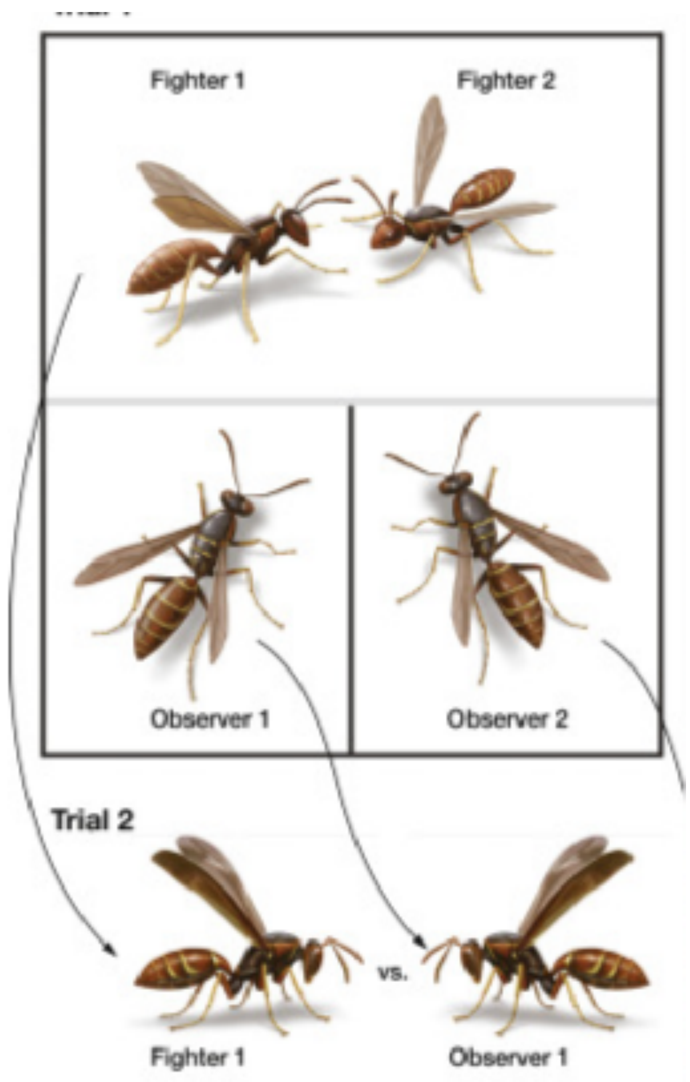
Change in receiver's fitness

Change in sender's fitness

	+	-/ nuetral
+	Signal mutually beneficial	Signal manipulation, deceit
-/ nuetral	Cue localization, eavesdropping	

Eavesdropping

- Eavesdropping: “illegitimate receivers” pick up on cues
  - ex. wasp learns of fighting ability by watching subject fight.

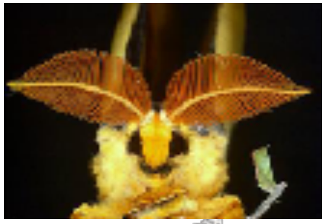


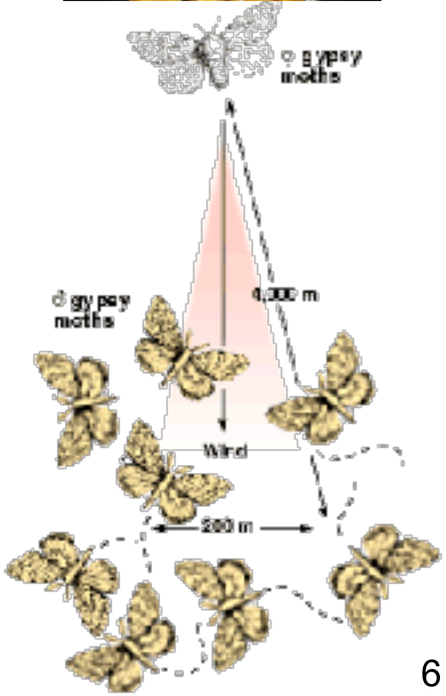
How do animals communicate?

- Five primary types of signal modalities
  - Chemical
  - Auditory
  - Visual
  - Tactile/Vibrational
  - Electrical

How do animals communicate?

- Chemical (probably oldest form of communication)
  - 1) Pheromones (<u>Intra</u>specific chemical signals)
    - – RELEASER = immediate response
      - » female moths attract males downwind
    - – PRIMER = gradual response
      - » inhibition of reproduction in termites

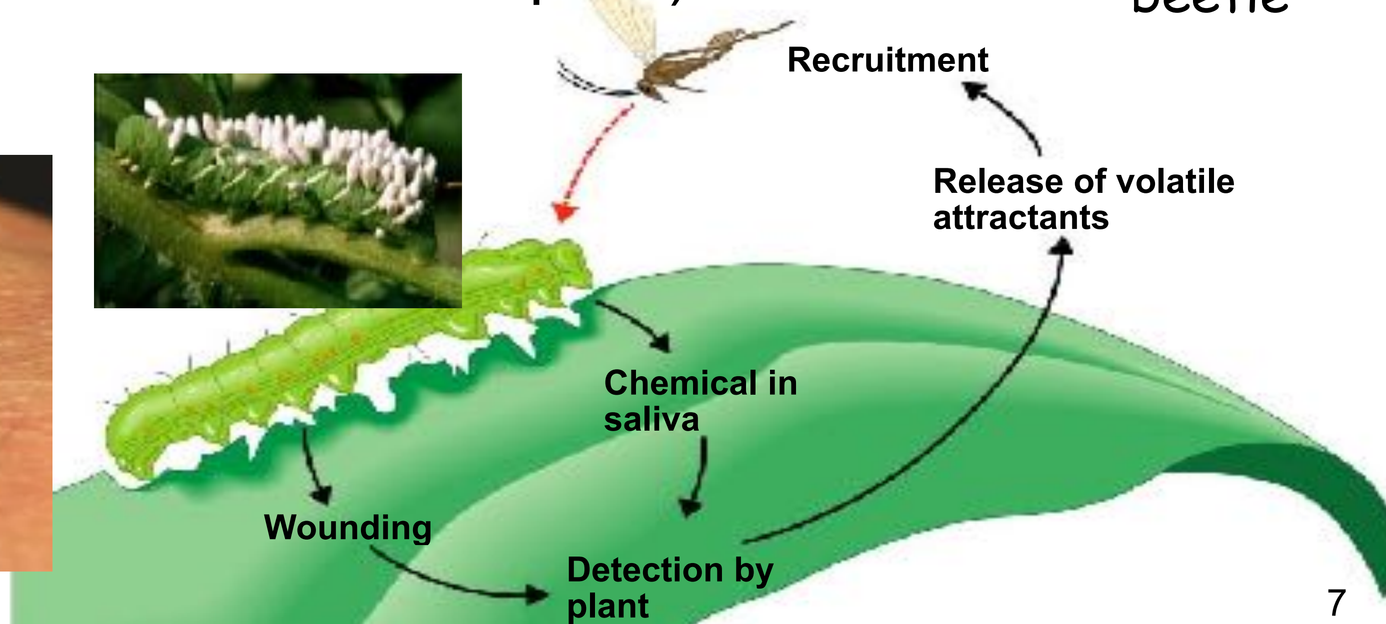




How do animals communicate?

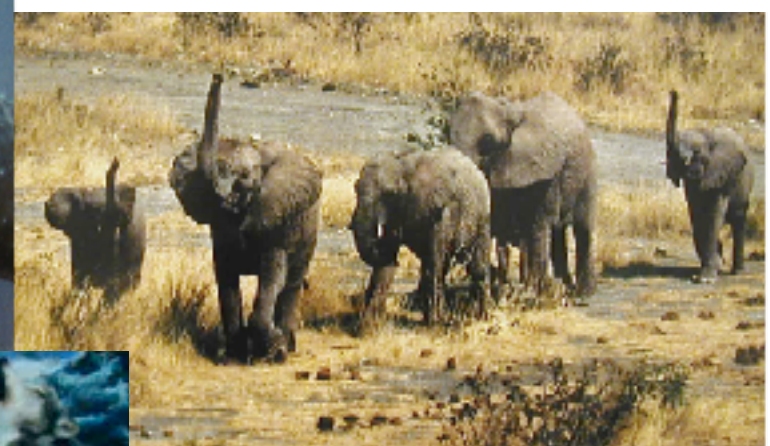
- Chemical (probably oldest form of communication)
  - 2) Allomones (interspecific chemical **signals**)
    - –favorable to signaler (ex. chemically toxic beetle)
  - 3) Kairomones (interspecific chemical ***cues***)
    - –favorable to receiver (ex. mosquito find host; parasite finds caterpillar)

Aposematic beetle



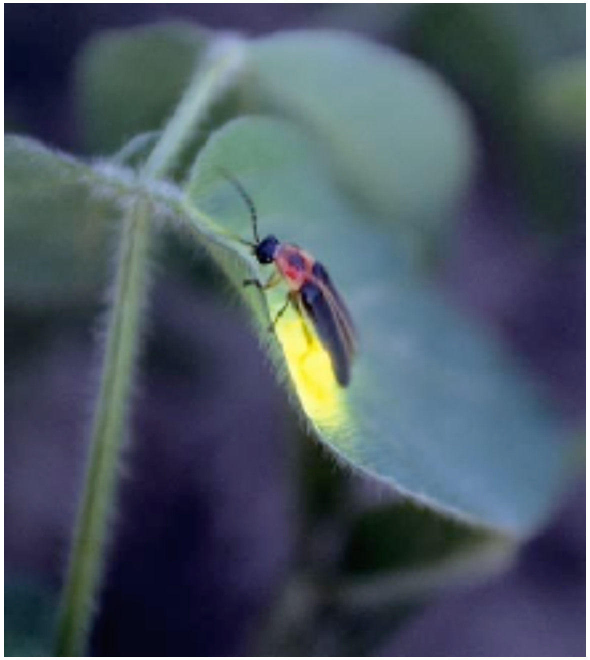
How do animals communicate?

- Acoustic
  - Least constrained by environment--night or day, air or water, can travel long distances
  - Potential for complexity and temporal modulation
  - Degraded by distance and environmental factors



How do animals communicate?

- Visual
  - Requires ambient light, or bioluminescense
  - Blocked by environmental obstacles
  - High potential for complexity, information coding



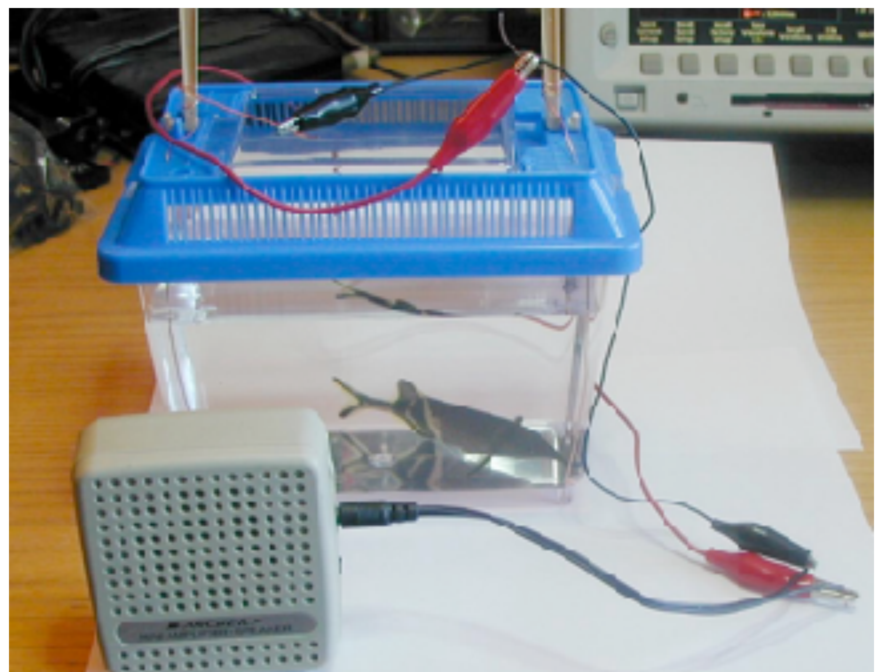
How do animals communicate?

- Vibrational/Tactile
    - Little morphological specialization needed
    - Low transmission range

How do animals communicate?

- Electrical
  - Only aquatic vertebrates (several fish lineages)
  - Short duration, rapid modulation
  - Low complexity, short range

http://www.youtube.com/watch?v=9bk35q5z3ug

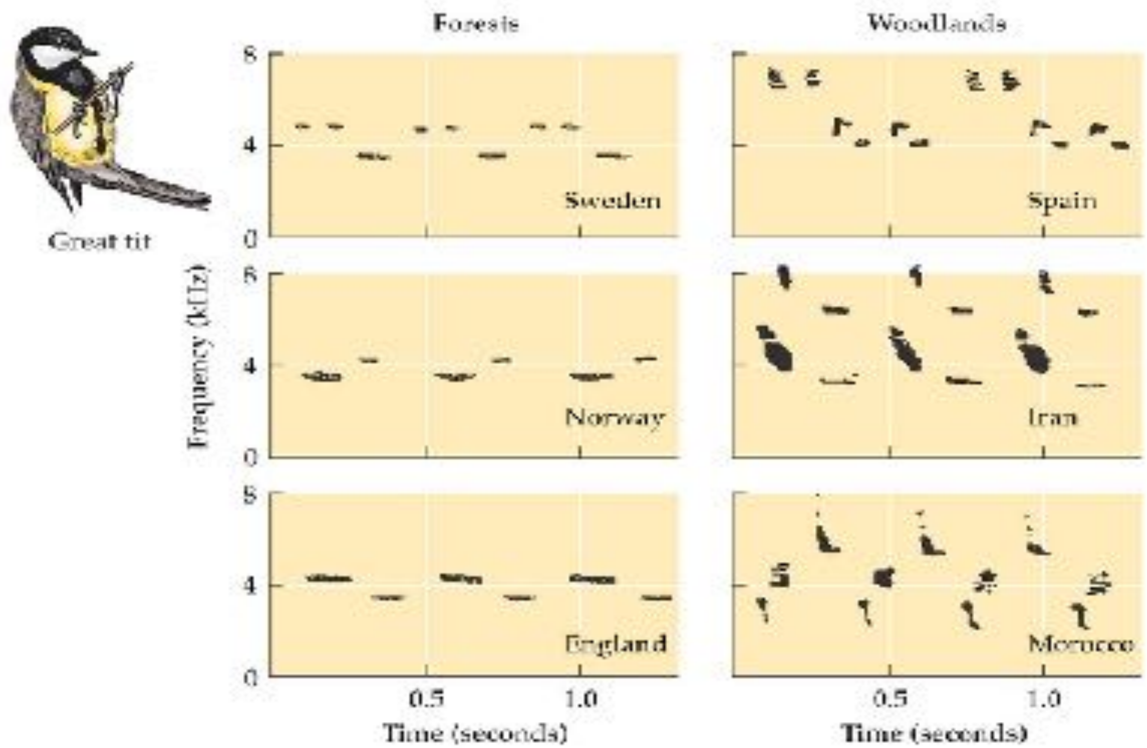


Transmission of signals in different modalities

	TYPE OF SIGNAL				
FEATURE	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

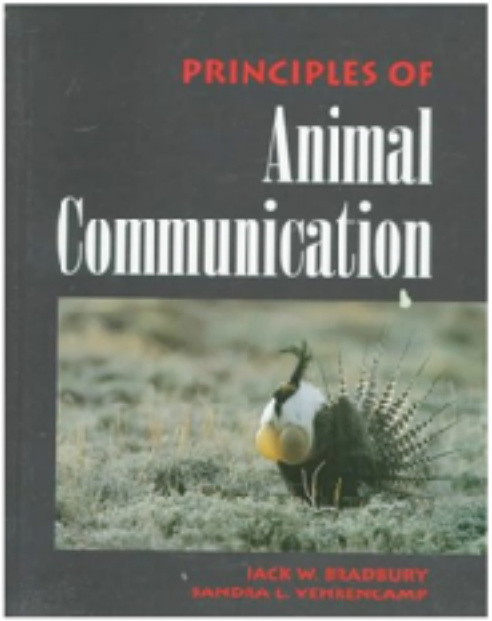
Signal design

- Regardless of modality, design often reflects need
  - Birds modulate calls in different environments to deal with constraints
    - ex. high frequency sound does not pass well through dense vegetation, so used only in woodlands



When are signals honest?

- Animal communication is generally not a cooperative interaction
  - Receivers ‘demand’ (through selection) honest signals



When are signals honest?

- Unforced honest communication
  - Interest of sender and receiver are congruent (mutual benefits for both parties)
    - Sender is closely related to receiver, or has overlapping interests with receiver

When are signals honest?

- Forced honest communication
  - Interest of sender and receiver are incongruent
    - Courtship: females often want best male, males want any/more matings
    - Predator-prey: prey wants to live, predator wants to eat
    - Dominance/Fighting: intimidate rivals without getting hurt

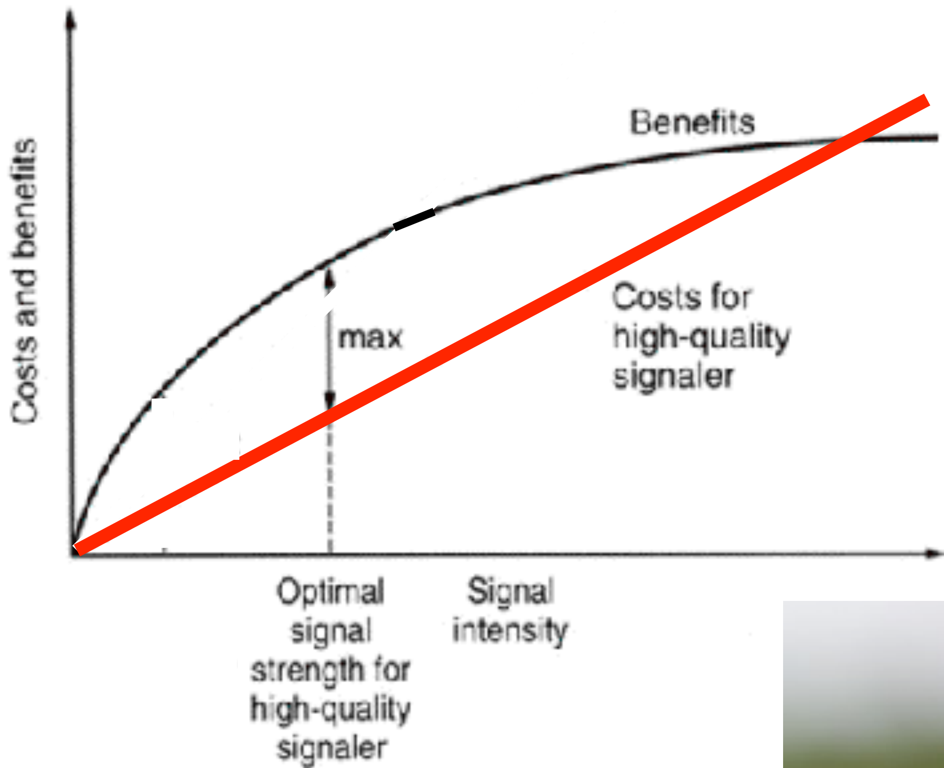


When are signals honest?

- How is honesty maintained?
  - 1) Handicap (condition dependent) signal
    - Signal production is condition dependent
      - Lower <u>marginal</u> costs for high quality individuals (i.e., higher quality individuals pay a ***relatively*** lower cost for a given trait)

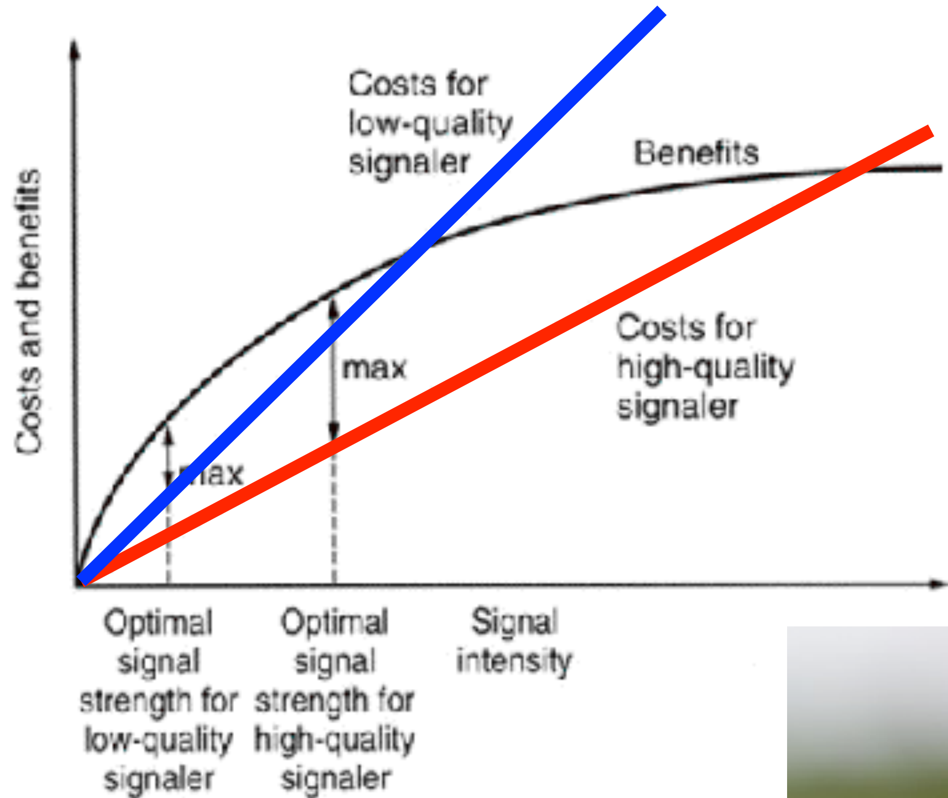
When are signals honest?

Condition-dependent signal costs



When are signals honest?

Condition-dependent signal costs



When are signals honest?

- A human handicap example
  - Two males of varying quality (measured in $$) attempt to attract mates by signaling their quality with a status symbol such as a car
    - What kind of car would a really rich guy buy?
    - What kind of car would a not-so-rich guy buy?
      - ASSUME both are maximizing benefits

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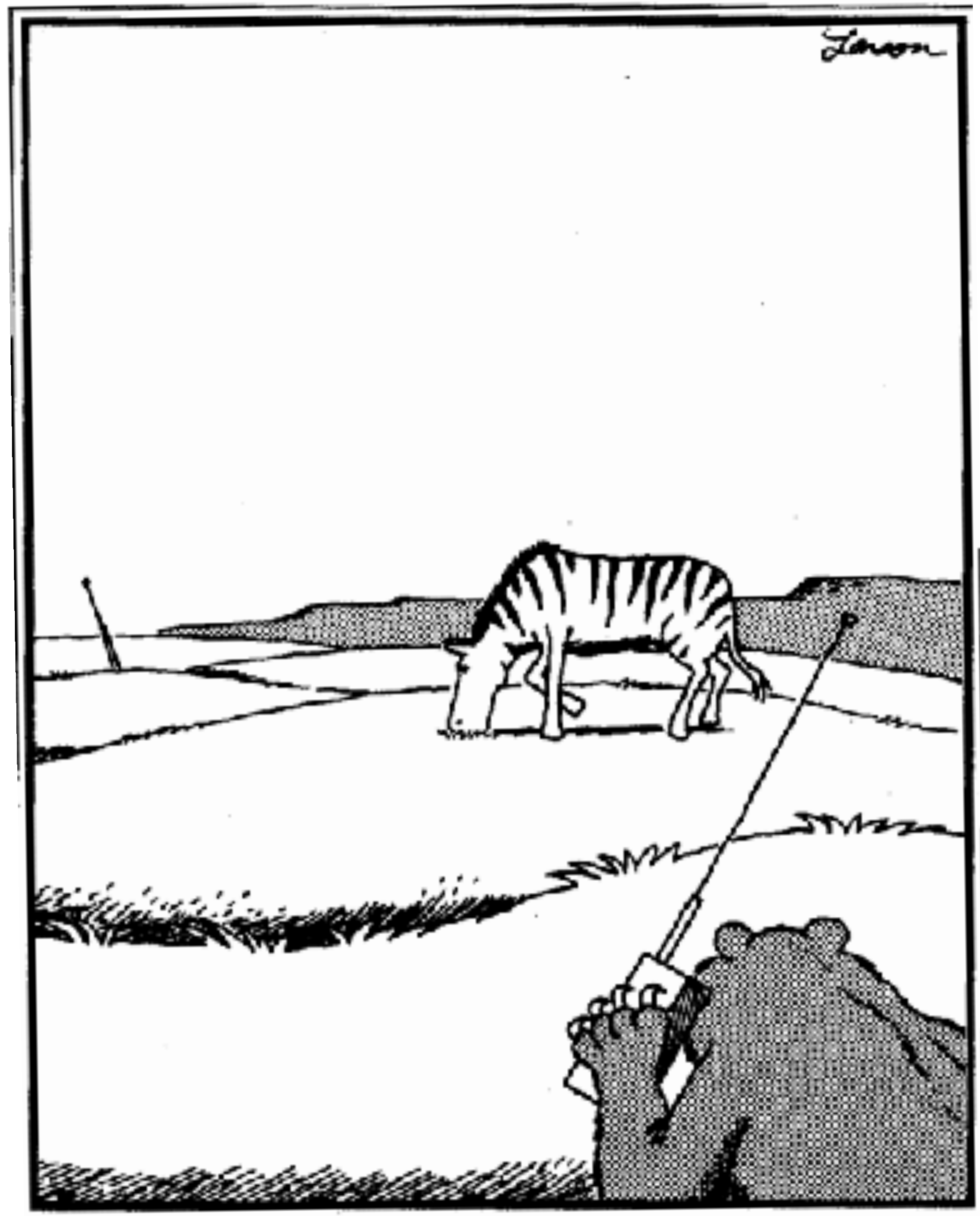
Animal communication



The modern lion

When are signals honest?

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When are signals honest?

- How is honesty maintained?
  - 2) Index signal
    - Signal production is physically constrained so that lying is not physically/physiologically possible
      - Frog call frequency is inversely proportional to body size
      - Bear scrapings indicate height

When are signals honest?

- How is honesty maintained?
  - 3) Socially enforced signal

    The honesty of a **status signal** that conveys information about dominance can be maintained by the threat of receiver retaliation (i.e. if you bluff you get attacked).

<


house sparrows

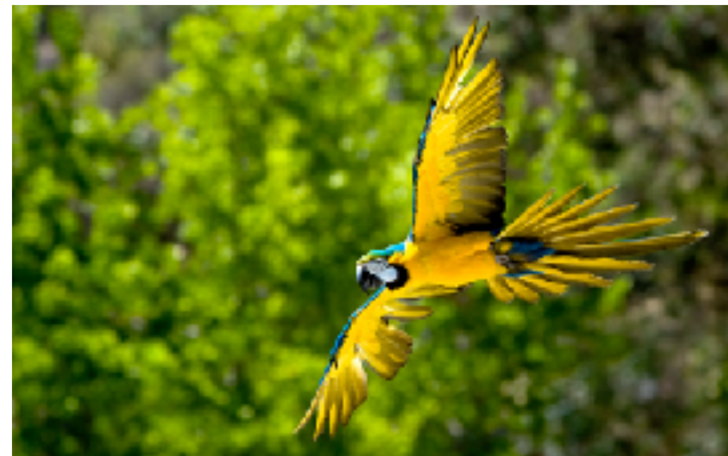
--ex. Black badge size indicates dominance

Signaler costs

- Production costs (costs when signal used/displayed)
  - Conspicuousness to predators & parasites
  - Energetic costs
  - Opportunity costs (lost time)

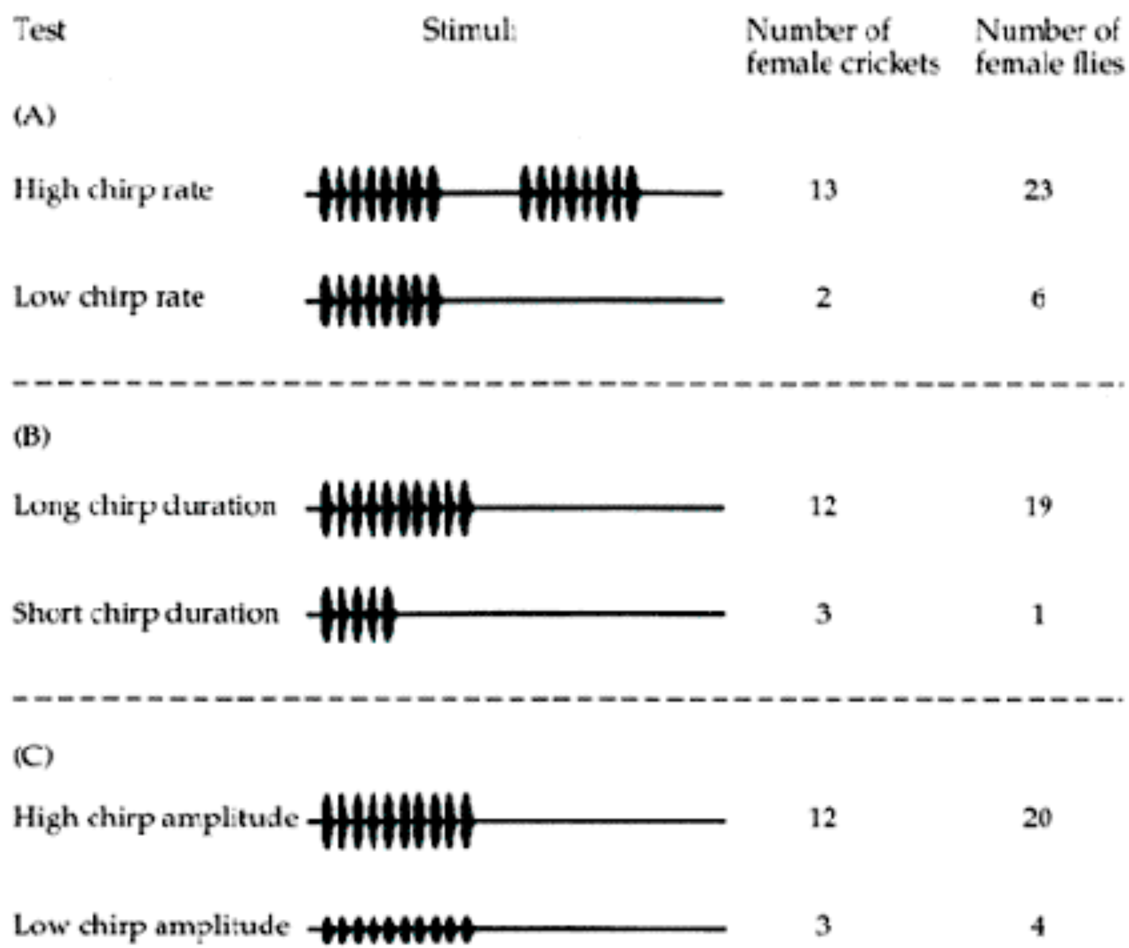
- Development costs
  - Energetic costs
  - (growth of antlers, long tails, neural circuitry)

- Maintenance costs
  - (flying with long tail, preening)



Signaler costs

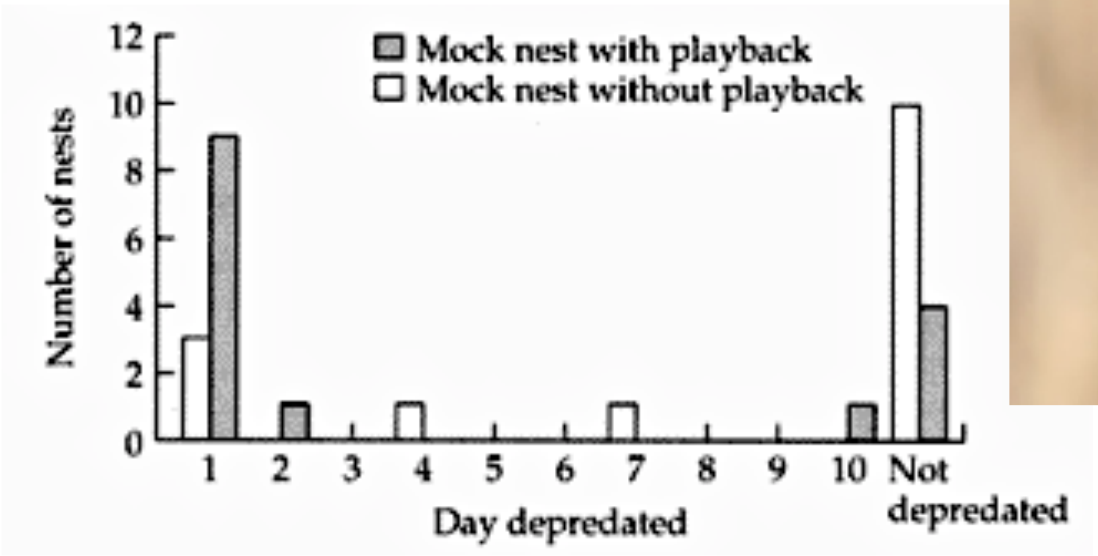
- Production costs
  - Male cricket chirps attract parasitic Ormia flies (and females)



Test	Stimuli	Number of female crickets	Number of female flies
(A)			
High chirp rate		13	23
Low chirp rate		2	6
(B)			
Long chirp duration		12	19
Short chirp duration		3	1
(C)			
High chirp amplitude		12	20
Low chirp amplitude		3	4

Signaler costs

- Production costs
  - Red-winged blackbird calls attract predators



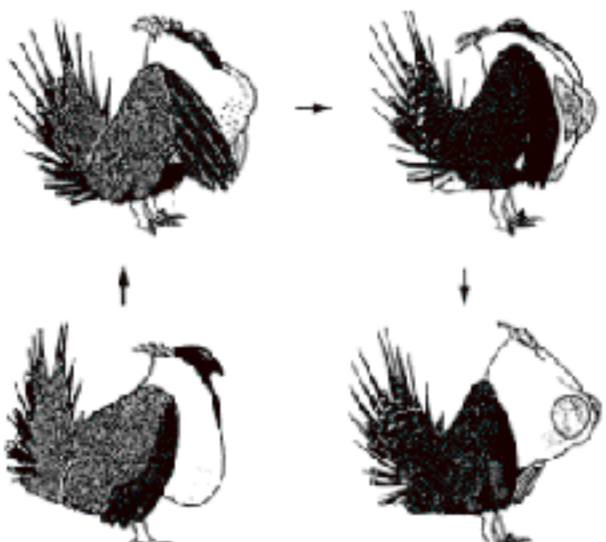
Signaler costs

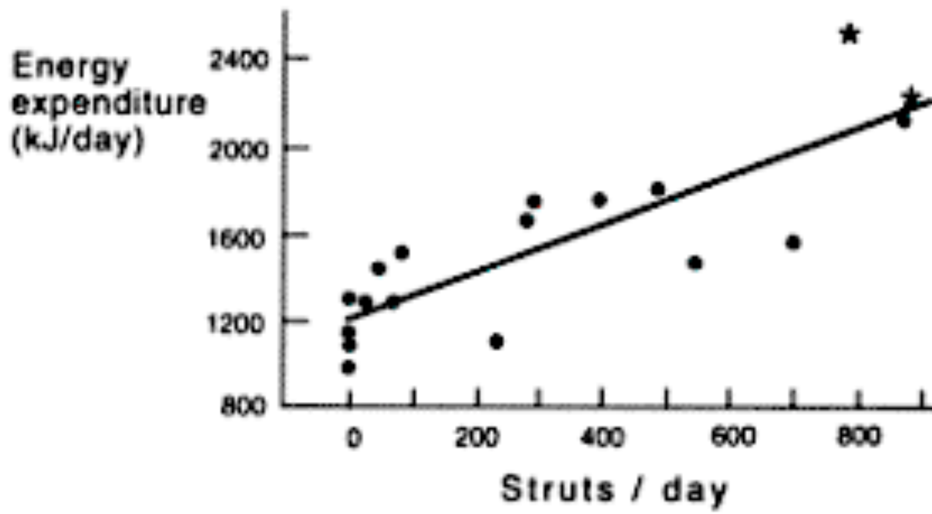
- Production costs
  - Sage grouse displays are energetically costly

Signaler costs

- Production costs
  - Sage grouse displays are energetically costly

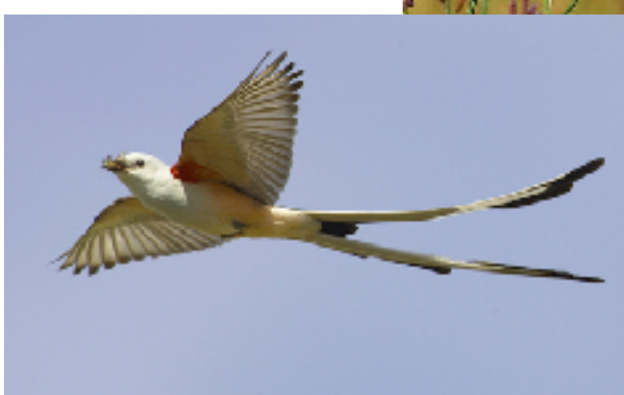
http://www.youtube.com/watch?v=m0M8pZnNlnI

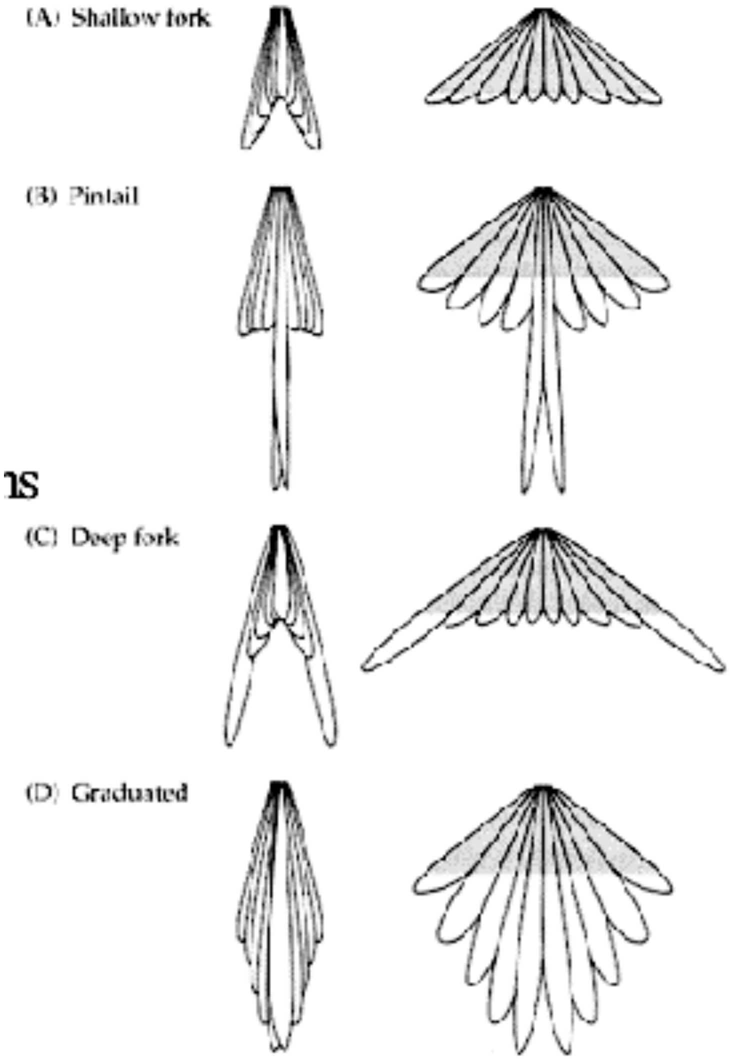




Signaler costs

- Maintenance costs
  - Drag of elongated tails





Gray - generate lift
White - produces drag

Signaler costs

- Maintenance costs
  - Preening, signal maintenance

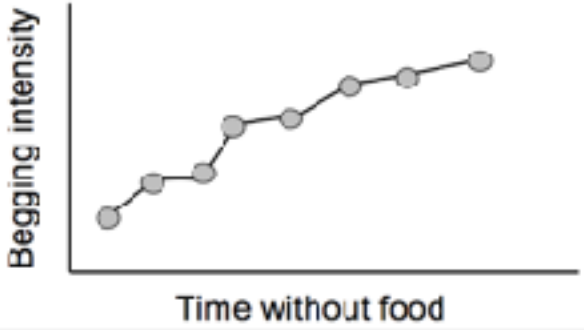
Signaler costs

- Developmental costs
  - Cost of learning
    - Neural tissue required for learning and memory is energetically costly to maintain
    - Learning often time-consuming and mistake prone
  - Cost of growth (e.g., long tail feathers)
  - Cost of allocation (e.g., carotenoids put into feathers are taken away from immune system)

When are signals honest: Differential benefits

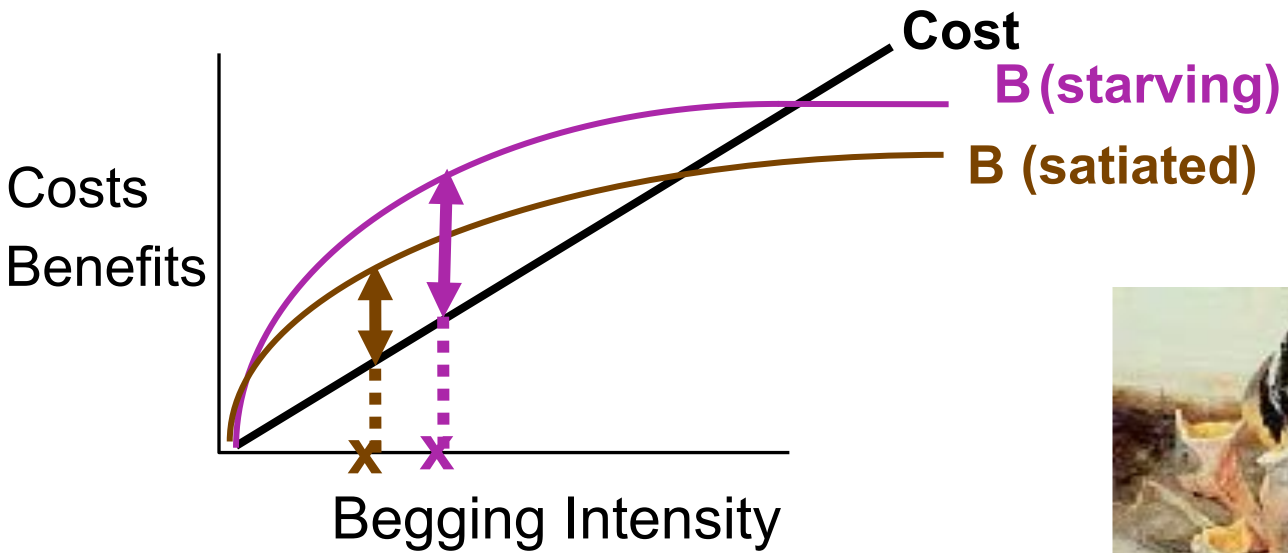
When are signals honest: Differential benefits

- Begging signals
  - Interests of parent and offspring do not completely overlap
    - thus, expect forced honesty
  - Energetic cost of begging appears low, but begging often increases attraction of nest predators (this is cost that keeps system honest)
  - Evidence signaling system is honest:
    - Begging intensity increases when nestlings are hungry



When are signals honest: Differential benefits

Condition-dependent benefits



Who benefits?

Change in sender's fitness \ Change in receiver's fitness	+	-/ nuetral
+	Signal mutually beneficial	Signal manipulation, deceit
-/ nuetral	Cue localization, eavesdropping	

Deceit

- Sender benefits, receiver is harmed
  - What could receivers do when sent a dishonest signal?
    - Ignore
  - Why would receivers pay attention to a dishonest signal?
    - Still a net benefit to paying attention to signal
      if frequency of deceit is low or cost of responding is low

Deceit

letters to nature

Nature 319, 143 - 145 (09 January 1986); doi:10.1038/319143a0

Birds that 'cry wolf'

CHARLES A. MUNN

Wildlife Conservation International, New York Zoological Society, The Bronx Zoo, Bronx, New York 10460, USA

Reports of animals using alarm calls deceptively are rare (refs 1–3 and R. Cheney and D. Seyfarth, personal communication in rf. 4). Here I have studied two species of flycatching birds in Amazonia, *Lanio versicolor* and *Thamnomanes schistogynus*, which lead flocks of mixed species in the canopy and understorey of the forest, respectively, and act as sentinels, giving alarm calls at the approach of bird-eating hawks. These two species feed to a large extent on the insects flushed out by the foraging of the rest of the flock. My observations suggest that *L. versicolor* and *T. schistogynus* use the predator alarm call deceptively to distract other birds, thereby increasing their own chances of capturing arthropods. This result suggests that deception among animals may be more widespread than is generally assumed.