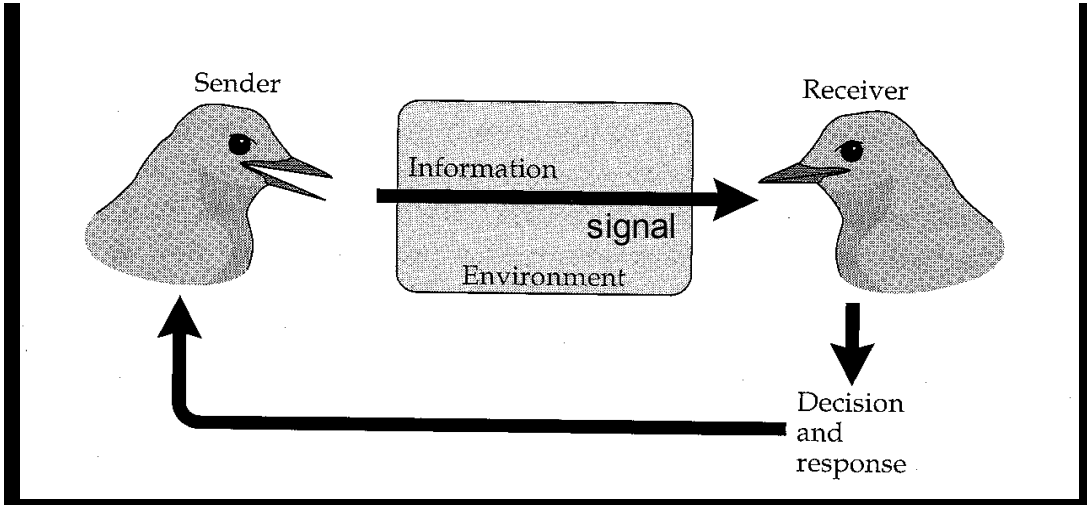
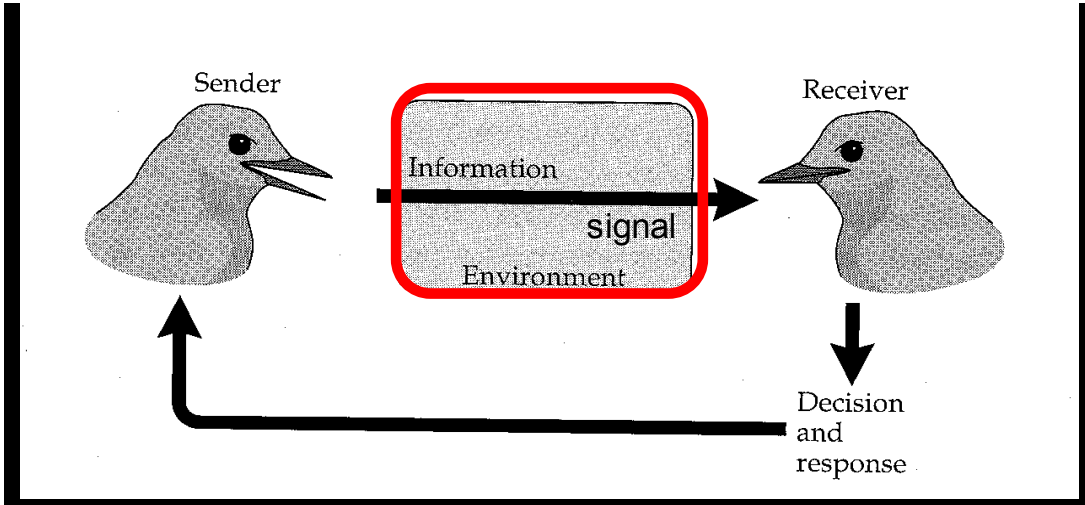
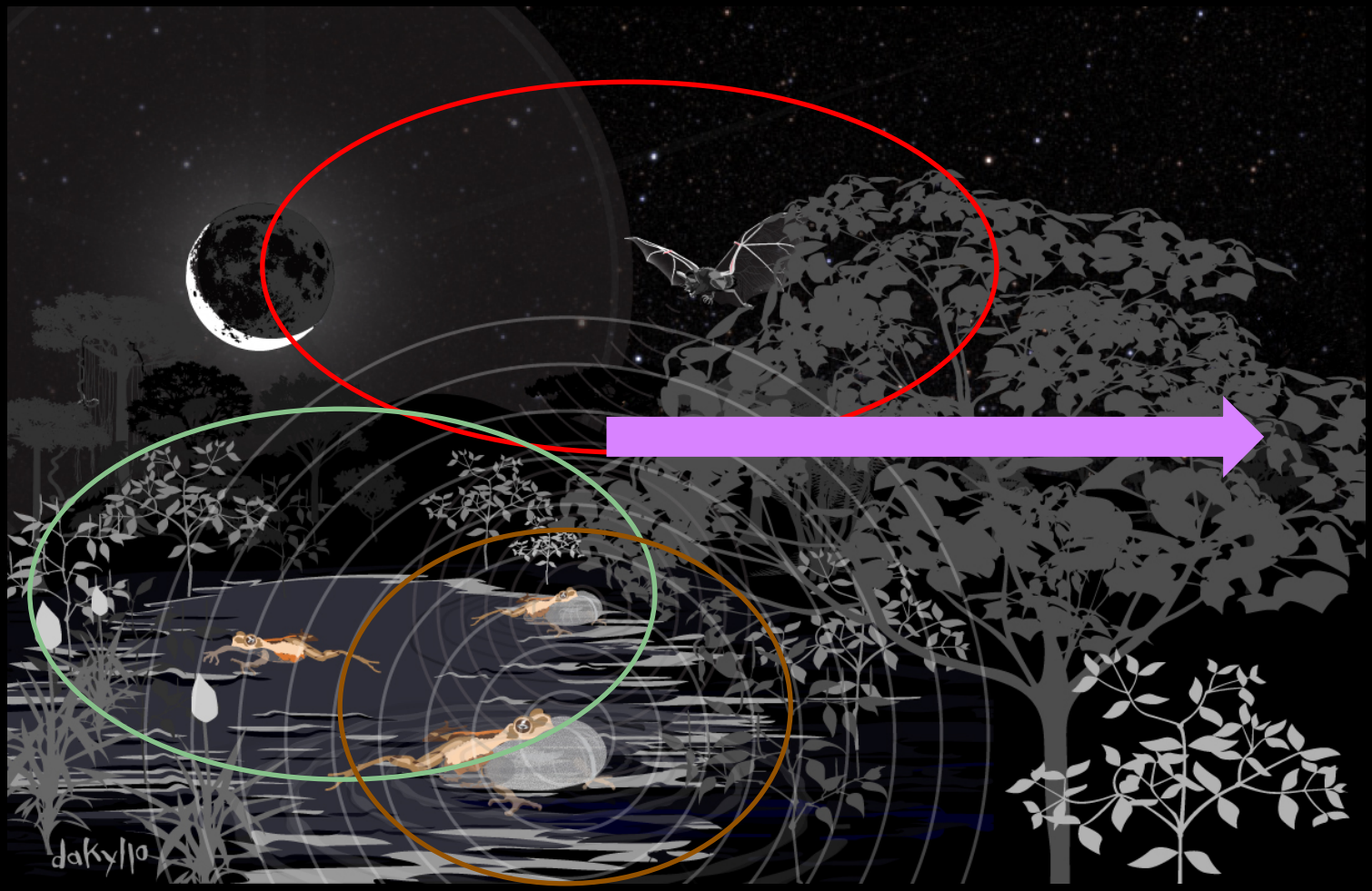


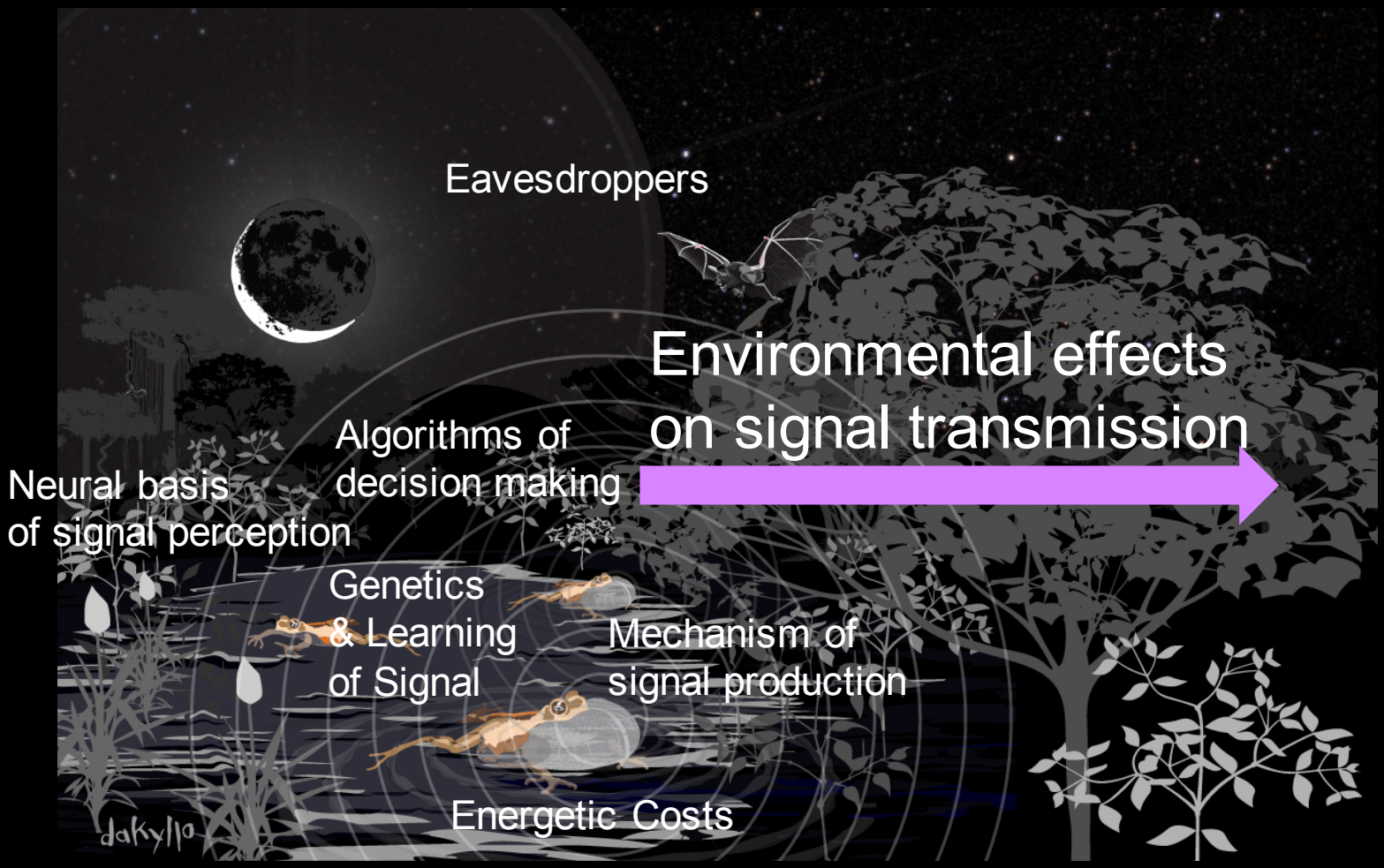
Animal Communication

- In its most basic form, a ***dyadic*** interaction.
- Involves a ***signal*** produced by a ***signaler***.
- The signal is detected and perceived by a ***receiver***.
- Occurs when the signaling behavior of one animal influences the probability of behavioral outcome of another without the use of force.

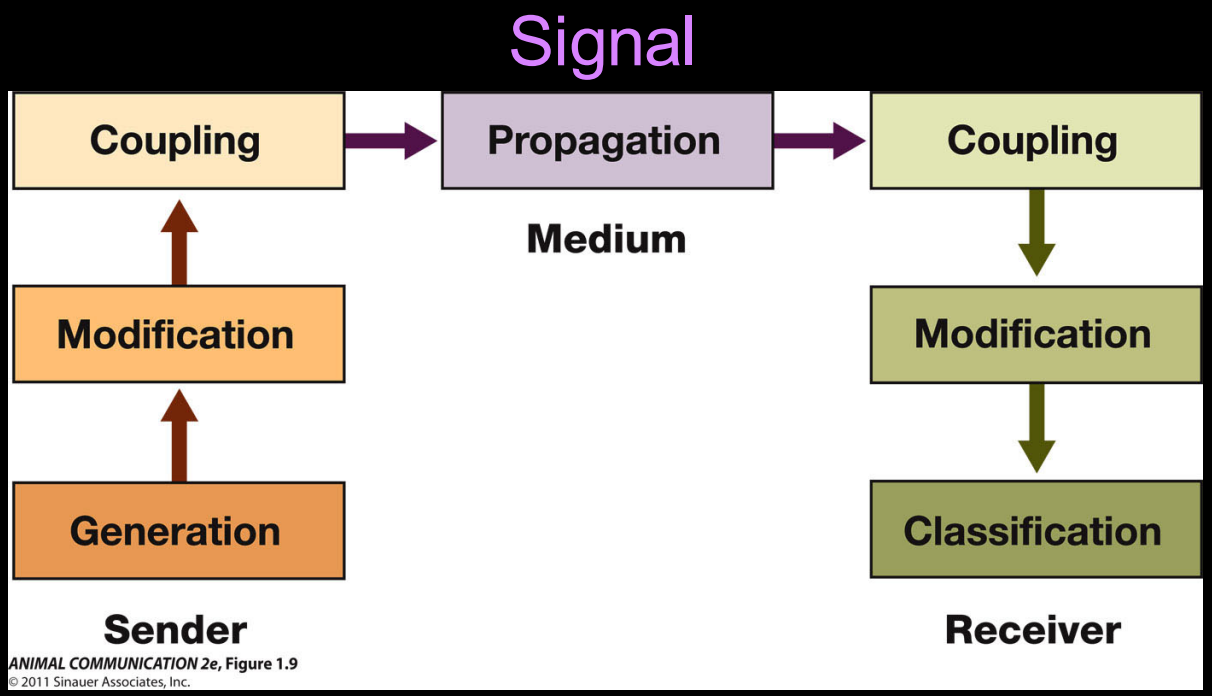


Communication is the phenomenon of one organism producing using an evolved physical stimulus (i.e. signal) to transmit information through the environment to a receiver that when responded to by the receiver, confers some advantage (or the statistical probability of it) to the signaler.


dakylla



How does all this evolve, and what are the fitness benefits?



Functions of Animal Communication: What are they talking about?

Mate Choice

- Females need to identify a male as the correct species, and healthy, wealthy and wise.
- Males evolve a variety of secondary sexual characteristics to court females. Males also use signals to exploit perceptual biases in the female's brain.

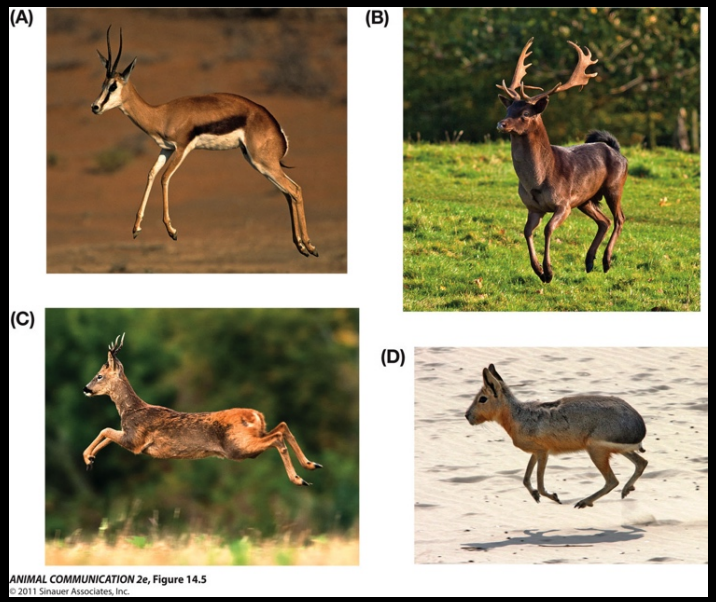
Predator Detection / Warning

- *Alarm Calls:* We have previously discussed 3potential functions of alarm calls.
- 1) warn kin
- 2) alert predator of detection
- 3) self preservation by inducing chaos

Predator Detection / Warning

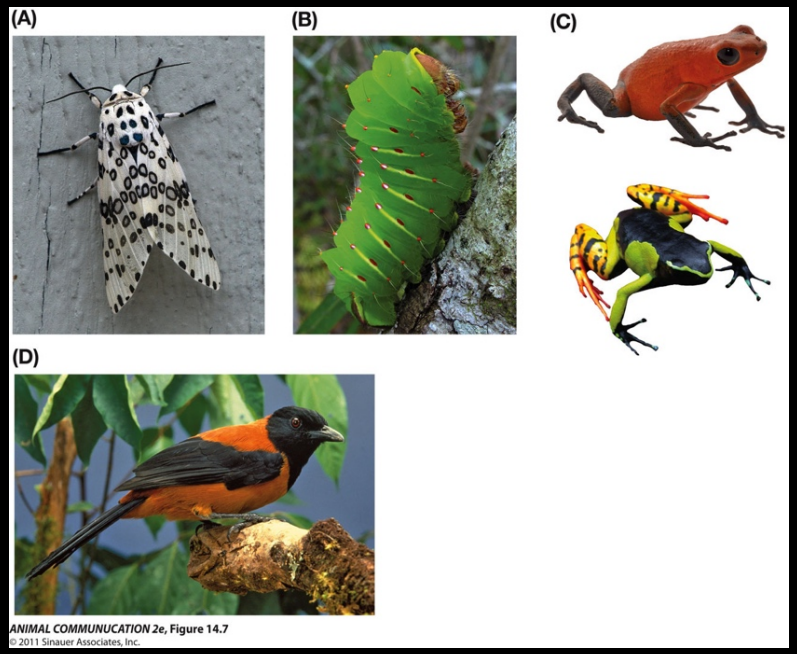
- *Alarm Calls:* We have previously discussed 3potential functions of alarm calls.
- 1) warn kin
- 2) alert predator of detection
- 3) self preservation by inducing chaos

Predator Detection / Warning



- *Stotting*: Many ungulates run from a predator with a hopping type of locomotion that seems to make them more conspicuous to predators. One explanation is the *Predator Invitation Hypothesis*, “don’t bother chasing me I already see you”.

Predator Detection / Warning



- *Warning*: many animals advertise that they are toxic.

Territoriality

- *Olfactory marking*: Animals advertise their ownership of territory in many ways: e.g., visual displays by lizards, song by birds. Olfactory cues are especially common and effective because they persist long after the signaler has left.

Agonistic

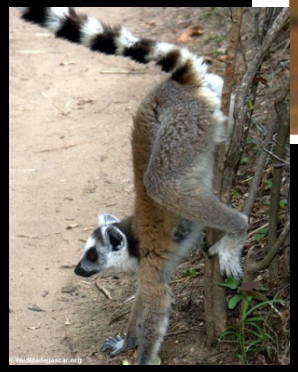
- *Aggression*: Many animals advertise their intentions to engage in aggression. They often do this by displaying their weapons, e.g. teeth, antlers, horns, jaws.

Parent - Offspring

- *Begging in bird nestlings*: They use calls, beak gapes, and sometimes patterns within the mouth that act as supernormal stimuli to induce feeding from parents.

What is a Signal?

- ***Signal***: A structure or behavior that evolved under selection for manipulation of receiver behavior.
- ***Cue***: An aspect of the phenotype to which receivers respond; cues have not evolved due to benefits of behavioral influence.



What is a Signal?

- ***Signal***: A structure or behavior that evolved under selection for manipulation of receiver behavior.
- ***Cue***: An aspect of the phenotype to which receivers respond; cues have not evolved due to benefits of behavioral influence.

Has the mouse “communicated” its location to the owl?

What is a Signal?

Has the frog “communicated” its location to the owl?

What is a Signal?

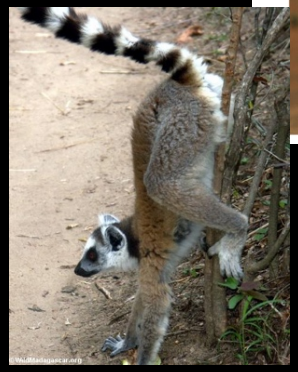
Is Echolocation = Communication?

Jamming or Communication?

Has the bat “communicated” with itself?

What is a Signal?

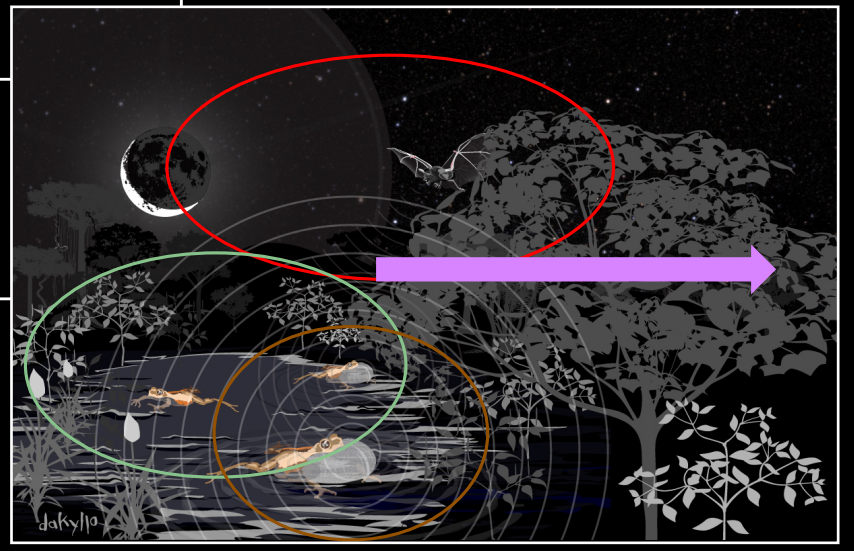
- ***Signal***: A structure or behavior that evolved under selection for manipulation of receiver behavior.
- ***Cue***: An aspect of the phenotype to which receivers respond; cues have not evolved due to benefits of behavioral influence.



Sender value in information

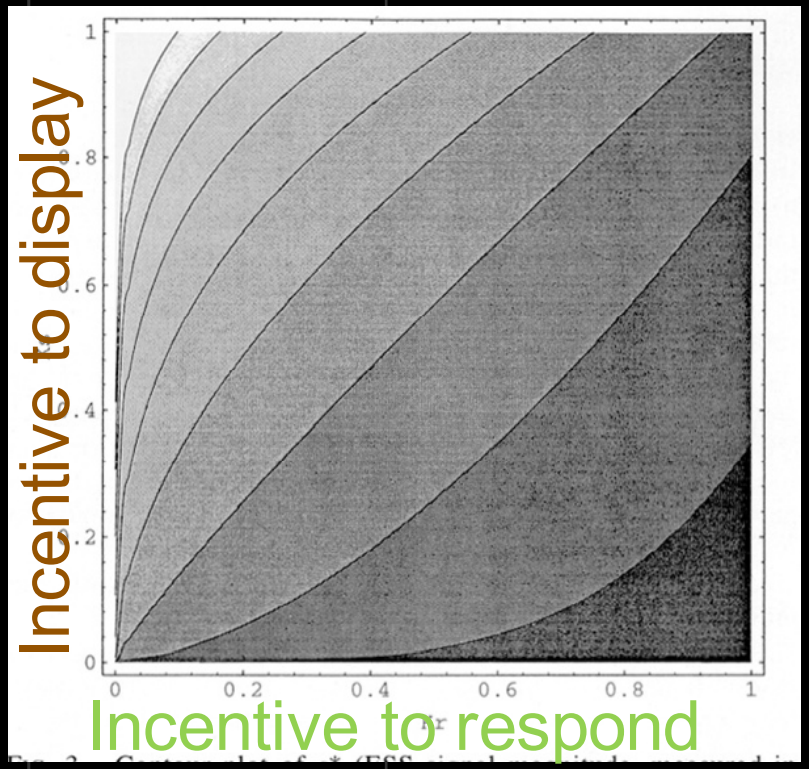
Receiver value in information

Sender value in information	Receiver value in information: Positive	Receiver value in information: Negative
Positive	True communication	Manipulative (deceit)
Negative	Eavesdropping (exploitation)	spite



Even in “true communication”, signaling systems can evolve as an arms race

Signal intensity



high

low

Evolution, 52(6), 1998, pp. 1554–1563

CONSPIRATORIAL WHISPERS AND CONSPICUOUS DISPLAYS: GAMES OF SIGNAL DETECTION

RUFUS A. JOHNSTONE

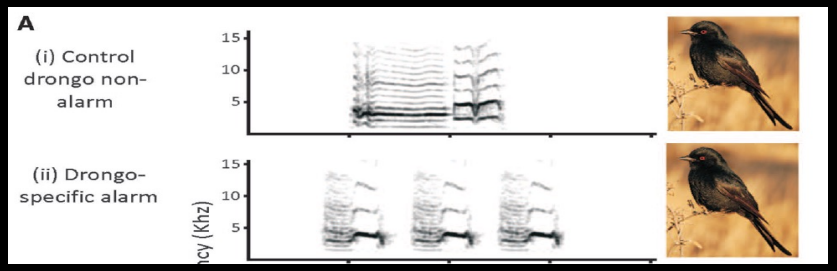
video

There is nothing subtle about a sage grouse display

Signal Reliability

Batesians mimic poisonous species

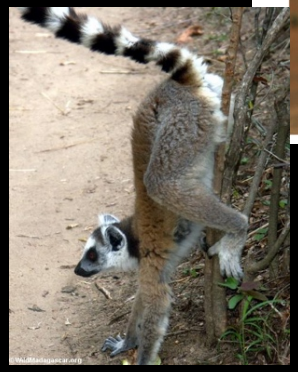
Orchids dupe bees into ‘mating’ with them.



Drongos imitate warning call of many other birds

Anglers lure mates and food with light to mimic food

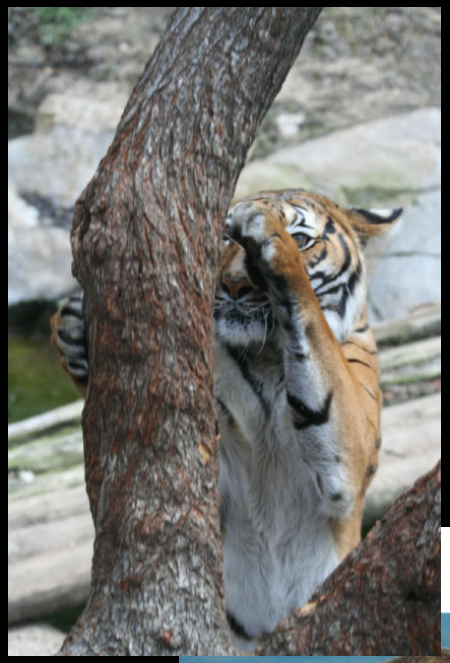
Signal Reliability

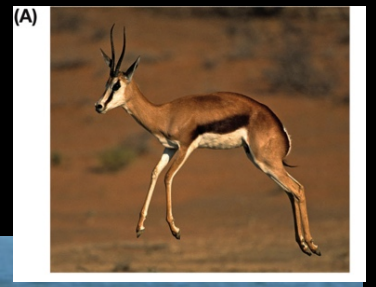


- “Honest Signals” refer to a signal that is a statistically reliable predictor of a quality about the signaler or its extended phenotype (e.g. resources it holds).
- What keeps signalers from lying, bluffing, cheating?

Index signals

- Some signals/cues are reliable indicators of signaler quality because they cannot easily be faked.





Physical Constraint can enforce reliability “honesty”

Index signals

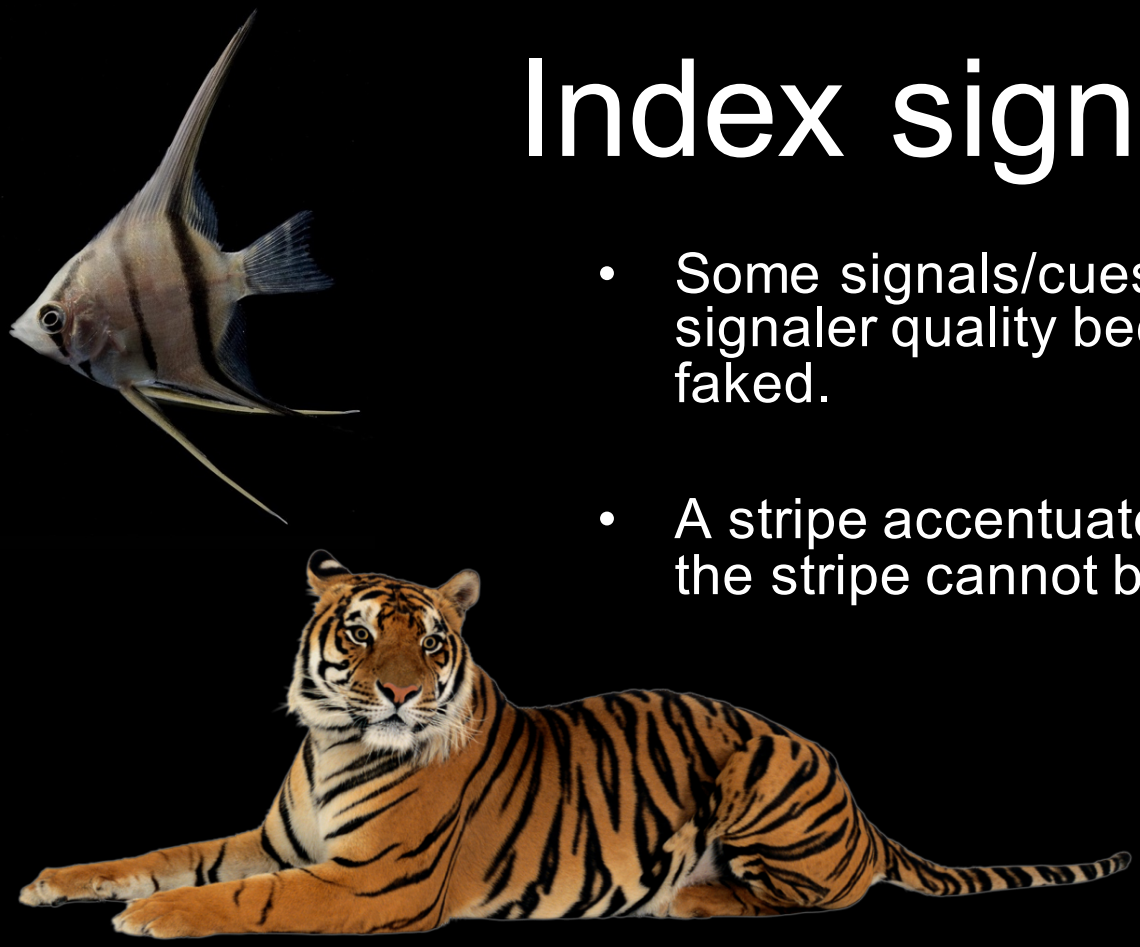
- Some signals/cues are reliable indicators of signaler quality because they cannot easily be faked.

You can't fake your weight.

- Web spiders transmit vibrations on webs.
- Frequency of vibrations are correlated to mass.
- An intruder spider senses size of resident through web vibration.
- Small spiders become winners if weights are placed on their backs.

Physical Constraint can enforce reliability "honesty"

Index signals

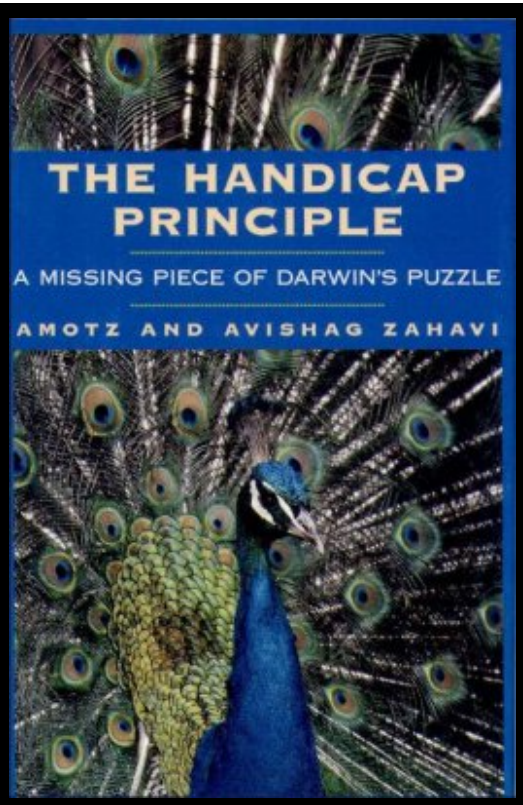


- Some signals/cues are reliable indicators of signaler quality because they cannot easily be faked.
- A stripe accentuates the size of an individual, but the stripe cannot be longer than the individual.

Physical Constraint can enforce reliability “honesty”

Signal Reliability

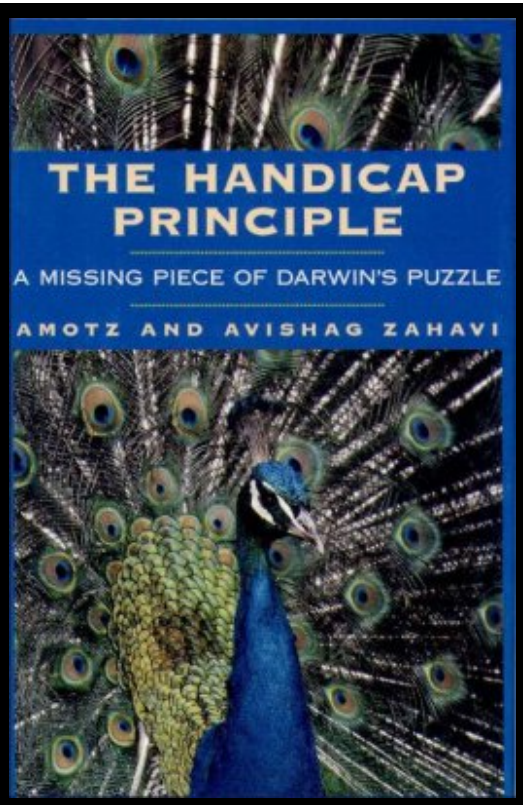
- On average, signals should reliably predict something about the signaler in order for evolution to maintain receivers that respond to that signal.
- Not all signals are constrained to be honest, as in Index Signals
- What keeps signals “honest”?



Signal Reliability

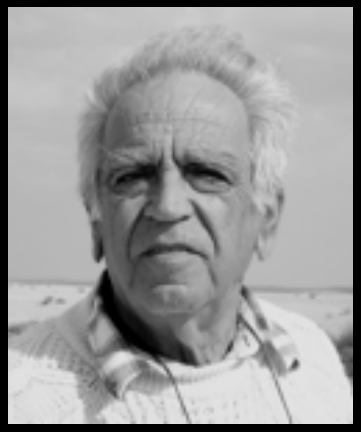
- On average, signals should reliably predict something about the signaler in order for evolution to maintain receivers that respond to that signal.
- Not all signals are constrained to be honest, as in Index Signals
- What keeps signals “honest”?
- ***Handicap Principle***: Costs of signals ensure that males with more elaborate displays will have superior genes for survival

Anyone can grow a sexy signal, but only those with good genes for survival can maintain it.



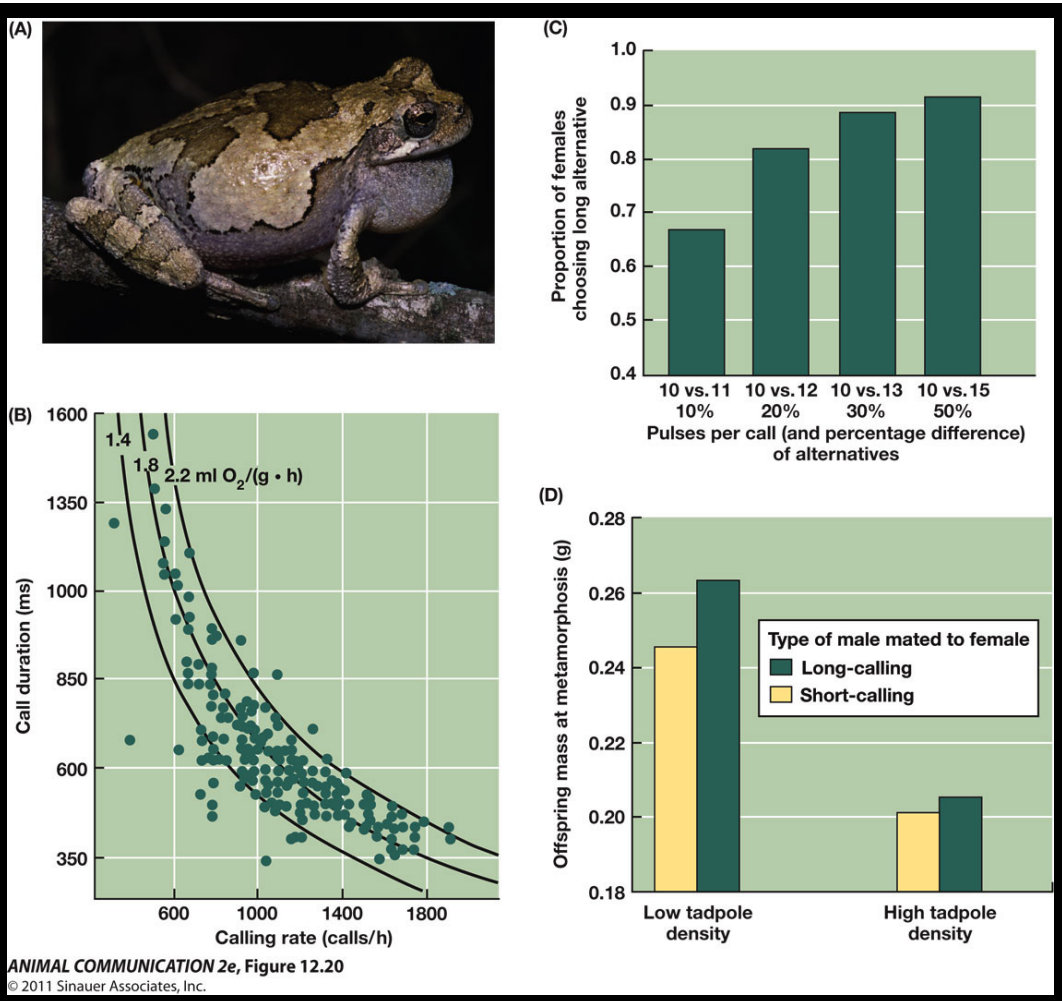
Signal Reliability

- ***Handicap Principle***: Costs of signals ensure that males with more elaborate displays will have superior genes for survival



Zahavi's ~~handicap~~ theory

the cost of producing an intense signal prevents some individuals from using them



Calling male gray treefrog

<u>First: Trait is costly</u>

Signaling is energetically expensive & cost increases with rate and duration.

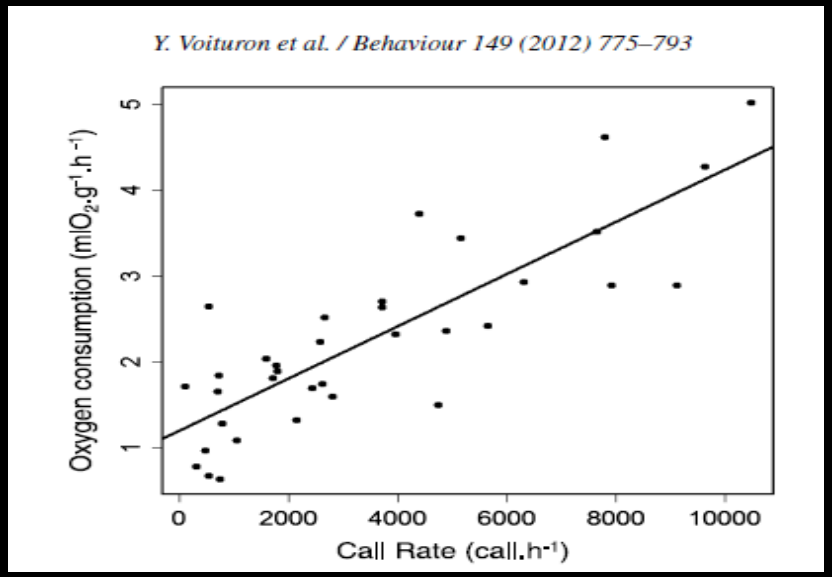
<u>Second: Females prefer costly signal</u>

Females prefer calls with more pulses, i.e. longer calls.

<u>Third: Offspring fitness correlate w cost</u>

In low densities tadpoles sired by long call males s are larger at meta-morphosis than tadpoles sired by short call males.

Signal Costs

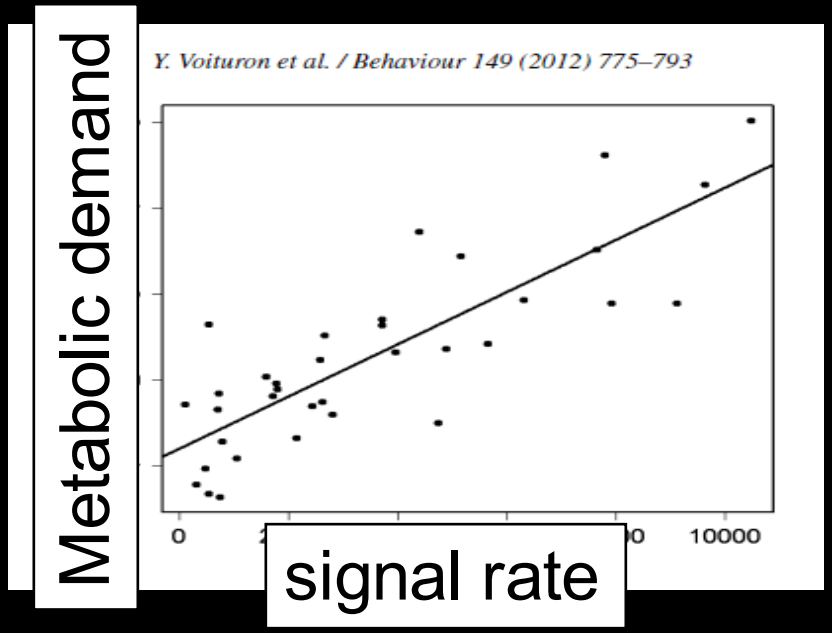


<u>First: Trait is costly</u>

Calling is energetically expensive & cost increases with call rate and call duration.

- ***Energetic Costs***: Animals usually expend energy to produce signals.
- Metabolic rate of all animals tested shows increase with rate of calling or singing

Signal Costs

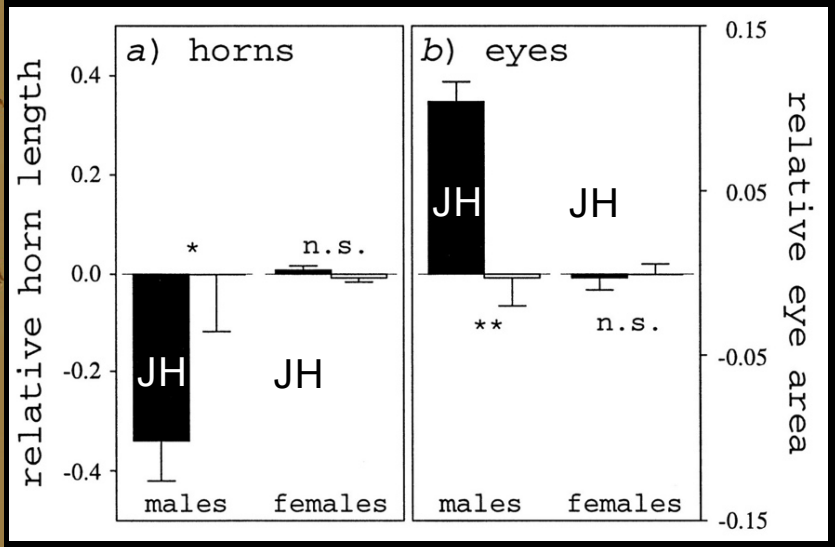


<u>First: Trait is costly</u>

Signaling is energetically expensive & cost increases with rate and duration.

- ***Energetic Costs***: Animals usually expend energy to produce signals.
- Metabolic rate of all animals tested shows increase with rate of calling or singing

Signal Costs

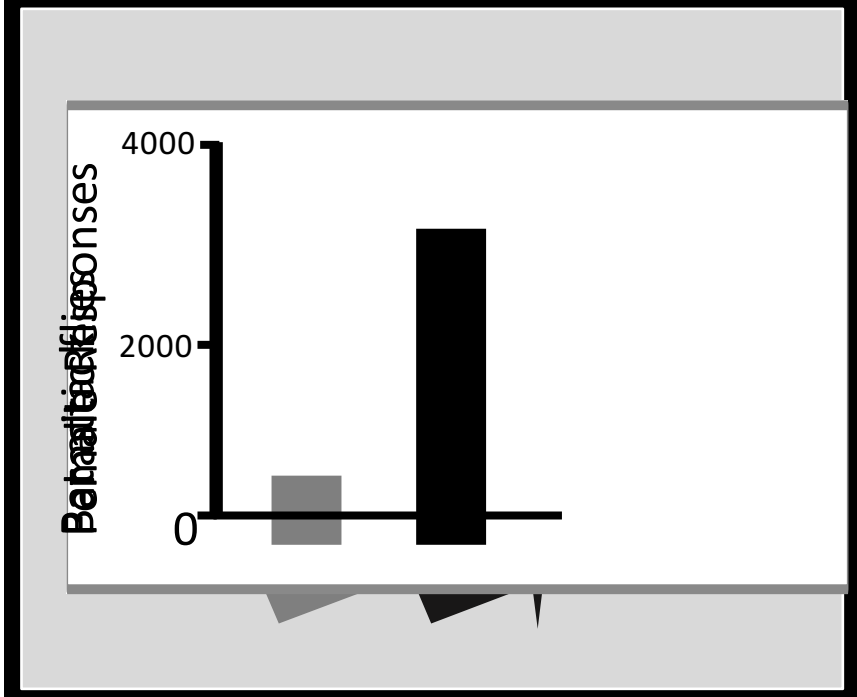


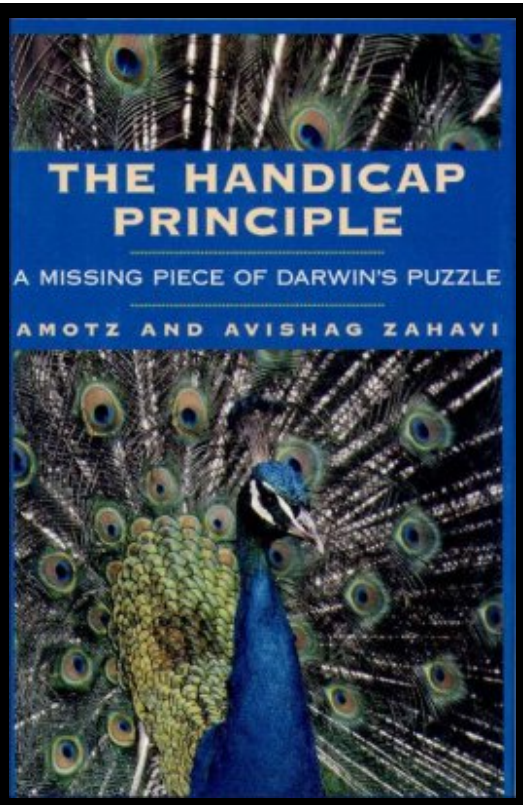
- ***Developmental Costs*:** One usually has to rob Peter to pay Paul to produce a more elaborate trait.
- Treatment with juvenile hormone results in smaller horns but bigger eyes.

Signal Costs

- ***Predation and Parasitism***: When animals communicate they become more conspicuous to intended receivers, but unintended receivers (eavesdroppers) exploit conspicuous signals to find meals.

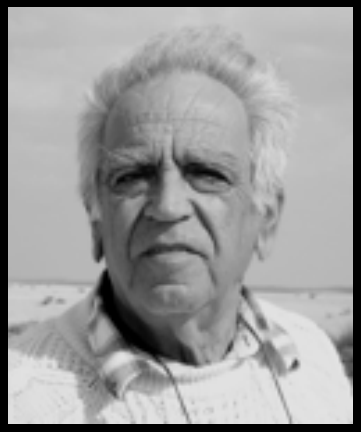
Signal Costs





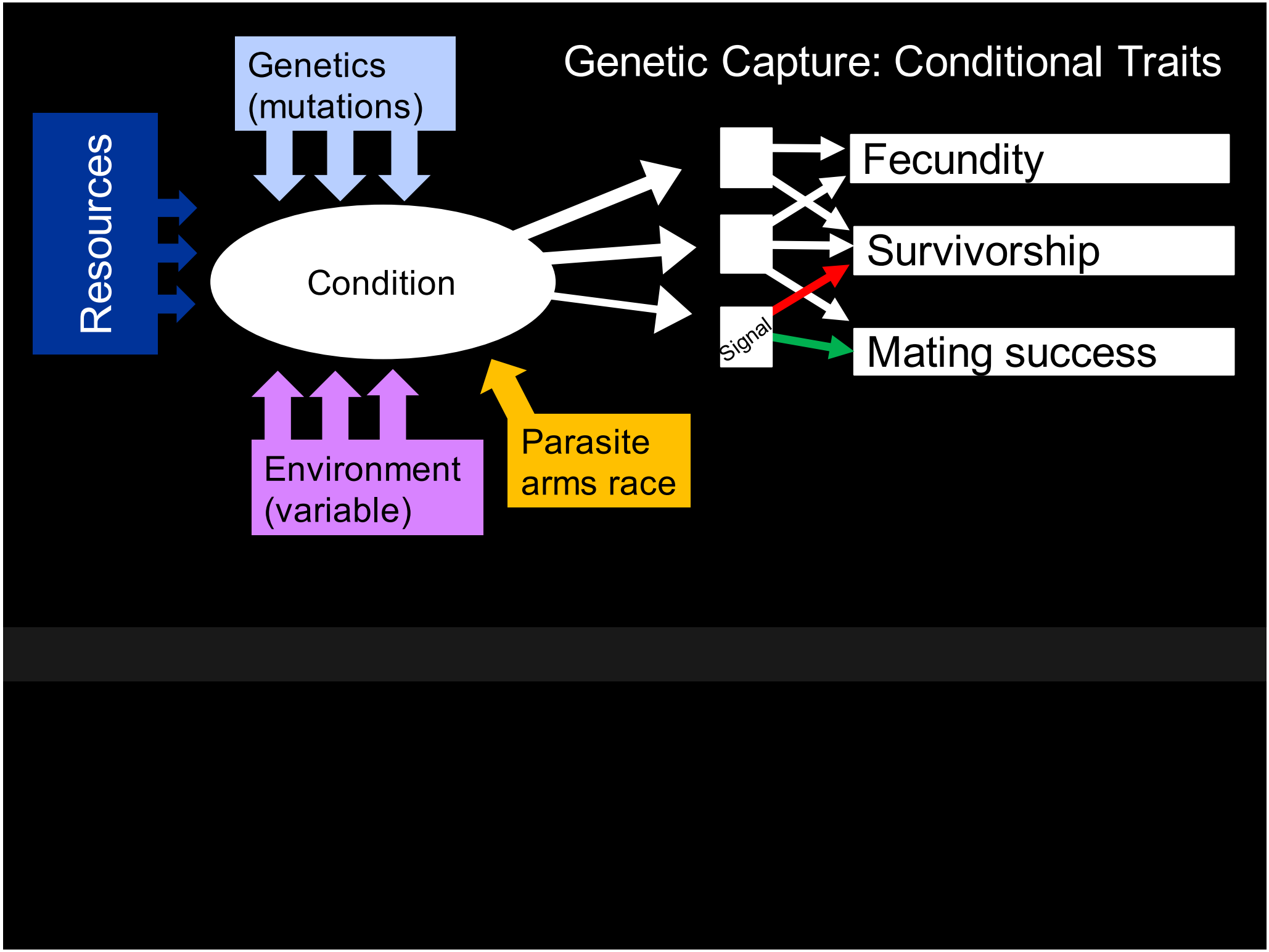
Signal Reliability

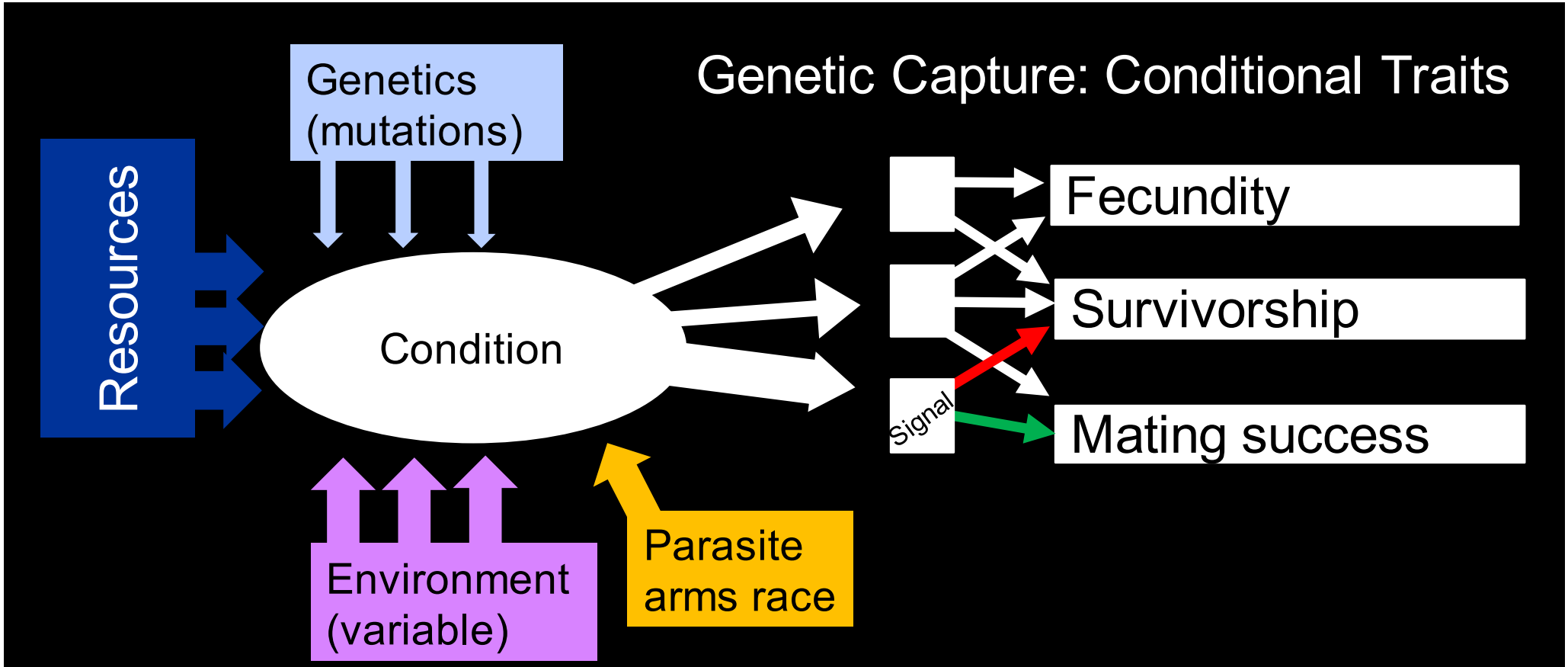
- ***Handicap Principle***: Costs of signa t
  males with more elaborate displays
  superior genes for survival



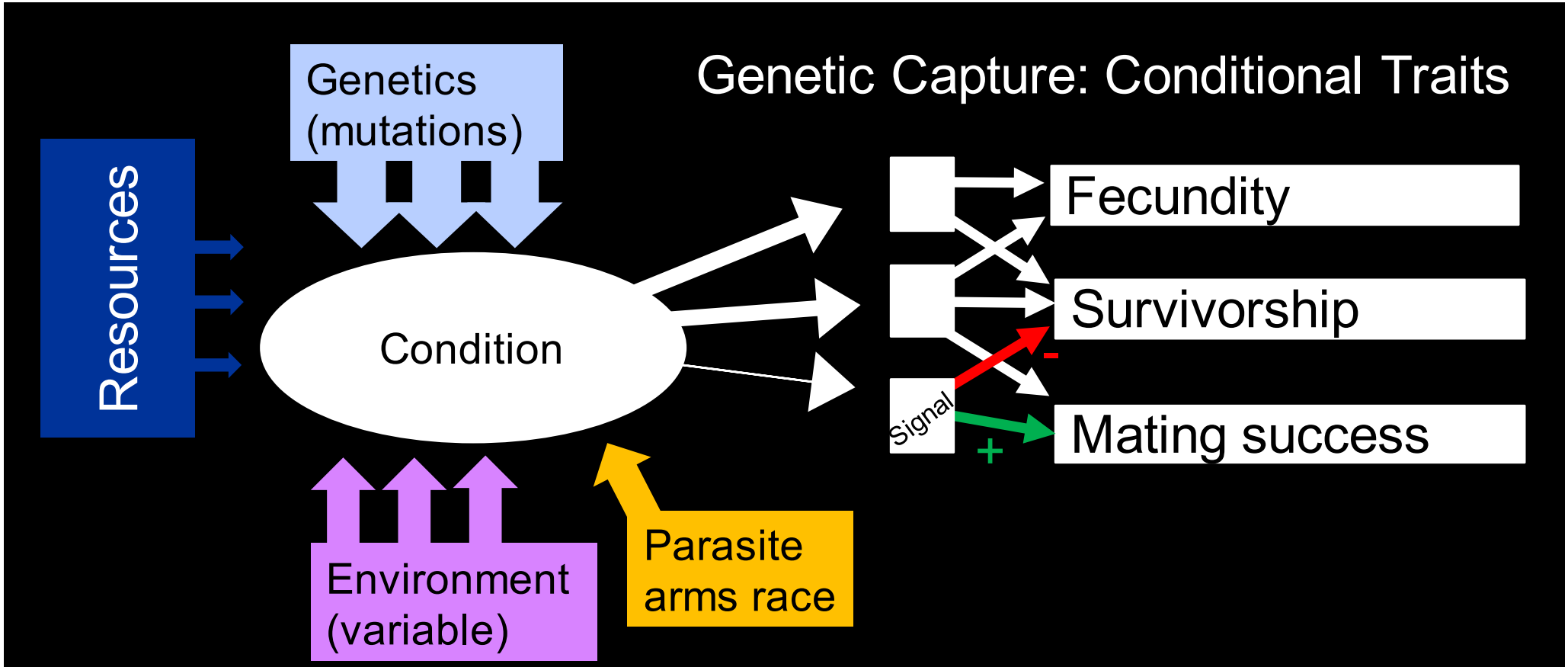
Zahavi's ~~handicap~~ theory

the cost of producing an intense signal prevents some individuals from using them


Genetic Capture: Conditional Traits
Genetics
(mutations)
Resources
Condition
Environment
(variable)
Parasite
arms race
Fecundity
Survivorship
Signal
Mating success



High resources, low mutations = high condition = attractive signal

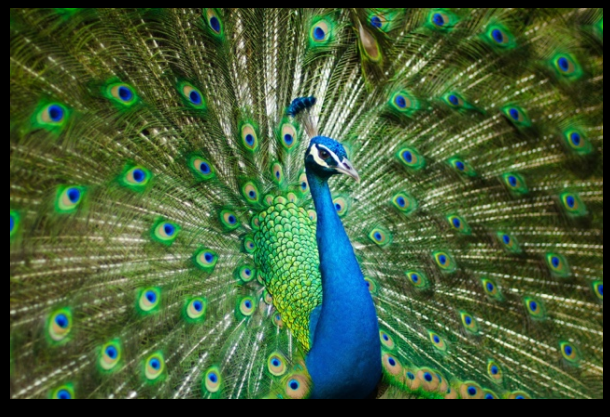


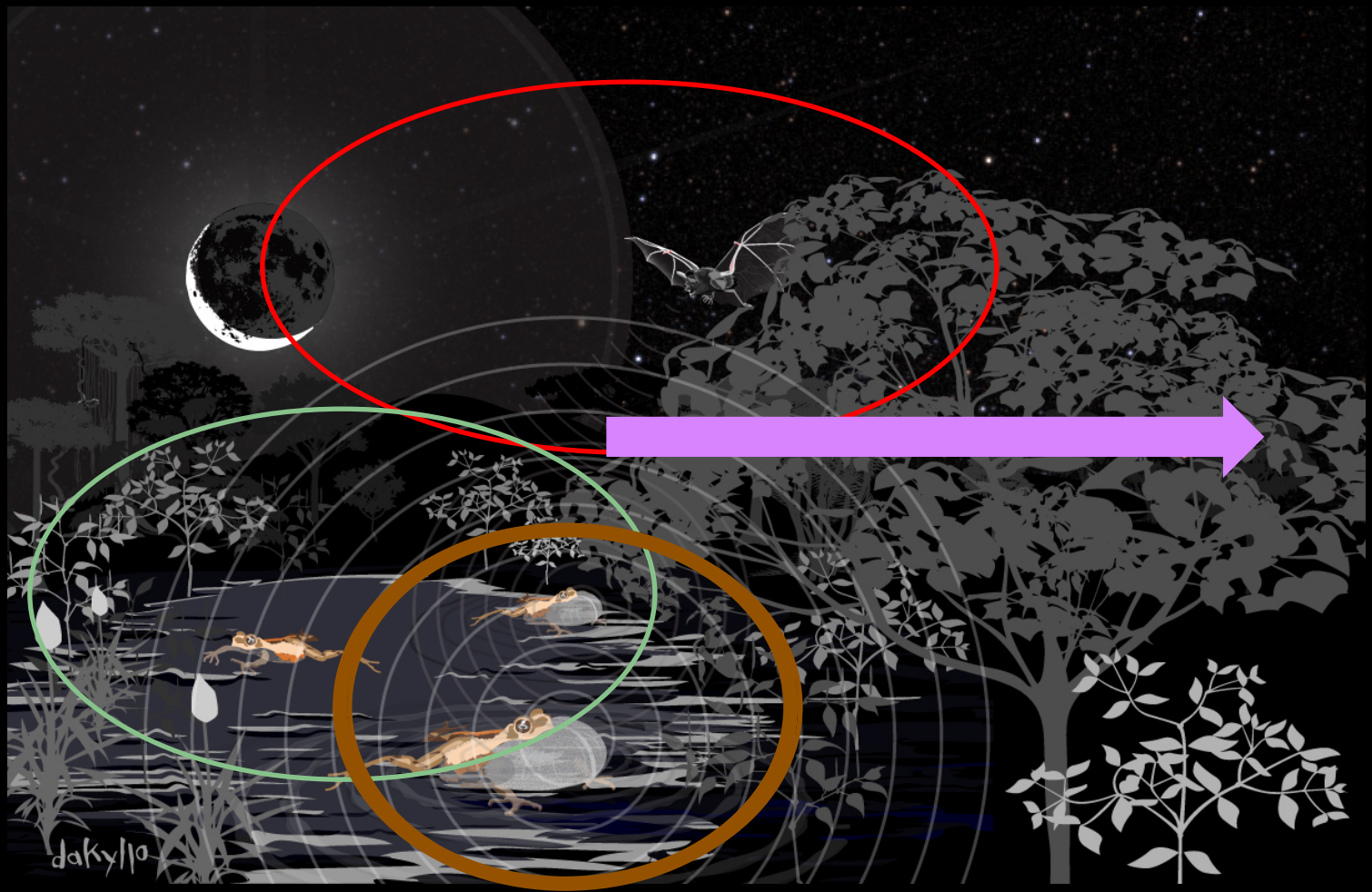
Low resources, high mutations = low condition = weak signal

Genetic Capture: Conditional Traits

Reliable (but ambiguous) Signals

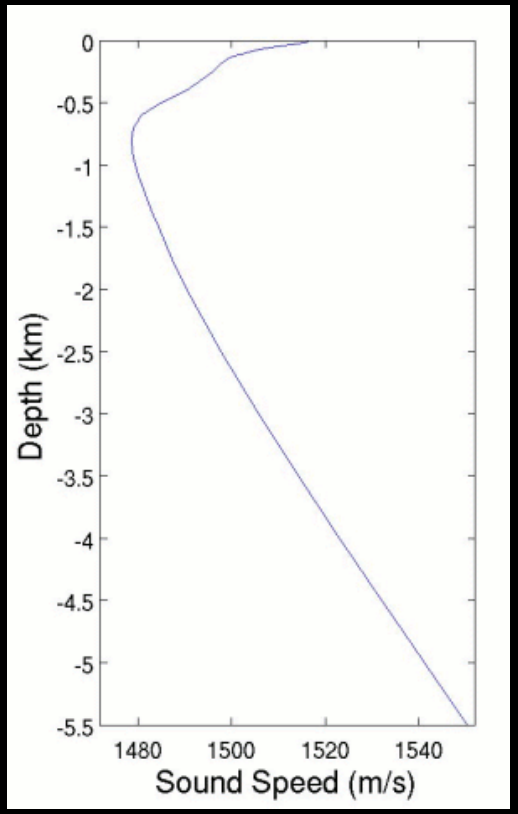
- Signaler's condition is determined by its genes and environment.
- Resources are allocated *Mating Success, Survivorship, Fecundity*.
- Allocation is varied based on *Condition*.
- More allocation to a sexual signal at a cost to *Survivorship*.
- Because *Condition* is dependent on many genes ongoing selection-mutation balance will maintain genetic variation for *Condition*.





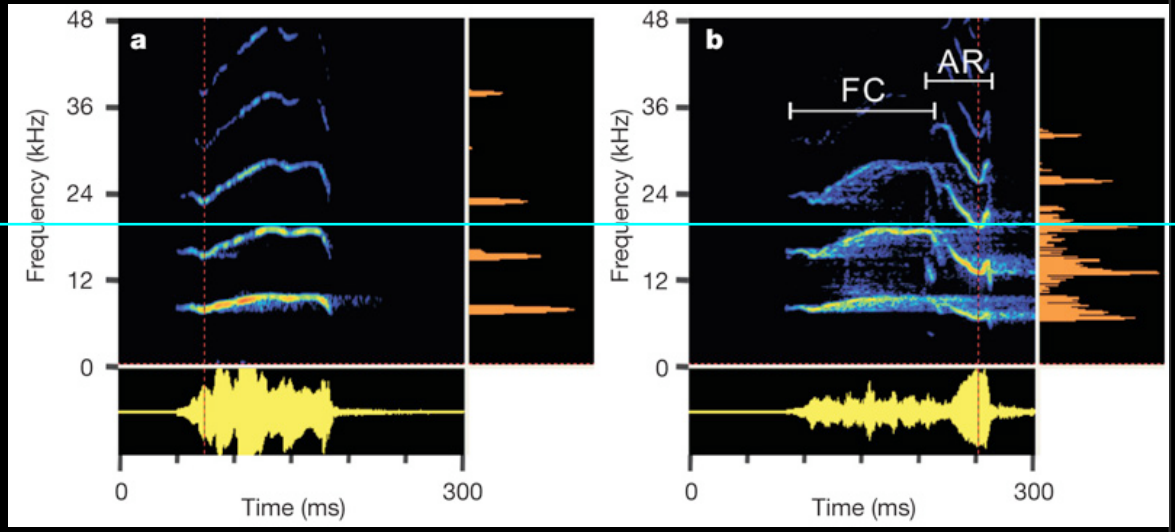
Environment can shape signaling behavior

SOFAR CHANNEL



Environment can shape signaling behavior

male



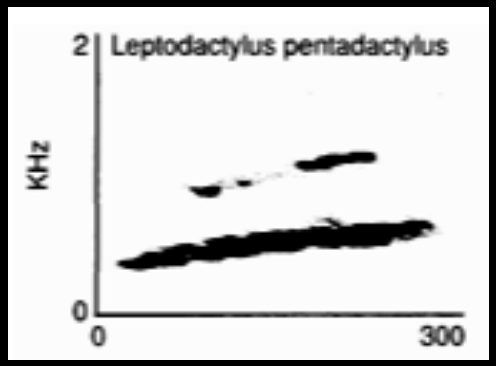
female

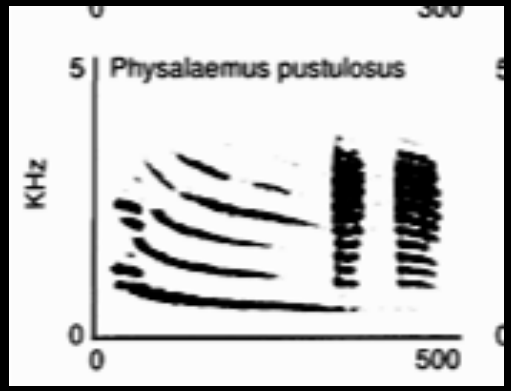
Nature **453**, 914-916 (12 June 2008) | doi:10.1038/nature06719; Received 6 October 2007; Accepted 19 March 2008; Published online 11 May 2008

Ultrasonic frogs show hyperacute phonotaxis to female courtship calls

Jun-Xian Shen[1], Albert S. Feng[2], Zhi-Min Xu[1], Zu-Lin Yu[1], Victoria S. Arch[3], Xin-Jian Yu[5] & Peter M. Narins[3,4]

Environment can shape signaling behavior

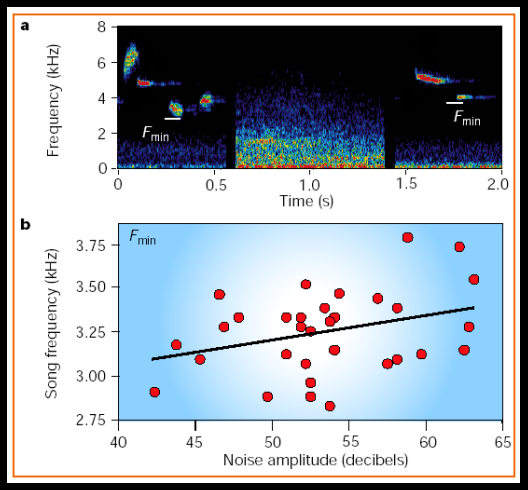




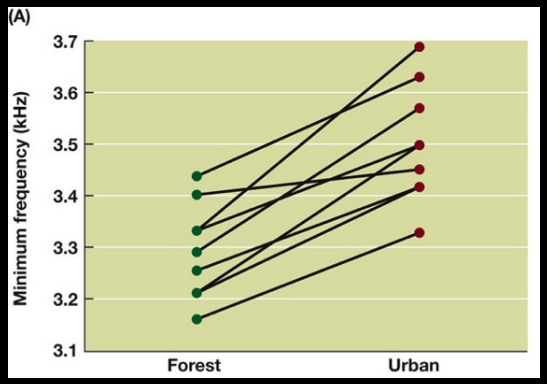
Environment can shape signaling behavior

Urban noise

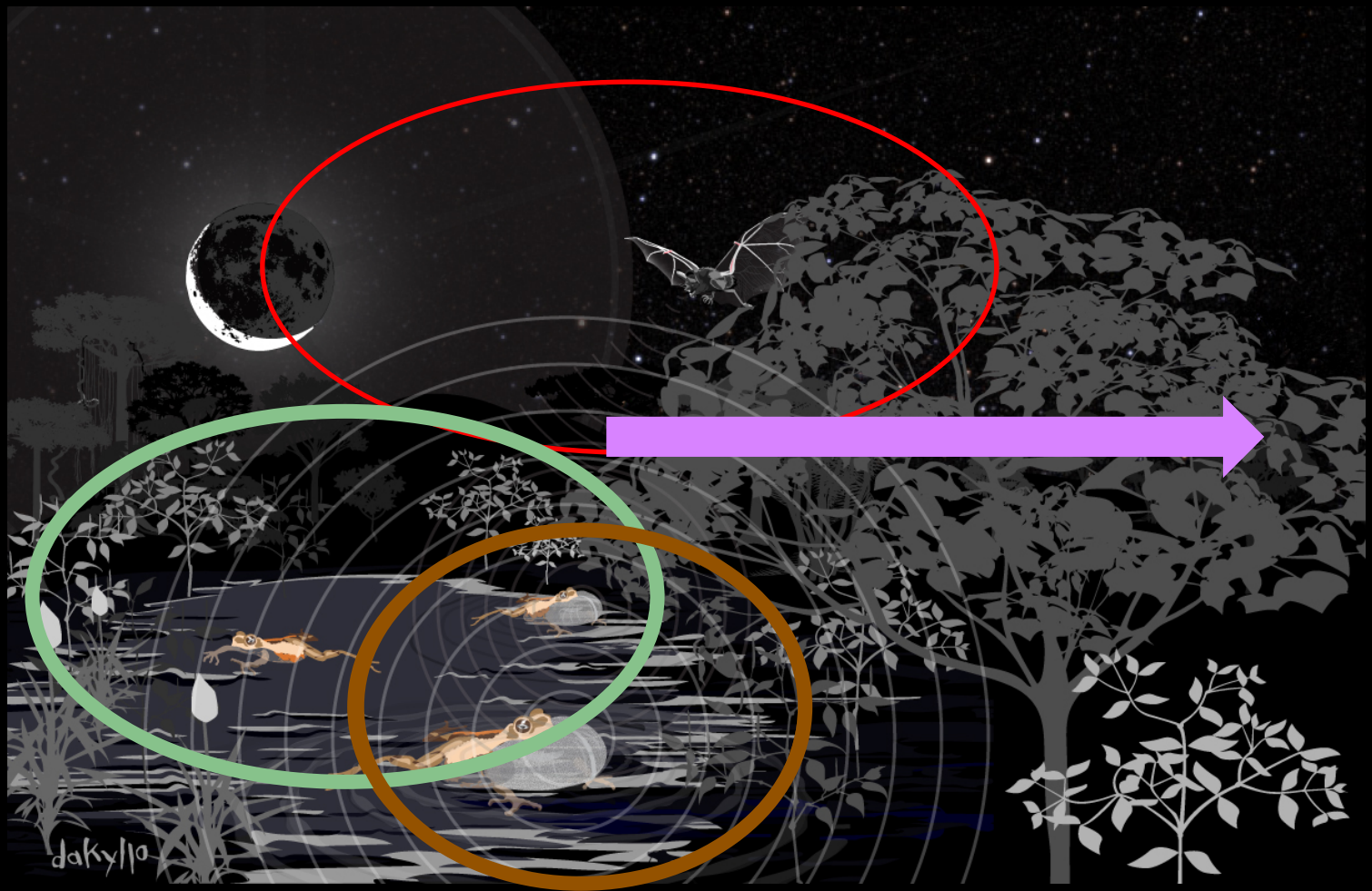
- Noise makes it more difficult to distinguish signals from background.
- Great tits call in a variety of urban and non-urban habitats.



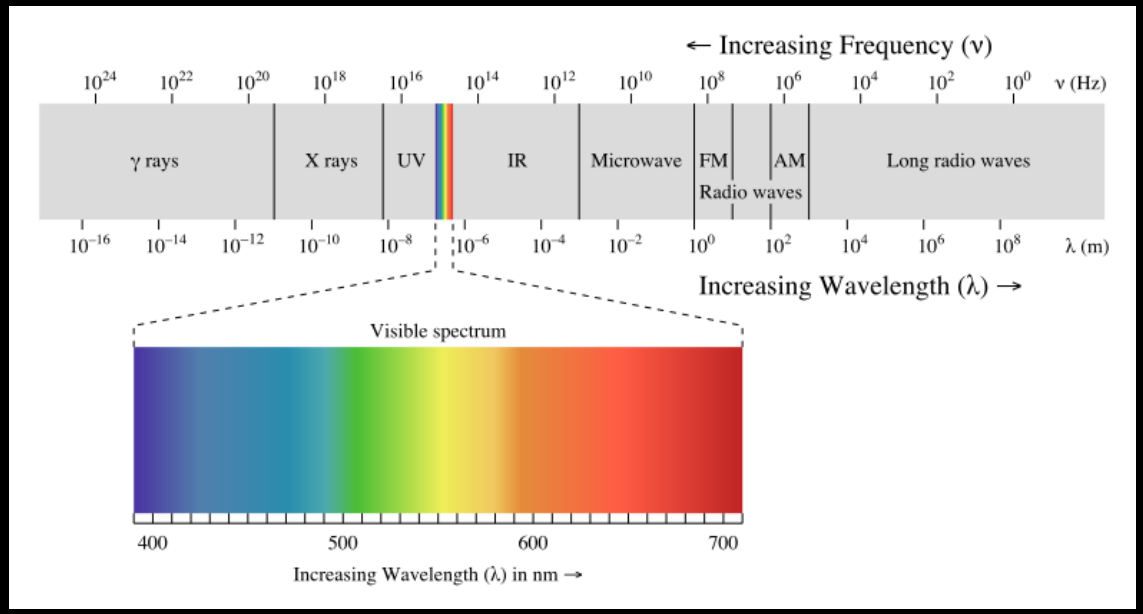
Birds plastically adjust frequency increase in noisy environment



urban populations have increased minimum frequency

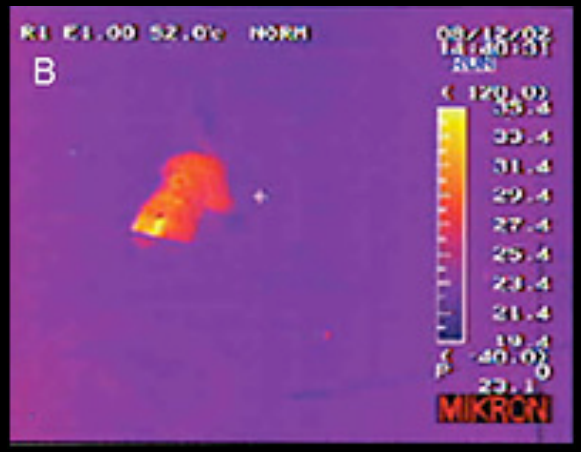


Environment can shape signaling behavior


← Increasing Frequency (ν)
10^{24} 10^{22} 10^{20} 10^{18} 10^{16} 10^{14} 10^{12} 10^{10} 10^{8} 10^{6} 10^{4} 10^{2} 10^{0} ν (Hz)
γ rays
X rays
UV
IR
Microwave
FM
Radio waves
AM
Long radio waves
10^{-16} 10^{-14} 10^{-12} 10^{-10} 10^{-8} 10^{-6} 10^{-4} 10^{-2} 10^{0} 10^{2} 10^{4} 10^{6} 10^{8} λ (m)
Increasing Wavelength (λ) →
Visible spectrum
400
500
600
700
Increasing Wavelength (λ) in nm →

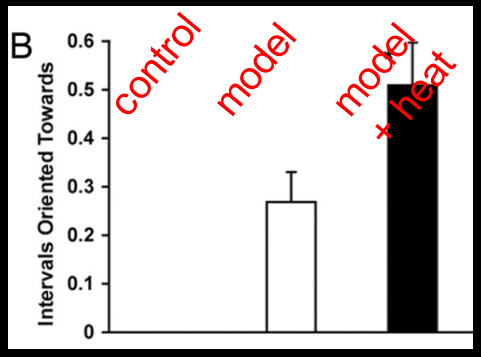

SCIENCEphotoLIBRARY

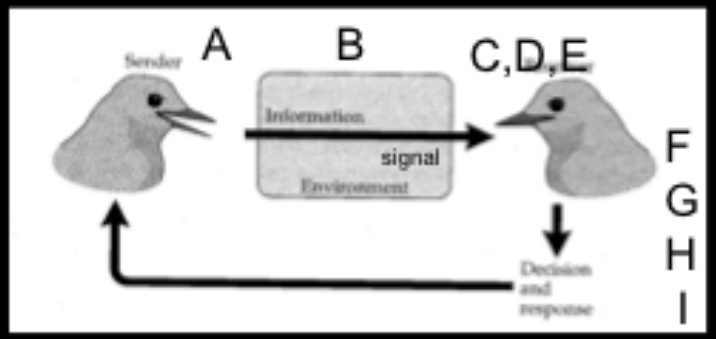
video fail

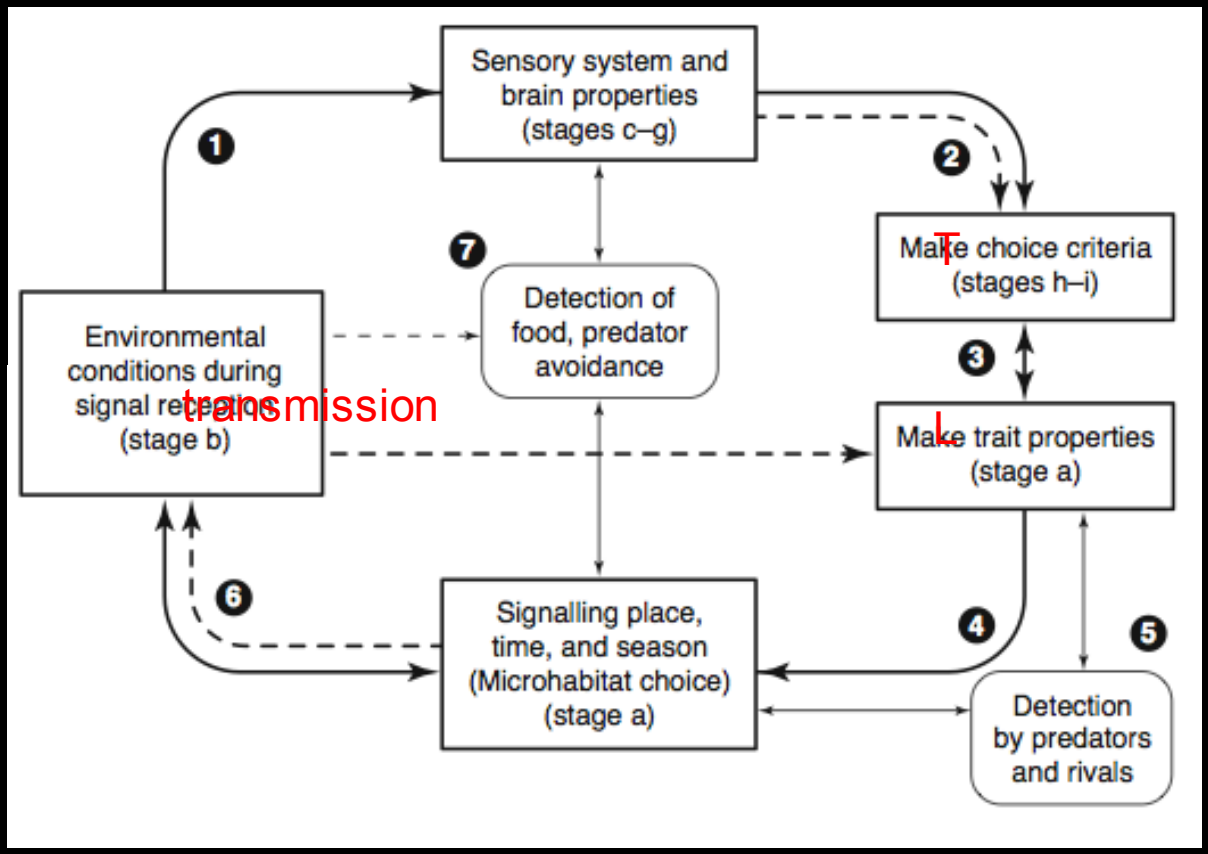


Rundus, Aaron S. et al. (2007) Proc. Natl. Acad. Sci. USA 104, 14372-14376

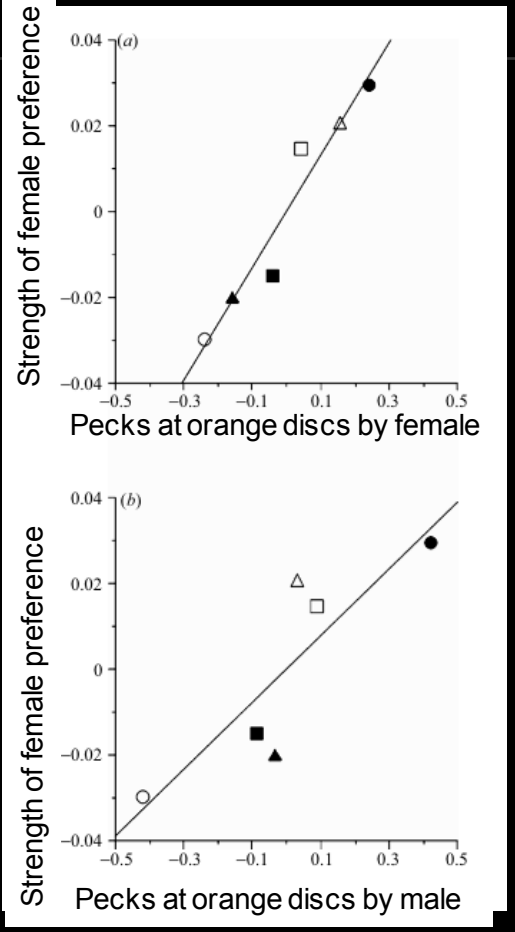
"I' m a big scary Squirrel"




A
B
C,D,E
Sender
Information
signal
Environment
Decision and response
F
G
H
I


Sensory system and brain properties (stages c–g)
Make choice criteria (stages h–i)
Detection of food, predator avoidance
Environmental conditions during signal reception (stage b)
transmission
Make trait properties (stage a)
Signalling place, time, and season (Microhabitat choice) (stage a)
Detection by predators and rivals
1
2
3
4
5
6
7

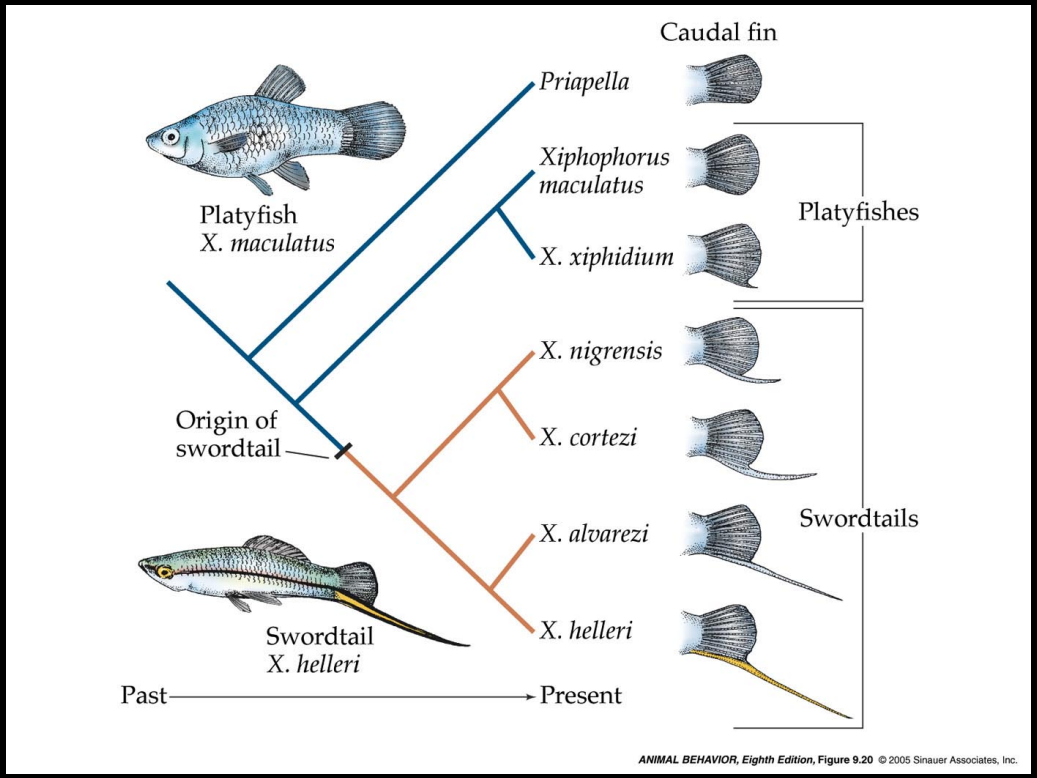
Sensory drive



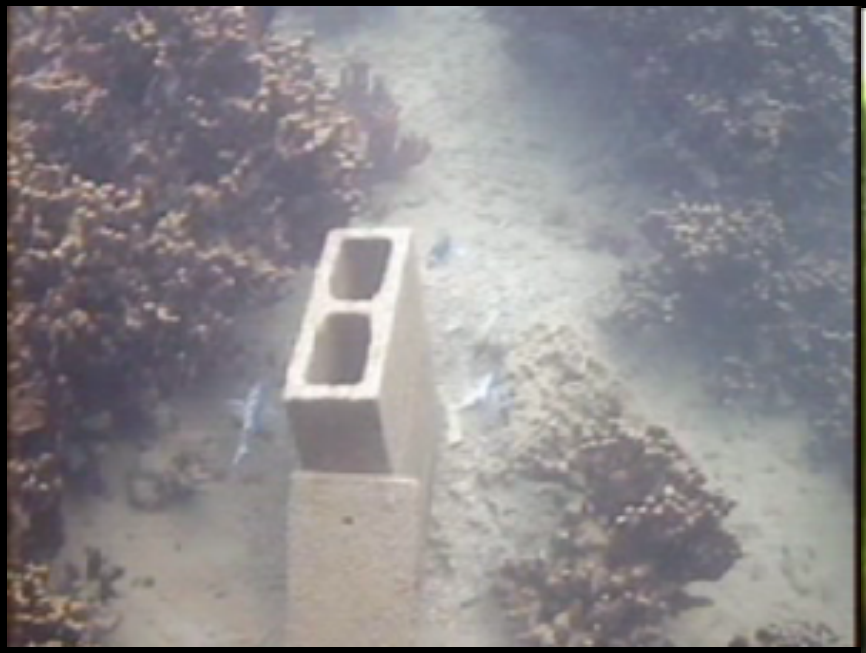
Rodd et al., 2002

Sensory drive

Sensory drive



McGurk Effect

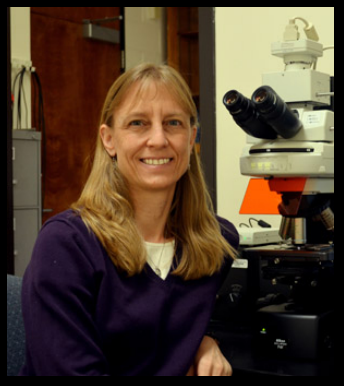


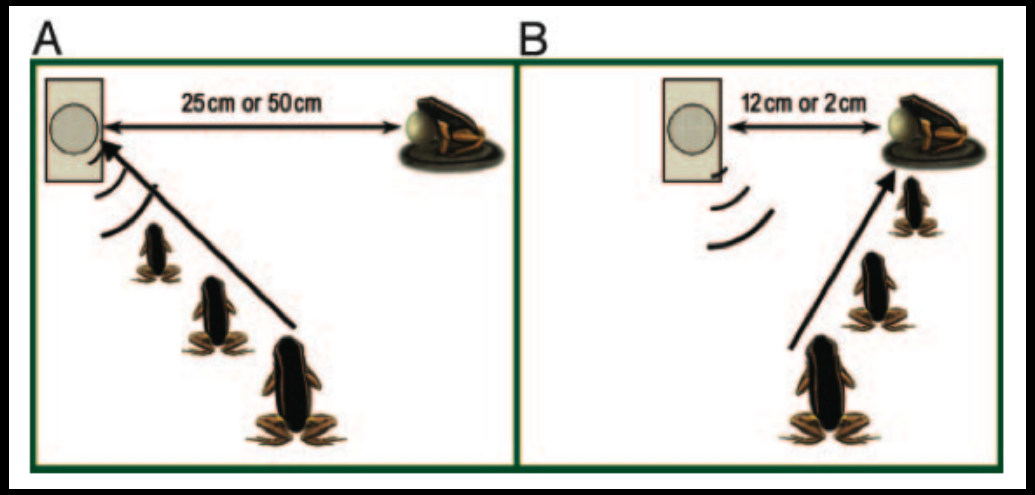
videos

LSU
LOUISIANA STATE UNIVERSITY

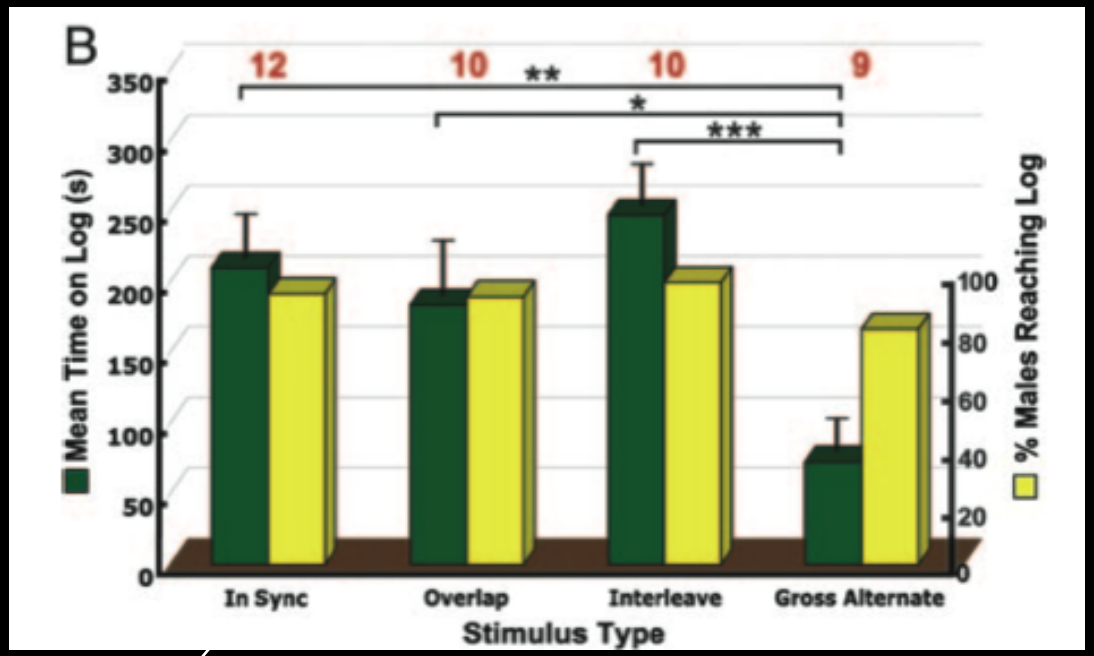
The Maruska Laboratory

Neural Mechanisms of Behavior • Hormones and Sensory Processing • Sensory, Behavioral and Neural Plasticity

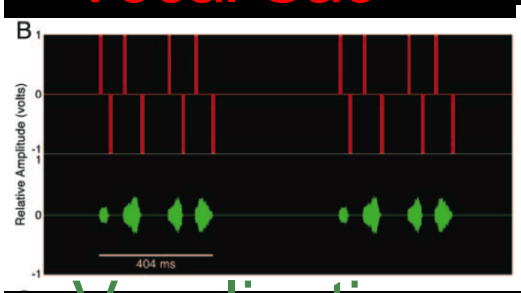


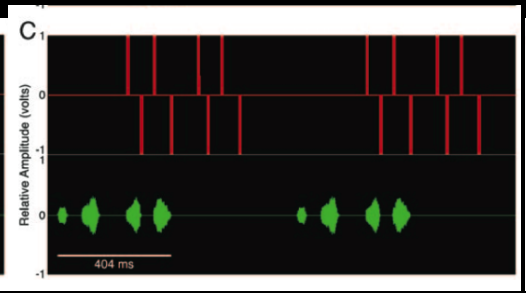


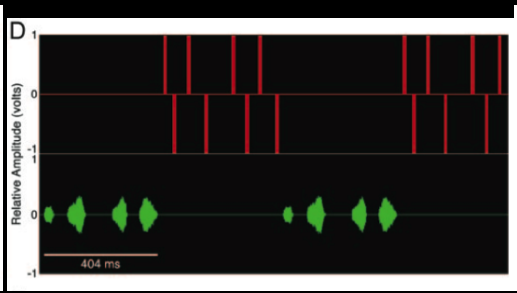
Narins et al 2005 PNAS

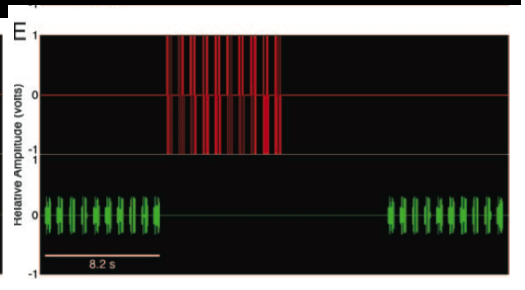


Vocal Sac



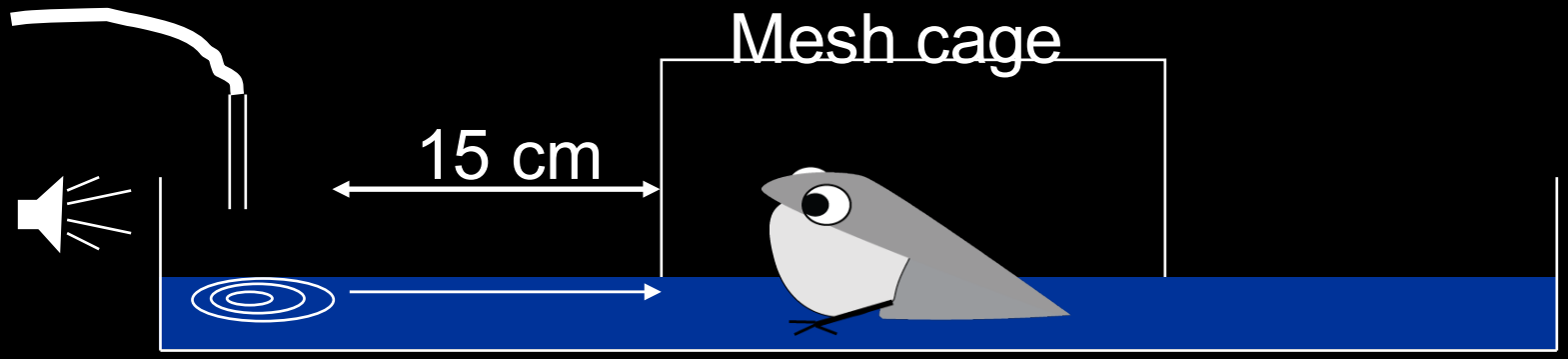


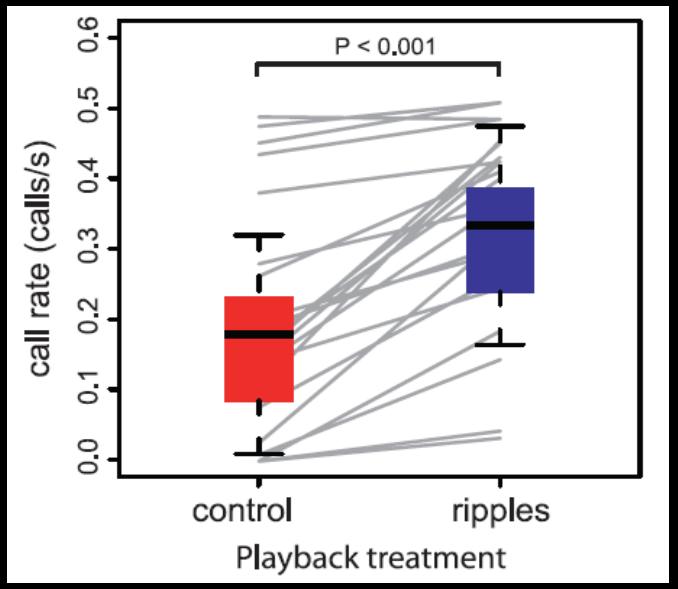




Vocalization

Narins et al 2005 PNAS





- Male tungara frogs are presented calls from a speaker and water ripples from a 'thumper'
- Males called more to multimodal signals, calls + ripples compared to a unimodal control signal, calls only.
- Male did not respond to ripples only.

video