Neural Mechanisms 1

- Basics about neurons ("nerve cells")
- Ethological concepts
- Sensory receptors

http://www.brainfacts.org/
Basics about neurons

Nervous system is made of neurons & glia, as well as other cell types.

Santiago Ramon y Cajal
Nobel Prize 1906
Graham Johnson based this drawing on ultra-thin micrographs of sequential brain slices.
mRNA & protein detection

ZENK mRNA

Red = ZENK protein
Green = vasopressin protein
Yellow = both

http://www.brainfacts.org/
http://www.youtube.com/watch?v=zXLeJFu57Wg
http://www.youtube.com/watch?v=uHeTQLNFTgU
Outline

• Basics about neurons ("nerve cells")
• Ethological concepts
• Sensory receptors
Ethology

• Study of the natural behavior of animals
  – Strong emphasis on wild animals & field work

• Initially, strong emphasis on instincts
  – behavioral patterns that appear in (largely) fully functional form the first time they appear
  – All animals must find food, avoid predators,locate mates, orient and move through their environment etc.
How do we access information about the environment?
- via sensory organs (vision, hearing, smell, touch, etc)
  and nervous system

Only a small amount of environmental information actually reaches our brain…and even less is consciously perceived.

Thus, our perception of the world does not exactly match the “true” & complete information present in our environment.

That tiny part of the environment which is perceived after sensory and central filtering = Umwelt
Perception is a product of
1) stimuli received
2) sensory and neural structures involved in the process of perception

Through natural selection, nervous systems and sense organs have been shaped by the demands & constraints imposed by the habitats in which animals live.
Begging behavior by a gull chick
Lorenz and Tinbergen proposed that simple stimuli, such as the red dot on a parent gull’s bill, can activate (or “release”) complex stereotyped behaviors, such as a gull chick’s begging response.

Sign Stimulus = component of the environment that triggers a specific instinctive behavior
...the neural circuit responsible for detecting the “releaser” and activating the instinct (or “fixed action pattern”)

Innate Releasing Mechanism
Fixed Action Pattern

...complex, stereotyped behavior that is instinctive.

Releaser

↓

Innate Releasing Mechanism

↓

Fixed Action Pattern
Effectiveness of different visual stimuli in activating begging behavior of gull chicks

A supernormal stimulus produces a greater response from an animal than does the natural sign stimulus.
Outline

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Sensory system adaptations & neural mechanisms that shape an animal’s *Umwelt*
Bats

- Donald Griffin & George Pierce: bats fly well in pitch black room

- Bat orientation in a dark room was severely impaired if ears were plugged or mouth was taped!

- Bats emit high energy ultrasonic pulses.

- Bats scan their surroundings with self-generated ultrasounds & detect the reflected signals for localization of objects

- Griffin coined the phrase “echolocation”

- Ultrasound is suited for the detection of small objects due to its short wavelength.

Bat detector: http://www.youtube.com/watch?v=k-Ja9CIMXOE
What is “ultrasonic”?

- **Anthropocentric** definition
  - Above 20 kHz (above human hearing)

- Animal vocal signals are very diverse
  - “Infrasonic” (few Hertz)
  - “Audible” (20 Hz to 20 kHz)
  - “Ultrasonic” (20 kHz to 200+ kHz)
Classification of bat ultrasound

- **Frequency Modulated (FM) signals**
  - broadband signal
  - short duration (<5 msec)
  - downward sweep (FM sweep)
  - bat species that hunt near the ground or in dense vegetation

- **Constant Frequency (CF) signals**
  - narrowband signal
  - longer duration (10 to 100 msec)
  - narrow frequency range
  - bat species that hunt in open spaces

- **Combined CF-FM signals**
The hunting bat

(a) Sonograms (a) brown bat and (b) the greater horseshoe bat.
2.8 Stages of prey pursuit and capture
Images are based on stroboscopic photographs taken at 100 ms intervals. The thin dotted line connects corresponding images of the bat and the insect to show target range. In the approach phase the cries occur at a relatively low repetition rate (the rate is indicated by the solid tick marks separating each frame). As the bat closes within a meter or so, the rate increases dramatically. In the terminal phase the cries come fast and furious. Each number next to the bat and the moth indicates their relative positions in the time frame. The distance closes to zero as the bat captures its meal (numbers 10 and 11). After Kick and Simmons 1984.

Ben Underwood

http://www.youtube.com/watch?v=qLziFMF4DHA&feature=PlayList&p=EA61DB696276FF07&index=0

http://www.ted.com/talks/daniel_kish_how_i_use_sonar_to_navigate_the_world