Sensory Guidance and Oriented Behavior

How organisms respond to external stimuli:
- ORIENTATION: turning response, or oriented response guided by stimulus location or direction.
- RESPONSE SELECTION: choice of response behavior as appropriate to stimulus.
- Nearly every behavior has a component to it that involves orientation.

Examples of Oriented Behavior
- Chemotaxis
- Chemical trail following
- Directional tactile sense
- Sensing compass directions
- Using landmarks and memory

How do organisms sense the direction of a stimulus?
- by detecting the incident direction of the stimulus using an array of detectors
- by comparing two sensors
- by successive comparison of a single comparison in time
- by measure of stimulus gradient with two simultaneous sensors
- with a single sensor compared successively in time.
Bacterial Chemotaxis

- no attractant: cell tumbles
- attractant: cell runs

Taxes

- Orientation relative to a stimulus direction
- Phototaxis: orientation toward the light
- Negative phototaxis: orientation away from the light
- Orientation of a planaria
- primitive photoreceptors provide some directional cue

Trail following in an ant

- normal trail following

Olfactory orientation to prey by a snake

- Snake (Vipera aspis) path of head movements tracks the pathway left by a mouse, recently dead by snake bite, which has been dragged across the 1x1 m arena.
- Dotted line: path of live mouse.
- Circle (hiding place of mouse).

Pheromone Sensing in Moths

- Pheromone trail

Paramecium has a directional tactile sense

- Paramecium avoids contact by reversing direction of swimming
Electrophysiology of Paramecium

From studies by R. Eckert

Orientation to Vibration Sources

Jaques Loeb’s Model for Taxes

Loeb (1918) Mechanistic approach to animal orientation: taxes and kineses. Applies to numerous cases of sensory guidance: light, heat, odor, sound, gravity, electroreception.

Using the sun to orient flight

Food is located at a distance from hive. The sun is used as the landmark. The direction of the dance corresponds to the direction of food relative to that of the sun. Gravity is substituted reference.

Orientation in Digger Wasps

(Tinbergen and Kruyt, 1938)

Digger wasp leaves nest and circles opening for 6 second. Pine cones are placed there during time she is belowground. Female returns to provide food. Pine cones have been moved. Thus, behavior is guided by learning.

Special Senses

Insect eye: sensitive to polarized light. Pigment molecules are embedded in membrane at random. Membranes are organized into structured microvilli. Orientation of pigment in rhodopsin now has a preferred alignment relative edge of microvilli. Senses polarized light.
Vertebrate Rod

R. Wehner

polarized light sensitive area of honey bee is essential to orientation to the sun’s compass.

Ommatidia in dorsal POL are sensitive to UV light.

The rhabdom does not twist in this area (so the plane of the microvilli are aligned only in one direction) area retain polarization sensitivity.

Other areas: twist destroys polarization sensitivity

Orientation in the desert ant, Cataglyphis bicolor

Use of sun depends upon polarized light sensitivity in UV.

Eye is organized to match the pattern of sky polarization. Ant gets intensity readout which is directionally sensitive.

Land and Collett (1974):
Visual chasing in flies

A classic paper in neuroethology.

Demonstrates visual guidance is controlled by angular position of target, and by angular velocity of target across the retina.

Demonstrates that males have “fovea” dorsal region of high velocity and temporal resolution.

How do electric fish locate sources?