# 9.20  M.I.T.  2013

## Lecture #13

Early evolution of behavior.

Genetics, learning and plasticity.

Navigation and migration.

- A novel stimulus results in a **conflict** between expected input and perceived input.

- The autonomic changes are the same as measured by a lie detector:  Lies cause a different kind of conflict.

I reported the finding that the autonomic responses to stimulus novelty are the same as the responses measured by a lie detector.

What can explain this fact?

The autonomic nervous system and the orienting mechanisms of the midbrain respond to any **conflict.**

A conflict can be between an internal (CNS) model of the world representing expected stimulus inputs and the actual inputs – which are always being compared with the model.

A conflict can also be between an internal representation of what is known to be true and a cognitive system that generates output, e.g., to the speech system.  In most cases, these two systems cannot be isolated from each other.  (For a minority of individuals, they can be, e.g., individuals who are classified as psychopaths or sociopaths.)

Do you think that animals can lie?
Could this be studied with lie detector technology?

*Scott, ch 4:* **C. Learning, pp 66-75**

9.   Why have scientists often chosen to study learning in animals like sea slugs and snails and certain insects?  Give more than one reason.

# *Aplysia californica*



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9.    Why do scientists choose to study learning in animals like sea slugs and snails and certain insects?  Give more than one reason.

> ➢ Simpler nervous system, fewer neurons
> ➢ Individually identifiable cells and synapses
> ➢ Predictability of responses

Next, Scott discusses a simple kind of learning that is known as "classical conditioning." It has been studied in many laboratory experiments. Often it is called Pavlovian conditioning.

You should be able to describe the conditioning procedure.

(Ivan Pavlov and is followers in Russia interpreted all learning in terms of conditioned reflexes. Their teaching became state policy in the Soviet Union, and scientists who did not go along with it were in danger of persecution.)

10. The author makes a mistake on p 71 in his description of classical conditioning. What is it?

Scott's statement: "The treatment received by one group of animals involved the application of the US and then the CS immediately after it every 5 minutes (paired CS-US) … … After a training period of 30 trials the animals in the paired CS-US group exhibited a much stronger response to the US than did those animals in the unpaired US-CS group…"

10.  The author makes a mistake on p 71 in his description of <u>classical conditioning</u>.  What is it?

- In classical conditioning, a CS is presented, and <u>then</u> the UCS (paired in this order)  [Scott's US = UCS]

- Originally, before any learning, the UCS→UCR

- After learning: CS→CR

  • The CR is very similar or identical to the UCR.

Examples:
-- Conditioned leg withdrawal (using the innate flexion reflex in response to painful stimulus)
-- Conditioned eye closure.

*Scott, ch 4:  C. Learning, pp 66-75*

11. (*Social learning*)*:* In your own development, how have you shown learning by imitation and by mimicry?  What is the difference between these two processes?

<p style="color:blue">p 74-75</p>

11.  (*Social learning*)*:* In your own development, how have you shown learning by imitation and by mimicry?  What is the difference between these two processes?

p 74-75.  Making the following distinction is often difficult.

**Imitation: there is immediate reward.**

**Mimicry: there is no tangible, immediate reward.**

12.  Imitation and/or mimicry have been observed in many non-human primates.  Briefly describe an example of such learning in non-primate animals, not found in the Scott textbook.

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**Kitten** imitates the hunting of its mother, filling in what it has inherited by linking a series of FAPs, and by adding coordination. Without this imitation, it will not have sufficient motivation to hunt.

**Jackdaws**: Remember the Konrad Lorenz story of how they learn the identity of enemies.

**Songbirds** (p. 75): Males learn songs from adults by mimicry.

**Newly hatched chicks**: The experiment described by Scott, p 75: Day-old chicks can learn what seeds not to peck at after they observe another bird learning to avoid one type of seed (because it was very bitter).

# Scott ch 4:   *D. Navigation, pp 76-86*

13. Describe Niko Tinbergen's experiment on **landmark orientation** in the female digger wasp.

   *These experiments were conducted on several different species of wasp by Tinbergen and his students and by another investigator, as described in three chapters of Tinbergen's book "Curious Naturalists" (one of which was assigned reading).*

Niko Tinbergen, *Curious Naturalists, "The bee-hunters of Hulshorst."*

**First**, pine cones are placed around the nest. After some time, they are moved as shown.

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*(Philanthus triangulum* Fabr.)  16

*From studies by Baerends:*
See Niko Tinbergen,
*Curious Naturalists, "The sand wasps" (Ammophila campestris)*

Figure removed due to copyright restrictions.

a. **Stage 1**

b. **Stage 2**

c. **Stage 3**

**What does the wasp have to learn and remember?**
**1) Locations of nests, 2) contents of nest after inspection.**

# Tests of homing by sand wasps:

Figure removed due to copyright restrictions.

Niko Tinbergen, *Curious Naturalists, "The sand wasps"*

**What does a wasp have to do in order for landmark orientation to work?**
**Why does it sometimes fail in these experiments?**

# Niko Tinbergen, *Curious Naturalists, "The sand wasps"*

Figure removed due to copyright restrictions.

# Observations of sand wasps
## by *A*. Adriaanse, *B*. Baerends

**(Originally thought to be the same species)**

Figure removed due to copyright restrictions.

*Conclusion:  They were observing two different forms, later named Ammophila adriaansei and Ammophila campestris.  It was Adriaanse's careful  comparisons, verified by morphological studies of wasps sent to Wilcke by Adriaanse, that led to this conclusion.*

Scott ch 4:  *D. Navigation, pp 76-86*

14.  What causes the problem of "photo pollution" for hatchling sea turtles?  What are two methods humans can use to improve the survival of the turtles faced with such photo pollution?

p 77 box [mentioned in earlier class, on how FAPs can become maladaptive]

# Animal navigation problems can be caused by humans: the case of sea turtle hatchlings

- Sea turtle hatchlings have strong positive phototaxis.

- As turtles evolved, the strongest light was almost always seaward.

- But now they encounter  "Anthropogenic photo pollution"
  - Causes: electric lights, also beach fires.

Solutions to the problem: Based on studies of attraction/ aversion to lights with different properties.
  - Less attraction to lights of colors on the spectrum from yellow to red.
  - They don't like flashing lights.
  - Conclusion from the studies: Use flashing orange lights.
  - (In addition, beach fires should be prevented in hatching areas during hatching season.)

Scott ch 4:   *D. Navigation, pp 76-86*

15.  To return to a starting point, both humans and ants use "dead reckoning" (deduced reckoning) to judge positions, directions and distances.  What is a likely difference in sensory cues used to make the necessary judgment?

See the next slide

# Dead reckoning in humans & ants

- Internal cues ( e.g., vestibular) used by humans,

- External cues (position of sun, visual landmarks) used by ants

- Desert ant of Sahara desert *Cataglyphis fortis* (p 80): use of sun position.
  - What does it do if sun has moved?
  - What does it do if the sun is hidden from view?
  - Recent work on two species of desert ants by Rudiger Wehner and students (talk in BCS, Oct 6, 2011)   Next slide

- Wood ants (p 80-81): visual landmarks; skyline features. Syrian hamsters do this also.

- See also p 81: another wood ant's use of vision to judge distances.
  - Use of the elevation of the top of a wall on one side, judged by angular elevation

*How do mammals and birds judge distances?*

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# Scott ch 4:   *D. Navigation, pp 76-86*

16.  What cues do homing pigeons use to direct their flight home from hundreds of miles away?

First, how do they know the right direction? Second, when close to home, how can they find the exact position of the loft?

p 84-85 box  (compass and map)

# Scott ch 4: *D. Navigation, pp 76-86*

16.  What cues do homing pigeons use to direct their flight home from hundreds of miles away?

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Multiple cues can be used.

- Compass direction: use of sun, or earth's magnetic field.

- Map of vicinity of goal
  - Visual landmarks
  - Olfactory cues
  - Possibly: patterns of ultrasound

Scott ch 4:   *D. Navigation, pp 76-86*

17. How does the Morris water maze provide evidence for a cognitive map in rats or mice?

How could you test for the sensory cues these rodents are using to solve the problem in this maze?

What cues do the animals actually use?

How do we know this?

9.20 Animal Behavior
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