Two forms of behavioral plasticity in which to explore the nature/nurture debate

Behavioral development

• Changes in behavior through ontogeny, as adult behavioral repertoire develops

Learning

• Adaptive behavioral flexibility at a particular life stage

Alcock treats these as two different manifestation of a general phenomenon: the flexibility of behavior in adapting the individual to specific environmental conditions
Traditional (psychological) learning theory

- Learning is viewed as an unconstrained process (all nurture, no nature)
- Two assumptions underlying this view:
  - **General Process Assumption**: all learning, in all organisms, is mediated by similar processes
  - **Equipotentiality Assumption**: all stimuli and responses are have equal potential to be learned
Associative Learning: the focus of traditional “learning theory”

**Definition:** animal’s behavior changes as result of experiencing association between two events (E1 and E2)

**Classical (Pavlovian) conditioning:**
- E2 (intrinsically meaningful *stimulus*)—leads to reflexive response
- E1 (arbitrary *stimulus*)—comes to trigger response if experienced prior to E2

```
E1       E2  →  Response
Bell     Food →  Salivation (unconditioned)
Bell     →  Salivation (conditioned)
```

**Instrumental/Operant/Trial-and-error conditioning:**
- E2: an intrinsically meaningful *stimulus* (e.g. food or pain)
- E1: initially arbitrary *action*—strengthened or weakened when associated with E2

```
E1(action)          E2(reinforcement)
Press Bar           Food
↑  reinforcement
```

*Traditional learning theory was about search for universal “laws” of learning*
Modern View of Learning: The Mind as a “Swiss Army Knife” (Leda Cosmides and John Tooby)

• Learning capacities evolve as required for special problems
  • No Equipotentiality
  • Special purpose rather than general processes
• Differences in learning ability (between or within species) should be expected as a result of differential natural selection
• Learning is "constrained" as a result of the balance between the benefits and costs of particular learning abilities.
Specialized learning abilities--

**Conditioned taste aversion:** a “constrained” version of classical condition designed to avoid toxic foods with delayed effects

<table>
<thead>
<tr>
<th></th>
<th>E1</th>
<th>E2</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classical conditioning:</td>
<td>Bell</td>
<td>Shock → Withdraw (UR)</td>
<td></td>
</tr>
<tr>
<td>Multiple trials</td>
<td>Bell</td>
<td></td>
<td>Withdraw (CR)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1-2 sec</td>
<td>Learning not permanent</td>
</tr>
<tr>
<td></td>
<td></td>
<td>several hours</td>
<td></td>
</tr>
<tr>
<td>Cond. taste aversion:</td>
<td>Taste</td>
<td>Nausea → Suppress eating (or vomit) (UR)</td>
<td></td>
</tr>
<tr>
<td>Single trial</td>
<td>Taste</td>
<td></td>
<td>Suppress eating (or vomit) (UR)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Learning virtually permanent</td>
</tr>
</tbody>
</table>

How these differ:

- E1-E2 latency that is effective for learning
- Number of trials needed for good learning
- Permanence of learning

Features of Conditioned taste aversion seem appropriate to problem
Conditioned Taste Aversion cont’d:
Cue specificity (violates Equipotentiality Assumption)

**Bright-noisy water experiment (rats)**
- Rats have choice between two water tubes
- Tasty water (saccharine)
- Bright-noisy water (light & buzzer)

**Results:**
- Rats avoid light/sound if reinforcer is shock
- Rats avoid taste if reinforcer is illness

**NOTE:** There are also species differences in cue specificity
- Mammals: readily associate odors and tastes with illness
- Birds: readily associate visual stimuli with illness

See also Alcock Fig. 4.23
Constraints on flower learning by insects
(and the ecological/evolutionary consequences of such constraints)

What nectar-feeding insects have to learn:
• recognition: colors, shapes, odors of rewarding flowers
• how to extract food from blossom

The constraint: insects forage more efficiently if they stick to one flower type (cost of being jack of all trades but master of none)

The consequence: this may favor evolution of different morphologies in flowers (so that each species can depend on loyalty of bees that have learned to handle it)
Evidence for specialized spatial learning mechanisms in birds and mammals

- Correlation between space use patterns and brain morphology (animals that rely more heavily on spatial memory have bigger brain regions devoted to spatial memory)

- Correlation between space use patterns and capacity of spatial memory: Clark’s nutcrackers remember locations of thousands of stored pine seeds, and perform better on nests of spatial memory

![Graphs showing retention intervals for different species](image)

Alcock Fig. 4.23
Species-specific sex differences in spatial memory: again, space use is correlated with spatial learning ability

Meadow voles: males “polygynous,” and have larger home range than females
Prairie voles: monogamous, and male and female home ranges are similar

In meadow voles, male spatial learning is better than that of females
In prairie voles, spatial learning is similar in the two sexes
Why learn?

Learning has costs (i.e., is not necessarily beneficial)
- Time cost
- Energy cost (for brain tissue)
- Cost of making mistakes initially

What are compensating benefits?
- Dealing with variable environments?
- Environment can’t be too variable: what you learn today has to be useful tomorrow
- Example: conditioned taste aversion--learning to associate odors (rather than other stimuli) with bad effects of food
Complex Learning Mechanisms for Complex Learning Problems?

What do we mean by “simple”?

- simple encoding of experienced events
- minimal internal processing of information acquired by animal
- Examples: habituation, associative learning

Complex learning:

- animals can generalize to novel situations, or
- combine prior experiences to generate new knowledge
- Caution: we must be parsimonious in our explanations!
Learning of novel feeding techniques: Observational learning or socially facilitated trial-and-error learning?

Hypotheses
H1: Observer watches how successful forager does it, and imitates body movements to achieve same goal

H2: Each individual discovers techniques for him/herself. Observer learns faster simply because of being attracted to food source
Vocal learning in African Grey Parrot

Alex: a parrot with a very large vocabulary
- No evidence of syntax or grammar--just sounds correlated with stimuli or outcomes (e.g., rewards such as cork)
- Irene Pepperberg uses language to study Alex's knowledge of concepts such as "same" or "different"
- Hypotheses
  - True concept learning?
  - Associative learning linking sounds to situations
  - Clever Hans effect?

Irene: “Alex find same”
Path integration

- Nesting animals (even insects) compute straight homeward path after circuitous outward path

Path integration results in new knowledge that is not part of prior sensory experience

- No way to explain it in terms of standard associative learning: must be a distinct learning mechanism
Specialized learning abilities--

**Habituation** (a type of "non-associative" learning): a mechanism for modulating reflexive responses to environmental stimuli

Gill withdrawal in *Aplysia* (a marine slug)

Initially strong response to Water Pik

Weaker response after several presentations

Strong response again after animal is goosed with different stimulus

What problem is habituation designed to solve?
What might be some features of habituation mechanism that fine tune it?
Goal of Learning Theory: Find “Laws” of Associative Learning

Examples of some such laws:
- E1 must come before E2
- Latency from E1 to E2 must be short (a few seconds) for both classical and trial and error learning
- Strength of learning depends on intensity of stimuli (e.g., louder bell is learned better), but otherwise any stimuli can be learned (Equipotentiality Assumption)

Universality of these laws justified by the General Process Assumption

Traditional learning theory started to unravel in 1960s and 70s