Chapter 5: Associative Learning And Unlearning

From Mechanisms of Memory, second edition
By J. David Sweatt, Ph.D.
Purkinje Neuron
**Terminology of Associative Conditioning**

<table>
<thead>
<tr>
<th>Stimulus or Response Term</th>
<th>Abbreviation</th>
<th>Actual Stimulus or Response by the Dog in Pavlov’s Experiments</th>
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<tbody>
<tr>
<td>Conditioned Stimulus</td>
<td>CS</td>
<td>A Ringing Bell</td>
</tr>
<tr>
<td>Unconditioned Stimulus</td>
<td>US</td>
<td>Food</td>
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<tr>
<td>Unconditioned Response</td>
<td>UR</td>
<td>Salivation</td>
</tr>
<tr>
<td>Conditioned Response</td>
<td>CR</td>
<td>Salivation</td>
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</table>
Pavlov and one of his Dogs

Figure 2
Nonsocial and Social Fear Learning in Humans

Figure 3
Fear Learning in Human Amygdala
Terje Lomo and Tim Bliss

Figure 6
Long-term Potentiation in the Amygdala

Figure 7
Tone CS → Auditory Thalamus/ Medial Geniculate Nucleus → Auditory Cortex

Lateral Nucleus of Amygdala

Thalmic inputs

Cortical inputs

Shock US

Central Nucleus

CS Weak

US Strong

Defensive Responses

Paired Activity

CS Strong

US Strong

Figure 8
Fear Conditioning Results in Potentiation

Figure 9
Effect of Paired/Unpaired Training on CS
Eye-blink Conditioning in Rabbits

- Corneal Air Puff Elicits Eyeblink Response
- Corneal Air Puff Given with Tone
- Tone Given Alone Elicits Eyeblink Response

Figure 11
Diagram of the Neural Circuit

Figure 12

- Granule Cells
- Pontine Nuclei
- VIII Nerve
- Motor Neuron
- Trigeminal (V) Ganglion
- Inferior Olivary Complex
- Parallel Fibers
- Climbing Fibers
- Mossy Fibers
- LTD
- GABA
- Corneal Air Puff
- Eyeblink Response
- Tone (Conditioned Stimulus)
- Unconditioned Stimulus

Diagram showing neural circuitry involving the corneal air puff as the unconditioned stimulus and tone as the conditioned stimulus, leading to LTD in Purkinje cells and eventually an eyeblink response.
Auditory Cue Reward Learning

Bar Press = Reward

Bar Press = No Reward
Diagram of the Limbic Corticostriatal Loop

Frontal Cortex

Amygdala

Nucleus accumbens

Brainstem response system

VTA (dopamine)
SNC (dopamine)
rhaphé nuclei (serotonin)
locus coeruleus (noradrenaline)
nucleus basalis (acetylcholine)

Neuromodulator projection systems
The Honeybee

A

B

Blue Box 2
Olfactory Learning in Drosophila-The Fruitfly

(A) Flies

(B) Train: Odor A or Odor B

Test: Vacuum

Odor A

Odor B
Pavlovian Conditioning in Hermissenda

(a) Before conditioning
Foot length in light (CS)

(b) Conditioned response (CR)
Foot-shortening elicited by presentation of the CS

(c) Before conditioning

(d) After conditioning
The Pond Snail Lymnaea
A Pigeon in a “Skinner Box”
## Birdbraains

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<tr>
<th>Species</th>
<th>Behavior</th>
<th>Type of Learning/Memory</th>
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<td>Pecking, bar-pressing</td>
<td>Operant conditioning</td>
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<td>Chicken (hatchling)</td>
<td>Instinctive bead-pecking</td>
<td>Conditioned taste aversion</td>
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<tr>
<td>Canaries, Finches</td>
<td>Song learning</td>
<td>Declarative memory? Language?</td>
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<td>Chickadees, Nutcrackers, Blue Jays</td>
<td>Seed caching</td>
<td>Spatial memory</td>
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<td>Barn Owls</td>
<td>Visual system adaptation</td>
<td>Motor adaptation learning</td>
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<tr>
<td>Crows</td>
<td>Tool making</td>
<td>Motor learning, instrumental learning</td>
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Blue Box 8