

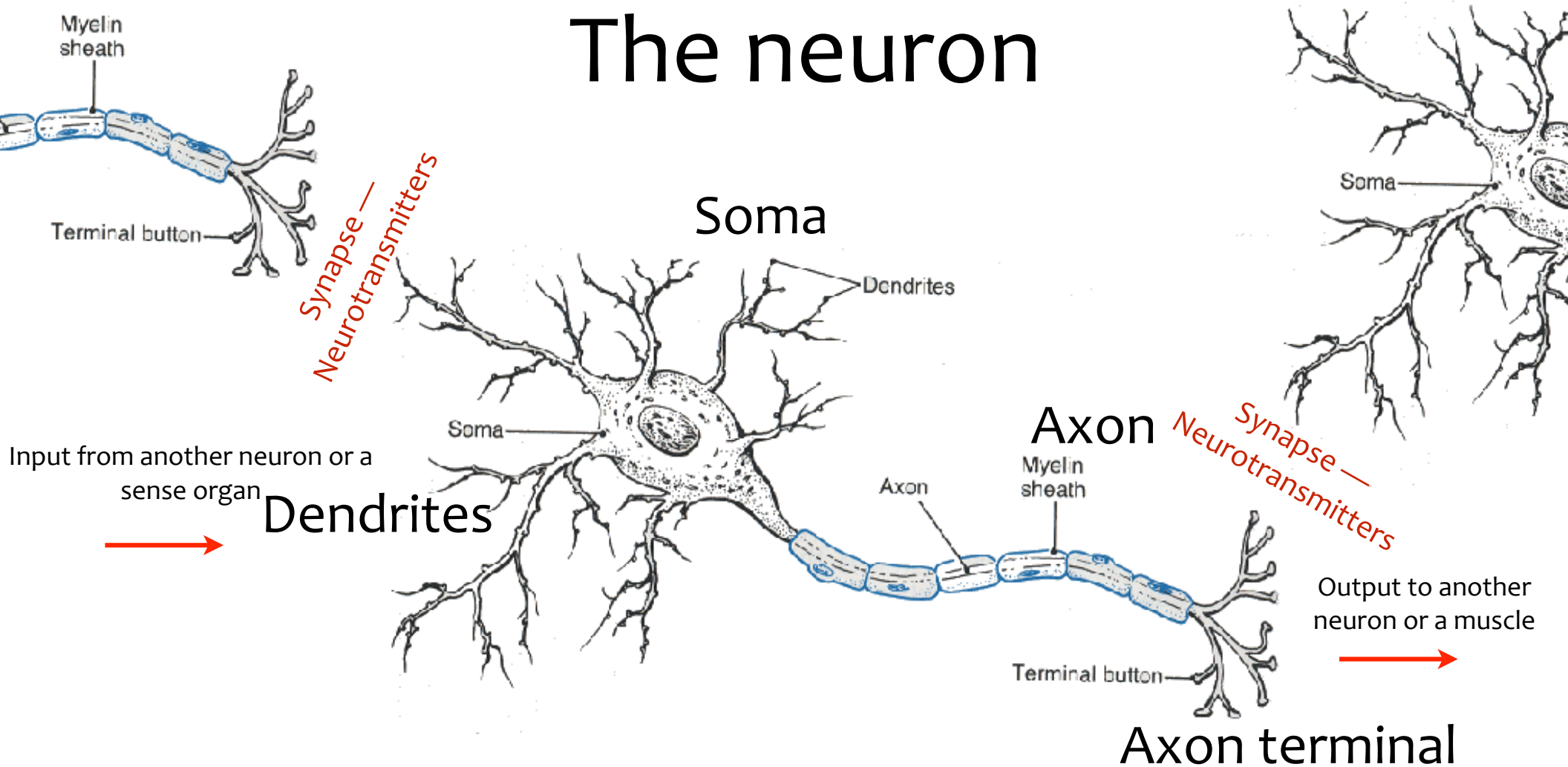
Truth tables

$$(A \wedge B) \wedge (A \vee B)$$

		B	
		true	false
A	true	TRUE	FALSE
	false	FALSE	FALSE

= the truth table for AND!

The neuron

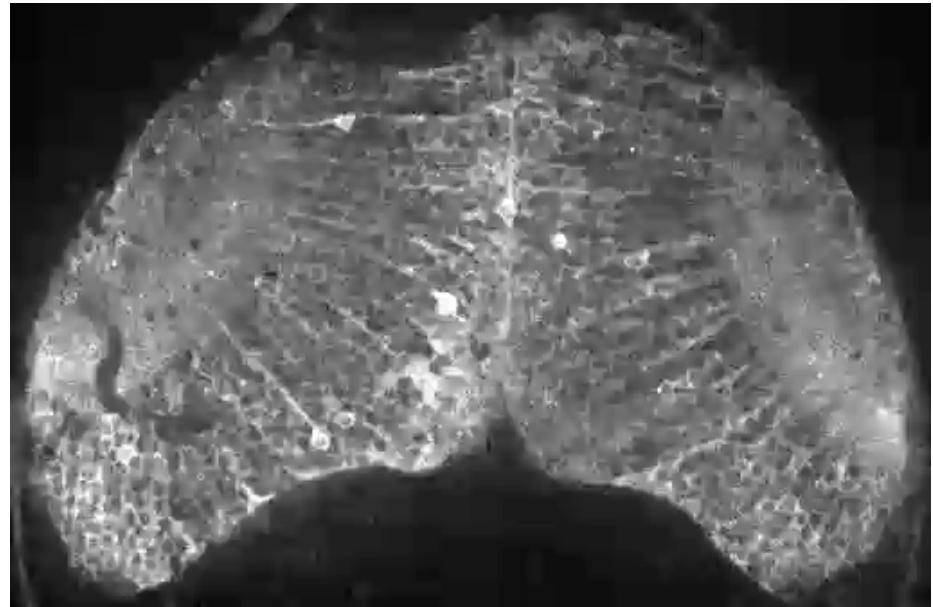


Neuron integrates **excitation** and **inhibition** to get total net **activation**;
If activation is above threshold, it “**spikes**” (sends an **action potential** down the axon)

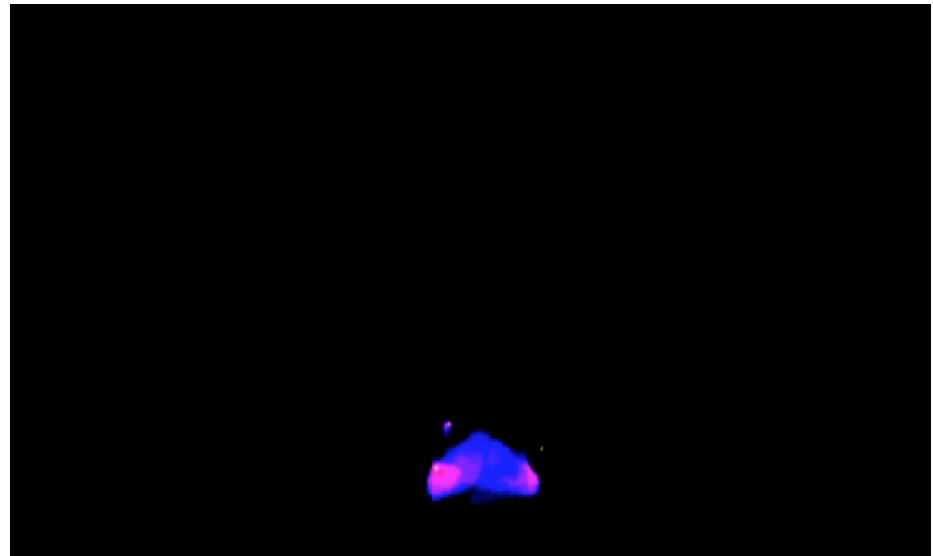
After firing, the neuron resets (~2 msec refractory period). If it is still being stimulated over threshold, it fires again. Hence the **firing rate** indicates the level of activation.

Neurons in action

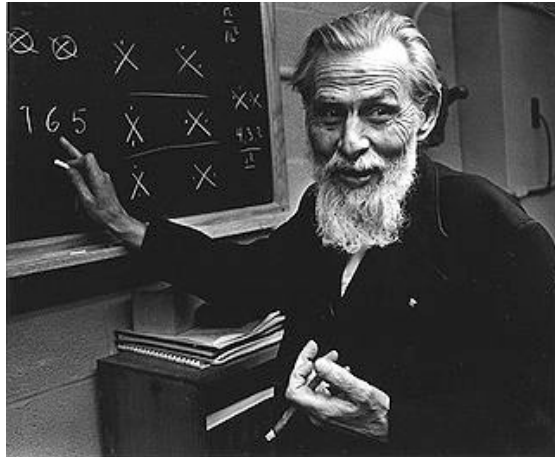
- Zebra fish brain



- Fish sees prey



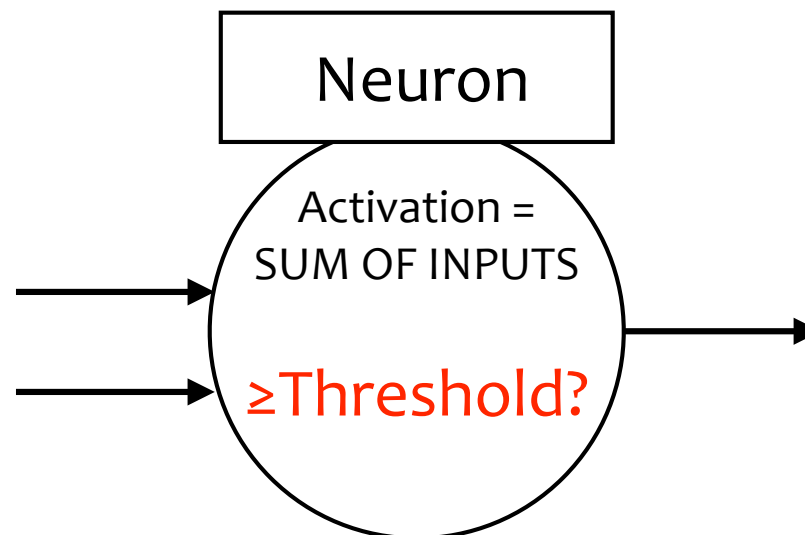
McCulloch & Pitts: Neurons are little computing devices



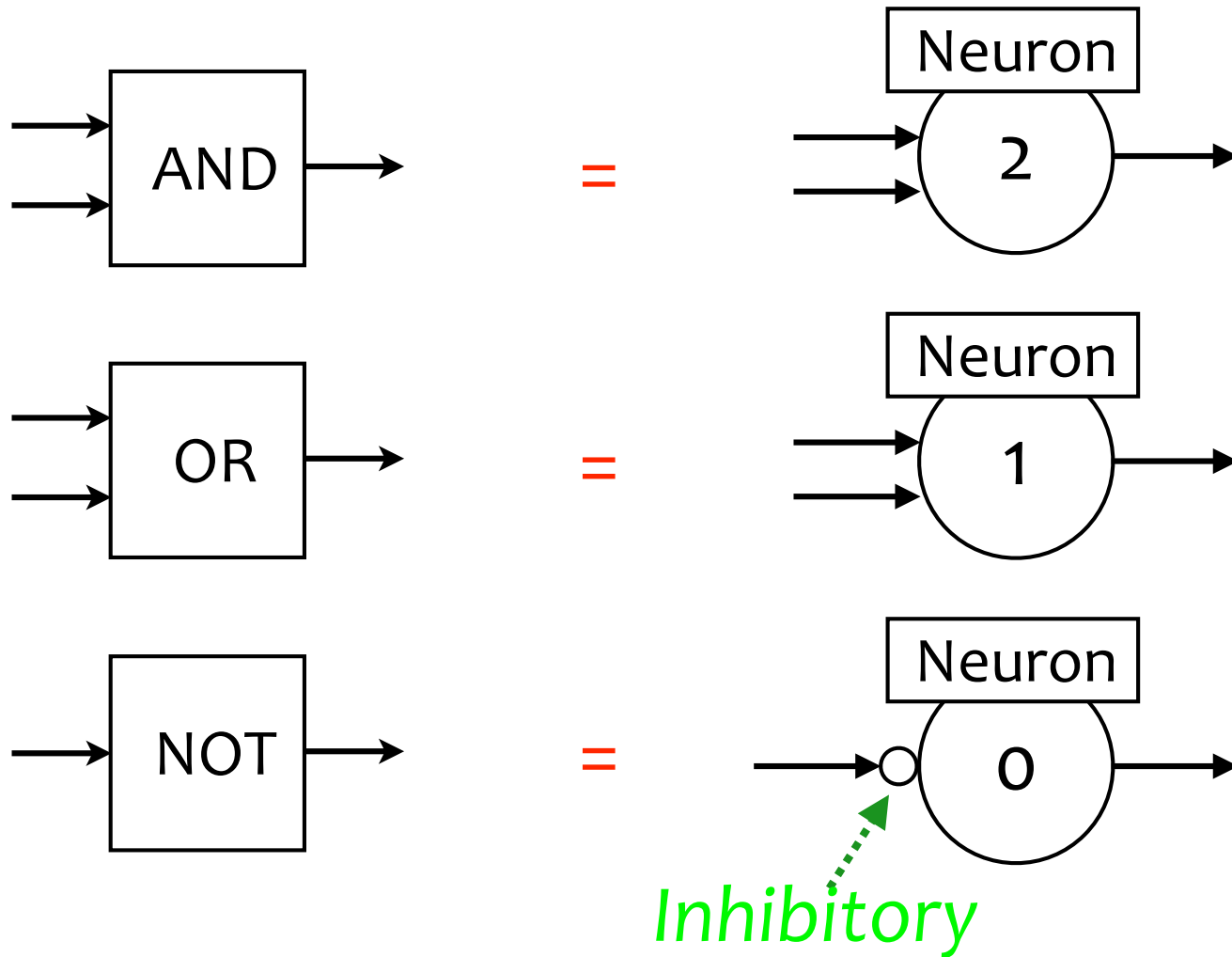
Artificial neuron

Summation/
integration &
thresholding

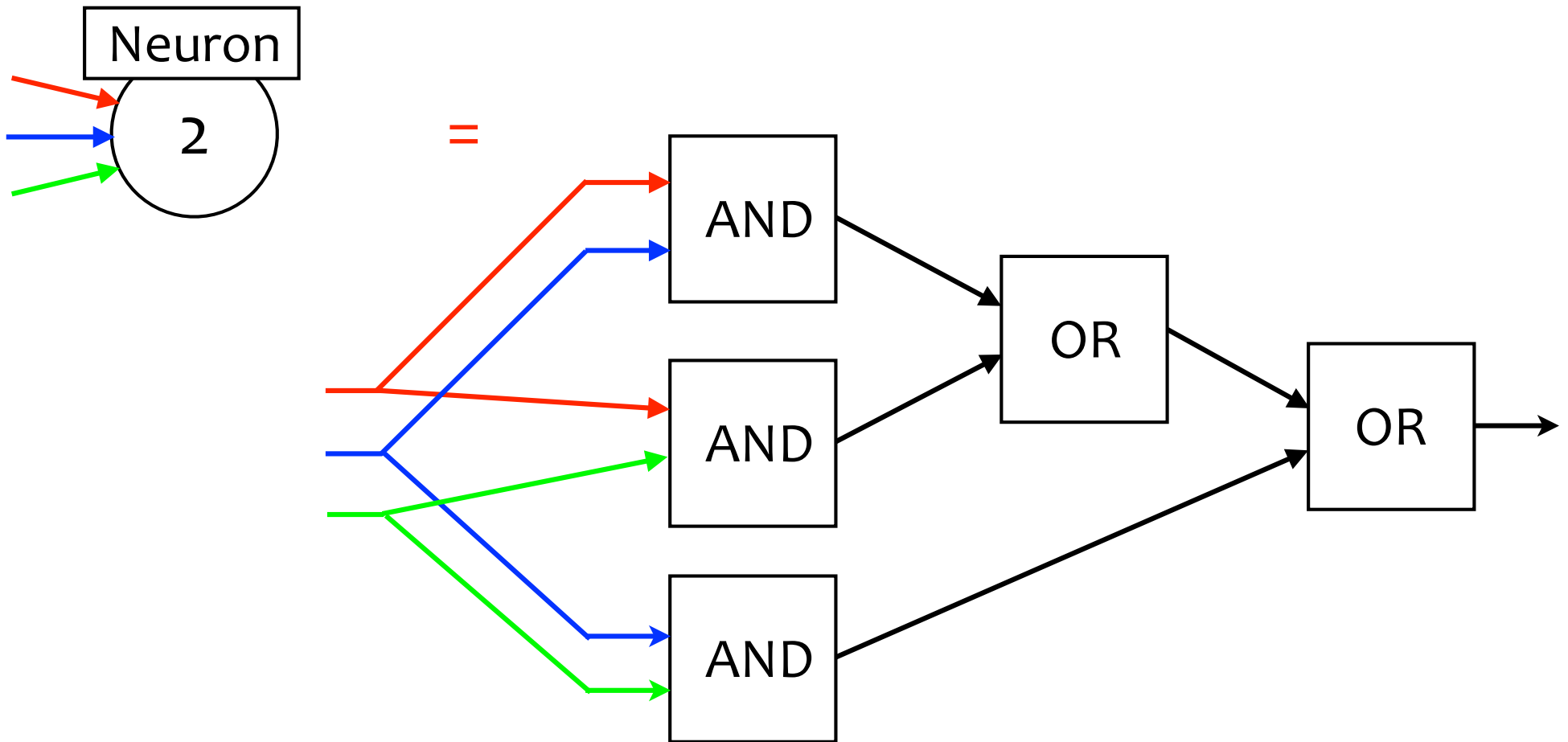
Excitatory/
Inhibitory
0/1 inputs



You can make **logic gates** out of **neurons**



You can make a neuron out of logic gates



- This means that **circuits made of gates** and **brains made of neurons** can simulate each other perfectly
- They are **equivalent in computational power**

- What is knowledge? Where does it come from?

Nurture

vs.

Nature



Locke



Decartes



Kant

Empiricism

- based on experience
Blank slate/ Tabula Rasa

Associationism

Behaviorism

General learning mechanism

Rationalism

- based on reason
innate knowledge

Nativism

Cognitivism

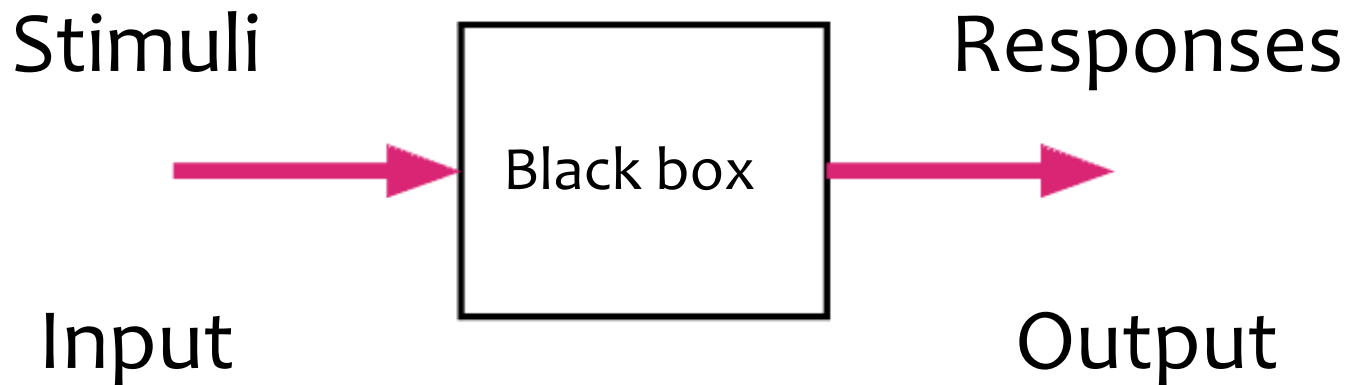
domain-specific innate modules

Behaviorism

Watson: Psychology is the study of the relationship between Stimulus and Response (“S-R psychology”)



B. F. Skinner: All learning is conditioned responses to stimuli.



You can't look inside the box!

Empiricism / Associationism / Behaviorism / Connectionism

- All knowledge comes from **experience**
- There is only **one** general principle of learning:
 - Locke: The formation of associations among sensory inputs
 - Skinner: Conditioned reinforcement of behavior
 - **Connectionism**: Modification of neural weights based on experience

Evidence against associationism

- Species-specific learning biases
 - e.g. rats associating smells with danger, etc.
- Critical periods for learning
 - bird song - certain song birds need to hear their species' song within a 2-week period
 - human language - humans need to be exposed to their native language prior to puberty (?)
- - These phenomena suggest that innate aspects of brain structure play an important role in learning
 - (-> nativism)

The cognitive revolution

- About 1960 many scientists rebelled against the Behaviorist paradigm
- They argued that stimulus-response pairings were **insufficient** to explain the complexities of human cognition
 - e.g. Chomsky's review of Skinner's *Verbal Behavior*)
- And they had a new model of the information-processing inside the head: **the computer**