

Embodied nervous systems

Gregor Schöner

Braitenberg vehicles

■ =embodied nervous systems with:

■ effectors

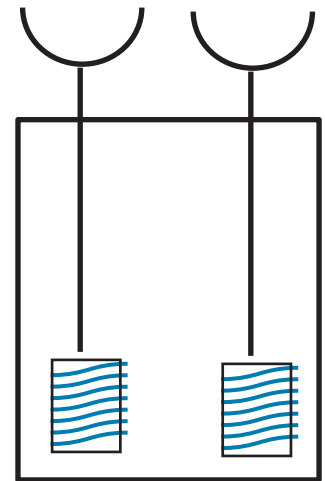
■ sensors

■ a nervous system

■ a body

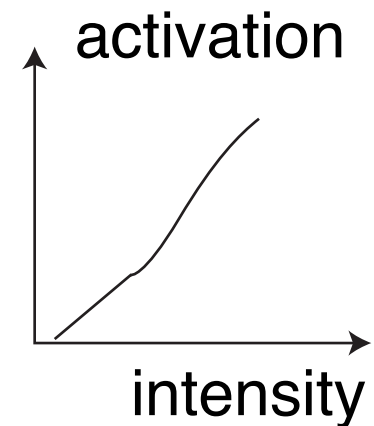
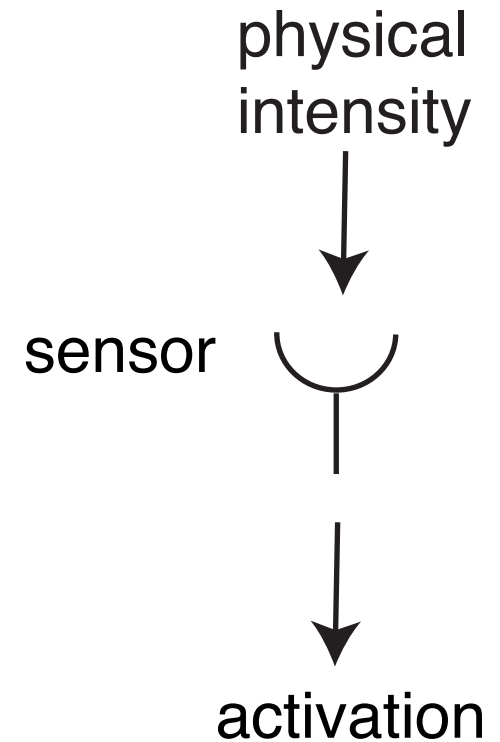
■ + situated in a structured environment

■ = emergent function



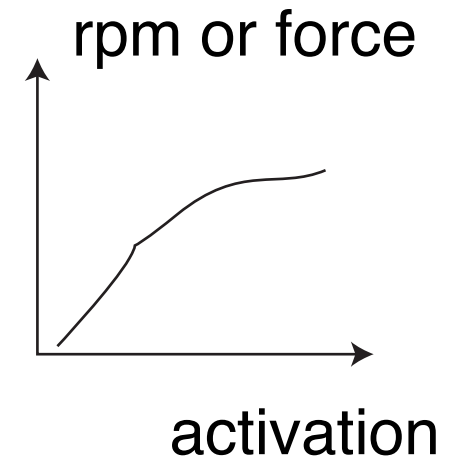
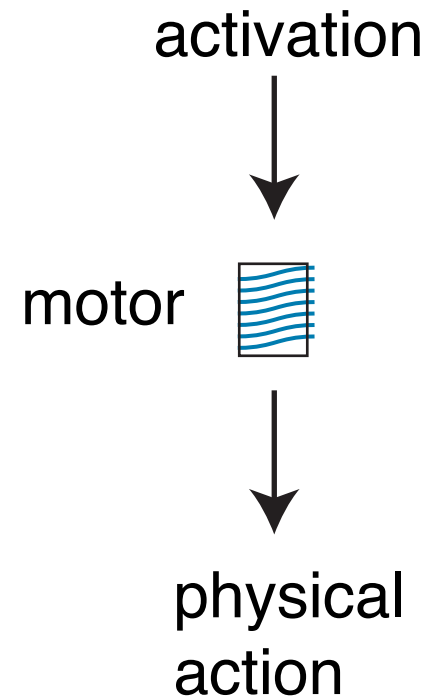
Sensors

- defined by sensor characteristic
=relationship between
- the physical stimulus intensity
 - e.g., sound, luminance, chemical concentration, mechanical pressure....
- and an activation variable



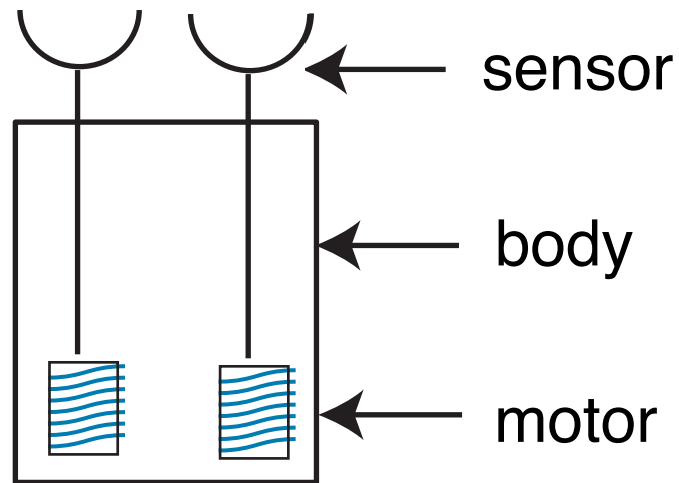
Effectors

- defined by the motor characteristic = functional relationship between
- an activation level
- and a physical effect generated
 - for example: turning rate (rotations per minute rmp), force level, stiffness, ...)



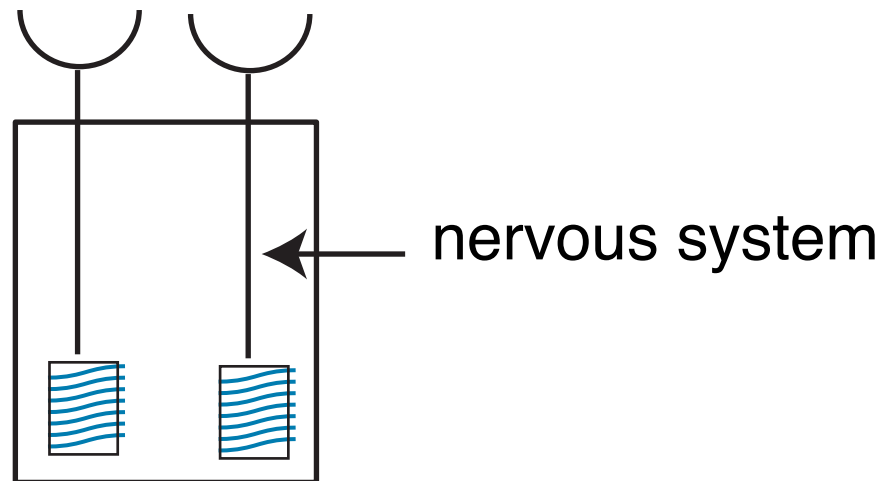
Body

- the body links the sensors and effectors mechanically

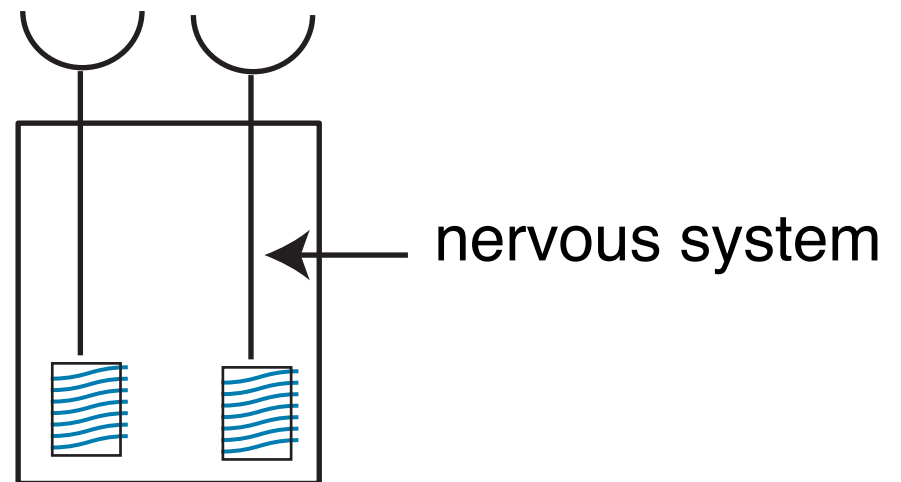
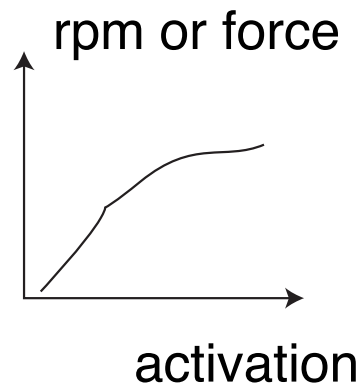
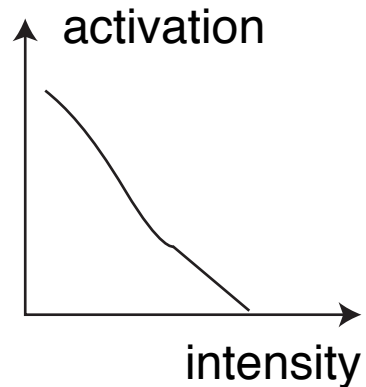


Nervous system

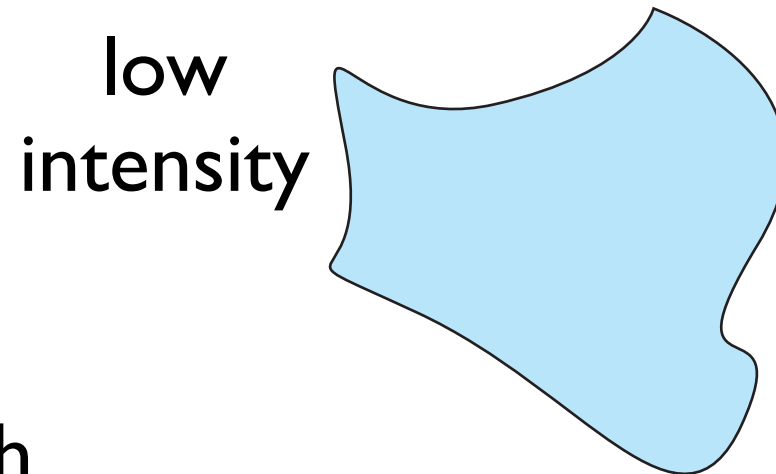
- links sensors to effectors



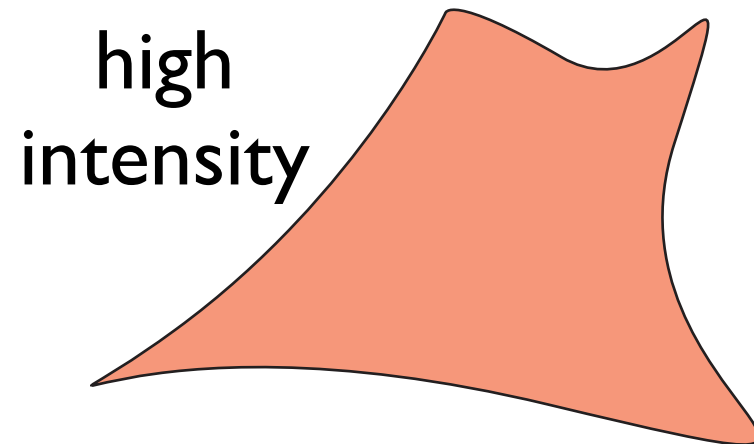
(I) A feed-forward nervous system can be characterized by input-output characteristics (information processing)



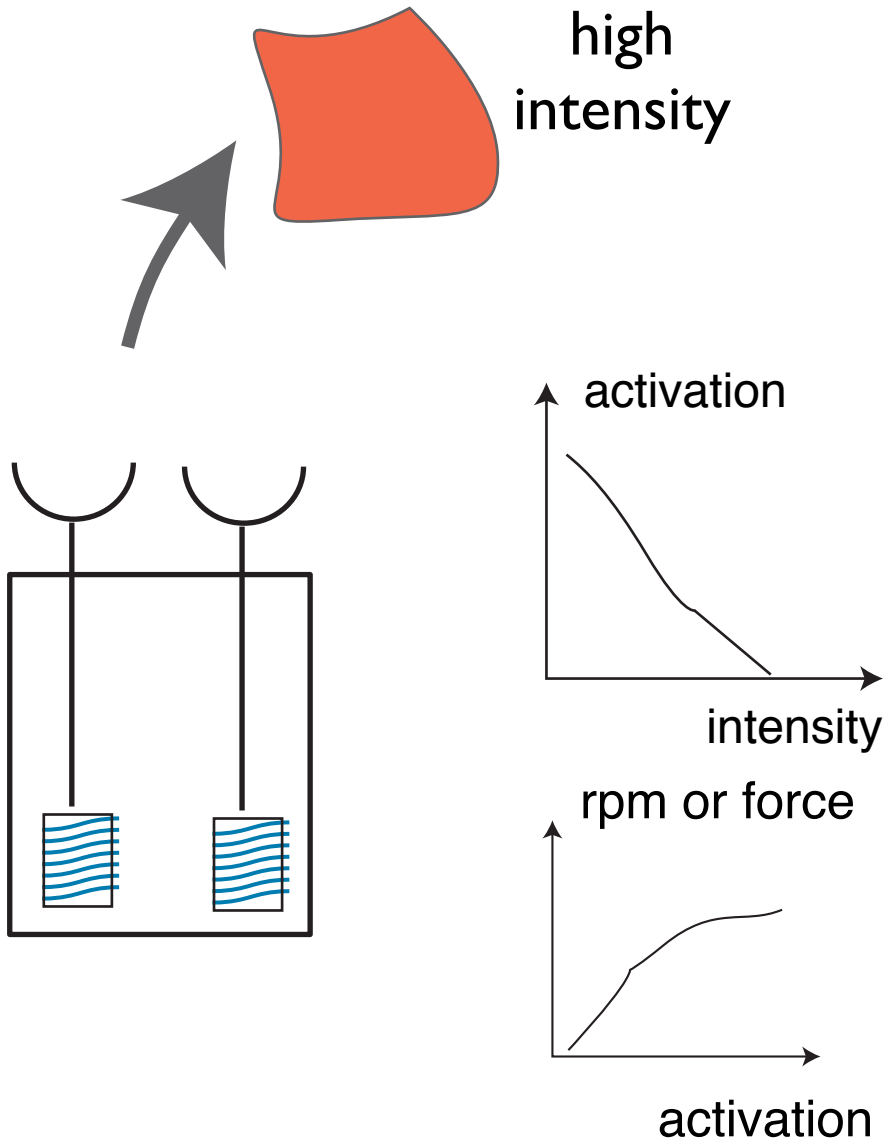
Environment



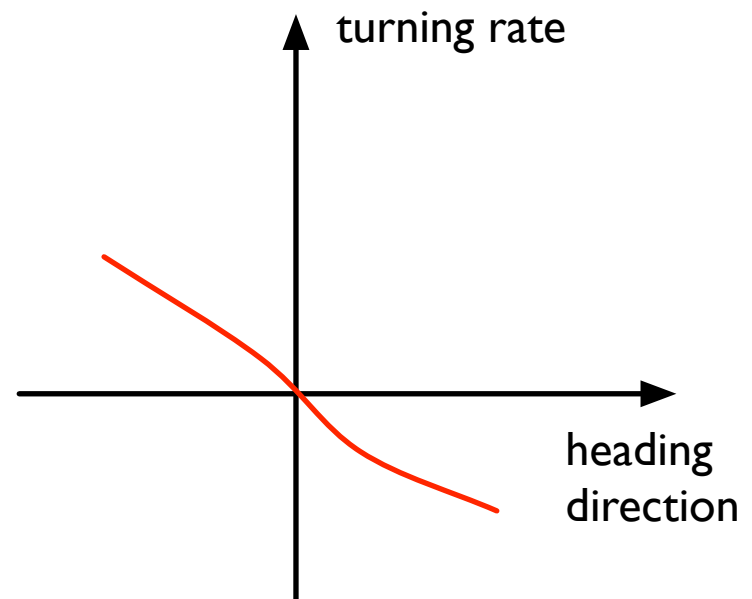
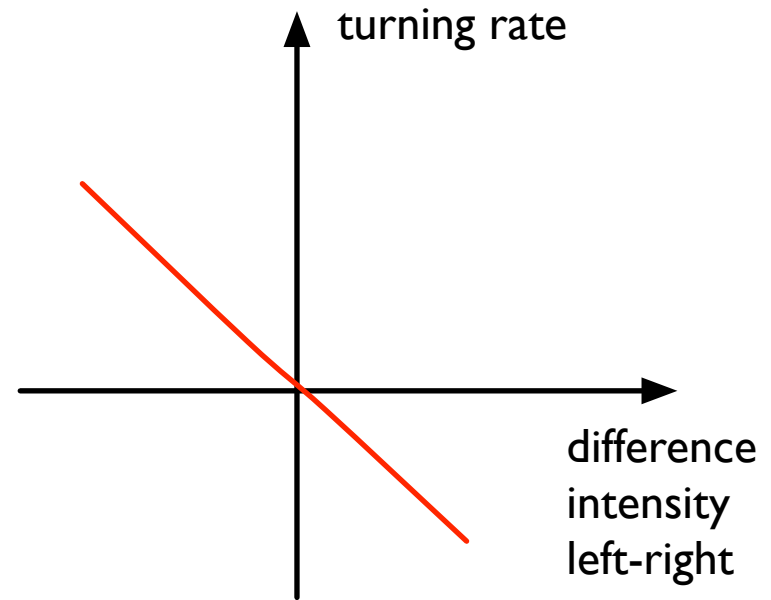
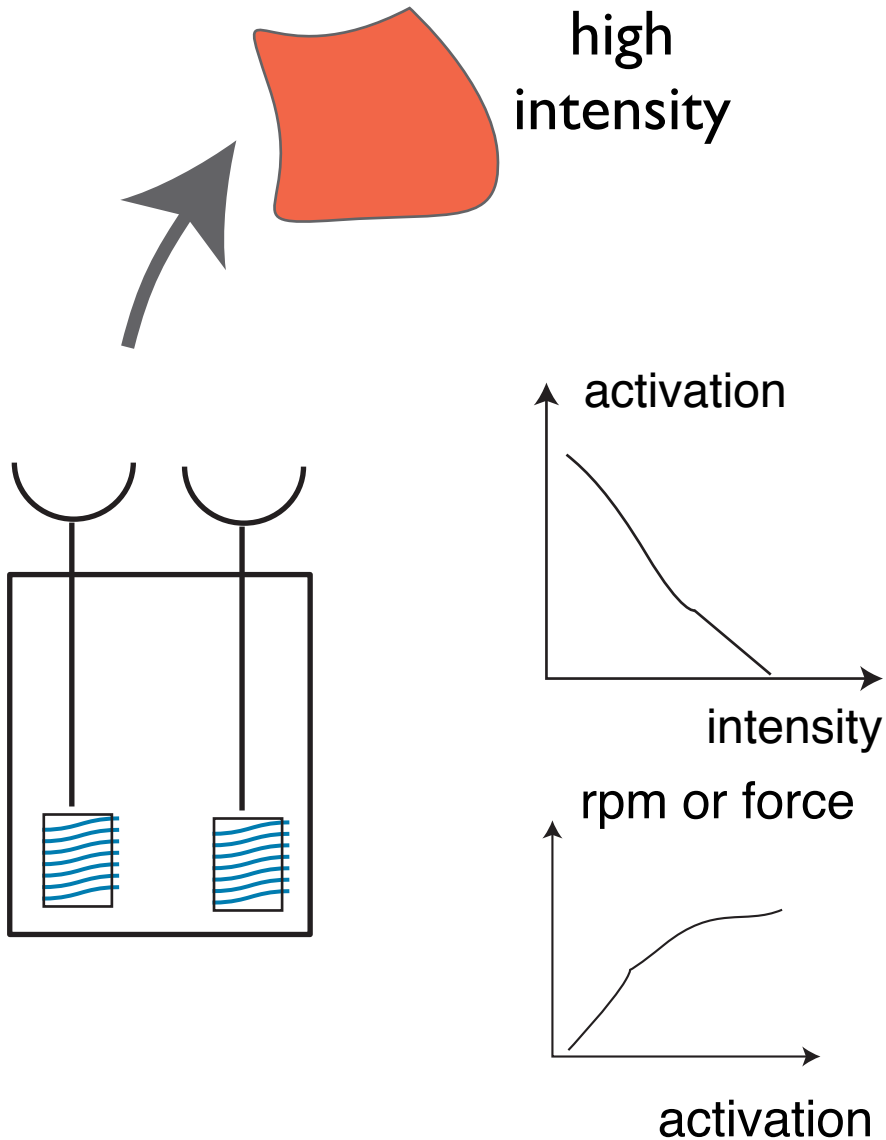
- non-homogeneous with respect to the physical intensity sensed



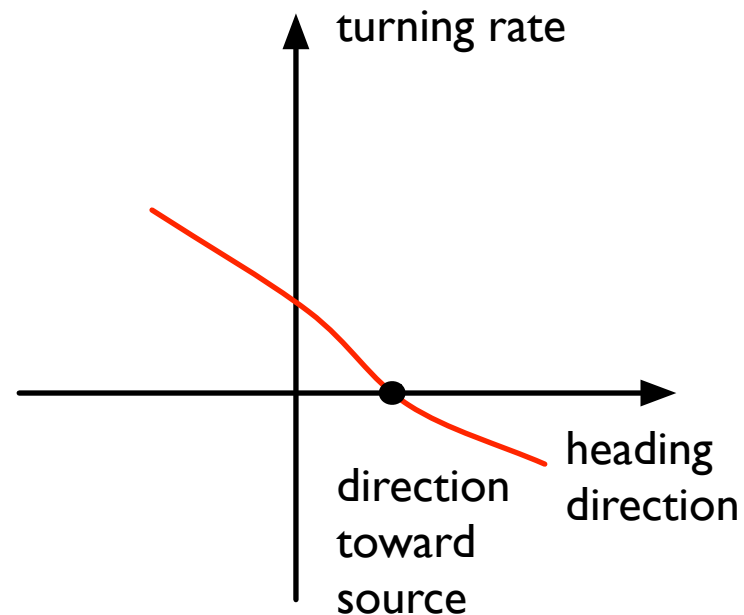
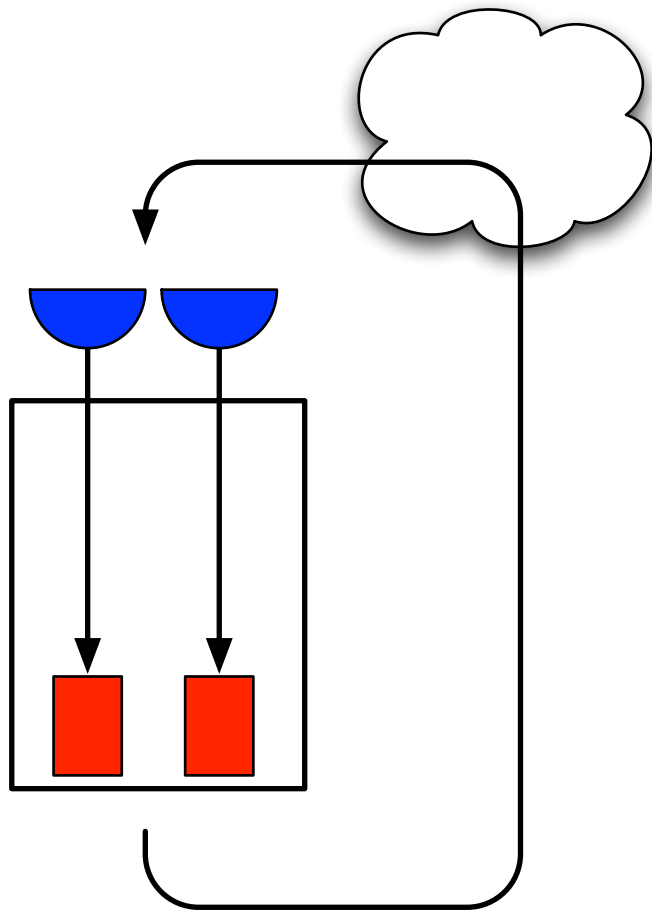
Emergent behavior: taxis



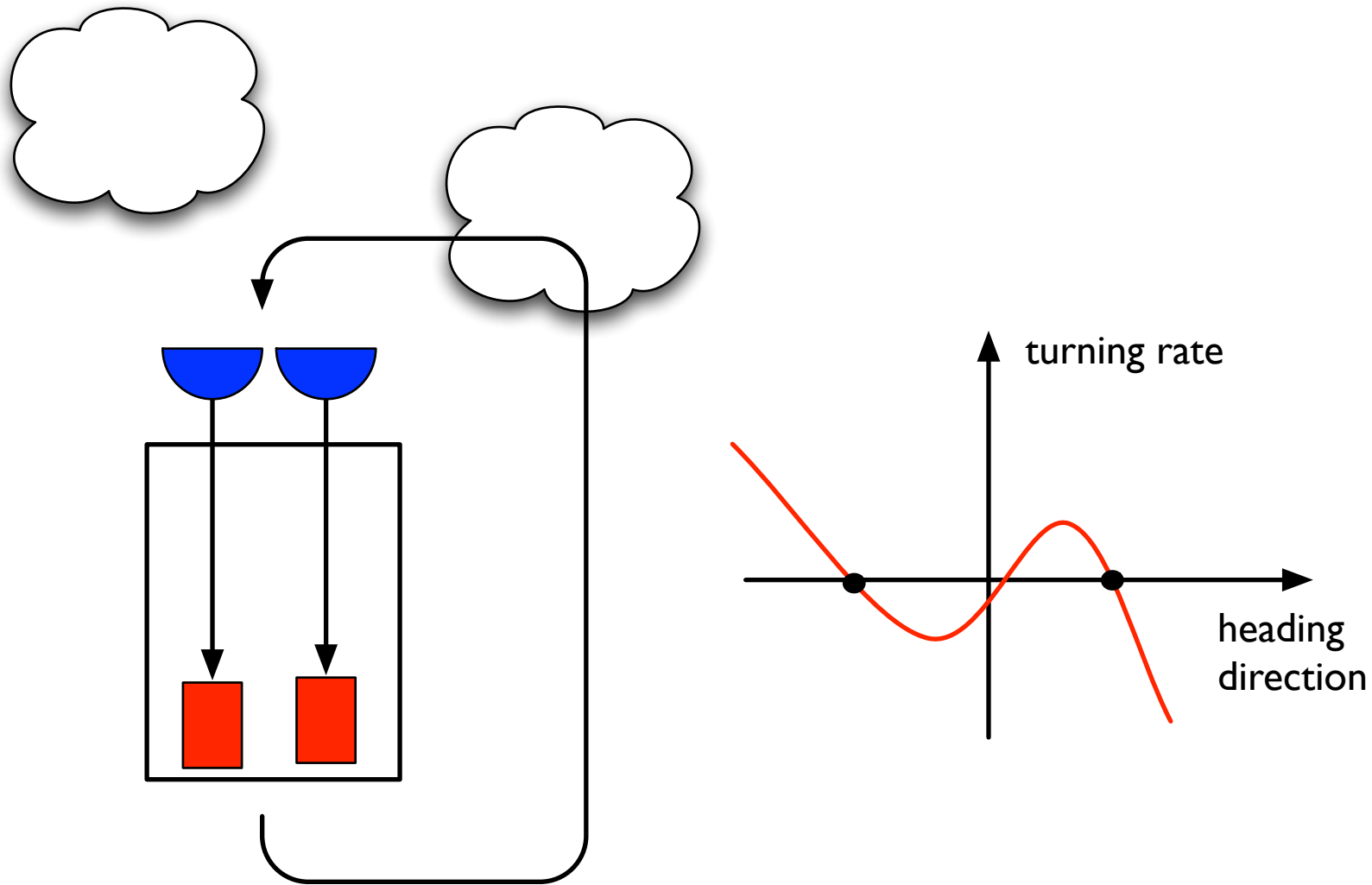
Emergent behavior: this is a dynamics



(2) Feedforward nervous system + environment in closed loop => behavioral dynamics



Behavioral dynamics may become non-linear and make decisions if environment is complex



(3) Recurrent neural network
may generate non-linear
dynamics on its own

