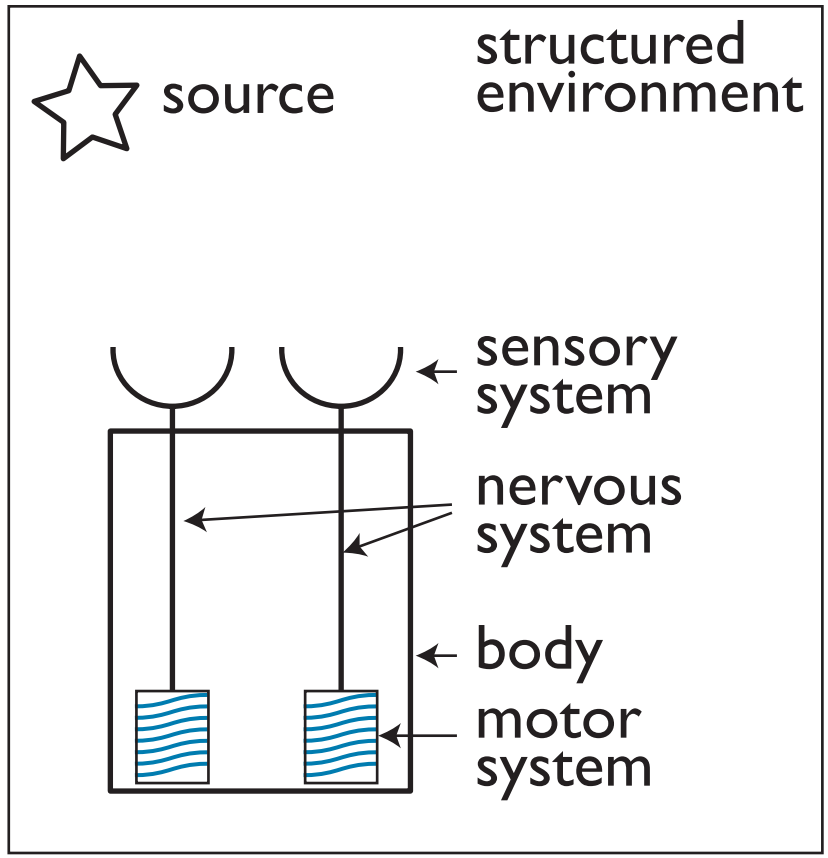
Embodied nervous systems

Gregor Schöner

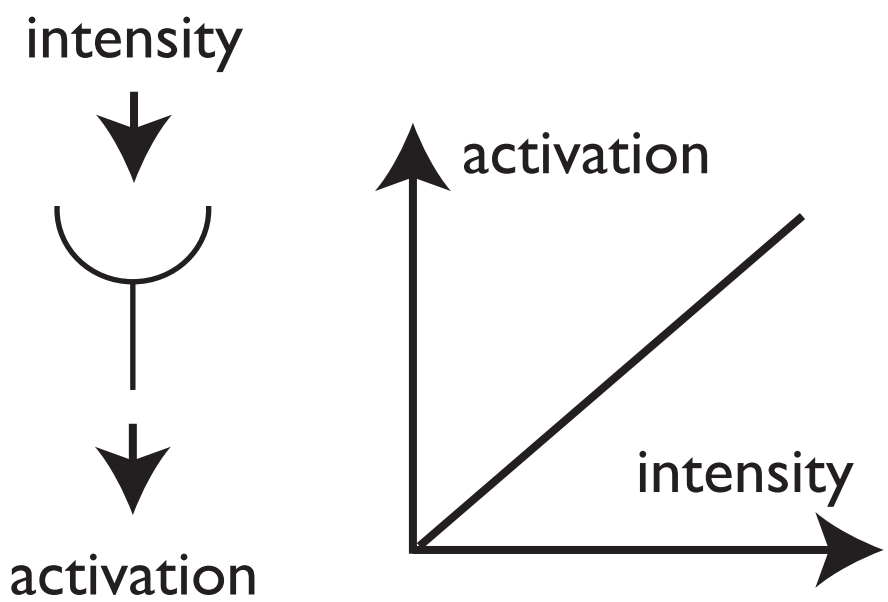
Braitenberg vehicles

- =embodied nervous systems with:
  - effectors
  - sensors
  - a nervous system
  - a body
- + situated in a structured environment
- = emergent function



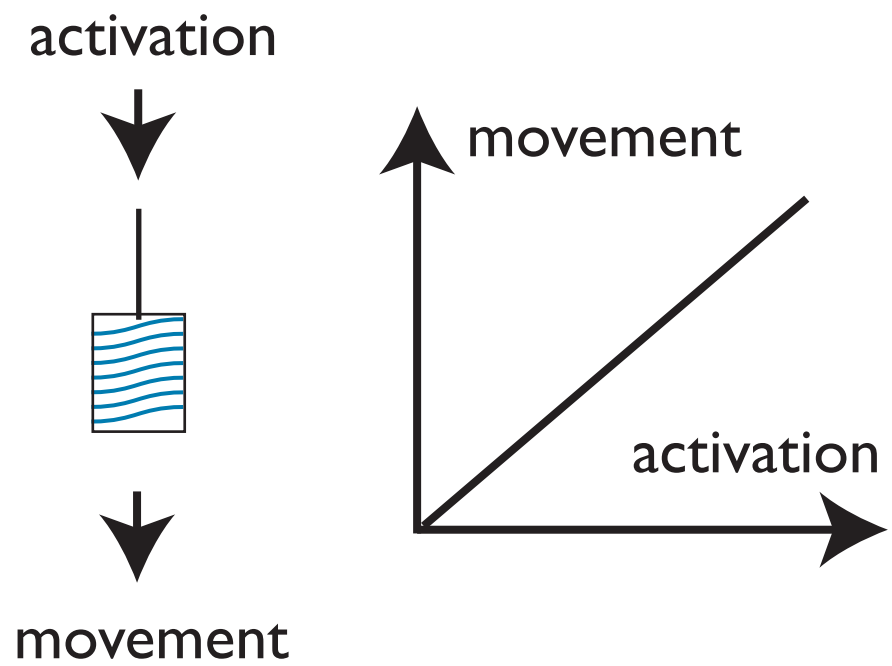
Sensors

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



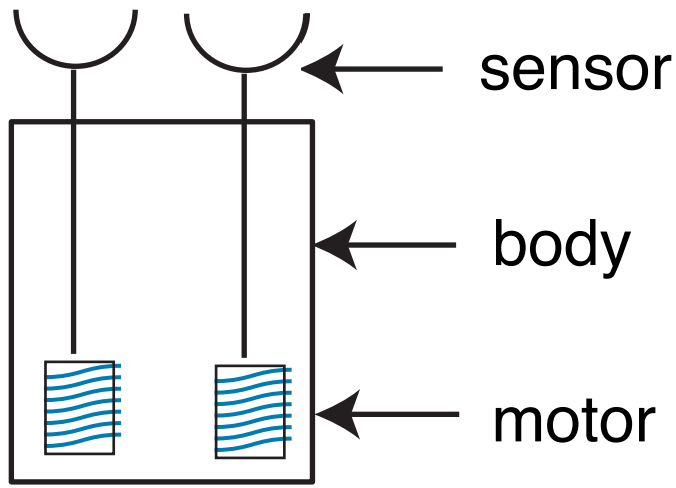
Effectors

- 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, ...)



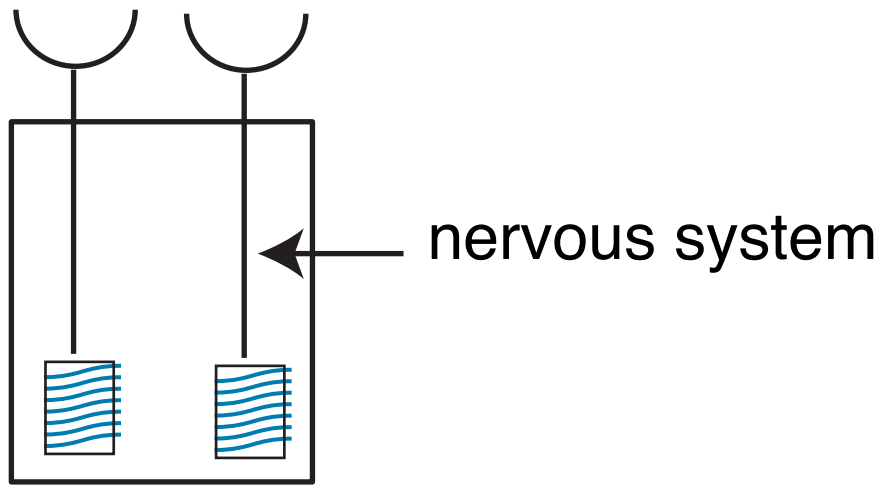
Body

- the body links the sensors and effectors mechanically



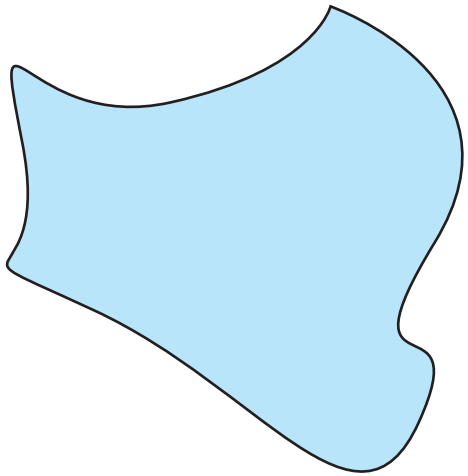
Nervous system

- links sensors to effectors



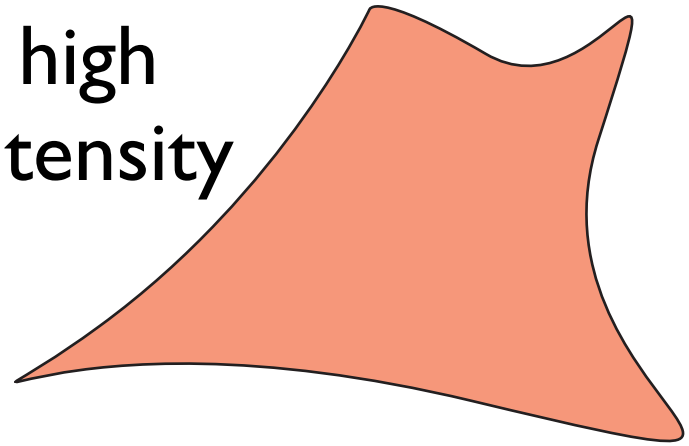
Environment

low intensity

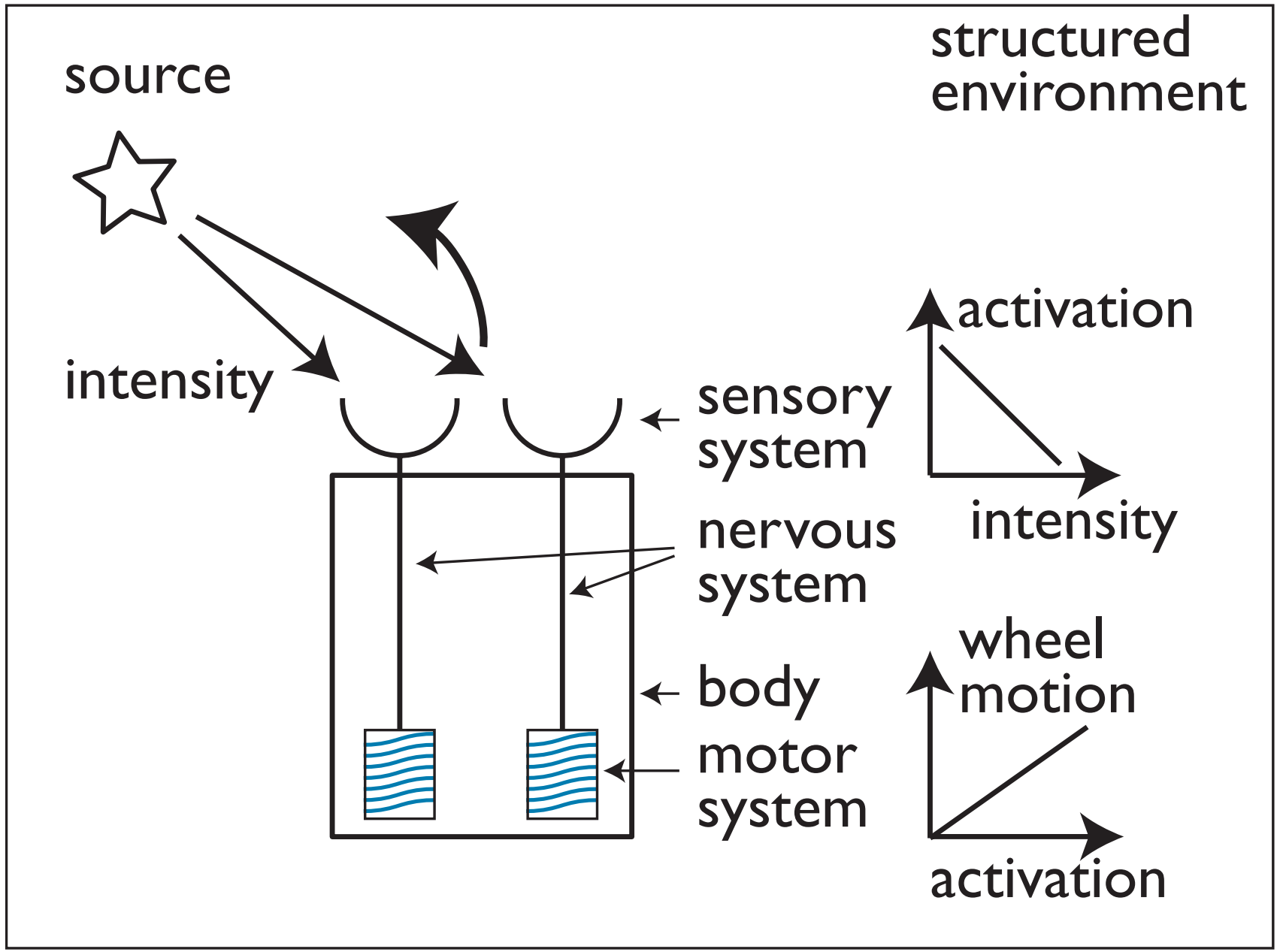


- non-homogeneous with respect to the physical intensity sensed

high intensity

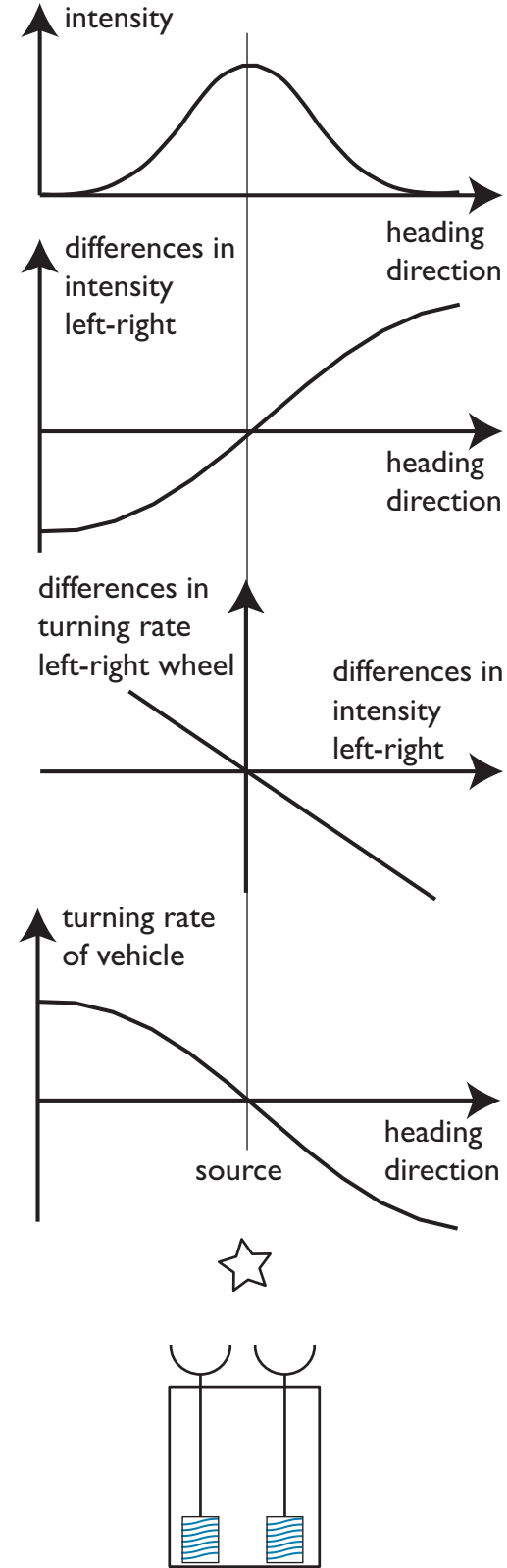


Emergent behavior: taxis



Emergent behavior: this is a dynamics

- feedforward nervous system
- + closed loop through environment
- => (behavioral) dynamics



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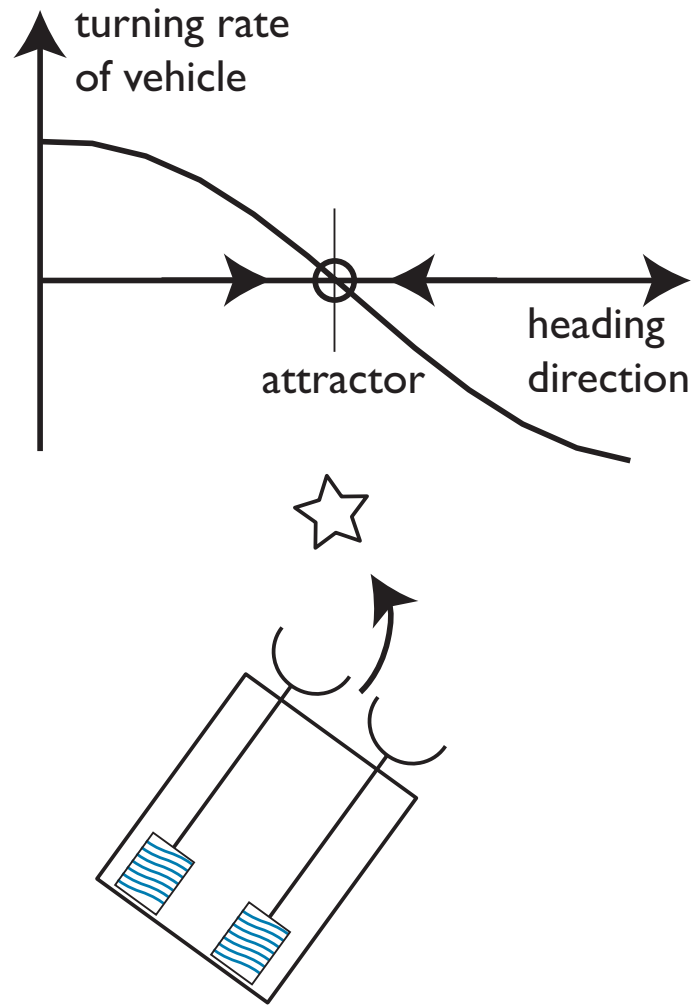
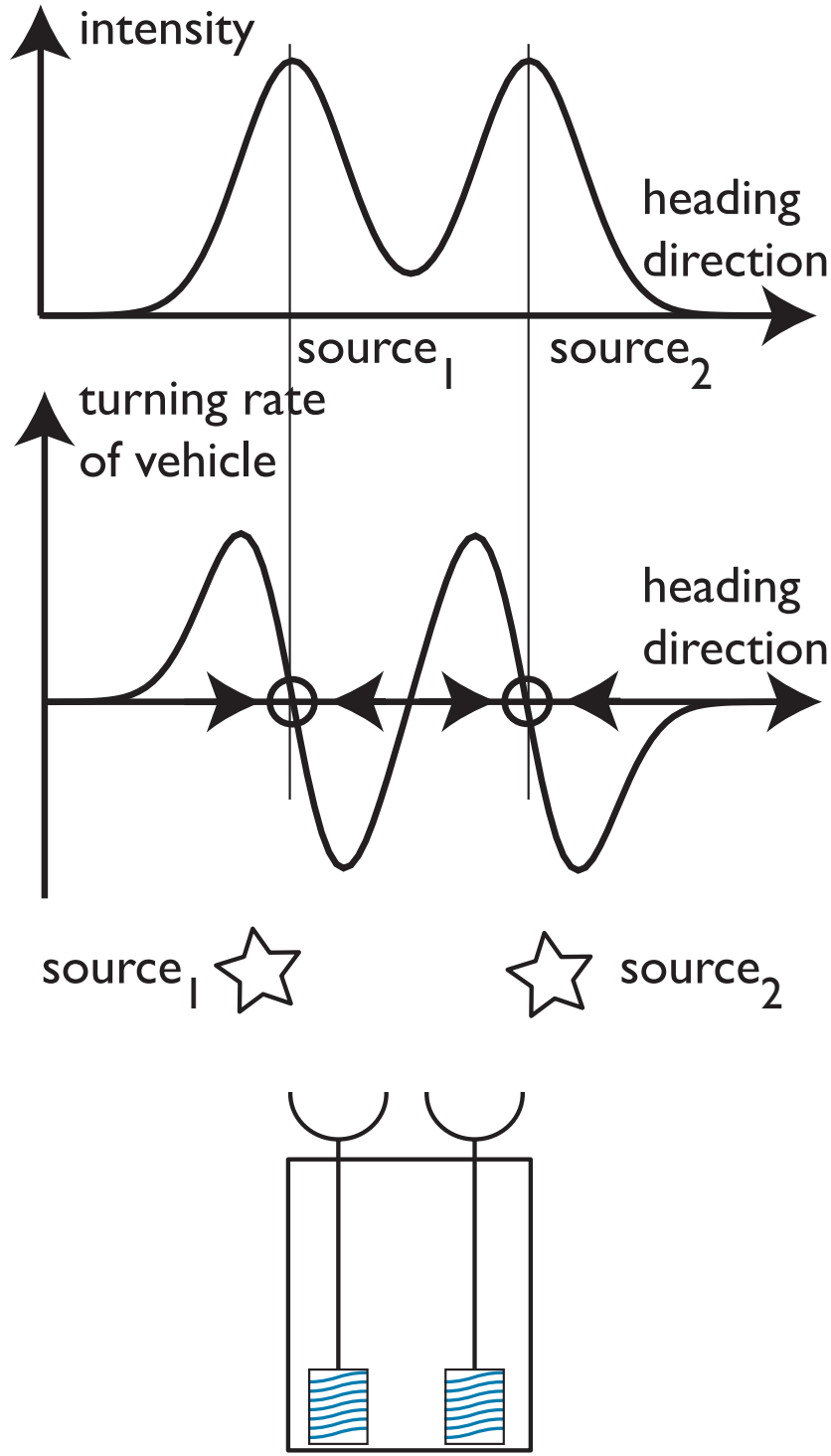


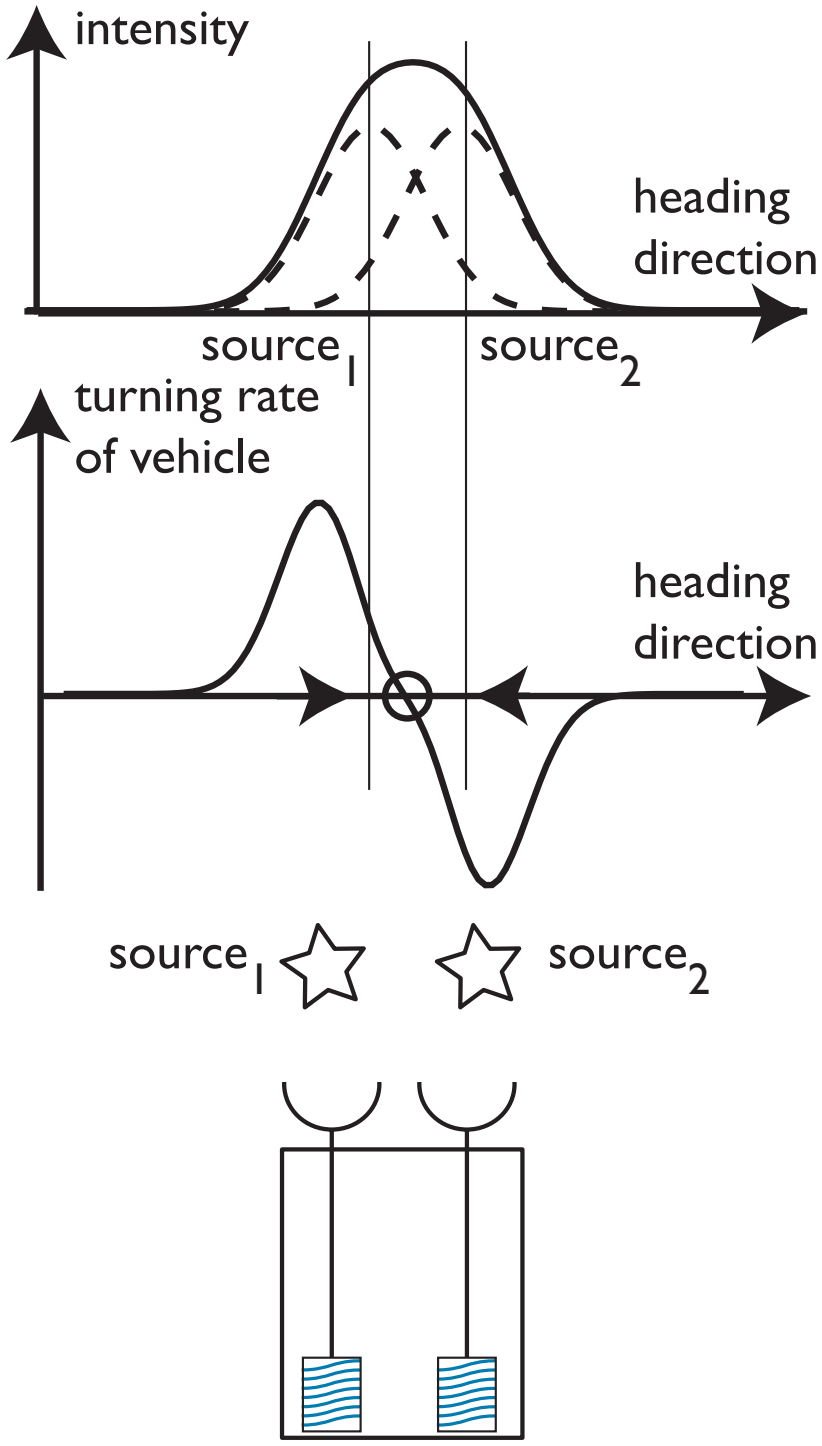
Complex environment => complex dynamics

- bistable dynamics for bimodal intensity distribution
- => nonlinear dynamics makes selection decision



Complex environment => complex dynamics

- transition to monostable for mono-modal distribution
- => instabilities lead to qualitative change of behavior



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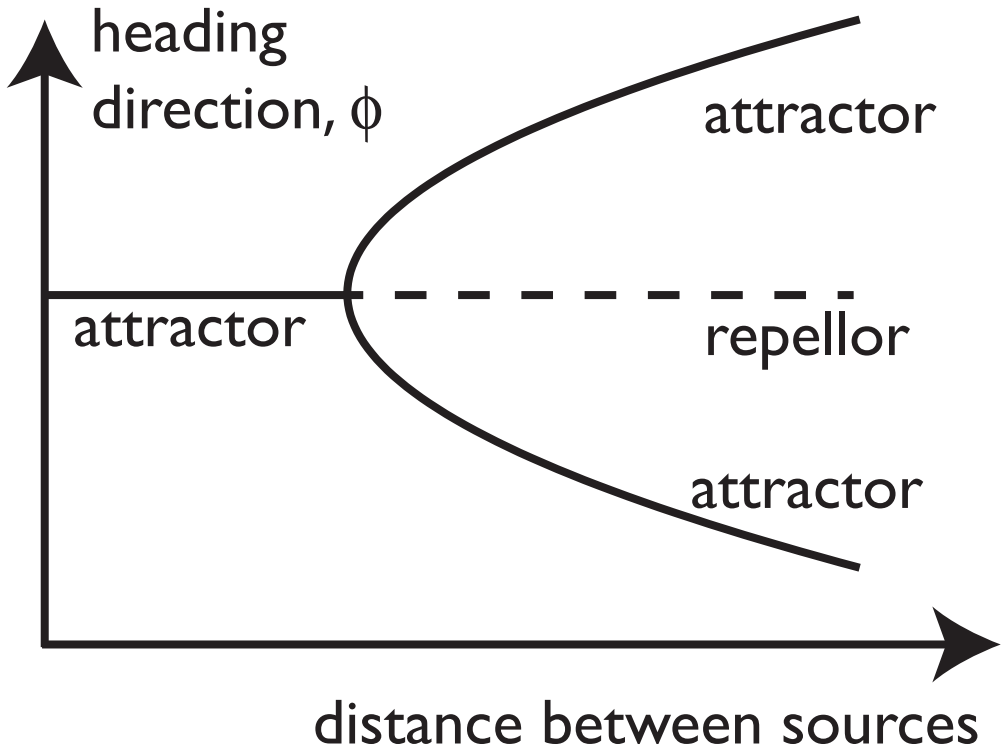
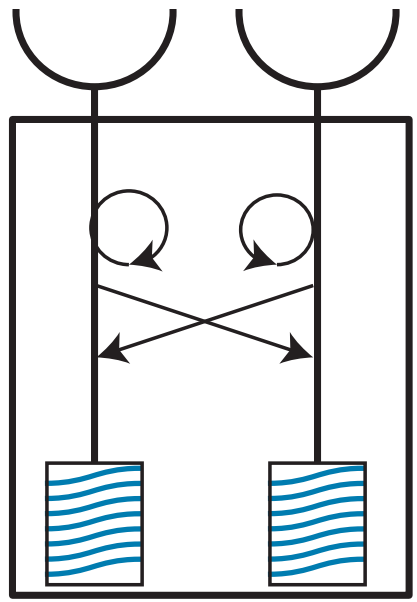


Internal loops generate neural dynamics

source$_1$ ☆ ☆ source$_2$

- that generate cognition: internal decisions…
- bifurcations => different cognitive regimes



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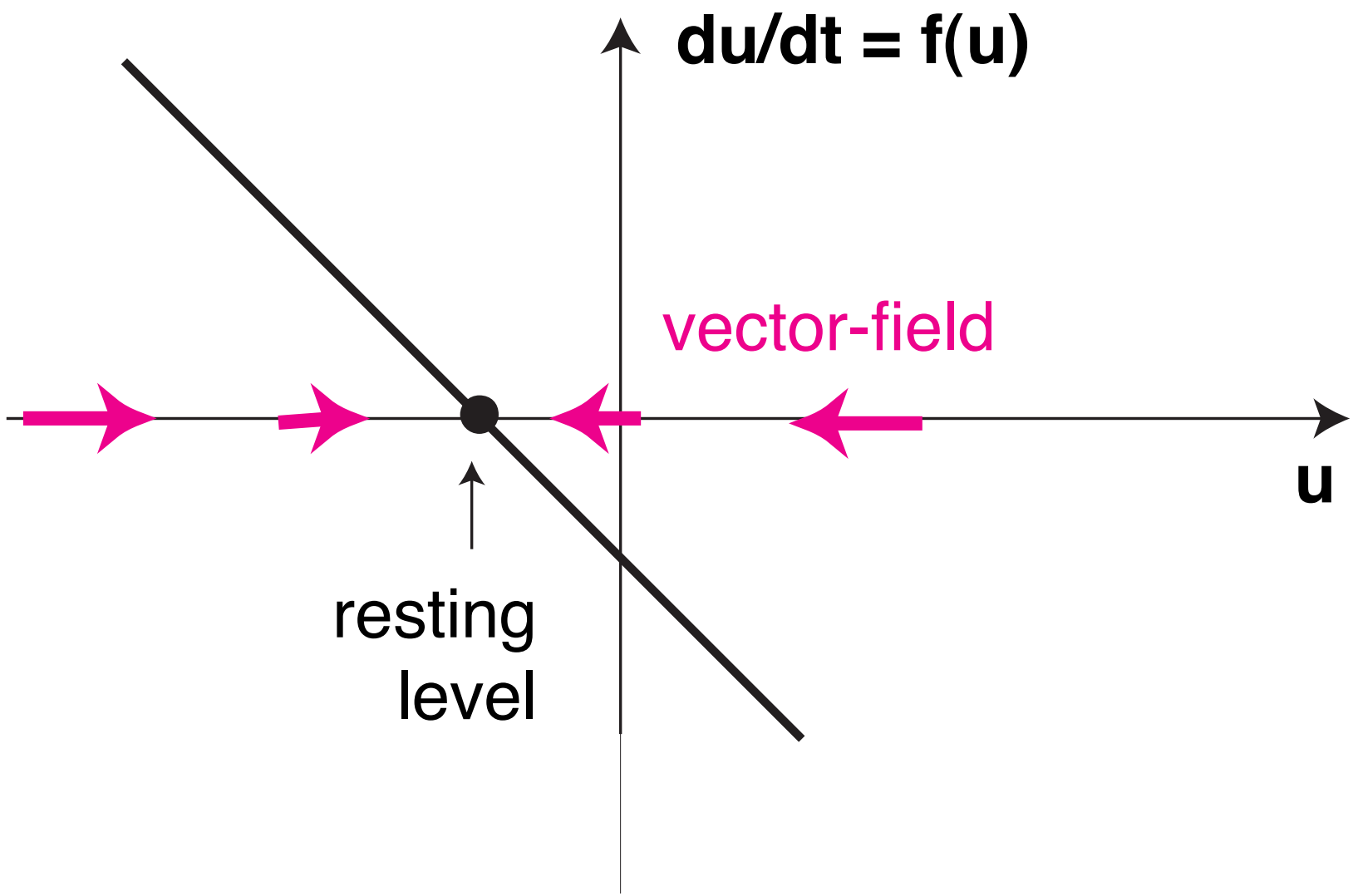

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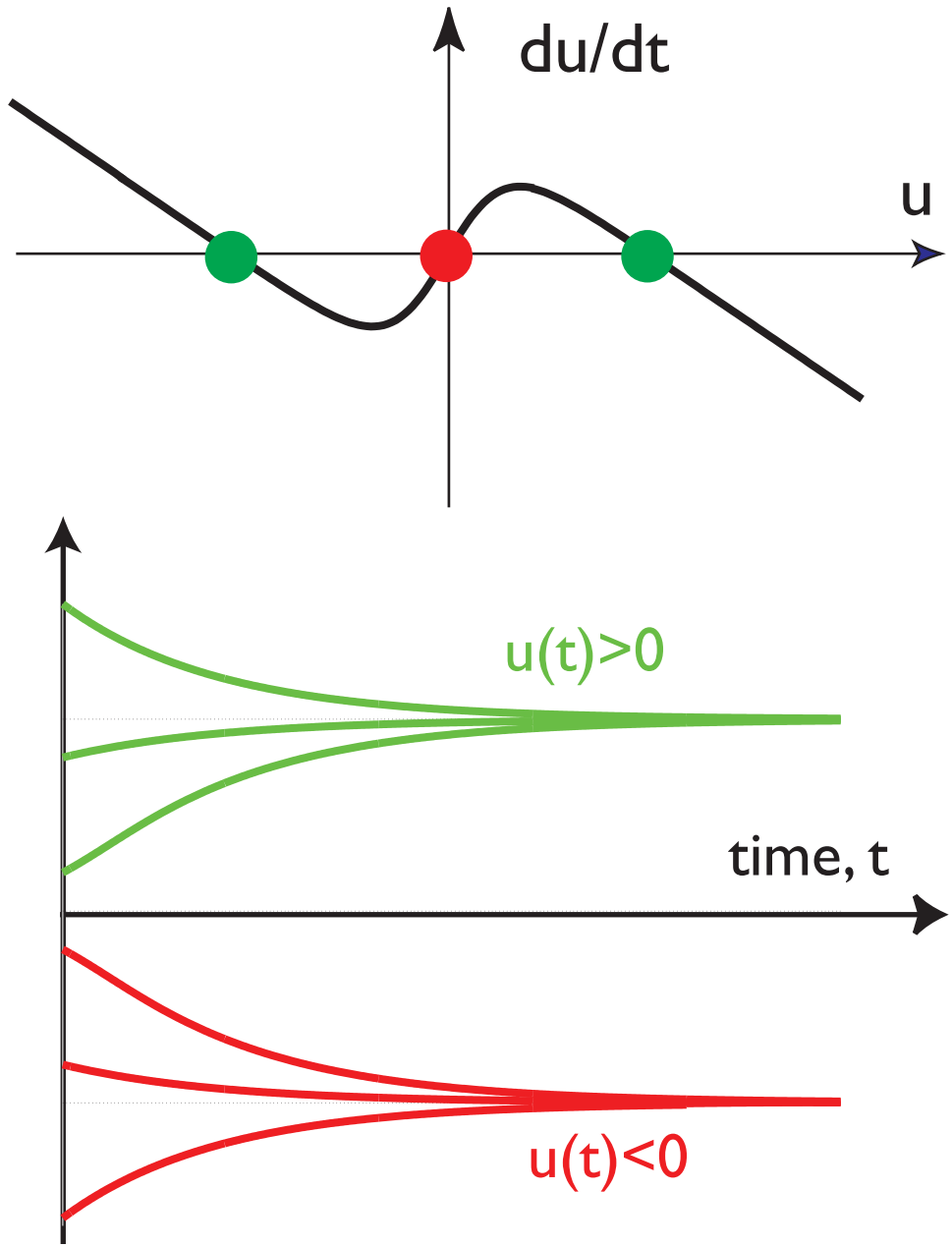

Outlook

- neural dynamics
- DFT