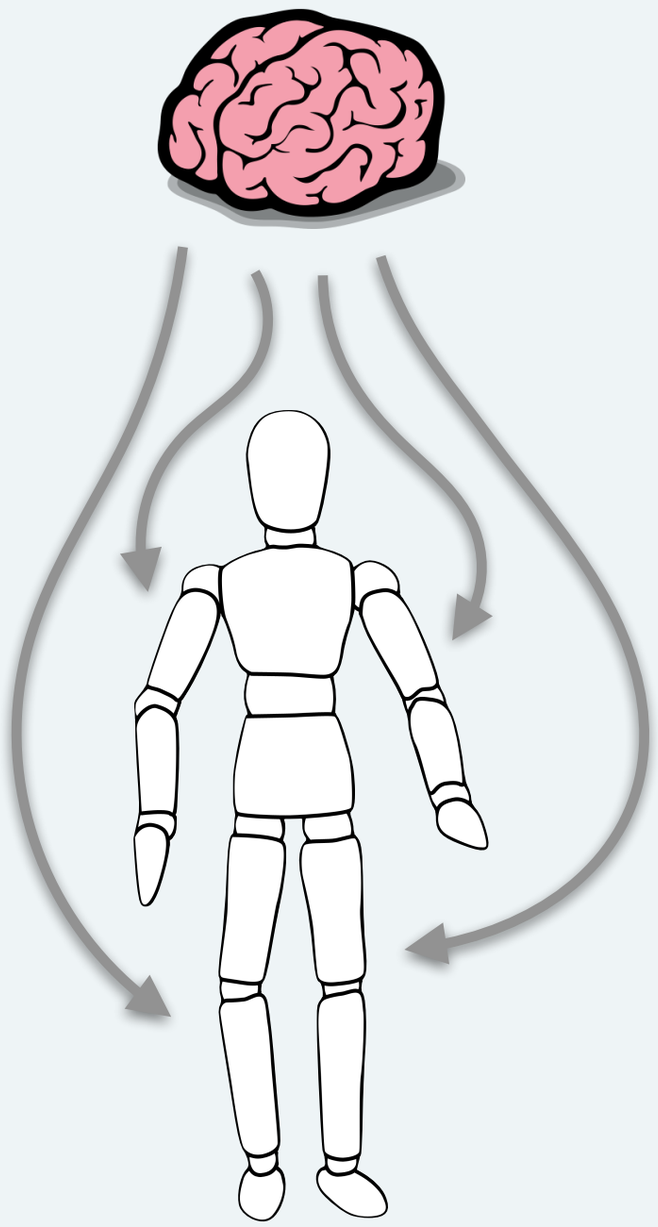
COGS300

Embodied Cognition

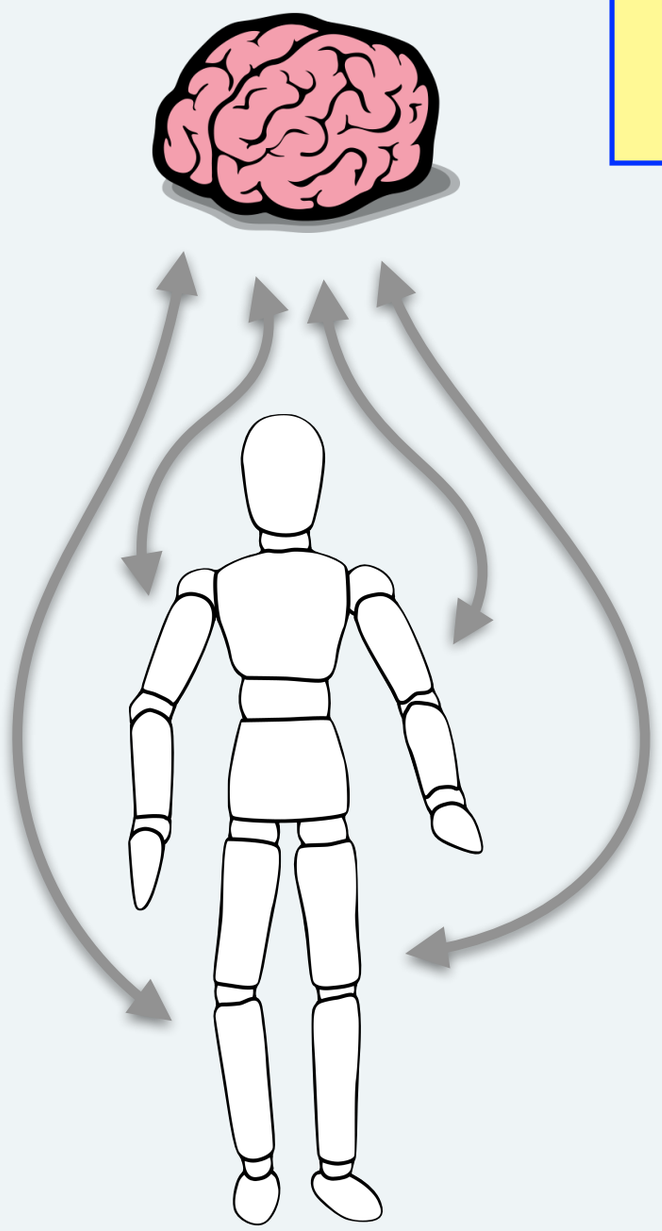
Instructor: Márton Sóskuthy
marton.soskuthy@ubc.ca

TAs: Daichi Furukawa · Victoria Lim · Amy Wang
cogs.300@ubc.ca

traditional "disembodied" cognitive science

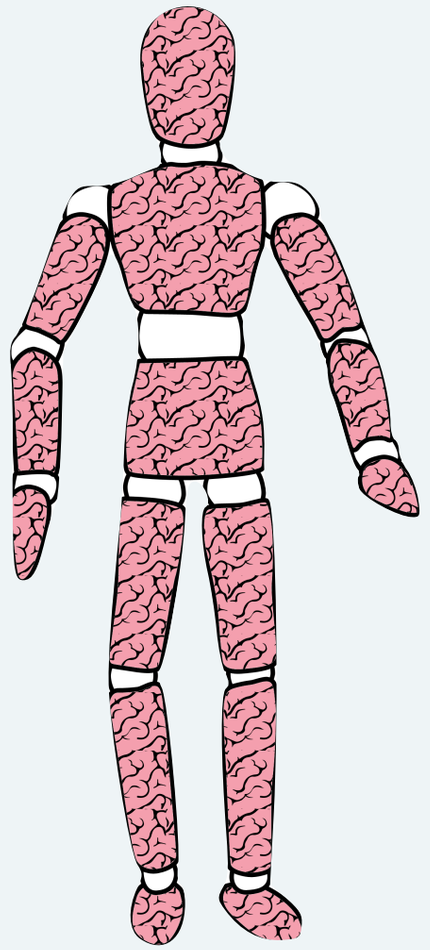


body-cognition interactions (next week!)



radical embodied cognition (replacement hypothesis)

cognitive processes do not stop at brain; occur throughout body



General style of argumentation

purely mechanical; just needs to be set up in the right way

Algorithmic walking

“astronaut who pooped his pants” doesn’t look very natural or adaptable

complex problem described in terms of cognitive processes operating on abstract mental representations

“Passive walker”

reduces to simpler problem when viewed in the context of the body & environment – no need for complex processes & representations

General style of argumentation

coordination does not require ‘central’ cognition

1. **What is the task?**
   Coordinate limb movements to achieve bipedal locomotion

2. **What resources does the organism have?**
   Natural “springiness” of joints, skeleton, muscles; counterbalancing via arm swing; limited degrees of freedom in e.g. knee flexion; etc.

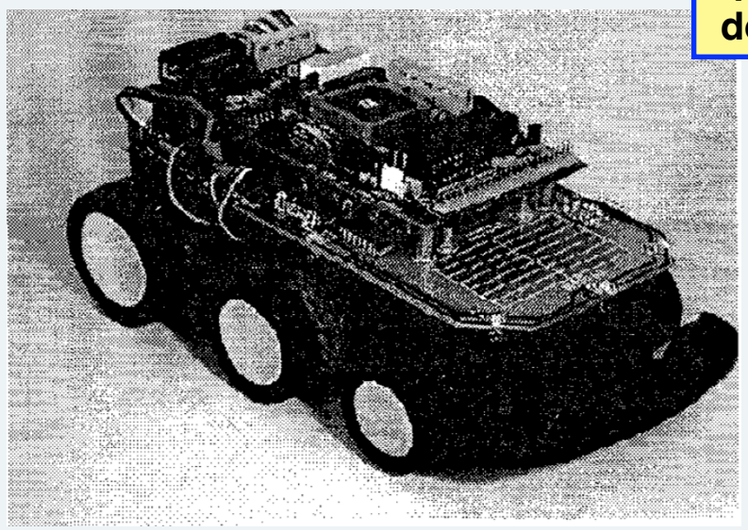
3. **How can these resources be deployed to solve the task?**
   Watch the video in the previous slide…

4. **Any evidence that this is actually how the task is solved?**
   (Not sure! But there is little doubt that human locomotion involves more than algorithmic joint-angle control.)

Tidy robots

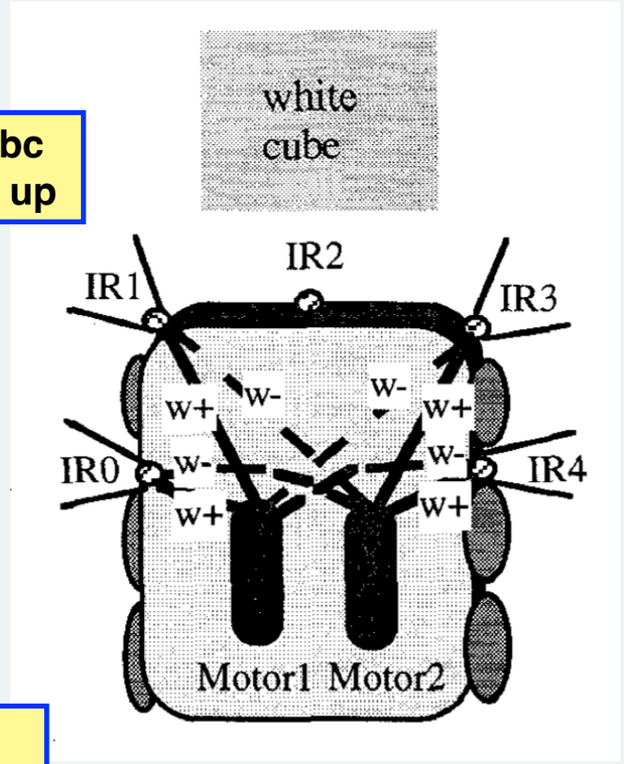
sensors; send signal to avoid obstacle
researchers forgot to add the middle sensor: it doesn't avoid blocks directly ahead of it

"Didabots"



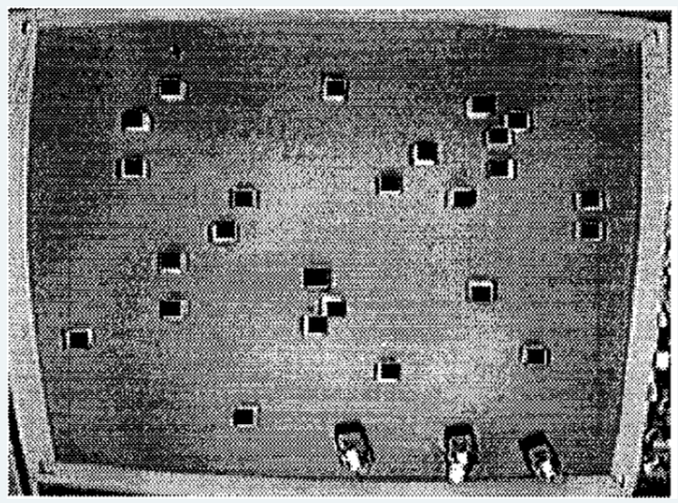
pushes them to middle bc doesn't reach wall, piles up

Control schematic

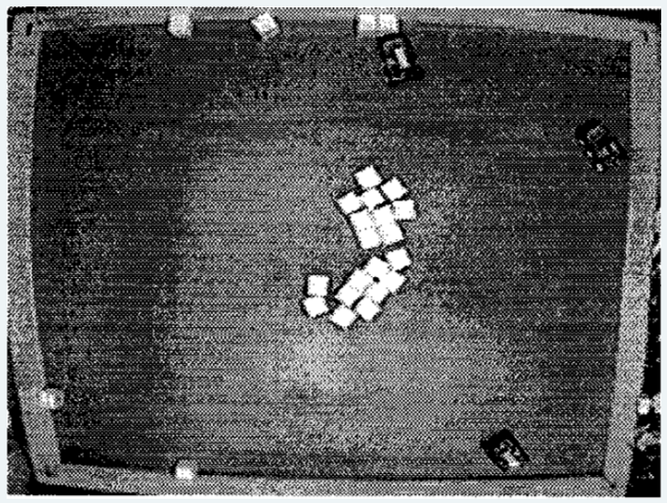


put on top of "messy" table:
not even designed to do this kind of tidying!
simple mechanism → complex behavior

Initial setup



After "tidying"



Maris, M., & Boeckhorst, R. (1996). Exploiting physical constraints: heap formation through behavioral error in a group of robots. In *Proceedings of IEEE/RSJ International Conference on Intelligent Robots and Systems. IROS'96* (Vol. 3, pp. 1655-1660). IEEE.

Flocking behaviour (boids)

easy to model boids (bird flocks)

1. Separation
2. Alignment
3. Cohesion

self organization enabled by context of algo.: embodiment

https://www.youtube.com/watch?v=V4f_1_r80RY

Outfielder problem

marton is just too coquette to understand baseball

1. **What is the task?**
   “The fielder’s task is to move themselves so that they arrive at the right place at the right time to intercept a fly ball.”

https://www.youtube.com/watch?v=BVBaKspcadQ

Outfielder problem

1. **What is the task?**
   “The fielder’s task is to move themselves so that they arrive at the right place at the right time to intercept a fly ball.”

simplification

Traditional explanation

Predicting trajectory of ball using initial direction, velocity & angle.

→ Mental representation of the future location of the ball.

Outfielder problem

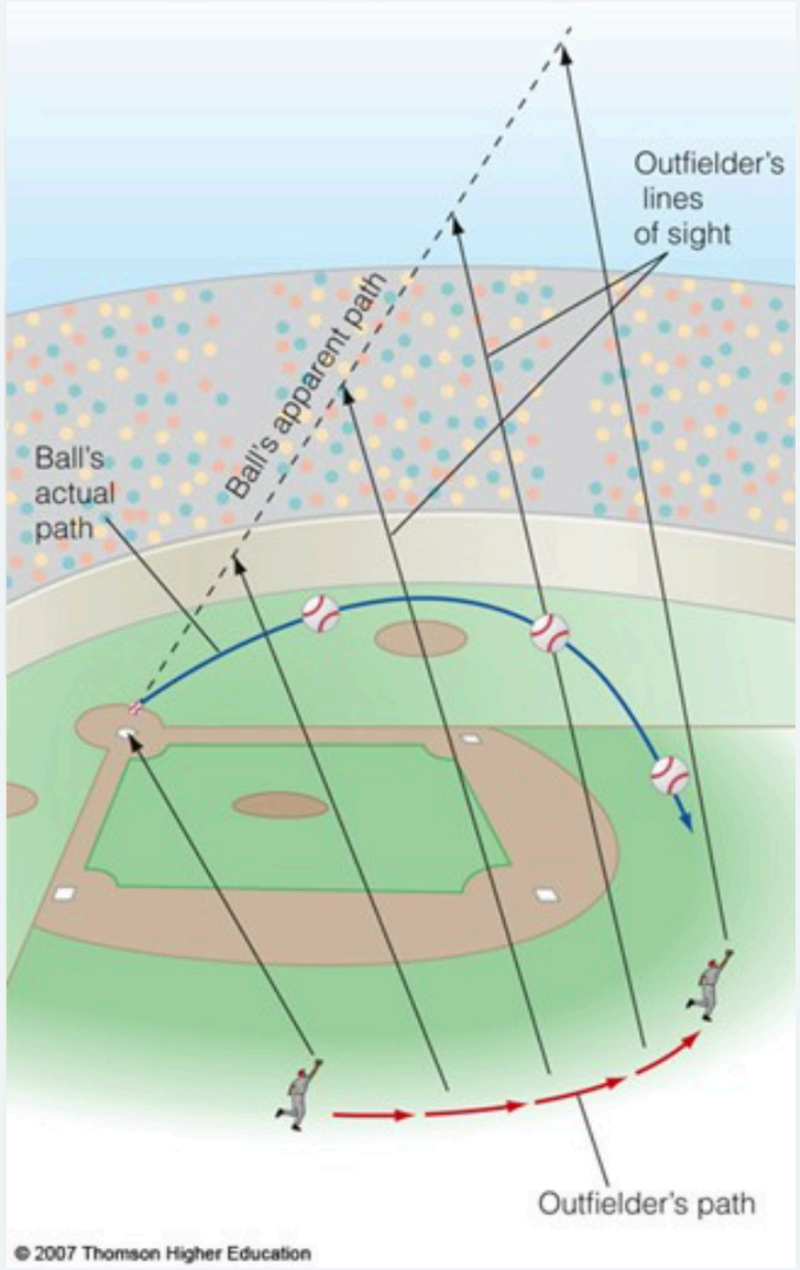
2. **What resources does the organism have?**
    - *noisy estimates of distance / direction / velocity / speed (propagating through projection!)*
    - *continuous kinematic information (→ infer underlying dynamics)*
    - *ability to detect kinematic information*
    - *ability to locomote*

Outfielder problem

3. **How can these resources be deployed to solve the task?**

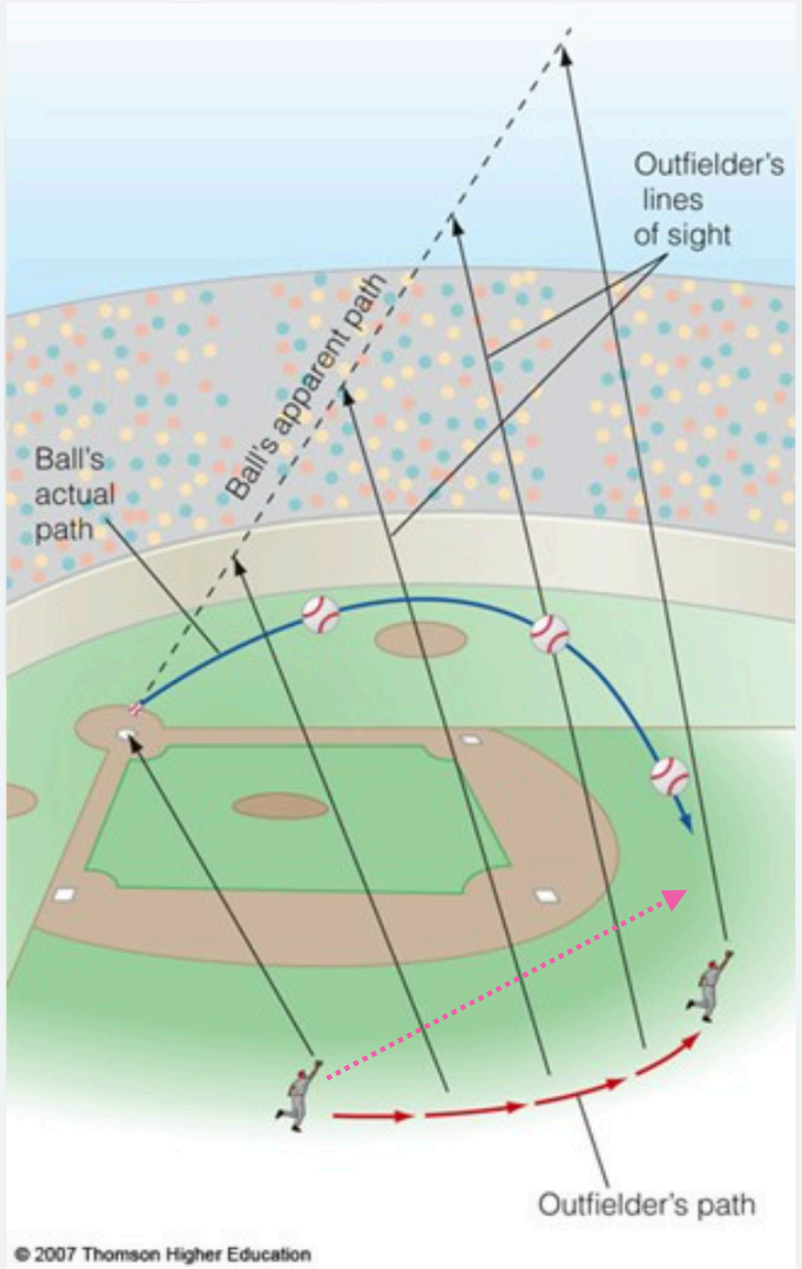
   - *heuristic solution: using perception & movement to offset some aspect of complex kinematics*
   - *linear optical trajectory…*

heuristic; linear optical trajectory
outfielder makes initial observation, starts running in a direction such that the ball appears to be going straight



Outfielder problem

4. **Any evidence that this is actually how the task is solved?**
    - *prediction-based solution predicts a straight path*
    - *real paths are typically curved!*



How do humans perceive AI art and its creative works? Is it considered less or more "artistic" and "creative" than human-made art (literary, visual, auditory)? For example, how would we react if we didn't know that the song to compare R and Python was written by an AI?

A-not-B problem

8-12 months: can reach, grab, have object permanence

1. **What is the task?**

   Find attractive object hidden in location B after it has already been hidden twice in location A. (age: 8-12 months)

using embodiment to understand why babies of this age tend to make the same error

they watch the object be hidden in location B, but still choose A because it was there twice already

dumbass

https://www.youtube.com/watch?v=lhHkJ3lnQOE

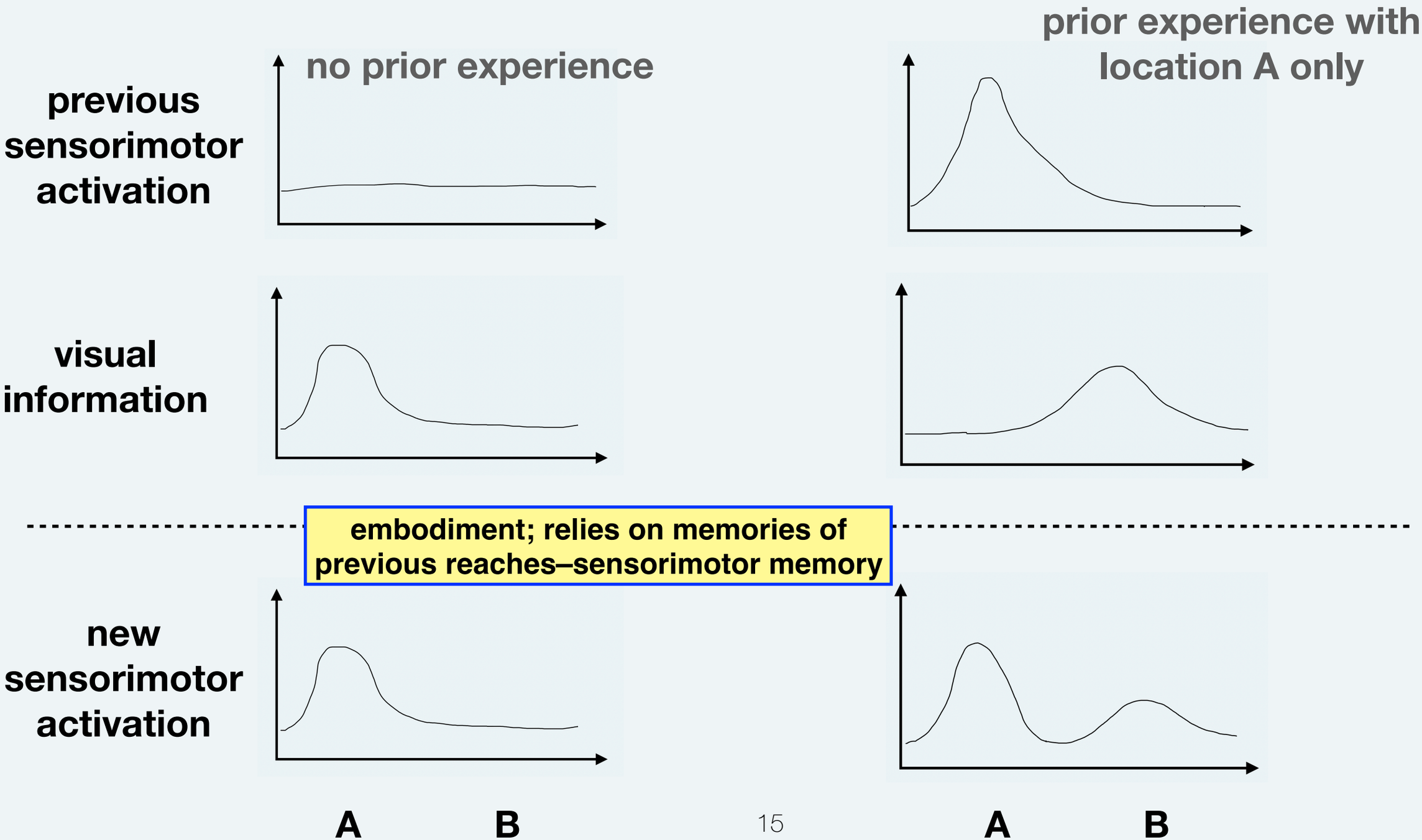
A-not-B problem

2. **What resources does the organism have?**
    - *visual input* 
    - *activations in the sensorimotor cortex from previous reaches (~ a memory of those reaches)*
- *visual attention & ability to perform visually guided reaches*

A-not-B problem

3. **How can these resources be deployed to solve the task?**

   - *“memories” of previous reaches + visual information interact to create a new reach*



A-not-B problem

If predictions are confirmed by data, strengthens argument

4. **Any evidence that this is actually how the task is solved?**
   - *model makes new predictions:*
     - *error should occur even if object isn't hidden*

yep, babies do that

     - *error can be reproduced in older children too if the task is sufficiently complex*

also true