Beyond the Centralized Mindset

… the emergence of order in interactions among decentralized elements is THE central concept of the distributed cognition approach.

How shall we explain behavior?

- What background assumptions guide our thinking as cognitive scientists?
- A long tradition of centralized thinking with linear causality
- Sometimes this works well

Another way to explain behavior

- What about decentralized thinking?
  - Emergence and mutual causality rather than linear causality
  - Self-organization rather than imposed organization
  - Local interactions instead of global plans

Emergent Phenomena

- Synchronized applause
  - A propensity to coordinate with others
  - Deciding on a frequency
- Everyone say a number
  - Convergence in information cascades
- Stadium Waves
  - Structure emerges from the interactions of simple agents

Resnick’ s five heuristics for moving beyond the centralized mindset

- Positive feedback is not always negative
  - Positive feedback can play a role in creating and extending patterns.
- Randomness can lead to order
- A flock of birds is not a big bird
  - Don’ t confuse the properties of the individuals with the properties of a group.
- A traffic jam is not a collection of cars
  - Some objects have an ever-changing composition.
- The hills are alive
  - Interactions with the environment can shape behavior in surprising ways
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**Decentralized thinking in biology too**

**Negative Feedback**

- **System State**
  - Sensor
  - Target
  - Compare
  - Effect

**Positive Feedback**

- **Signal**
  - Amplifier

**Unmodulated positive feedback**

**Modulated Positive Feedback**

- **Amplifier**
  - Microphone
  - Speaker
Products of Positive Feedback loops

- Washboard roads
- Galactic structure
- Slime mold aggregation
- Coral branching
- Cities and roads

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NetLogo Slime Mold Model

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System levels and emergent properties

- Aggregation
  - Molecules/pressure
  - Cars/density
  - Voters/election result
- Emergence
  - cars/traffic jams
  - fans/stadium waves
  - neurons/brain states
  - social practices/institutions
  - cultural practices/human cognition

Using evolutionary programming to create oil skimmer swarms

Michael Hayward
CogSci PhD 2004
The problem: Oil Spills

- There are over 2000 large oil spills every day
- How can the spills be contained?

A solution: Smart Oil skimmers

- What should the skimmers do?
  - Go to densest oil area?
  - Contain the perimeter?
- How can the individual skimmers be programmed to produce the best aggregate performance?

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Mind in Society (Vygotsky)

- High level cognitive processes always appear twice:
  - First as interpsychological process
  - Only later as intrapsychological process
- A social group may have cognitive properties that are different from the properties of the individuals in the group.

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Society of Mind (Minsky)

- Our minds are composed of hundreds of specialized agents.
- These specialists get combined into organized interactions to produce our mental abilities.
  - “…each brain contains hundreds of different types of machines, interconnected in specific ways which predestine that brain to become a large, diverse society of partially specialized agencies” (Minsky, 1988)
- This means that an individual person’s mind is a system of distributed cognition
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A special relation between society of mind and mind in society
- How do the internal agencies get organized?
- Biological maturation (by seed?)
- By interaction with the social and material world while engaging in cultural practices.
- Each society of mind develops in a society of other societies of mind.

Individual and group rationality
- Prisoner’s dilemma
- Tragedy of the commons
- The recent economic crash

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<tr>
<td>B</td>
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</tr>
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Irrational behavior at the group level does not require ‘individual irrationality’.

Society of societies of mind
(parallel emergence on adjacent levels, Resnick)
- In many animal systems, there are two types of emergence.
- First, the behavior of each individual creature emerges from interactions among the "agents" that make up the creature’s mind.
- At the same time, the behavior of the entire animal colony or society emerges from the interactions among the individual creatures.
- In short: the colony level emerges from the creature level, which in turn emerges from the agent level.

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“Things” that have ever-changing composition:
- Waves
- Clouds
- Language
- Culture
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Where are the physiological boundaries of the spider?

The attribution problem

- If mind is caused by something inside of us, what exactly is it that one must assume is IN THERE in order to account for the organized behavior one can observe?
  - A robot that loves light

Braitenberg’s Vehicle 2

Loves Light

What is the source of the observed patterns of behavior?

- Inside the creature? A program? LOGO?
  - If light-left, turn left;
  - if light-right, turn right;
  - else, go-straight
- Behavior organized by the interaction of agent anatomy and environmental patterns?
Braitenberg’s Vehicle 2

Loves Light

Hates Light

How do you remember what you heard in lecture?
- Taking notes.
- Does this amplify your memory?
- Have you “off loaded” memory into the environment?
- It is a cultural practice that creates a new functional system.
- We must distinguish
  - the cognitive abilities needed to engage in the cultural practice
  - the abilities that are achieved by engaging in the practice.

CPR Assignment 1

CPR procedures

Guidance for Writing Your Text
Use the following questions as a guide, because they are exactly how your essay will be evaluated.
1) Did you write a brief title?
2) Is your essay formatted correctly with a blank line between the title and the main paragraph(s)? Use the "Formatting Help" button to the right to find the correct HTML tag.
3) Did you write two reasons for choosing (or thinking about choosing) this major?
4) Were there any grammar, spelling, or vocabulary errors in your text?

Writing Prompt
Write a 100-200 words paragraph about why you chose your major. If you have not yet chosen a major, write about the one you’re most attracted to right now.
For this, as for all CPR assignments, you may type directly into the text entry window. If you do, use the SAV button frequently to avoid losing work. However, and especially for longer assignments, it is best to compose it on a word processor (again, saving frequently) then copy/paste your text into the CPR text entry window.
In either case, use HTML tags for formatting! Click on the "Formatting Help" button if you are not sure how to do this. After you save your work in CPR, use the "Preview Text" button to see how your text entry will appear to others. It will be obvious if there are any problems with HTML formatting.

Homework
- Set up your user profile on CPR
- Take the pre-test
For Thursday

- Review Cognition, Distributed reading
- Read CITW Introduction and Chapter 1
- Write your text for CPR Assignment 1