Cogs 102A * Distributed Cognition * Dr. Christine Johnson

Lec 1: Cognitive Ecology

In this course, we will shift our perspective to see ***Cognition as a SYSTEM!***

The Brain e.g. **Minsky, 88**, *Society of Mind*: Many active co-constraining modules generate behavior
- e.g. Neuroscience shifting to focus on connections (e.g white matter)

Engagement with World e.g. **Hutchins 95** Human + Human and/or Artifacts, in Cultural Context
- As above, shift to focus not on elements but on their connections

Repercussions of this shift to a Systems perspective
- Change boundaries of phenomena to be studied
  - Traditionally, cognition is "in the head", bounded by the skull
  - We will EXPAND that boundary to include multiple participants, artifacts, & cultural settings
- Change questions addressed, interpretations applied
  - Traditionally "Does subject have ability X?" "What (invisible) mental rep can we infer?"
    - i.e. Cognition as something you HAVE
  - We will ask "How does engagement proceed?" "How does info flow thru this system?"
    - i.e. Cognition as something you DO
- Change methods used
  - Traditionally manipulate one variable while holding others "constant" >>>
    Generate one measure (e.g. # correct responses) as evidence for/against ability
  - We will integrate multi-modal, multi-party, multi-scalar observations >>>
    Generate ecological description of transformations and co-constraints

WHY? Why make this difficult, confusing, laborious shift?

Ecological Validity

Cognition evolved as a situated response to complex environmental challenges
- e.g. Navigate, Forage (seek & process resources), Socialize, etc.

Since we evolved to cogitate in real-world, our adaptations match real-world affordances
- Artificial conditions of lab do not pose same challenges, so will not reveal natural processes
- By focusing on one element at a time, we MISS critical role played by others, objects & env!

System-Level Properties Matter

Properties of a system do not = properties of its elements
- e.g. Flock shape not = bird shape; AAABBB not = ABABAB; AB AB AB not = ABA BAB
- e.g. Positive & negative feedback, synchrony, configuration, sequence, etc
  - i.e. Cannot be investigated by looking only at elements (Whole not = sum parts)

Critical concept: **Emergence** through dialectic engagement
- When multiple parties come into coordination, shaping each other's options & actions
  - Such coordination is an emergent property of that system
- e.g. Ant trails (a colony-level property, not programmed into individuals) **See LAB 1**

From this view, we will define Cognition as **adaptive engagement with the world**

So, Cognition is Situated Practice, a range of activities-in-context, not a set of abilities
- "Adaptive" not nec = "optimal" or even "successful", but "relevant" to task or situation

Basic Assumptions of **Distributed Cognition**

Cognition is **Embodied**
- Cognizers, and thus many cognitive resources, are embodied
  - Sensori-motor constraints: Dolphins hear high, eleph low, gulls see UV, primates are handy
  - Action biases: Individuals go TO resources, FROM threats; Engage per target affordances
- **Gibson's** Ecological Perception includes "**Affordances**" perceiving how can interact w/object
  - e.g. For humans, chair affords sitting, pen affords gripping, floor (not cliff) affords walking, etc.
    - Note: "Canonical Cells" in parietal cortex respond to affordances of objects
- Multi-Modal coordination, within and between individuals
  - e.g. Hand-Eye coordination involves org of visual + proprioceptive + tactile + motor info
  - e.g. Conversation involves relative timing of vocalizations, facial expressions, gestures, etc.
- Multi-Body - Communicative activity (e.g. gestures, words) afford certain kinds of engagement
  - e.g. Pointing affords co-attention to target; Naming topic affords collaborative discussion

Cognition is **Distributed**

- Multi-party, including participants, their artifacts & cultural norms

-Problems are solved by systems, not by any one element (Like joint-accomplishment of **Maze**)

- If examine elements in isolation, will miss data critical to system operation

-e.g. "Across Fiber Coding", such as joint activity of Cool-Best + Warm-Best receptors

- Activity of single receptor ambiguous; Instead, relative proportion codes for temp

-e.g. "Snub": Not reacting to a solicitation is a reaction! ***("Nothing never happens!")***

- Tho Snubber did not change his behavior, info available in their system changed

-NOTE: We can say "Meaning" of Snubber's non-movement has changed, where…

Meaning, Informativeness = **Relevance = role of event in larger system**

Cognition is **Situated**

- Social, physical & cultural resources shape cognitive activity

- **Vygotsky 78:** "Zone of Proximal Development"

- Learning as apprenticeship: Novice+Expert engage until Novice can play all parts

- Vygotsky: Cognition is first inter-personal, only later intra-personal

- So, whatever "internal resources" participant brings (perception, memory, inference) will be based on (& largely visible in) its embodied, polyadic, & situated experience

- Norman 94: "Things that make us smart" - Cognitive artifacts task us

- By constraining our practices w/their physical and informational affordances

- And, if well designed, these constraints facilitate accomplishing task

Guides to the Study of a Cognitive Ecology

"Systems Thinking" increasingly widespread in science, esp via nonlinear math of Dynamical Systems

- e.g. Physics: Chaos theory; Economics ("*A Beautiful Mind*"); Behavioral Ecology

- Ecologies are complex and difficult to study!

- Require collecting a rich, multi-faceted database, and change over time is an integral part

- Consider some lessons from the biological study of Ecology. . .

Track transformations *e.g. The Water Cycle*

ASK: What info goes where, when, in what form?

- **Hutchins 95b** "How a cockpit remembers its speed" *Cognitive Science, 19*, 265-288

- Co-ord plane fuel weight with speed on found card, position card for joint access, align "bug" on dial to speed #, track juxtaposition of bug with needle as decelerate, etc

- Spatial info (needle proximity to bug) less demanding than doing the math

Observe change over time *e.g. The Emergence of an Oak Woodland*

ASK: How does cumulative change affect system function?

- Animal Trails: Problem-solving processes build up solutions over time > Δ practices

- Humans, especially, do such **Cognitive Niche Construction**

- e.g. Make and use Tools, Cultural Practices, Institutions, etc.

- **Hutchins, 05**: **Cognitive Artifacts** = "crystallization of partial solutions to common problems"

Examine co-constraints *e.g. The Nitrogen Cycle*

ASK: How do constraints on activity in this system interact?

- e.g. **Thelen & Smith 94** Seems that baby does not "have ability to walk" until 1 year

- But, makes proper moves if immersed in water, just can't support weight

- Walking, as a dynamical system, emerges through interaction of multiple factors