COGS 102A * Distributed Cognition

Cognitive Ontogeny

In Psychology, Learning has traditionally been seen as the individual's acquisition of knowledge
In contrast, in DCog…

Learning = Adaptive processes by which learner's behavior is brought into coordination with a task
- Task demands include engaging with affordances of a cognitive artifact, situation, another person, oneself, etc
  - "Coming into coordination" includes changing how stably & flexibly learner engages the task
- Process is largely observable in changes in allocation of attention, affect, object manipulation, vocalization, etc.

- **VYGOTSKY** (1896-1934) – Best fit with (inspiration for!) our perspective in this class
  - Russian Psychologist; Embraced (Marxist) dialectic; Focused on social aspects of cognitive development
    - Saw cognition as at first social and visible, and only later internalized as invisible "higher psychological process"
- **Zone of Proximal Development** = Child participates, with more proficient other, in some organized practice
    - Child comes to make relevant moves, time & place those moves well, eventually play both roles, etc.
    - Zone "spans" distance from what child can do to child's current "potential" with help
  - Methodologically, can observe behavior to *see* learning happening over time
    i.e. Observe changes in the **nature, timing, & proportion of contributions** of participants

- In any **Apprenticeship** - involving children or adults - social learning includes this sort of **Scaffolding**
  - More proficient participant, "Expert" (e.g. parent, teacher, practiced peer) scaffolds "Novice"
  - In fact, applies to any **mediated learning** situation, even when Expert is a book (!)
  - When "Expert" is an artifact, Novice plays a more active role in directing attention to affordances

Wood, Bruner & Ross (1976) on functions of the **Expert** in scaffolding:
- Recruit Novice's interest, via positive engagement, **highlighting** (Goodwin) relevant objects, affordances
- Simplify the task (often into sub-tasks); Challenge, always just ahead of Novice proficiency
- Demonstrate idealized version, Mark critical features of discrepancies (e.g. via imitation & correction)
- Maintain pursuit of goal, pay off despite amateurity; Maintain trust, Control frustration, risk

Rogoff (1991) Stresses **Active role of Novice** ; Children are active participants in Zone, even if role limited
- Child most frequent initiator of interactions; Elicits talk, help from others
  - Infant whines/Adult helps/ Infant relaxes - Infant reach, touch/Adult ask want?/Adult hands obj, infant grasps
  - If task too easy/Infant bored/Challenges Adult for more elaborate involvement

So, ZPD a **Dialectic** - Expert and Novice create, and adapt to, problem-space changes during learning

Some Discoveries of Distributed Development

Bakeman & Adamson (1984) - Classic paper – fine example of MACRO-level quantitative analysis.
- Longitudinal 6-18 month olds, Paired w/Mom or w/Peer, Free-play with objects. Scored "engagement states"
  - *Unengaged, Infant Onlooking*, *Inf engaged* w/*Person*, *Inf engaged* w/*Object, Passive Joint, Co-ord Joint*
- Results include… Mother-Infant dyads, compared to interactions between Peers, show…
  - More *Passive Joint* (Both attend object, but inf not attend mom) & *Coord Joint* (Both attend to obj & to other)
  - Mom more likely (than Peer) to do Passive Joint after kid *Onlooking,* or after kid in solitary *Object* play
- So, Mom **scaffolds** by watching for infant's relevant state, making object salient, & self available for co-ordination
- But this study's developmental account is limited to gross transitions in proportions of these macro-level states at diff ages
  - Does NOT provide info on HOW such changes come about, (e.g. rep'ing intentions? dynamic sensorimotor couplings?)

Smith & Thelen (2003) Re: Piaget's (Vanishing) A-not-B Error
- Piaget - Premiere developmental psychologist of 20th century; One discovery: Infants reliably error when…
- As infant watches, repeatedly hide object under A, let infant reach. Then hide under B & after short delay let reach.
  - 8-10 month old infants reach to A (not B!); At 12 months looks, reaches to B.
  - **Piaget**: Only 12 month "know "objects exist & persist.

  BUT 9 month act like 12 month if…
  - Shift posture of infant to standing; Put on wrist weights; Highlight hole covers; Exaggerate hiding event, etc.
- So, just as it is problematic to ask if an infant "has the ability" to crawl (when they can do so early on, but only in water)
  - Similarly here, there are multiple factors that will determine performance on an A-not-B task
- Ask not What does infant know? but under what conditions get stable/unstable perf? How do factors interact, change?
  - What real-world activity improves perf? Crawling (can get to)? Fine motor control (more ways to handle, see)?

MICRO MATTERS!

- Contemporary technology: Video, motion sensors, etc and computer processing of multiple, massive datastreams
  - Allows multi-modal, moment-to-moment assessments of the development of cognitive activity

Shen et al, 2010 Infants Use their Heads - to Reach!

- Subjects 1.5 to 5 years. Motion sensors on Head & Hands, Bird's Eye and Face-on cameras
- Presented with pairs of objects, free to reach
- All showed head stabilization before reach & co-orientation of head and reaching hand
  - Older looked longer before reach, younger just at reach
- IMPLICA: Reaching (finding & getting) not just about hand, but cross-modal, sensory-motor coordination

Consider the following problem in Language Development

"**Gavagai**" The problem of identifying the referent in language

- Classic problem in Linguistics: Proficient speaker says "Look at the Gavagai!"
  - How does learner know to which of myriad aspects of the visual world the speaker is referring???
    - Rabbit? Grass? Path? Ears? Eye? Prey? Green? etc. etc. etc.
- Traditional solutions propose conceptual constraints e.g. Innate categories, Perceptual biases, etc.
- But new, DCog research shows how actual word learning is constrained by the activity of participants!
  - For example . . .

Yu, et al 2009 Active Information Selection - "Feed your head!"

- Subjects 19-23 months & Moms. Head-cam on Infant and Mom, plus Bird's Eye camera
- Free play with Mom and 3 same-size toys; Computer vision IDs toys, hands, faces
- An infant-grasped object looms in his visual field & block view of other objects, thereby increase salience
- IMPLICA: Infant actively segments own cluttered, ambiguous world, by grasping and looming objects
  - i.e. An alternative to positing innate conceptual constraints for parsing the noisy input of a cluttered world

Yu & Smith 2010 Focused Attention Bootstraps Association Learning

- Subjects 14 months. Eye Tracker (to determine infant's point of focus).
- Played a spoken nonsense word & showed a pair (from 6) of novel shapes, word is name of one shape in pair
- Assessed behavior during learning by best (learned 5 or 6 words) vs. by poor learners (learned only 1 or 2)
  - As training proceeded, best learners gave fewer, longer looks to stimuli, reducing ambiguity of input
- IMPLICA: Best bootstrap own learning (**pos feedback**, **ratchet**), improving their chances of detecting regularity

Yu, Ballard & Aslin, 2005 Mom's Multimodal Coordination >> Neural Nets Learning Words

- Mom only. Eye tracker, Head-mounted camera, Microphone, Hand & Body motion trackers
- Vocally describe own actions (e.g. "reading" "writing" "stapling" etc), "as if to a child" (slow, enunciated)
- Neural Net learns image-sound associations (words for actions) based on these time-locked, multi-modal streams
  - i.e. When computer shown new videos of same actions, could segment video, generate correct "word"
- IMPLICA: Directed eye and body movements enabled computer vision to track & isolate pertinent aspects of scene

Yu, Smith & Pereira 2008* Vocalizations Contingent w/Sustained Hand/Eye Engagement >> Name Learning

- Subjects 17-20 mos & Mom, Head cam & Head Motion tracker on Inf & Mom, Bird's Eye cam & Computer vision
- Free play with sets of 3 toys, Mom teach names (nonsense words) for novel toys; Tested later, request Inf to give toy
- Names learned NOT most frequently spoken, but for toy grasped &/or loomed, w/head-stabilized look at time named
- IMPLICA: Language researchers often presume name learning requires "mind-reading" Mom's "intentions"…
  - Instead about **saliences that emerge** from multi-party, time-locked, co-oriented, multi-modal attention