Lecture 6:

Cognitive Ontogeny

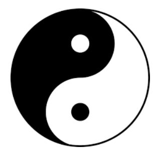
Cogs 102A * Dr. Christine Johnson

Learning

- 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 the learner engages the task
  - Process is largely observable in changes in allocation of attention, affect, object manipulation, vocalization, etc.

Vygotsky

- Russian psychologist (1896-1934)
- Embraced (Marxist) ***Dialectic***



- Focused on ***social*** aspects of

  development
- "Socio-historical"
  (**Cultural**) development

VYGOTSKY

- All higher cognitive functions

  "appear twice"

  - First as **inter**-personal (social, visible)

  - Later as **intra**-personal (invisible, mental)

Vygotsky

"Zone of Proximal Development"

Vygotsky

“Zone of Proximal Development”

- Child participates, with more proficient others,
  in some organized practice

- Child comes to make relevant moves,
  to correctly time & place those moves,
  eventually to play all roles, etc.

- Zone “spans” distance from what child <u>can do</u>
  to child's current “<u>potential” with help</u>

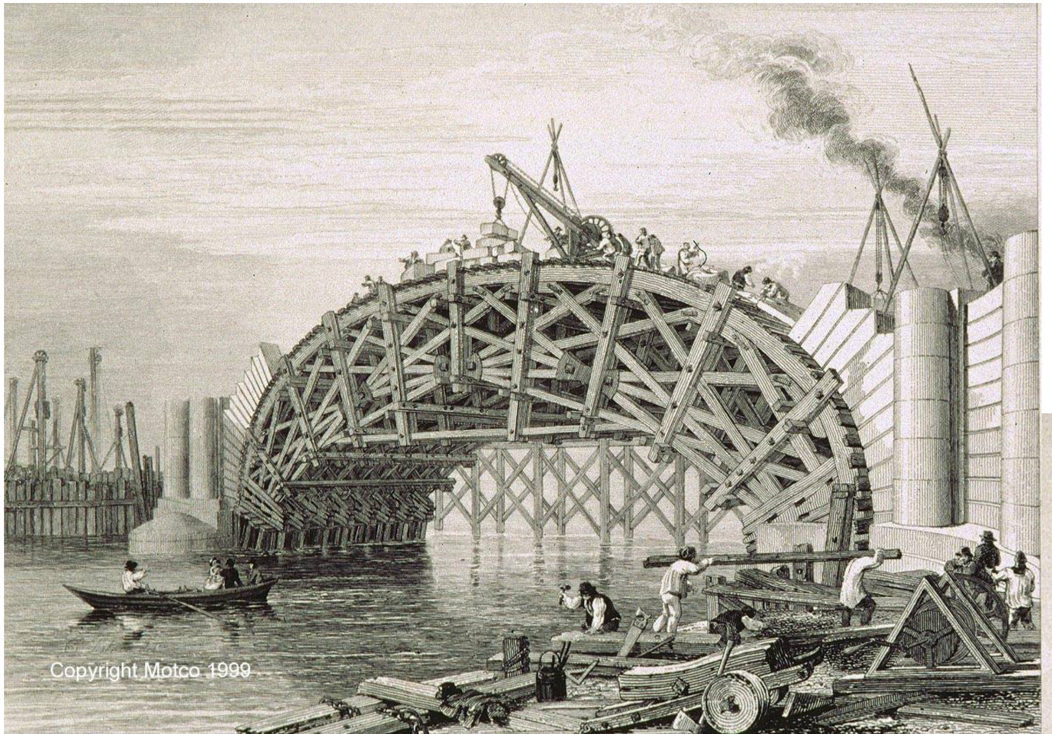
Vygotsky

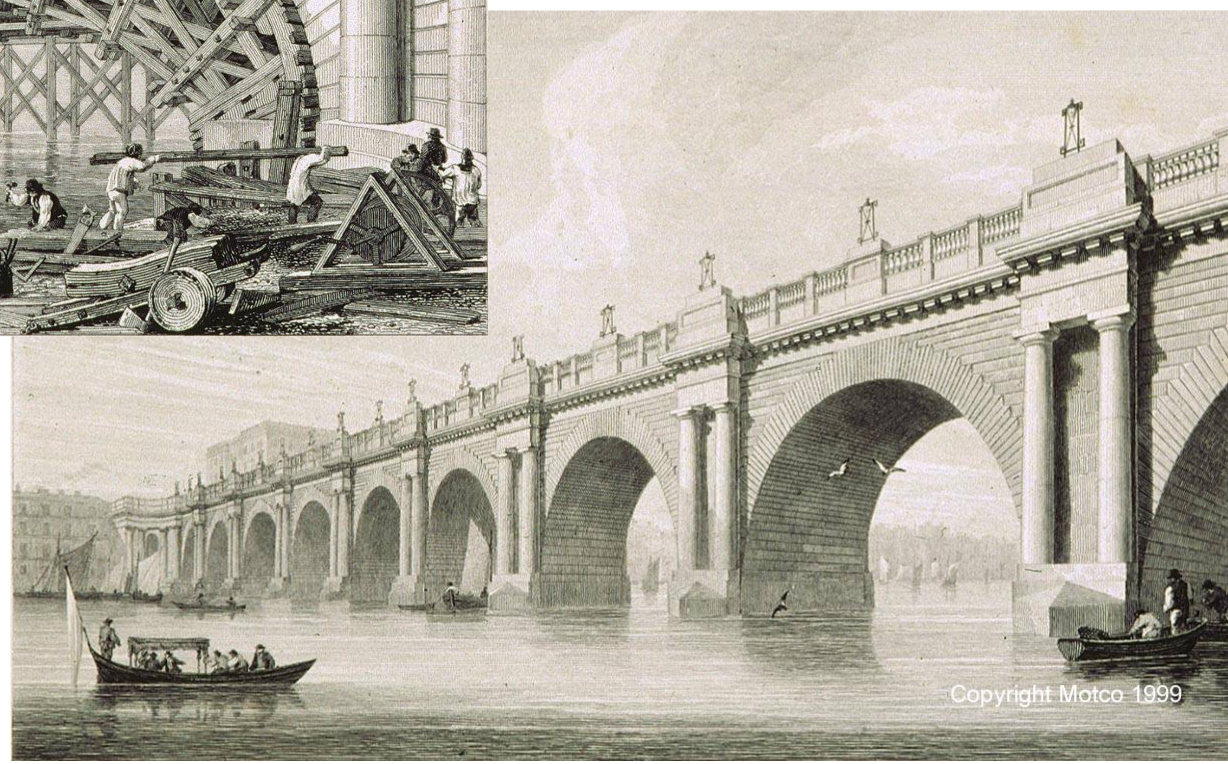
"Zone of Proximal Development"

KEY to today's Lab!

- Methodologically, observe changes in the nature, timing, and proportion of contributions of the participants.

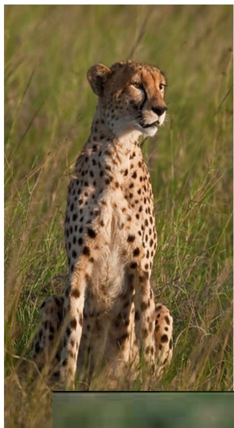
Scaffolding





Scaffolding

- In any **Apprenticeship** - involving children or adults - social learning includes Vygotskian **Scaffolding**



- More proficient "Expert" (e.g. parent, teacher, practiced peer) scaffolds "Novice"

Scaffolding

- 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

Functions of the **Expert** in Scaffolding

Wood, Bruner & Ross (1976)

- Recruit Novic's interest, via…
  - Drawing in to positive engagement
  - ***Highlighting*** relevant objects, affordances
- Simplify the task (often into sub-tasks)
  - Challenge, just ahead of Novice proficiency
- Demonstrate idealized version
- Mark critical features of discrepancies
  - e.g. Via imitation & correction
- Maintain pursuit of goal
  - Provide interim payoffs
  - Maintain trust
  - Control frustration, risk

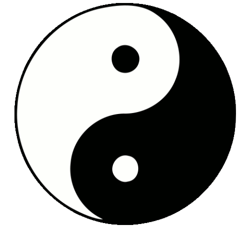
Active Role of **Novice**
Rogoff (1991)

- Children are *active* participants in Zone, even if role limited

- Child is most frequent initiator of interactions
  - Infant whines, Adult helps, Infant relaxes
  - Infant reach, touch, Adult asks "Want?"
    Adult hands object, Infant grasps
  - Child elicits talk, support from others

- If task too easy, Infant bored . .
  - Will challenge Adult for more
    elaborate involvement

So, the ZPD is a **Dialectic**



- Expert and Novice create, and adapt to, <u>problem-space changes</u> during learning

Discoveries from Distributed Development

Macro-Level Analysis

Bakeman & Adamson (1984)

"Coordinating Attention to People and Objects in Mother-Infant and Peer-Infant Interaction"

Macro-Level Analysis

Bakeman & Adamson (1984)

METHODS

- Longitudinal study, Infants 6 to 18 months
- Paired with Mom or with Peer
- Free play with objects

- Scored video into macro-level "Engagement States"
  - Infant unengaged
  - Infant onlooking (as other engages with object)
  - Infant engaged with person only
  - Infant engaged with object only
  - Passive Joint (both attend object, but infant not also attend mom)
  - Co-Ord Joint (both attend to object and to each other)

Macro-Level Analysis

Bakeman & Adamson (1984)

RESULTS:

- Mother-Infant dyads (compared to Peers) show…
  - More *Passive Joint* & *Coordinated Joint*
  - Mom more likely (than Peer) to do *Passive Joint* after kid *Onlooking,* or after kid in solitary *Object* play

IMPLICATIONS:

- Mom **<u>scaffolds</u>** infant activity by . . .
  - Watching for infant's relevant state (e.g. Onlooking or *Engaged w/obj*)
  - Making object salient (by timing own engagement to coincide w/inf's)
  - Making self available for co-ord (again, by timing own engagement)

Macro-Level Analysis

Bakeman & Adamson (1984)

BUT!

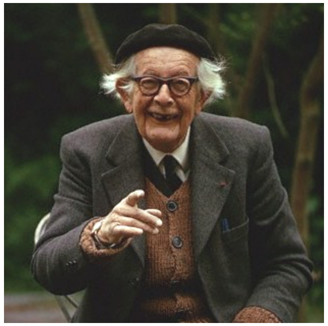
- This developmental account is limited to gross transitions in engagement states across the ages

- Does NOT provide info on HOW such changes come about
  - e.g. Via capacity to represent intentions of other?
  - e.g. Via dynamic sensori-motor couplings?
  - Need to actually LOOK at those details . . . (See last lecture!)

Piaget's **A-not-B Error**

Piaget

Premiere developmental psychologist of 20th century



(1896-1980)

TASK:

- Repeatedly, as infant watches, hide object under cover **A**

Piaget's **A-not-B Error**

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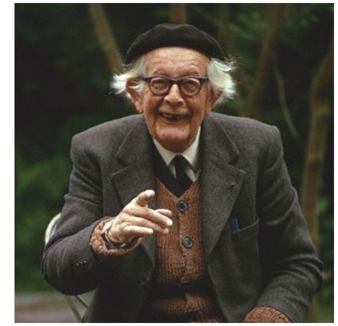
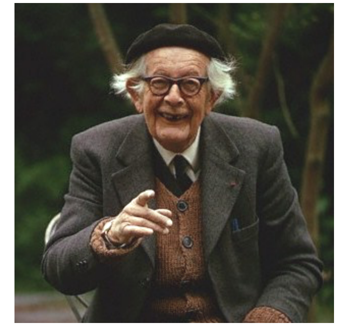


(1896-1980)

TASK:

- Repeatedly, as infant watches, hide object under cover **A**
  - Then let infant reach for hidden object

Piaget's **<u>A-not-B Error</u>**



Piaget

Premiere developmental psychologist of 20th century (1896-1980)

TASK:

- Repeatedly, as infant watches, hide object under cover **A**
  - Then let infant reach for hidden object
- Then hide under **B** and, after short delay, let infant reach

Piaget's **A-not-B Error**

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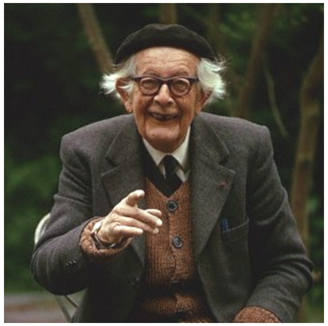


(1896-1980)

TASK:

- Repeatedly, as infant watches, hide object under cover A
  - Then let infant reach for hidden object.
- Then hide under B and, after short delay, let infant reach

- 8-10 month old infants reach to A (not B!)
  - By 12 months, infant looks & reaches to B.
- **Piaget**: Only 12 months "know" that objects exist & persist.

Smith & Thelen (2003)

Contemporary Vygotskians, on Piaget's (*Vanishing*) **<u>A-not-B Error</u>**

- <u>BUT</u> 9 month old acts like 12 month old if…
  - Shift posture to standing
  - Put on wrist weights
  - Highlight hole covers
  - Exaggerate hiding event
  - Etc!

- So, just as we saw with the issue of asking…
  - "Does infant <u>have the ability</u> to crawl?"
  - Problematic, since there are MULTIPLE interacting factors (movements, gravity, etc)
  - Same is true of performance on A-not-B task!

Smith & Thelen (2003)

Contemporary Vygotskians, on Piaget's (*Vanishing*) **A-not-B Error**

SO:

- ASK not "What does infant *know*?"
- But "Under what conditions do we see stable/unstable performance?"
- And "How do factors interact, change?"
- Also, "What real-world activity improves performance?"
  - e.g. Crawling (Can get to out of sight objects)
  - e.g. Fine motor control (More ways to handle, & therefore see, stuff)

Micro Matters!

- Modern technology
  - Video
  - Motion tracking
  - Eye Tracking
  - Massive datafile processing

- Allows…
  - Multi-modal
  - Moment-to-moment
  - Detailed developmental record

Infants use their heads - to reach!

Shen et al. (2010)

Infants use their heads - to reach!

Shen et al. (2010)

METHODS:

- Subjects 1 ½ to 5 years of age
- Motion sensors on Head & Hands
- <u>Bird's Eye</u> view and <u>Face-on</u> cameras

- Presented with pairs of objects
  - Free to reach

Infants use their heads - to reach!

Shen et al. (2010)

RESULTS:

- All showed Head-stabilization before reach
- Also co-orientation of Head and reaching Hand
- Older looked longer before reach, younger just at reach

IMPLICATIONS:

- Reaching is not just about the hands!
- Instead, about cross-modal sensory-motor coordination

"**Gavagai**"
The problem of identifying referent

- 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 also constrained by <u>activity of participants</u>!

Active Information Selection

Yu et al. (2009)

"Feed your head!"

Especially once you can sit stably

Active Information Selection

Yu et al. (2009)

METHODS

- Subjects 19-23 months & Moms
- Head-Camera on Infant and on Mom
- Plus Bird's Eye camera

- Free play with Mom and 3 same-size toys

- Computer Vision can identify Toys, Hand, Faces

Active Information Selection

Yu et al. (2009)

RESULTS

- Objects grasped by infant *LOOM* in his visual field
- Block his view of other objects
- Thereby increase <u>**salience**</u> of grasped object

IMPLICATIONS:

- Instead of positing innate *conceptual* constraints required for parsing the noisy input of a cluttered world
- Infant <u>actively segments & thus disambiguates its own input</u>

Bootstrapping Association Learning

Yu & Smith (2010)

Bootstrapping Association Learning

Yu & Smith (2010)

METHODS

- Subjects 14 months & Moms
- Eye Tracker determines Infant's point of focus

- Each trial, simultaneously presented…
  - A spoken nonsense word ("gasser", "manu", "colat", etc.)
  - Two (of 6) visual shapes
  - Word is name of one shape in each pair

- After several trials, determined that name was learned if infant looked longer at the named (vs. unnamed) shape

Bootstrapping Association Learning

Yu & Smith (2010)

RESULTS:

- "*Best Learners*" learned name of 5 or 6 shapes
- "*Poor Learners*" learned name of only 1 or 2 shapes
- As training proceeded, "Best" displayed
  fewer and longer looks at stimuli

IMPLICATIONS:

- Focused looking reduces ambiguity of input
- Infant BOOTSTRAPS (Scaffolds) his own learning
  - "Positive Feedback" or "Ratchet"
- Improves their own chances of detecting regularity of assoc

"What you ***learn*** is what you ***see***"

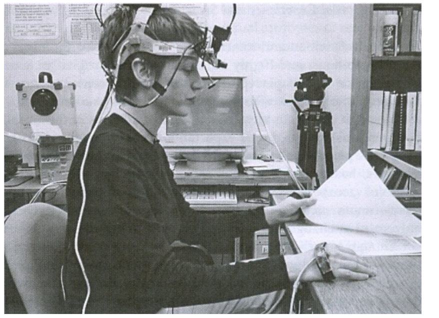
Neural-Net Learning

Yu, Ballard & Aslin (2005)

Mom's multi-modal coordination enables Neural-Nets to learn name-action associations

FIGURE 1.9 The associate training the computational model is wearing ASL eye tracker, CCD camera, microphone, and position sensors. The computational model thus shares multisensory information like a human language learner. This allows the association of coincident signals in different modalities. (From Yu, Ballard, and Aslin 2005, by permission)

Neural-Net Learning
Yu, Ballard & Aslin (2005)



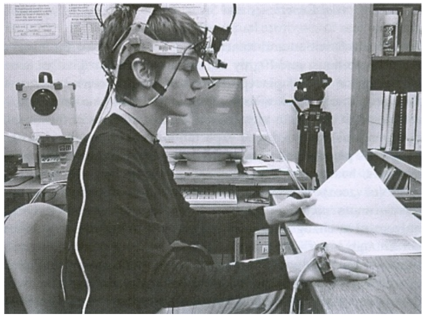
METHODS:

- 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 Learning

Yu, Ballard & Aslin (2005)



RESULTS:

- Neural Net learns image-sound associations
  - i.e. Words for actions
  - When computer shown new videos of same actions . . .
    - Could segment video scene appropriately and
    - Generate correct “word”
  - Based on **time-locked, multi-modal** streams

IMPLICATIONS:

- Directed eye and body movements enabled computer vision system to isolate & track pertinent aspects of scene
- Such multi-modal contingencies also available to human language learners

Grounding Word Learning

Yu, Smith & Pereira (2008, Required)

Vocalizations contingent with sustained hand/eye engagement

>> Learning names of objects

Grounding Word Learning

Yu, Smith & Pereira (2008, Required)

METHODS:

- Subjects 17-20 months with Mom
- Head camera & Head Motion tracker on Infant & Mom
- Plus Bird's Eye camera & Computer Vision analysis of video

- Free play with sets of 3 toys,
- Mom teach names (nonsense words) for novel toys
- Tested later by requesting Infant to give named toy

Grounding Word Learning

Yu, Smith & Pereira (2008, Required)

RESULTS:

- Names learned were NOT most frequently spoken
- Instead, were names for toys that were grasped &/or loomed, w/head-stabilized look at time named
    - i.e. **Multi-modal** (relevant) input makes learning easier!

IMPLICATIONS:

- Language researchers often assume name learning requires "mind-reading" Mom's "intentions"….
- But may be more about **saliences that emerge** from multi-party, time-locked, co-oriented, multi-modal attention.

LAB 4:

Consider the Scaffolding
(gradual change in participation profile)
that occurs even
between expert and novice adults . . .

LOAD “Scaffolding” Video from Lab Page