CS 184 * Modeling the Evolution of Cognition

Lecture Wk 8: Human Development

Note on **Recapitulation**

- Some claim "Ontogeny recapitulates phylogeny" (Development duplicates the stages of evolution)
  - Certain aspects of human (and NHP) development do fit this (e.g. cortex develops last)
    - Others do not (e.g. brain:body ratio decreases as human develops, unlike in phylo-history)
- A better variant may be von Baer's Law:
  - In phylogenetically related species, early stages of ontogeny are more similar than later ones
    - So, the more ontogeny you share, the more closely related you are
    - But again, tricky, since crucial differences (e.g. between humans & aps) are NOT always later
- Still, ontogeny and phylogeny are related in important ways
  - e.g. Cross-species homologies are often defined per common embryology
  - e.g. Behaviors that appear *earlier* in development are often of special significance to a species
  - e.g. Some behaviors are necessary prerequisites for later ones

Newborns manifest indicators of future importance

- **Hand and mouth** initially coupled (later increasingly separate, but never completely independent)
  - Babkin Reflex – press on palm, mouth opens - When hand comes near face, mouth opens
  - By 3 mo: Infant will grasp an object placed in its hand & bring it to its mouth
- **Imitation** of few facial expressions (raise eyebrows, stick out tongue, round mouth)
  - Probably the only changes discernable by the still ill-developed visual system
  - Also recently reported in Chimpanzee & Macaque monkey newborns (e.g. Bard et al, 2006)
- Extended index finger ("**Point**") emerges in first weeks, long before directional hand/arm/eye control
  - By 3mo: Point often accompanied by vocalization, although still not well coordinated with world

Hand control develops more rapidly than Vocal control in humans, but slower than Hand control in NHPs

- 3-4 mos, begin visually guided reach & grab
- By 6 mos, well-controlled hand/eye co-ord, but still involves whole arm and whole-hand grasp only
- By 9 mos gain control over individual fingers
- By 1 year precision grip, becomes best of primates
  - Note: Using 1 or 2 fingers involves **more** premotor activity than using whole hand to grasp
    - i.e. Additional active inhibition is required to isolate and differentially move fingers
- Also by 9 months begin differential bimanual, (2 Hands do diff but coordinated behavior)
    - Eventually this becomes the most complex of any primate
- By 1 year, active "**tertiary" object use** (use one object on another) including subassembly
  - NHPs do virtually no tertiary object use, unless enculturated by humans
  - Consider prehistory: Tools to make tools, Attach point to spear

Greenfield (1991): Model of ontogenetic & phylogenetic relationship between hands/tools and mouth/speech

- Area of frontal cortex that becomes Brocas at first organizes motor output of hands and mouth
- Area then differentiates into 2 areas that connect to approp. motor cortex for hands or mouth (Broca's)
- Then significant connections from elsewhere (e.g. Parietal, Temporal, respectively) are made
- This is reflected in similarities, then differences, in infant's object combination and vocal combination
  - Three phases can be called "Pairing", then "Pot", then "Subassembly"
  - Nested cups: Youngest repeatedly touch one to another (Pair), next put one in/on others (Pot), finally hierarchical "**Subassembly**" (1 inside next, those 2 inside next, those 3 inside next)
  - Similarly, given spoon, first bang spoon (Pair), then put spoon in mouth or in dish (Pot), finally scoop food from dish and bring that Subassembly to mouth
  - Slightly lagging above, first **vocalizations** = simple pairings ("da, da, da, da"), then combine same sound w/diff others ("da" "ma" "pa"), finally subassemble such combinations ("byebye daddy")
  - Eventually, language more hierarchically complex than (most? all?) manual activity
- Suggests a common shift from **pairing to hierarchical** combinatoric strategies

Vocal control lags behind Hand control somewhat, tho eventually vocal control far surpasses any in NHPs

- First emotional, state of arousal; Vowel-like resonance of vocal chamber, tense/relaxed breathing
- By 6 mos, actively **babble**, includes sounds of all languages;
    - Spontaneously take-turns w/other speakers
  - Preceded by sharp increase in rhythmic, repetitious **hand** movements
      >> first structured Babbling involves repeated syllable ("**bababa**")

- Plus, when babbling and rhythmic hand movements co-occur, vocalizations have more language-like shorter syllables and formant-frequency transitions
- By 9 mos, show inflection (babbling modified by affect) & shaped by heard language (Vocal imitation)
  - Also get first strings of mixed syllables (first subassembled combinatorics)
- By 1yr, usually first words in appropriate contexts
  - Babbling is now restricted to sounds of heard language

Motorically altricial => Socially precocial

- As described earlier, our bipedal species have extra-small pelvic openings and extra-large brains
- So, human infants are highly **altricial** (helpless, under-developed) at birth compared to other primates
  - i.e. Our early motor development is retarded in many areas, although advanced in others…
    - e.g. Locomotion extremely retarded relative to NHPs, cannot crawl until ~8mos, bipedal ~1 yr
      - NHPs are independently mobile by 2 to 6 months, depending on species
- Human infant compensates for slow phys development, via accelerated **social** development (Vauclair)
- Engages with others, via coordinated attention and imitation, to accomplish what it can't alone
  - i.e. Makes earlier use of (**cooperative**) ***Social*** **Tools** to manipulate and navigate its environment!

Attention Interactions – In some ways humans similar to NHPs, in others, very different

- Like other mammals, born with adult sized-eyes in baby-sized face – highly salient, attractive
  - But visible parts of human sclera are unpigmented ("**whites**" of the eyes)
    - Anatomical adaptation for making eyes and eye direction especially salient!
- Only & all humans engage in **gaze-games**: Wide eye/arch brows, loom/recede, peek-a-boo
  - Attunes infant & elders to visual attention, first toward each other, then to world: **Joint Attention**
- Only & all humans **point & show**: Both infants and adults grab and then direct the attention of others
  - NHPs DO develop Gaze Following, Social Referencing, Attention Getting Gestures
  - But do NOT develop Pointing (**Diectics**), unless enculturated by humans
  - Even language-trained NHPs use mostly Imperatives (do/get that!), not Declaratives (look at that!)
    - By 9 months, before "language", humans point and show!
- **"You-Me-It":** Tertiary interaction between 2 people and object – basis of linguistic reference!
  - i.e. Directed co-attention & co-confirmation is necessary to assigning names to things

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