LING 319: Biological Bases of Language Development

319_15_17_22JAN08
This Week’s Topics

- Language as a human universal
- Language as exclusively human
- The genetics of language acquisition
- Brain development and language acquisition
- The Critical Period Hypothesis

Hoff Chapter 2

**Hoff pp 40 (2nd half)-52 won’t be covered directly in lecture, but you should read it**

**Hoff pp 82 (bottom)-85 won’t be covered in lecture and you are not responsible for it**
Language as a Human Universal

- All human societies have language as an *integral* part of their society
- All human children (barring pathology) acquire language:
  - same timeframe
  - uniform stages & outcome
  - wide variety of environmental conditions
Language Can be Created

- Home sign
  - Deaf children of hearing parents

- Pidgins & Creoles
Pidgins & Creoles

- **Pidgin**: A common language created if it is absent in a community
- **Creoles**: When a pidgin acquires children?
- **Nicaraguan Sign Language** = recent language creation
Nicaraguan Sign Language

- Background = Sign Languages are REAL languages
- Nicaraguan Sign Language: 1978
- NSL has been evolving/changing since 1978
- Learner age at first exposure to NSL, and at what period of NSL’s evolution, play a big role in signers performance
Nicaraguan Sign Language
(Ann Senghas)

- Spatial modulation to mark modifiers
  - "tall" and "cup" signs in same location = adj + noun in ASL

- Subject-verb agreement inflections - next slide

- The signs for numerals
  - Early system - 30 yr olds: two hands, iconic gesture for "15"
  - Middle system - 20 yrs olds: one hand, partially iconic for "15"
  - Current system - children: one hand, opaque/arbitrary sign for "15"
Figure 2.1 Effects of year and age of entry on use of verb agreement inflections in Nicaraguan sign language

Hudson Kan & Newport 2005

- Taught an artificial language to both adults and children
- Artificial language had consistent word order patterns overall, but some inconsistent (irregular) patterns with determiners (e.g. ‘the’, ‘a’)
- Children, but not adults, “regularized” the inconsistent patterns
Theoretical Views on Language Creation

- The language bioprogram hypothesis
  - all creoles share certain properties.
  - core biological program for language structure = skeletal syntax

- A domain-general, cognitive view of language creation:
  - Social necessity & the general human brain
Language as Exclusively Human

Do other species have language?
Can apes learn language?
What is language?

- Reference /arbitrariness
- Syntax: combinations
  - Grover, Big Bird, hug --> Grover hugs Big Bird
    Big Bird hugs Grover
- Intentionality
- Ability to express non-concrete /non-essential ideas
- Specific elements of system learned
# Animal Communication Systems

<table>
<thead>
<tr>
<th>Animal</th>
<th>Arbitrary Reference</th>
<th>Syntax</th>
<th>Intention</th>
<th>Non-concrete/non-essential</th>
<th>Specific elements learned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vervet Monkeys</td>
<td>?</td>
<td>no</td>
<td>?</td>
<td>no</td>
<td>?no</td>
</tr>
<tr>
<td>Killer Whales</td>
<td>yes</td>
<td>no</td>
<td>?</td>
<td>?</td>
<td>?yes</td>
</tr>
<tr>
<td>Bees</td>
<td>no</td>
<td>yes</td>
<td>? (N/A?)</td>
<td>no</td>
<td>no</td>
</tr>
<tr>
<td>Song Birds</td>
<td>yes</td>
<td>?</td>
<td>?</td>
<td>no</td>
<td>yes</td>
</tr>
</tbody>
</table>
Can we teach language to primates?

- Efforts to teach chimpanzees to speak
  - Kellogg (Gua- 1930) and Hayes (Viki – 1950)

- Efforts to teach ASL to chimpanzees
  - Washoe: 132 signs and some combinations
    MORE FRUIT; PLEASE TICKLE
  - Nim Chimpsky: 125 signs and some combinations
    TICKLE ME; MORE EAT; MORE DRINK
    GRAPE NIM EAT; FINISH HUG NIM
    BANANA ME EAT BANANA
Limitations of Ape Signing

- The learning process
  - Closeness of trainer and animal
  - Intensive training

- Structure of their utterances
  - MLU over time
  - Range of combinations

- Content and function of their utterances
  - Dependence on interlocutor
  - Lack of topic/comment function
  - Concrete
  - No turn-taking skills

- Reference?
Can apes understand speech?

- Bonobos (Kanzi)
- Kanzi learned some lexigrams without intensive training
- Kanzi’s speech comprehension:
  - “Go to the oven and get the tomato”
  - “Put the rubber band on the soap”
  (ceiling = 59% correct)
Why can’t primates learn language?

- Nativist argument:
  - Language faculty = domain-specific = species specific

- Non-nativist argument (Michael Tomasello)
  - Language culture = species-specific
    - Problem-solving + collaboration
    - Theory of Mind and intentionality
What do we mean by genetics of language acquisition?

- Is language acquisition the unfolding of a genetic program?
  - Program of knowledge? Of learning procedures?

- What aspects of language acquisition might be controlled by such a program?
Twin Studies

- How twin studies work:
  - Compare monozygotic and dizygotic twins

- Heritability: amount of variation in individual development that can be attributed to genetics

- Overall, twin studies show some language development explained by genetics

- Grammar explained more than vocabulary:
  - Dale, Dionne, Eley & Plomin (2000): grammatical development heritability: 39 %
    vocabulary development heritability: 25%
Specific Language Impairment

- “Specific” language impairment
- Children with SLI:
  - 7% prevalence in general population
  - 25% chance another family member has it
  - Monozygotic twins more likely to both have it than dizygotic
  - Multiple genes interacting with environment
- The “K” family (Gopnik & Crago, 1991: domain specific & genetic) vs. Vargha-Khaden et al (domain general & genetic)
Language Acquisition and Brain Development
Equipotentiality vs. Invariance: Lateralization

- Equipotentiality
  - Childhood aphasia: (Lenneberg, 1967) vs. Woods & Teuber (1978)
  - Damage in utero or first few months of life
- Invariance
  - Intact brain functional studies: Molfese et al (1975)
- Who is right?
  - Degree of lateralization less for young children
  - *Plasticity*: ability of parts of the brain to take over functions they would not ordinarily serve
Neurological Correlates of Language Acquisition

- Human brain takes 15 years to develop
  - A lot of changes in first four years

- What is the relationship between neural events and language events in young children?
8-9 months

- **Neural events**: Distribution of metabolic activity; frontal lobe activity increase; long-range axonal connections; cell death

- **Language events**: word comp; decline in speech perception; intentional communication

- **Hypothesis**: structural & functional changes = groundwork for word comp; cell death = decline in speech perception
9-24 months

- Neural events:
  - synaptogenesis (synapse = connections between neurons)
  - Full left hemisphere specialization for language

- Language events: word prod; vocab spurt(?); beginning of grammar

- Hypothesis: synaptogenesis and left hemisphere = spurt & grammar? Or vice versa?
ERP Studies with Infants

- ERP = measuring electrophysiology of the brain
- Infants with small vocabularies, or for newly-learned words = left and right hemisphere activation

Why right hemisphere in infants?
- Episodic memory; context-bound
- Shift to left due to weakened connections in right as more language experience
24-48 months

- Neural events: peak in metabolic activity
- Language events: grammar foundations; automaticity; metalinguistic ability
- Hypothesis: structure-to-function shift; peak = from novice to expert
- ERP studies show that for grammar, “function” takes a long time to reach adult performance
The Critical Period Hypothesis

*CPH*: Period in an organism’s development where they are receptive to input of a certain kind; they must receive this input during this time, or else the ability to use the input shuts down.
Possible Evidence for CPH

- Feral children and late L1 acquisition
  - Genie

- Late L1 acquisition of sign language
  - NSL
  - Newport (1990): Sign proficiency of older learners is low
  - Lexicon = resilient; grammar = fragile

- Late second language acquisition
  - Continuity (linear) or discontinuity (nonlinear) in AOA effects?
  - Phonology, lexicon(semantics), grammar equally affected?

- **Subjects:**
  - 240 Italian L1-English L2 speakers in Ottawa
  - AOA ranged from 2 to >20 years

- **Methods**
  - Native speaker ratings of foreign accent in production of set of sentences

- **Results:**
  - Strong and linear relationship between degree of foreign accent and AOA
240 Native Italian Ss' Production of English Sentences

Flege et al. (1995)

- 61 Chinese-English bilinguals who learned English at different ages: 1-3, 4-6, 7-10, 11-13, >16. Native-speaker controls

- **Method & Results**
  - Behavioral: GJ tasks with semantic & syntactic anomalies; Neurological: ERP
  - AOA *linearly* related to syntax scores, but not semantic (except post 16 year olds)
  - AOA *linearly* related to processing speed & location for syntax, starting at AOA 3, but less related to semantic
General Conclusion

- Critical Period for Language Acquisition?
- Resilient and fragile aspects of language
  - Lexical/semantics = resilient
  - Computational (grammar & phonology) = fragile

“Language is the jewel in the crown of cognition, and grammar is the jewel in the crown of language”