Modularity and Non-modularity in Language Acquisition

A Review

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Overview

- **Concepts**
- **Pinker – *Rules of Language***
- **Fodor's interview**
- **Experimental evidence**
- **Bloom – word learning in children**
- **Deacon – genetic assimilation**
- **Bloom – Deacon parallel**
- **Synthetic Modelling**
- **Synthetic Modelling – genetic assimilation**

Concepts

Nativism

- FLN
  - Internalised Language (linguistic computational component)
  - Chomsky - Language acquisition depends on an innate, species-specific module that is distinct from general intelligence
- FLB
  - IL + sensory motor system + conceptual-intentional system

Empiricism

- Induction on Primary Linguistic Data (Data) gives rise to rules of language

Behaviourism

- Chains of stimulus - response
- Learning through associations

Steven Pinker
"Rules of Language"

- Presenting an argument for modularity (broad sense)
- Evidence from children with impairments
- **Specific Language Impairment (SLI)**
  - Language deficits not attributable to auditory, cognitive or social problems
  - Includes delayed onset of language, articulation difficulties in childhood, problems with grammatical features
  - Appears to have an inherited component
  - Language impairments found in
    - 3% of family members of normal probands, 23% of language-impaired probands
    - 80% concordant in monozygotic twins, 35% concordant in dizygotic twins
    - One case study: 16 of 30-member family had SLI

Steven Pinker …

- **Williams Syndrome**
  - Associated with a defective gene expressed in the central nervous system
  - Causes unusual kind of mental retardation
  - IQ measured around 50, but grammatical abilities close to normal in controlled testing
  - Language preserved despite severe cognitive impairments
  - Suggests that language system is autonomous of many other kinds of cognitive processing

Steven Pinker …

- **Pinker's conclusion**

  The language system is:
  - Modular
  - Non-associative
  - Developing on a schedule not timed by environmental input
  - Organized by principles that could not have been learnt, possible with a distinct neural substrate and genetic basis

Fodor Interview (2001):
"The Mind Doesn't Work That Way"

- **Are all mental processes modular**?
  - Modular: perception and articulation of action
  - Non-modular: most of cognitive mind
- **Local and Global processes**
  - Local: modular
  - Global: non-modular (reasoning, theory construction etc. – stuff that computers can't do)
- **Modularity and Darwinism**
  - Combining the two: modular mind is probably adaptation
  - Mind is not "massively" modular
- **What is innate?**
  - Concepts and prototypes - not innate
  - Mechanism linking the two - innate

Fodor's View - Comments

- **Earlier position**
  - All concepts are innate

    (In the 1975 book in which Fodor introduced the Language of Thought Hypothesis)

  - His argument:
    - Learning concepts is a form of hypothesis formation and confirmation
    - It requires a system of mental representations in which formation and confirmation of hypotheses are to be carried out
    - There is a non-trivial sense in which one already has (albeit potentially) the resources to express the extension of the concepts to be learned

- **New position**
  - Concepts are not innate
  - Innate faculty of language connecting concepts and prototypes implies that language is not separated from concepts, instead defined by them

Experimental Evidence

- **"Emergent Modularity"**

  Beyond Modularity
  Annette Karmiloff-Smith

  - Young children who suffer brain damage to the "language centers" of the brain are very often capable of learning language just as well as children without lesions
  - MRI - they just use a different part of the brain to do language
  - Localization seems to be the result of learning a language, not its precondition
  - Undermines the idea of innate modularity in language

Experimental Evidence…

- **Dissociation between language and mathematical ability**

  Agrammatic but Numerate

  Varley, Klessinger, Romanowski, Siegal

  - Patients with severe grammatical impairment (aphasic) – difficulties in grammatical comprehension and production
  - Basic computational procedures intact
  - Solved mathematical problems involving recursiveness and structure-dependent operations
  - Results demonstrate independence of mathematical calculations from language grammar
  - *Comment – Is vice-versa true?*

Paul Bloom
"Mindreading, Communication and the Learning of Names for Things"

- **Summary**
  - Word Learning – Theory of Mind
    - Children solve name-object mapping problem through inferring referential intentions of other people
  - No sub-module dedicated to communication
    - Mindreading ability used in language is the same as used in intentional attribution more generally, and is not a product of a distinct module or sub-module (E.g. Gaze)

- **Interesting argument**
  - Word-spurt
  - Phonological maturation

Genetic Assimilation – A Solution

- *The Symbolic Species: The Co-Evolution of Language and the Brain* Terrence W. Deacon, Professor of Anthropology, Boston University (1997) (Comments by Mark Turner)

- **Language arose**
  - Through cognitive and cultural inventiveness

- **Language improved**
  - Invented linguistic forms subjected to a long process of selection
    - The child's mind doesn't embody innate language structures - language has come to embody predispositions of the child's mind *(Art of Poetry - Paul Valéry)*
  - Changes in the brain – response to cognitive burden
    - Cognitive effort and genetic assimilation interacted as language and brain co-evolved

Genetic Assimilation...

- **Pinker – Bloom status**
  - Genetic specialization for language must have begun the process
    - "There must have been a series of steps leading from no language at all to language as we now find it, each step small enough to have been produced by a random mutation or recombination"
  - Cannot propose that language is a cognitive invention that underwent genetic assimilation
- **Deacon's opposition**
  - Language was a cognitive and cultural invention that underwent genetic assimilation
  - Language was "acquired with the aid of flexible ape-learning abilities"
  - Grammatical form is not independent of conceptual meaning

Genetic Assimilation…

- **What is genetically assimilated?**
  - GA involved neurobiological changes that assisted attention, memory, and association - easing the burden of language
  - Neurobiological changes were "a direct consequence of the use of words"
    - "An idea changed the brain"
- **Reconciliation**
  - Theoretical linguistics – opposing camps dismiss rather than confront
  - Evidence from other human sciences

Synthetic Modelling

- **Three basic approaches**
  - Genetic Evolution
    - Linguistic structure coded in gene
    - Modular approach (Innate LAD)
    - E.g. McLennan (communication): genetic transmission +adaptation improves survivability
  - Adaptation
    - Cognitive system (PMS + LS) genetically transmitted
    - Non-modular approach (Language acquired and stored in memory)
    - E.g. DeBoer (phonology): realistic vowel systems emerged
  - Genetic Assimilation
    - Baldwin effect (1896)
    - Reconciliation of modular and non-modular principles

Synthetic Modelling – Genetic Assimilation

Cultural transmission, learning cost and the Baldwin effect in language evolution
Steve Munroe, Southampton University; Angelo Cangelosi, Plymouth University

- **Baldwin Effect**
  - Quoted for playing a role in the evolution of linguistically-specialized structures such as the LAD
  - Can explain the assimilation of neural substrates that favour the evolution of general cognitive abilities

- **The Model**
  - Multi-agent model - simulates the evolution of shared compositional languages
  - Neural networks simulate the process of language learning and cultural transmission
  - Genetic algorithm models some of the mechanisms of natural selection

Synthetic Modelling – Genetic Assimilation

- **Parameters**
  - Noise level in the process of cultural transmission
  - Fitness cost of language learning for the individual
- **Results**
  - **Case I**: Language environment varies during cultural transmission and there is an associated high learning cost
    - Agents develop an increased predisposition to learn the language quickly and efficiently
    - No actual linguistic structures are assimilated in the agents' genome
  - **Case II**: Language environment remains static and there exist high learning costs
    - Agents incorporate aspects of language structure into their genome
    - Before cultural transmission starts, agents already have some knowledge of the language to be learned

Synthetic Modelling – Genetic Assimilation

- **Results**
  - **Case III**: Low learning costs
    - Baldwin effect is much reduced
    - Little evolutionary pressure to translate the lifetime learning task into genetic structures
- **Conclusions**
  - Noise-free transmission of language, which implies a **stable language**, favours and strengthens Baldwinian mechanisms
  - **Higher learning costs** strengthen the Baldwinian assimilation of linguistic traits
  - Baldwin effects accompany evolution of **adaptive neural structures**
    - Evolution of a predisposition to learn language:
      Agent's neural networks produce categorical perception effects before learning starts. These category learning abilities speed up the acquisition of linguistic structure

References

- [1] S. Pinker, *Rules of Language*, Science 253 (1991): 530-535
- [2] *Global Processes, Innate Concepts and a Few Words on Ontology*:
  An Interview with Jerry Fodor
  http://www.netn.fi/201/netn_201_fodoeng.html
- [3] P. Bloom, *How children learn the meaning of words,*
  http://cognet.mit.edu/library/books/view?isbn=0262024691
- [4] Varley, Klessinger, Romanowski, Siegal, *Agrammatic but Numerate*, 2005
- [5] Hauser, M. D., Chomsky, N. & Fitch, W. T. (2002) *Science* 298, 1569–1579.
- [6] Terrence W. Deacon, *The Symbolic Species: The Co-Evolution of Language and the Brain* (W.W. Norton & Company, 1997)
- [7] Bart de Boer, *Self-organization in vowel systems*, Journal of Phonetics, 2000
  http://www.idealibrary.com
- [8] S. Munroe, A. Cangelosi, *Cultural transmission, learning cost and the Baldwin effect in language evolution*
  http://www.ling.ed.ac.uk/evolang2002/ABSTRACTS/munroe.txt

Thank You!

Questions?