Outline

- External Modularity:
  - Language and Mind

- Internal Modularity
  - The Architecture of Language

- Implementation
  - Language and Brain

External Modularity

- Double dissociations:

<table>
<thead>
<tr>
<th>Language</th>
<th>IQ Mentally normal</th>
<th>Neurologically Normal</th>
<th>Theory of mind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Blind, deaf, etc.</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Insanity, psychopathy</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Down’s syndrome</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Williams syndrome</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S.L.I.</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Broca’s Aphasia</td>
<td>-</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>(Severe) Autism</td>
<td>(✓)</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
External Modularity

- Acquisition is independent of intelligence
  - Down's Syndrome, Williams Syndrome

- Acquisition is independent of formal teaching
  - Language acquisition seems to happen automatically / instinctively (cf. Pinker 1994)
    - Child-directed speech ("motherese") is helpful but not a prerequisite
    - The !Kung San drill their babies in sitting up

- Acquisition is independent of learning skills
  - Requires good learning: math, playing instruments, games, reading, writing ...
  - No "bad" language users
  - Infants acquire language but are incapable of much else
  - Williams Syndrome: poor learners, very good language-users

- Acquisition seems to follow a specific biological clock
  - …like sitting, walking, milk teeth, puberty, etc.
  - Language is universal
  - All children go through the same stages
  - There is a 'sensitive period' for first language acquisition before puberty

Internal Modularity

- The linguistic sign

- Duality of patterning
  - meaningless sounds \( \rightarrow \) morphemes
  - meaningful morphemes \( \rightarrow \) words and phrases

Structure dependency:
  - ‘Garden paths’ (problem: structure):
    - The horse raced past the barn fell.
    - Fat people eat accumulates.
    - The old man the boat.

  - Well-formed nonsense (problem: meaning)
    - Colourless green ideas sleep furiously.
    - More people have been to Paris than I have.

  - "The Autonomy of Syntax"
Internal Modularity

• The Language Faculty consists of at least:
  
  ![Diagram showing the Language Faculty with modules like Lexicon, Morphosyntax, Semantics, and Pragmatics.]

  - Lexicon
  - Phonetics
  - Phonology
  - Morphosyntax
  - Semantics
  - Pragmatics

  • ...all of which in turn consist of sub-modules.

Implementation

• Modules may be found at all levels of description
  - (See also “Outline”, slide 2)

• There need not be any simple correspondence between modularity at one level and modularity at another level.

  - Module (level n) ≠ Module (level n±1)

Cognitive Modules:
(Chomsky 2000)

- Face recognition
- Language

Input systems:
(Fodor 1983)

- Perception
- Neurons

Cell Structure:

- Neurons

Implementation

• Syntactic and semantic anomalies elicit qualitatively different changes in the electric fields around the brain
  - Different timing, distribution, and polarity

  • Syntactic: P600, (E)LAN
  • Semantic: N400
    (Osterhout & Nicols 1999, Saddy et al. 2004)
Implementation

• Neuroimaging with fMRI (Christensen 2005)
  – The Language module does not correspond to a single module in the brain

Linguistic task: Anomalous / OK?
The doctor didn’t hear any noises.
Which houses didn’t the expert eat?

Non-linguistic task: 4...3...2...1...

Implementation

• Syntactic displacement
  – A sub-component of the syntax sub-module

Non-canonical word order:
Hvilke fejl har lægen ikke fundet?
Which errors has the doctor not found?

Canonical word order:
Har lægen ikke fundet nogen fejl?
Has the doctor not found any errors?

In short

• Language is a cognitive module, a self-contained sub-component of the mind.

• The architecture of language consists of several distinct sub-modules.

• Language is implemented in the brain as a network of sub-modules distributed over several computational “centres”.

References