Language and the Brain

- Harley, 2008, pp. 14-19
- Lesion Studies
- Neurology and neuropsychology have been concerned with **localization of function**
  - Which parts of the brain play what role/s in behavior
- Cognitive neuropsychology goes a step further
  - Neurological functioning associated with cognitive processes such as language, memory, and perception
  - Emphasis on understanding normal, not disordered, processes

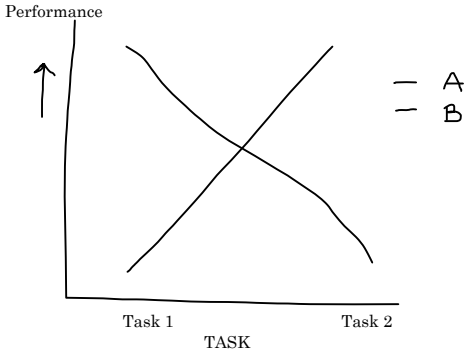
Wernicke-Geschwind Model

- Language processes flow from back of left hemisphere to the front
- High level planning and semantic processes toward the back – Wernicke's area
- Low level retrieval and articulation more forward, Broca's area
- Connected by arcuate fasiculus
- Image Diagram of Wernicke-Geschwind on p. 70 of Harley (2008); see also Figure 1.4 p.15

Double dissociation (see next slide)

- (Def) pattern in which two patients show opposite profiles
  - One patient can do one task but not another, and the second patient cannot do the first task but can do the second.
  - Conclusion = Different processes underlie each task
  - Evidence of differing brain lesions can support this
- Limitations:
  - Assuming modularity or separate routes because of evidence of double dissociation is not accurate.
    - Connectionist modeling has shown that double dissociations can emerge from single-route systems.
  - Problem of inferring normal from disordered
  - Clinical categories are not "pure" or distinct in patients, as often implied in descriptions/labels

FIGURE 1.5 P. 16 HARLEY 2008

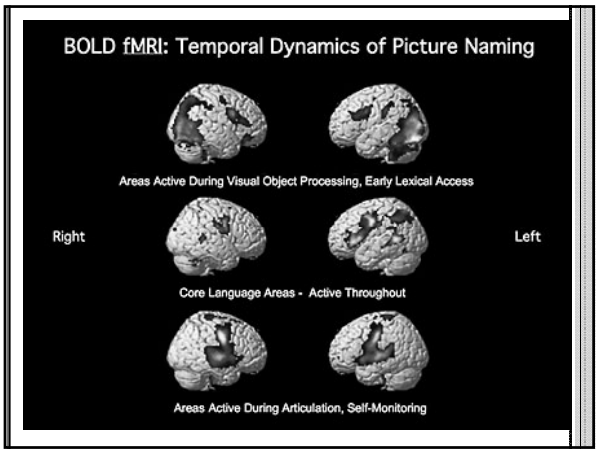


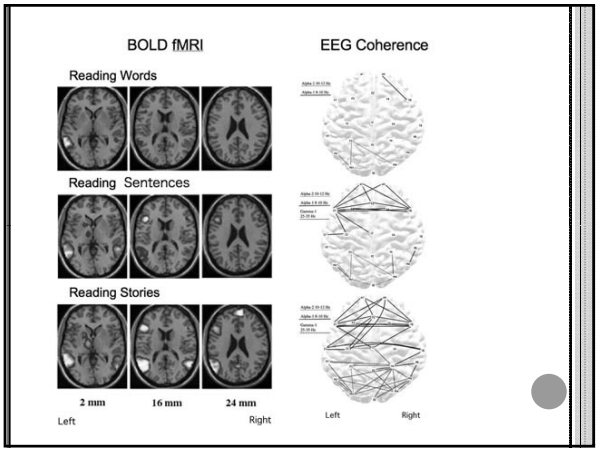
NEUROIMAGING

Techniques that measure electrical activity of the brain:

- EEG - electroencephalogram and ERP - event related potentials
  - Electrodes placed on the scalp measure volts
  - Waves are evaluated as positive running versus negative running
  - Amplitude of waves and latency of waves used to interpret
  - Adv: Both EEG and ERP have good "temporal" or timing info for behaviors of interest (P300), not very good "spatial" info i.e., regions of brain involved
- MEG - magnetoencephalography
  - New technique to measure magnetic activity
  - Good spatial and temporal info
  - Expensive, not available

- CAT - computerized axial tomography
  - Uses integrated x-ray pictures, medium resolution
- MRI - magnetic resonance imaging
  - Uses radio frequency waves instead of x-rays, higher resolution
- PET - positron emission tomography
  - Radioactive glucose injected into the blood stream, measures glucose uptake in the brain
  - Results indicate brain regions that are most active during various tasks
- fMRI - functional magnetic resonance imaging
  - Detects the brain regions with the most blood and oxygen based on hemoglobin molecules
  - Temporal and spatial resolution is better than PET
- TMS - transcranial magnetic stimulation
  - Magnets stimulate cortex and participant's response – behavior or experience – is assessed.





Clinical Applications

- Disadvantages:
  - Many procedures remain expensive or not available
  - Not easily interpretable – validity, reliability
- Advantages:
  - Identify damage/lesions for brain injuries
  - Anticipate future use of assessment and treatment

Themes and Controversies

Harley, 2008, pp. 19-24

10 Themes Recur in Book (see p. 20, Fig. 1-7):

1. What processes are involved in understanding and producing language?
2. Are different language processes related to one another?
   - Are the processes of speaking the same as processes for reading
3. Do language processes operate independently or do they interact?
   - Modularity

4. Is language innate?
5. Is language processing best described with reference to specific rules?
6. Are these processes of interest specific to language or are they more general processes involved in cognition?
7. To what extent do the experimental methods affect the findings and theories?
8. What do studies of individuals with brain damage teach us about the brain and language?
9. How does speaking more than one language affect cognitive processing and expand our understanding of language processes?

10. How can psycholinguistic knowledge be applied to everyday issues?

    Applications include:
    - Understanding normal language development
    - Treatment for language impairment
    - Teaching reading and overcoming learning disabilities
    - Rehabilitation for individuals with acquired brain injury
    - Developing computer systems that can process language

Modularity

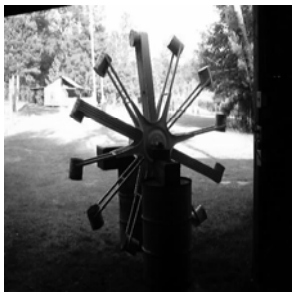
- (def) A module is a self-contained set of processes.
- text, p. 21 text
- Modularity is the idea that the mind is built from separate modules.
- The processes in each module are independent or autonomous from the processes in other modules.

Autonomy vs Interaction

- Interactive models involve influence from one module to another or from some processes to other processes.
- Two questions related to the type of interaction

1. Is there overlap in the processes?
   - Discrete Model vs Cascade Model
2. Can processes reverse direction? i.e., is there feedback?
   - Can information from one level influence a lower level?

Water Wheel and Waterfall analogy

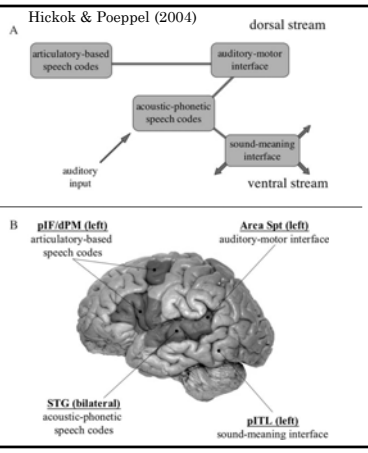


TOP-DOWN VS BOTTOM-UP PROCESSING

- Bottom-up is data driven
  - processing flows from the sensory system to the higher level mental representations
- Top-down starts at the mental representation or concept and processing can flow down to the lower level of sound representation

SUPPORT FOR MODULARITY

- Modular models tend to be simpler than other models of language processing
- Belief that evolution favors modularity
  - Different animals have human correlates
- May be neural correlates to fit modularity, e.g., Wernicke's and Broca's
  - Idea of a physical modularity that corresponds with processing modularity
  - See Hickok and Poeppel diagrams, next slide
- Modules provide a fixed framework for studying the mind
- Psycholinguists who support modularity – Pinker, Fodor – also tend to favor models of language that are heavily innate



Question of Modularity cont'd

- Broader idea of modularity: Is language one big module? Chomsky's LAD
  - Separate from cognition
- Or, are the separate language subsystems modules
  - syntax, speech perception, word recognition
- Innateness, modularity, rules, and language-specific processing are all part of one "camp" in the debate regarding what is language.
  - Separate from those who support more general cognitive processes as the basis for language.

What does Connectionism bring to this discussion?

- Focus on what are those processes hypothetically within modules
  - what takes place in the boxes
- Connectionist models don't require explicit rules on the front end, instead rules develop following exposure to data or input
  - emergentist
- Learning through repeated exposures or **probabilistic models** of language processing
  - idea that children are learning through statistical or distributional analysis.

GRAY…

- "uncertainty is a fact of life when trying to understand the psychology of language" p.24 text