

## Mind-Brain

There are 2 broad approaches to connecting brain and cognitive activity:

1. (modern) "Imaging" techniques
2. (classic) Patients with brain trauma
  - H. Jackson, A.R. Luria, O. Sacks

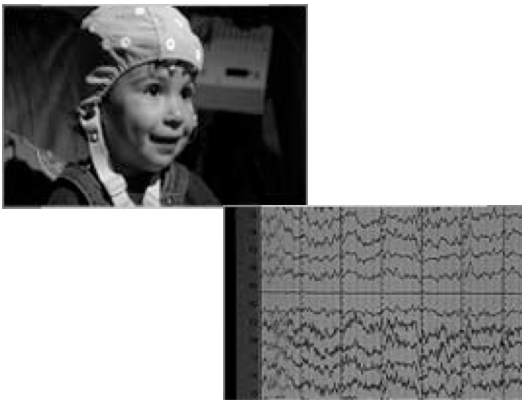
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## Methods for "Seeing" the Brain

(<http://www.pbs.org/wnet/brain/scanning/>)

- **Electroencephalogram (EEG)**
  - Records electrical activity of the brain.
  - Indicates when the brain responds

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## Methods for "Seeing" the Brain

- **EEG**
  - Often used in sleep research.
- **ERP**
  - Event related potential
  - Changes in "component" (onset, amplitude, duration) in response to a stimulus.
    - P300, N400, etc.

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## Methods for “Seeing” the Brain

- Computerized Axial Tomography
- CT- or CAT-scan
  - A 3-D X-ray of the brain.
  - Detect changes in soft tissue
    - damage due to tumors, intracranial bleeding, stroke

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## Methods for Studying the Brain

- Magnetic Resonance Imaging
- MRI
  - Provides information about soft tissue that is clearer than CT.
  - Don’t need to ingest “tracers”
    - Diffusion Tensor

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## Methods for Studying the Brain

- functional Magnetic Resonance Imaging
- fMRI
  - Cerebral blood flow is measured while doing a task in a scanner
  - BOLD-response
    - blood oxygenation level dependent-response

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## Methods for Studying the Brain

- Magnetoencephalography
- MEG
  - Like EEG, but measures magnetic fields, not electrical fields associated with neural activity.
  - Better at localizing regions of activity than EEG.
    - M350 associated with lexical activation
      - Pykkänen, L., Stringfellow, A., & Marantz, A. (2002).

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## Methods for Studying the Brain

- Positron Emission Tomography
- PET
  - Assess metabolic activity.
  - Detects changes in blood flow that correspond to mental activity

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## Methods for Studying the Brain

### Assumptions of fMRI and PET

- metabolic change = neural activity = cognitive activity
- Donderian subtraction method
  - Is your baseline task appropriate?
- Talairach space
- Hard to distinguish among activation, competition, inhibition.
  - What does “more activity” mean?
    - It’s a hard task so the brain must work harder
      - Expert will have less activity
    - Or, is a lot of activity a sign of expertise
      - You are inhibiting irrelevant information

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## Classic approach: Patients (Cognitive Neuropsychology)

A popular methodology is the *case study*

- Study every aspect of one (or a few) individuals.
- Each patient is a separate “experiment of nature” that a theory must account for.

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## Classic approach: Patients (Cognitive Neuropsychology)

Aren’t neurology patients just outliers?

- Do we really need to account for outliers?

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## Classic approach: Patients (Cognitive Neuropsychology)

Aren't neurology patients just outliers?

- Do we really need to account for outliers?
  - Discrepancies in planetary orbits
    - Led to discovery of other planets & to the idea that the earth goes around the sun!
    - » Thomas Kuhn *The Structure of Scientific Revolutions*.

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Hanley (1996). The case study method in cognitive neuropsychology. In Haworth (ed.) *Psychological Research: Innovative methods & strategies*. (pp. 251-262).

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## Classic approach: Patients

Look for functional (double) dissociations among patients:

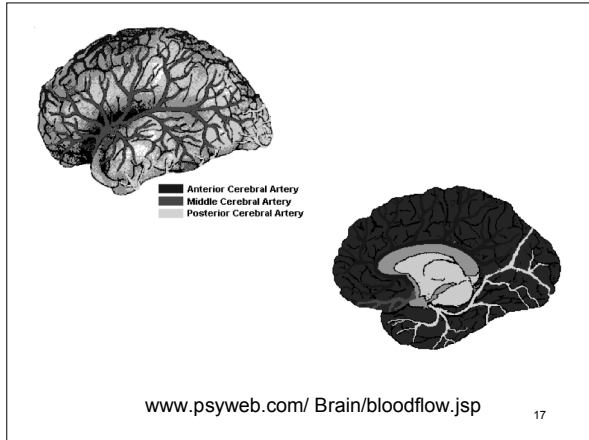
- Damage to A impairs function of A' but area B and function B' are intact.
- Damage to B impairs function of B' but area A and function A' are intact.
  - Language use in Broca's vs. Wernicke's areas

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## Assumptions of (classic) Cognitive NeuroPsychology

- 1) It is assumed that brain injury is *selective* resulting in dissociations of cognitive tasks.
  - How "localized" is cerebral blood flow?
  - How *selective* can the damage be?

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Assumptions of (classic) Cognitive NeuroPsychology

- 2) Any theory that is not compatible with CogNeuroPsych data is seriously weakened.
  - cf., Dror & Gallogly (1999)
- 3) Brain is modular
  - What about connectionism/ANN?

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Issues to be aware of when evaluating CogNeuroPsych case studies

- Anecdote or evidence?
  - Improper training of researcher may produce anecdotal evidence rather than data from systematic observation, with psychological tests, from comparison of patient performance to appropriately matched control group, etc.
- Patients recover
  - Monkeys with amputated fingers restructure the motor strip.
  - People with strokes “relearn” or learn a new way to do everyday things.

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Issues to be aware of when evaluating CogNeuroPsych case studies

- The demands of the tasks used in the study of dissociations must be equivalent.
  - Is one task harder than the other, making it appear like a “dissociation”?

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Issues to be aware of when evaluating  
CogNeuroPsych case studies

- Finding the right comparison/control group is difficult
  - Standardized tests vs. new tasks
    - Standardized tests are typically not “normed” on clinical patients.
    - New tasks may not be “normed” at all.
  - New statistics (e.g., bootstrapping techniques) may help with these concerns.

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Issues to be aware of when evaluating  
CogNeuroPsych case studies

- **Replication** is hard with patients
  - Hard to find another patient with exactly the same kind of damage.
  - If the results are different, it’s hard to know if the patients were different or if the method/task was flawed?

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Issues to be aware of when evaluating  
CogNeuroPsych case studies

- Pre-trauma condition
  - Was the patient’s cognitive system organized the same way as a normal person’s cognitive system before it was damaged?
    - Maybe a different organization made them susceptible to damage???
  - May not be able to determine causality very easily.

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Issues to be aware of when evaluating  
CogNeuroPsych case studies

- Because double dissociations rely of negative reasoning, they do not *absolutely prove* the existence of separate modules.
  - If a person is unable to perform a certain cognitive or perceptual activity and, compared to those who can perform the activity, suffers from some injury or deficit to the nervous system, we infer that the uninjured structure or process is involved in the normal cognitive or perceptual activity.

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### Issues to be aware of when evaluating CogNeuroPsych case studies

- Studies that rely on negative reasoning show that something is *necessary*, but it doesn't show that something is *sufficient*.
  - Damage to ANY part of the brain may affect processing, but it doesn't necessarily mean that THAT part is doing the work.
    - A car “goes” because of a combustible engine...a flat tire prevents the car from “going” but the wheel in itself is not doing the propulsive work.

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### Case versus Group Studies

Instead of looking at 1 patient, you look at many.

- Much like a traditional experiment with a control and experimental (or treatment) group, you compare the performance of the patient group to a control group.

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### Case versus Group Studies

Some concerns with this alternative approach:

- 1) Are all the patients the same?
- 2) Symptoms may appear for uninteresting reasons.
- 3) Will averaging data hide important differences?

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### Damasio (2001)

Examined the neural systems involved in the retrieval of words and concepts from memory.

- Why? Doesn't Broca's & Wernicke's areas control language processing?
- How? Functional imaging or the lesion method?

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## Damasio (2001)

### Lesion Study

- Used CT scans to localize damaged areas.
- Patients with unilateral brain damage had to name pictures of faces, animals, and tools.
  - Naming accuracy
    - "ball"
  - Recognition accuracy
    - Not named, but described "a round object used in sports"

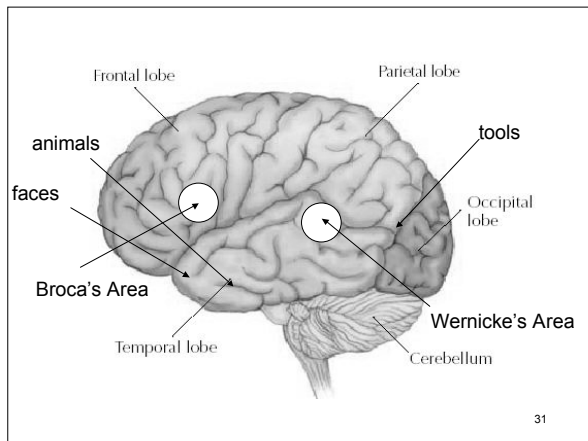
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## Damasio (2001)

### Lesion Study

- Impairments in naming faces, animals, and tools were associated with different regions in the brain (outside of classic language areas) in the cortex (and subcortical white matter).
- The patterns of impairment (face/animal & animal/tools, but NEVER face/tools) are consistent with anatomical data.

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## Damasio (2001)

### PET Study

- Normal adults named the same pictures while in a PET scanner (upside-down faces served as the baseline).
- The same areas identified in the lesion study were activated during the naming of faces, animals and tools in the intact brains.

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## Damasio (2001)

- Other areas of the brain are involved in language processing (via lesions & PET).
- Word and concept retrieval are separable.
  - This is consistent with models of word recognition and production.
- Different types of words are retrieved from different brain areas.
  - Is the same process used to retrieve all different types of words? Why the redundancy?

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