Language and Aphasias

Term Test:

- 30% of the final grade
- **Office hour today 1-2**
- **Similar format as Test 1**
- ~30 pts multiple choice (mainly textbook)
- ~10 matching points (any material)
- ~10 points diagram (any material)
- ~50 points shorter/longer answer (any material)
- Banich chapters 6, 8 & 9
- Sacks chapters 1, 4, 8 & 9
- Lectures 4, 5 & 6
Lecture Outline:

- Neurological Approaches
  - Language Impairments – Aphasia
    - Non-fluent impairments
    - Fluent impairments
  - Psychological Approaches
    - Phonology, Syntax and Semantics
  - Combined Approaches – Imaging etc.
- Reading
  - The phonological route
  - The direct route
- Right hemisphere contributions
  - Prosody, narrative and inference

Neurological Approach to Language

- Paul Broca & Tan
- Broca’s patients - production impaired but comprehension relatively intact
- Carl Wernicke
- 2 patients – fluent, but nonsensical sounds, words, sentences
Neurological Approach to Language

- **Aphasia** refers to a disorder of language apparent in speech, in writing (*agraphia*) or in reading (*alexia*) produced by injury to brain areas specialized for these functions.
- Disturbances of language due to severe intellectual impairment, to loss of sensory input (especially vision and hearing), or to paralysis or incoordination of the musculature of the mouth (called *anarthria*) or hand (writing) are not considered aphasic disturbances per se.
- **Primary aphasia*** - due to problems with the language-processing mechanisms
- **Secondary aphasia** - due to memory impairments, attention disorders, or perceptual problems

---

Summary of Symptoms

<table>
<thead>
<tr>
<th>Disorders of Comprehension</th>
<th>Disorders of production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor auditory comprehension</td>
<td>Poor articulation</td>
</tr>
<tr>
<td>Poor visual comprehension</td>
<td>Word-finding deficit (<em>anomia</em>)</td>
</tr>
<tr>
<td></td>
<td>Unintended words of phrases (<em>paraphasia</em>)</td>
</tr>
<tr>
<td></td>
<td>Loss of grammar or syntax</td>
</tr>
<tr>
<td></td>
<td>Inability to repeat aurally presented material</td>
</tr>
<tr>
<td></td>
<td>Low verbal fluency</td>
</tr>
<tr>
<td></td>
<td>Inability to write (<em>agraphia</em>)</td>
</tr>
<tr>
<td></td>
<td>Loss of tone in voice (<em>aprosidia</em>)</td>
</tr>
</tbody>
</table>
Classification of Aphasias

- Three test parameters: spontaneous speech, auditory comprehension, and verbal repetition
- Three broad categories:
  - **Nonfluent aphasias** – there are difficulties in articulating but relatively good auditory verbal comprehension (e.g., Broca’s severe, Broca’s mild)
  - **Fluent aphasias** – fluent speech but difficulties either in auditory verbal comprehension or in the repetition of words, phrases, or sentences spoken by others (e.g., Wernicke’s or sensory aphasia; Anomic)
  - **“Pure” aphasias** – there are selective impairments in reading, writing, or the recognition of words (e.g., agraphia, alexia without agraphia)

Non-Fluent Aphasia
Broca’s Aphasia

- A.k.a. - Expressive aphasia
- Nonfluent speech, short phrases, pauses, makes errors, repetitious errors in grammar, omits function words (verbs - Telegraphic speech)
- Poor repetition
- Somewhat good comprehension
- Can be mild or severe
Non-Fluent Aphasia
Broca’s Aphasia

- Associated with damage in the frontal lobe
- Not due to damage to the motor strip
- Broca’s area (BA44 and 45)

Fluent Aphasia
Wernicke’s Aphasia

- Problems in comprehending speech – input or reception of language
- Fluent meaningless speech
- Word salad
- Paraphasias – errors in producing specific words
- Semantic paraphasias – substituting words similar in meaning (“barn” – “house”)
- Phonemic paraphasias – substituting words similar in sound (“house” – “mouse”)
- Neologisms – non words (“galump”)
- Deficit in categorization of sounds (e.g., “l” vs. “r”)
- Poor repetition
- Impairment in writing
Fluent Aphasia
Wernicke’s Aphasia

Associated with damage to the temporal lobe near Heschel’s gyrus (primary auditory cortex)

Fluent Aphasia
Conduction Aphasia

Carl Wernicke suggested that there could be another aphasia that could be produced by damage to connections between Broca’s and Wernicke’s areas

Difficulty in repeating what was just heard (no repetition or paraphasias)

Comprehension and production intact
Developing a Model of Language in the Brain

- Concept center – place where meanings are stored

Transcortical Motor Aphasia

- Transcortical motor: Comprehension and repetition are preserved, however the speech is nonfluent
Transcortical Sensory Aphasia

- **Transcortical sensory**: Repetition is preserved, speech is fluent but comprehension is impaired.

Fluent Aphasia
Anomic Aphasia

- “Amnesic aphasia”
- Comprehend speech
- Fluent speech
- Repetition OK
- Cannot name objects
- Naming problems tend to be a result of temporal damage, whereas verb finding problems tend to be a result of left frontal damage.

“What is this object called?”
“I know what it does… You use it to anchor a ship”
Fluent Aphasia
Anomic Aphasia

First of all this is falling down, just about, and is gonna fall down and they're both getting something to eat....but the trouble is this is gonna let go and they're both gonna fall down....I can’t see well enough but I believe that she will have some food that’s not good for you and she’s to get some for her, too...and that you get it there because they shouldn’t do up there and get it unless you tell them that they could have it. And so this falling down and for sure there’s one they’re going to for food and, and this didn’t come out right, the, uh, the stuff that’s uh, good for, it’s not good for you but it, but you love, um mum mum [H.W. intentionally smacks lips]...and so they've...see that, I can’t see whether it’s in there or not....I think she’s saying, I want two or three, I want one, I think, I think so, and so, so she’s gonna get this one for sure it’s gonna fall down....”

Global Aphasia

- Associated with extensive left hemisphere damage
- Deficits in comprehension and production of language
Summary of Aphasias

<table>
<thead>
<tr>
<th>Type of Aphasia</th>
<th>Spontaneous speech</th>
<th>Paraphasias</th>
<th>Comprehension</th>
<th>Repetition</th>
<th>Naming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broca’s</td>
<td>Nonfluent</td>
<td>-</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Global</td>
<td>Nonfluent</td>
<td>-</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Transcortical motor</td>
<td>Nonfluent</td>
<td>-</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Wernicke’s Aphasia</td>
<td>Fluent</td>
<td>+</td>
<td>Poor</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Transcortical sensory</td>
<td>Fluent</td>
<td>+</td>
<td>Poor</td>
<td>Good</td>
<td>Poor</td>
</tr>
<tr>
<td>Conduction</td>
<td>Fluent</td>
<td>+</td>
<td>Good</td>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Anomic</td>
<td>Fluent</td>
<td>+</td>
<td>Good</td>
<td>Good</td>
<td>Poor</td>
</tr>
</tbody>
</table>

Psychological Perspective

- Psycholiguists do not breakdown language into production and comprehension
- According to psycholiguists, language has three components: phonology, syntax and semantics
Psychological Perspective

Phonology

- Phonology – sounds that compose language and the rules that govern their combination
- Phoneme is the smallest unit of sound that can signal meaning (e.g., /b/ in /bat/ and /p/ in /pat/)
- Allophones are different representations of the same phoneme (e.g., /p/ in /pill/ vs. /spill/)
- People with Broca’s aphasia have difficulty producing the correct allophone of a phoneme (lack of fine control) mispronunciation of a phoneme
- Individuals with Wernicke’s aphasia do not make these mistakes they produce the wrong phoneme (e.g., they might substitute /p/ for /b/) phoneme substitution

Psychological Perspective

Syntax

- Syntax - the admissible combinations of words or phrases and sentences (called grammar in popular usage)
- Individuals with damage to anterior parts of the brain (e.g., Broca’s aphasia) show difficulties with syntax
- Broca’s patients often omit function words (e.g., verbs)
- This is not only a problem in production
- They have problem comprehending syntax as well
- “The lion killed the leopard”
- “Who is alive?” Broca’s patients have problem with syntax and do not know the answer to this question
- Wernicke’s aphasia patients usually do not have difficulties with syntax their sentences contain syntactic markers (i.e., verb endings, prepositions, auxiliary verbs)
Psychological Perspective

Semantics

- Semantics – meaning of words and word combinations
- Sentences might have different syntactic structure yet have approximately the same meaning
- “Immediately after the class I started to study”
- “As soon as the class was over I initiated my studying”
- Wernicke’s aphasia is characterized by semantic deficits (understanding the meaning of words).
- This deficit is seen in written language as well
- Token test
- “Point to the yellow square and then blue circle”
- Broca’s aphasia patients have relatively intact semantic processing problems arise when syntax is important (e.g., “Place the blue circle on top of the big red square”)

Psychological Perspective

Summary

<table>
<thead>
<tr>
<th>Location of Damage</th>
<th>Phonemes</th>
<th>Syntax</th>
<th>Semantics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior (e.g., Broca’s aphasia)</td>
<td>Difficulty in producing particular phonemes</td>
<td>Impaired</td>
<td>Unimpaired (unless syntax important)</td>
</tr>
<tr>
<td>Posterior (e.g., Wernicke’s aphasia)</td>
<td>Phoneme substitutions</td>
<td>Relatively Unimpaired</td>
<td>Impaired</td>
</tr>
</tbody>
</table>

Summary of neurological and psychological perspectives:
1. Anterior regions (i.e., the frontal lobe) is important for speech production and syntax
2. Posterior regions (i.e., temporal and parietal lobe) is important for comprehension and semantic processing
Converging Evidence
Wada Test

- Left hemisphere role in language
- Wada technique using sodium amobarbital
- **Crossed aphasia** – aphasia arising from right hemisphere damage

<table>
<thead>
<tr>
<th>Handedness</th>
<th># of cases</th>
<th>Speech Representation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right</td>
<td>140</td>
<td>Left: 96%</td>
</tr>
<tr>
<td>Left</td>
<td>122</td>
<td>Left: 70%</td>
</tr>
</tbody>
</table>

Converging Evidence
Imaging Studies

- Peterson et al. study
- Passively presented words (or pseudowords) either visually or aurally to passive subjects (a passive task)
- Another condition involved subjects repeating words (an output task)
- Final task (an association task) involved subjects suggesting a use for the object named by target word (e.g., “cake”)
Converging Evidence
Imaging Studies

- Peterson et al., results
- Passive task – viewing: activation in primary and secondary visual areas
- Passive task – hearing: activation in secondary hearing area
- Repeating task – activation of motor and sensory facial areas, supplementary speech area, right cerebellum and insular cortex
- An association task – generating verbs was associated with activation of the frontal lobe and posterior temporal cortex (also the anterior cingulate and cerebellum)

Binder et al., presented subjects with either tones (500- or 750-Hz) or meaningful words (nouns designating animals)
- Also had a rest condition
- Subtracted method revealed that large portions of the brain are involved in language processing
Converging Evidence
Imaging Studies

Damasio et al. measured activation associated with naming persons, animals and tools (semantic processing).

Converging Evidence
Imaging Studies - Summary

Imaging data does support evidence that classical language areas (e.g., Broca’s and Wernicke’s areas) are important for language.

However, many other parts of the brain are also important for language functions.

It is more likely that the brain is organized in units devoted to phonology, syntax and semantics rather than speaking, repeating and listening (e.g., classical model).
Neurological Bases for Visual Language Processing

Brain damage can produce alexia or agraphia
Alexia – inability to read
Agraphia – inability to write
Is there a double dissociation?

Neurological Bases for Visual Language Processing - Reading

2 routes whereby visually presented words are linked to meaning
1. **Phonological route to reading** – see the word, sound it out understand the meaning (grapheme-to-phoneme)
2. **Direct route** – printed words are directly linked to meaning (useful to reading irregular words, such as “yacht” or “colonel” or “pint”)

16
Reading – Two Routes
Neuropsychological Evidence

- **Damage to direct route**
  - **Surface alexia**
  - Reading by sound
  - Can not recognize words but can understand them by using grapheme-to-phoneme relations
  - Words can be understood if they are ‘sounded’ out
  - Regular words are read normally (“home” or “dome”)
  - Irregular words are not read properly: yacht, debt, ache or quay.
  - Patients read ‘lace’ as ‘lake’, “come” as “comb”
  - These patients can pronounce regular non-words (e.g., glimay)
  - Overgeneralization of rules
  - Does every language have surface dyslexia?

- **Damage to phonological route**
  - **Phonological alexia**
  - Patients do not have problem reading previously learned words (regular or irregular) as they are using the direct route
  - Patients extract the meaning directly from the visual form of the word
  - They have problems reading new words both regular or irregular
  - Intact direct route is not enough because they do have the connection between the visual form of the word and meaning
Reading – Two Routes
Neuropsychological Evidence

- **Deep alexia** (related to phonological alexia)
- Key feature are semantic errors
- Patients read semantically related words in place of the word they are trying to read
  - “merry” as “Christmas”
  - “cow” as “horse”
  - “food store” as “grocery store”
- Function words are very difficult for these patients
- Concrete words better than abstract words
- Unable to read nonwords.

Reading – Other Deficits
Attentional Dyslexia

- Reading individual letters or words is normal
- Unable to read if more than one type of stimulus is present in the visual field
Reading – Other Deficits
Neglect Dyslexia

- Patient misreads or omits the initial (left neglect) or terminal (right neglect) parts of the words

<table>
<thead>
<tr>
<th>LEFT NEGLECT</th>
<th>RIGHT NEGLECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Let Wet</td>
<td>Breaking Break</td>
</tr>
<tr>
<td>Clock Lock</td>
<td>Registrar Registration</td>
</tr>
<tr>
<td>Anyone One</td>
<td>Tongue To</td>
</tr>
</tbody>
</table>

Processing of Non-Indo-European Languages – Kana and Kanji

- Not all languages use a phonetic alphabet
- Japanese have two writing systems
- Kana is syllabic and sound-based (phonologic route)
- Kanji is logographic each symbol stands for a concept
- no relationship between visual representation and pronunciation direct route
- Double dissociation??
Right Hemisphere Contribution to Language

Since Broca, the left hemisphere’s role in language has been central and right hemisphere has viewed as non-language hemisphere.

In split-brain patients language can emerge from the right hemisphere.

The right hemisphere cannot produce speech, use phoneto-grapheme correspondence or understand syntax.

The right hemisphere can extract basic meaning.

Right Hemisphere Contribution to Language

- **Prosody** – the intonation pattern, or sound envelope, of an utterance (interpreting whether the tone is friendly, sarcastic, condescending or excited)
- “we need to talk” vs. “we need to talk”
- **Narrative** – ability to construct or understand a story line
- **Inference** – ability to ‘fill in the blanks’