Clinical and Experimental Neuropsychology

Lecture 7: Language Function and Dysfunction
Origins of Language
- As humans we can create abstract symbolic representations of the world which enable us to produce and understand language.
- Coherent meaning of spoken or written language depends on the analysis and interaction of many different elements and the involvement of different brain areas.
Broca’s area - necessary for the production of speech

Wernicke’s area - necessary for comprehension of speech
Broca’s, Wernicke’s Area, & Connections

- Lichtheim’s (1885) and Geschwind’s (1965) model
- Auditory input mediated by Wernicke’s area
- Motor output mediated by Broca’s area
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td><strong>Phonemes</strong></td>
<td>individual sound units</td>
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<td><strong>Morphemes</strong></td>
<td>smallest meaningful unit of a word</td>
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<td><strong>Syntax</strong></td>
<td>combinations of words in phrases and sentences</td>
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<td><strong>Lexicon</strong></td>
<td>collection of all words in a given language</td>
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<tr>
<td><strong>Semantics</strong></td>
<td>meaning connected to words and sentences</td>
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<td><strong>Prosody</strong></td>
<td>vocal intonations, tone of voice</td>
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<tr>
<td><strong>Discourse</strong></td>
<td>linking sentences to constitute a narrative</td>
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Language – the basics

Core Skills

Categorisation

Labelling

Sequencing behaviour

Mimicry  e.g. African grey parrot
Origins of Language

- <200,000 years old
- Advantages: communicate without sight, free hands
- Gestural theory
  - non human primates gesture
  - fMRI studies of sign language (Newman et al 2002)
  - accompany 90% of verbal utterances
- Speech is multimodal (McGurk effect)
Evidence of Modularity – Neurological Cases

- Until relatively recently, the syndrome-based approach to classification has been dominated
Lichtheim’s House (1885)

CONCEPTS

A

M

B

Transcortical motor aphasia

Transcortical sensory aphasia

Motor Patterns: Broca’s aphasia

Auditory images: Wernicke’s aphasia

Conduction aphasia

Subcortical motor aphasia

Subcortical sensory aphasia

OUTPUT

INPUT
A disorder of language apparent in speech, writing or reading

Specifically refers to cases where specialised language areas are damaged

Production vs Comprehension

Fluent, Nonfluent, Pure
Broca’s Aphasia (non-fluent)

- Broca’s Aphasia (or Expressive Aphasia) Language comprehension skills relatively preserved
- Typically observed in patients with damage to left inferior prefrontal cortex adjacent to the motor cortex (BA 44 & 45)
- Damage to insula underlies articulation problem, Broca’s area associated with working memory impairment
- Basal ganglia damage linked to poor articulation
Examiner: All right, I'm going to ask you to... tell me some uh answers to these questions. What do you do with a hammer?
Patient: Found... flound... uh... sss... tuh found... oh... ssst...
Examiner: You know, don't you?
Patient: Yes... sss... sss
Examiner: Do you write with it?
Patient: No.
Examiner: Do you eat with it?
Patient: No.
Examiner: Do you pound with it?
Patient: Yes.
Examiner: Okay.
Wernicke’s Aphasia (fluent) – Neologistic Jargonaphasia

- Speech appears to have no information content
- Preserved function words, impaired content words
- Comprehension impaired
- Even simple sentences not well understood
- Associated with left temporal lobe damage (BA 22)
Wernicke’s Aphasia

Examiner: I’m going to ask you some questions, and I just want you to answer “yes” or “no.” Okay? “Yes” or “no.” Is your name Smith?
Patient: Where would I be, what they’re eating avarment I don’t know.
Examiner: Is your name Brown?
Patient: Oh mistress triangland while listen you walking well things things this for year for thee.
Examiner: Okay, just say “yes” or “no.” Okay, is your name Brown?
Patient: What it is here, then let me see, I just don’t know. No I’m not going to an eat any sigh no.
Examiner: No? . . . Are the lights on in this room?
Patient: No [laughs] not. I just don’t sorry what you’re doing and you just saving walking and walking around here.
Examiner: You’re doing fine. That’s okay, I know it’s kind of hard for you. You’re doing fine.
Patient: I kinnd my own my eat my only for my and everythin like that an cleanin my dead me by is always clean me breveret eating and I can watch and everything in the morning.
Examiner: I see.
Lichtheim’s House (1885)

CONCEPTS

Transcortical motor aphasia

Motor Patterns: Broca’s aphasia

Subcortical motor aphasia

OUTPUT

Transcortical sensory aphasia

Auditory images: Wernicke’s aphasia

Subcortical sensory aphasia

INPUT

Conduction aphasia
Conduction aphasia

- able to understand and produce speech but have difficulty in repeating what they have heard
  - good fluency and comprehension, very mild speech disturbance if any
  - semantic intrusions (hear lemon, say apple)
  - difficulty in repeating nonsense syllables
  - Disconnection of perceptual word image and motor systems needed to produce words
Lichtheim’s House (1885)

- **Subcortical sensory aphasia**
- **Auditory images:** Wernicke’s aphasia
- **Transcortical motor aphasia**
- **Motor Patterns:** Broca’s aphasia
- **Subcortical motor aphasia**
- **Conduction aphasia**

**CONCEPTS**

**INPUT**

**OUTPUT**
Transcortical Sensory Aphasia

- Can occur if lesions disconnect Wernicke's area from the parietal lobe
- Can repeat and understand words and name objects but cannot speak spontaneously
- Poor comprehension, words fail to activate associations
Anomic Aphasia

- Specific difficulty finding the names of objects

Temporal cortex = nouns
Left Frontal = verbs
The Boston Diagnostic Aphasia Examination
(e.g. BDAE-3, Goodglass, Kaplan & Barresi, 2000)
JJR: “the boy is trying to get a cookie. Uh, cookie, um. This is high. The danger is that the person is in danger of falling. And, women is trying to cook. Um, with a plate and a couple of these. This is running and the lady is getting wet. What she needs to do is turn off that.”

RC: "Um water um man, no, woman um child (pointing to the boy) no man, boy, and girl um um boo um pate (pointing to the plate) cupboard um oh cup and .... cup, shoes... socks..... jar cakes um head face ..... window."

Shapiro et al, 2000
Shapiro & Caramazza, 2003
Category-Specific Deficits
Many modern neuropsychologists have argued against the syndrome-based classification.

- Fails to fully address the modularity of language.
- Too much individual variability.
- Each category contains a range of impairments that are not always present.
- Alternative approach: deal with the single case.
Evidence for Modularity – Functional Imaging

- Zatorre et al (1992), Science
- Language processing areas make up a large part of the brain
Listening to noise activated primary auditory cortex (Heschl’s gyrus) in both hemispheres (early acoustic analysis)
- Listening to speech (with noise subtracted) – bilateral activation in superior temporal gyrus forward of Heschl’s gyrus (B).
- Also activations in left inferior frontal lobe and left posterior temporal area (C) (higher order perceptual analysis)
Making phonetic judgments (with passively listening to speech subtracted) → **Increased activations in Broca’s area** (sub-vocal articulation allowing sounds to be compared).
Making phonetic judgments also involved activations in the left **superior parietal area** – decoding the articulatory gestures associated with speech sounds.
Finally, when subjects had to judge the pitch of syllables, rather than their consonant sound, a completely different area of the brain was activated, namely the right frontal lobe.
Other Imaging Studies:

- Modality specific activations (e.g. tool words activate pre-motor areas)
- Naming categories (persons, animals and tools) activates specific areas in inferior temporal lobe

Summary of Imaging results:

Confirm lesion studies but highlight a much wider network of areas than was originally thought
Evidence for Modularity – Electrical Stimulation

- Complete inability to produce speech
- Hesitation and slurring of speech
- Distortion and repetition of words and syllables
- Confusion of numbers while counting
- Inability to name
- Misnaming and perseveration

Also TMS
Evidence for Modularity – Electrical Stimulation

- Many of these results confirmed with TMS
- Mapping of Broca’s area – semantic (anterior) and phonological (posterior) function
Temporary Category-Specific Deficits (Shapiro et al, 2001)

Change in reaction time (ms)

Sham TMS  Real TMS  over left prefrontal cortex

-120  -100  -80  -60  -40  -20  0  20  40

Nouns  Verbs

(Shapiro et al, 2001)
Current questions...

- Why these similarities across impaired categories? fruits, vegetables, tools...
- Are these dissociations real?
- What does that suggest about the mental organisation of semantic information?
- Genetic predisposition to storing our knowledge of the world in certain clusters?
- One way to answer: multilingual patients with category-specific impairments...
Gazzaniga & Kolb and Whishaw Language Chapters.
