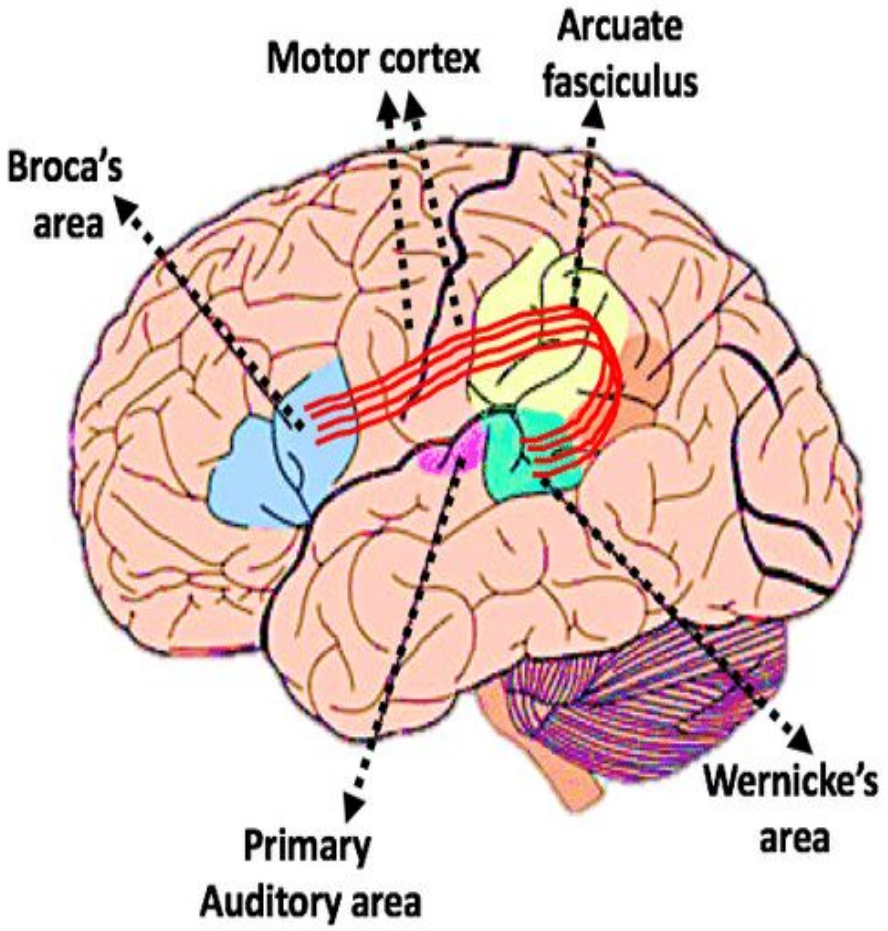
Cortical Localization of Language and Language Disorder

Broca's Area

- Inferior left prefrontal lobe in left hemisphere
- Damage leads to deficits primarily speech production (problems with **expression**) and also grammatical comprehension

Wernicke's Area

- Left temporal lobe, just posterior to the primary auditory cortex
- Damage leads to deficits to semantic language comprehension (problems with **reception**) and speech is imcomprehensible, despite having correct grammar, rhythm an intonation (**word salad**)



Broca's area: involved in production of speech sound

Wernicke's area: involved in Understanding of speech

Motor cortex: controls the Movements of muscles

Arcuate fasciculus: connects Wernicke's area to Broca's area.

Parts of the Brain that controls Speech

Wernicke-Geshwind Model

- Seven components in Left hemisphere: primary visual cortex, angular gyrus, primary auditory cortex, Wernicke's area, arucate fasciculus, Broca's area, and primary motor cortex

Responding to a heard question

- Primary auditory cortex to Wernicke's area where comprehended
- To respond, concept generated in Wernicke's area, goes via arcuate fasciculus to Broca's area, then to primary motor cortex and articulatory areas (face, lip, and tongue muscles, voice box, and muscles associated with lungs)

Reading aloud

- Primary visual cortex to left angular gyrus, which transmits visual code to auditory code
- Then to Wernicke's area to arcuate fasciculus to Broca's to primary motor cortex to articulatory areas

Evidence against W-G Model

- Damage to these boundaries has little lasting effect on language
- Damage to other brain areas can produce aphasia
- Broca's and Wernicke's aphasia are rarely "pure" - aphasia is both receptive and expressive
- Major individual differences for cortical localization for language

Cognitive Neuroscience Approach to Language

- Cannot perform lesion studies because humans are only known species with language
- Use Cognitive Neuroscience (brain imaging) to study relation of brain and language

Cognitive Neuroscience Approach to Language

(1) Each of of the components in W-G model can be broken down further into **constituent cognitive processes**

(1) **Phonological analysis** (sounds)

(2) **Grammatical analysis** (structure)

(3) **Semantic analysis** (meaning)

Cognitive Neuroscience Approach to Language

(2) Areas of brain involved in language are not solely dedicated to language; many of the constituent cognitive processes also play roles in other behavior

Example - some areas involved in short-term memory and visual pattern recognition are involved in reading, too

Cognitive Neuroscience Approach to Language

(3) W-G model assumes that brain areas involved in language are large, circumscribed, and homogenous but Cog neuro assumes they are small, widely distributed, and specialized

Broca's Aphasia

Damage to a region of the left prefrontal lobe in left hemisphere **(Broca's area) disrupts the ability to speak**.

This disorder is characterized by **slow, laborious and non- fluent speech.**

they have great difficulty saying the little words with grammatical meaning such as a, the, some, in,about. these words are known as **function words**. because they have important grammatical functions.

the words that they do manage to say are **content words**- words that convey meaning, nouns, verbs, adjectives adverbs- apple, house, throw

Cont….

Sample of speech:

Cookies…..can….candy…..cookiescookies…..he……down….That's all. Girl….. slipping water…..water……and it hurts……much to do….her……clean up……dishes…..up there...i think that’s doing it. (obler and gjerlow 1999, p.41)

Contd….

people with broca's aphasia can comprehend speech much better than they can produce it.

Broca (1861) suggested that this form of aphasia is produced by a lesion of the frontal association cortex, just anterior to the face region of the primary motor cortex.

Contd….

Wernicke (1874) suggested that Broca's area contains motor memories- in Particular, memories of the sequences of muscular movements that are needed to articulate words.

Talking involves rapid movements of the tongue, lips, and jaw, and these movements must be coordinated with each other and with those of the vocal words; thus talking requires some very sophisticated motor control mechanisms.

Contd..

Three major speech deficits are produced by lesions in and around Broca's area:

1. **Agrammatism**- it refers to a patient's difficulty in using grammatical constructions.

For e.g. Picture of a girl giving flowers to her teacher

Girl….wants to….flowers...flowers and wants to….

The woman….wants to….The girl wants to….the flowers and the woman.(Saffron, Schwartz, and Marin, 1980, p.234)

Contd...

The second major speech deficit seen in Broca's aphasia is

2. Anomia- "without name". it refers to a word finding difficulty and because all aphasics omit words or use inappropriate ones, anomia is actually a primary symptom of all forms of aphasia.

Contd...

3. Difficulty with Articulation- patients mispronounce words, often altering the sequence of sounds.

For example lipstick might be pronounced as likstip.

people with Broca's aphasia recognize that their pronounciation is erroneous , and they usually try to correct it.

Speech Comprehension

Comprehension of speech begins in the auditory system, which detects and analyzes sounds. but recognizing words is one thing and comprehending them is another.

For eg. we can learn to recognize a foreign word we have heard several times even though we do not understand its meaning. recognizing a spoken word is a complex perceptual task that relies on memories of sequences of sounds. this task appears to be accomplished by neural circuits in the middle and posterior portion of the superior temporal gyrus of the left hemisphere, a region named as **wernicke's area.**

Wernicke's aphasia

1. poor speech comprehension
2. production of meaningless speech.

Unlike Broca's aphasia, wernicke's aphasia is fluent and unlaboured; the person does not strain to articulate words and does not appear to be searching for them.

Example:

Examiner- What kind of work did you do before you came into the hospital?

Patient:Never, now mista oyge I wanna tell you this happened when happened when he rent. His- his kell come down here and is- he got ren something. it happened, in these ropiers were with him or hi- is friend- like was. and it just happened so i don't know, he did not bring around anything. and he did not pay it. and her roden all o these arranjen from the pedis on from iss pescid. in these floors now and so. he hadn't had em round here. (Kertesz, 1981, p.73)

Conduction Aphasia

- Damage to pathway connecting Broca's and Wernicke's areas called the **arcuate fasciculus**
- Comprehension and spontaneous speech are intact. is characterized by meaningful fluent speech; relatively good comprehension; but very poor repetition

Example

Examiner: Bicycle

Patient:Bicycle

Examiner: Hippopotamus

Patient:Hippopotamus

Examiner:Blaynge

Patient:I didn’t get it

Examiner: North

Patient:North

Examiner: Rilld

Patient: Nope, I cant say

Contd...

Sometimes when a person with conduction aphasia is asked to repeat word, he or she says a word with the same meaning- or at least one that is related. For e.g. if the examiner says *house*, the patient may say *home*. if examiner says *chair*, patient may say *sit*.

Examiner: The auto's leaking gas tank soiled the roadway.

Patient: The car tank leaked and made a mess on the street.

Anomic Aphasia

Speech of patients with anomic aphasia is fluent and grammatical, and their comprehension is excellent, but they have difficulty finding the appropriate words.

they often employ Circumlocutions (literally speaking in a roundabout way) to get around missing words.

Contd...

It is different from the wernicke's aphasia. people with anomic aphasia can understand what other people say and what they say makes a perfect sense, even if they often choose roundabout ways to say it.

The drawing of the kitchen story, part of the Boston Diagnostic Aphasia Test.

From Goodglass, H., and Kaplan, E. *The Assessment of Aphasia and Related Disorders,* 2nd ed. Philadelphia: Lea & Febiger, 1983. Reprinted with permission.

Example

Examiner: Tell us about the picture

Patient: it's a woman who has two children, a son and a daughter, and her son is to get into the…. cupboard in the kitchen to get out [take] some… cookies out of the[cookie jar]... that she possibly had made, and consequently he's a slipping [falling]...the wrong direction [backward]...on the…. what he's standing on [stool] heading to the...the cupboard[floor] and if he falls backwards he could have some problems [get hurt], because that [the stool] is off balance.

Alexia

- Damage to the **left angular gyrus** (area of left temporal and parietal cortex just posterior to Wernicke's)
- Inability to **read** despite intact language comprehension and production

Agraphia

- Also due to damage to the **left angular gyrus**
- Inability to **write** despite intact language comprehension and production
- Involvement of LAG in alexia and agraphia show its responsible for language related visual input

Dyslexia and Cognitive Neuroscience

- **Dyslexia** is pathological difficulty in reading, does not result from general visual, motor, or intellectual deficits
- **Developmental dyslexia**- apparent in childhood
- **Acquired dyslexia** - damage in individuals who were already capable of reading

Developmental Dyslexia

Some children have great difficulty learning to read and never become fluent readers, even though they are otherwise intelligent. specific language learning disorders, called developmental disorders.

tend to occur in families, a finding that suggests a genetic and hence biological component (Pennington et. al. 1991; wolff and Melangailis, 1994)

Contd...

Linkage studies shows that chromosomes 6 and 15 may contain genes responsible for different components of this disorder (Grigorenko et. al. 1997; Fisher et. al. 1999; Petryshen et. al. 2001)

Acquired Dyslexia

- Two strategies for reading aloud:
  - **Lexical procedure** - based on specific stored information that has been acquired about written words - looks at it, recognizes it and says it
  - **Phonetic procedure** - looks at words, recognizes *letters*, *sounds them out* and says word

Acquired Dyslexia

- **Surface Dyslexia** - is a deficit in whole word reading, usually caused by a lesion of the left lateral temporal lobe.
- **Phonological dyslexia**- they can read by the whole word method but cannot sound words out.. thus they can read words that they are already familiar with but have great difficulty figuring out how to read unfamiliar words or pronounceable non words.

References

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Pinel, Barnes- Introduction to Biopsychology. Pearson Publication

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