Neuropsychology of Language

SCHOOL-NEUROPSYCHOLOGY
POST-GRADUATE
CERTIFICATION PROGRAM

Presented By:
Robb Matthews, PhD, LSSP, HSPP, NCSP
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Outline

- Neuroanatomical bases of language
- Language development in children
- Childhood language disorders
- Models of developmental language disorders
- Diagnoses of language disorders
- Speech disorders
- Language Classified with the Integrated SNP/CHC Model

Neuroanatomical Basis of Language

Functions of the brain

Frontal lobe
- behaviour
- intelligence
- memory
- movement

Parietal lobe
- language
- reading
- sensation

Occipital lobe
- vision

Temporal lobe
- hearing
- memory
- speech
- vision

Cerebellum
- balance
- coordination

Brain stem
- blood pressure
- breathing
- consciousness
- heartbeat
- swallowing
Neuroanatomical Basis of Language

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Neuroanatomical Basis of Language

- The two main aspects of communication processes are:
  - Receptive
  - Expressive

Several processes in the dominant hemisphere play crucial roles in language expression (encoding) and reception (decoding).
Neuroanatomical Basis of Language

1. Sound sensations enter the brain through the auditory pathway.
2. Sound images are stored in Wernicke’s area.
3. ...and are sent to Broca’s area...
4. ...for articulation over the motor pathway.

Neuroanatomical Basis of Language

[Diagram of brain showing various areas and pathways related to language processing.]
Speech signals are transmitted through the auditory nerve and discriminated in Heschel’s gyrus, in the primary auditory area of the temporal lobe. It has a distinct role in the analysis of music.
2. **Wernicke’s area** is where the interpretation, or comprehension of speech meaning of, takes place. It is behind Heschl’s gyrus at the posterior section of the superior temporal gyrus (STG). This area may also be referred to as posterior speech zone.

3. **Broca’s area** acts with the motor cortex to produce movements needed for speaking. **Broca’s area** is in the dominant inferior frontal gyrus and is responsible for the organization of grammar & syntax (syntactic encoding) of speech (see PET studies by Indefrey et al., 2001).
4. Verbalization is mediated by the frontal lobe in association with periaqueductal gray matter (PAG).

**Language Functions** | **Associated Brain Region**
---|---
Retention of sequential verbal information | Inferior region of the dominant temporal lobe
Comprehension of logical grammatical relationships | Dominant parietal-occipital and frontal areas
Awareness of prosody | Posterior area of the right hemisphere
Repetition of spoken words | Dominant temporal or frontal speech areas and/or the pathways connecting these areas
## Neuroanatomical Basis of Language

<table>
<thead>
<tr>
<th>Language Functions</th>
<th>Associated Brain Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Word Finding (aka naming to visual confrontation)</td>
<td>• Dominant temporal-parietal-occipital area and with Broca’s area in the dominant frontal lobe</td>
</tr>
<tr>
<td>• Expression of prosody</td>
<td>• Anterior region of the right hemisphere</td>
</tr>
</tbody>
</table>

## Anatomical Areas/Landmarks Associated With Language

- Core Language Regions of the Brain: Areas associated with language functions (a) in relation to fissures and gyri, (b) Brodmann’s areas, (c) with the lateral fissure retracted to expose the insula and the medial bank of the superior temporal gyrus.
Neurology of Language

The Wernicke-Geschwind Model showing the regions of the cortex taking part. Sequences 1 through 3 illustrate how the model explains different language functions.

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Timetable of Language Development

- **Phonemes**
  - Fundamental language sounds
- **Morphemes**
  - Smallest meaningful units of words
- **Lexicon**
  - Collection of all the words in a language
- **Syntax**
  - Rules of grammar
- **Semantics**
  - Meaning of words and sentences
- **Prosody**
  - Vocal intonations
- **Discourse**
  - Stringing sentences together to form a meaningful narrative

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Timetable of Language Development

- **Birth - 1 month**
  - Reflexive Cries, different sounds for pain and hunger.
- **2-3 months**
  - Babbles, coos, prelinguistic communication begins.
  - Vagal nerve myelination
- **4-6 months**
  - “talks” to self, different sounds for pleasure and repeats, responds to name.
## Timetable of Language Development

### 6-9 months
- Imitates speech sounds, puts sounds together and repeats, responds to name.

### 10-20 months
- Single word utterances, understands gestures, responds to simple commands, **speaking vocabulary of 5-50 words.**

### 2-3 years
- Makes 2-3 word phrases, syntax emerges, gives full name, identifies 5 objects, speaking vocabulary of about 300 words.

### 4 years
- Understands basic rules of grammar, speaks in sentences, vocabulary of about 1000 words.

### 5-6 years
- Language elaborations emerge, vocabulary expands
- Typically master articulation of all phonemes by about 6-years
- Demonstrating normal prosody
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Childhood Language Disorders

Two general categories:

- **Developmental** - may be manifested by failure to develop language, delay in acquisition, or development of deviant language.
- **Acquired** - an impairment or loss of normal language resulting from a brain dysfunction that occurs after language has developed.
  - Despite the fact that children with acquired language disorders are a small minority of those with language deficiencies, the literature seems to focus on this type of disorder (Novick & Arnold, 1988)
**Language Disorders**

<table>
<thead>
<tr>
<th>Acquired Disorders</th>
<th>Developmental Disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td>• The classification system used for Aphasia in adults is typically applied to</td>
<td>• In the majority of language-disabled children, the disorder is of the developmental</td>
</tr>
<tr>
<td>childhood Aphasia</td>
<td>variety, which is referred to as <strong>Dysphasia</strong>.</td>
</tr>
<tr>
<td>• Predominately-Receptive Aphasia</td>
<td>• <strong>Dysgenesis</strong> – defective development</td>
</tr>
<tr>
<td>• Predominately-Expressive Aphasia</td>
<td>• <strong>Agenesis</strong> – absence of development</td>
</tr>
<tr>
<td>• Receptive – Expressive Aphasia</td>
<td></td>
</tr>
</tbody>
</table>

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Neuropsychological Models

Two models:
1. Receptive or expressive disturbances

2. Receptive, central processing (poorly defined), or expressive disturbances
   - Comprehension deficits occurring in the presence of normal expressive and receptive language.

Neurolinguistic Syndromes

- **Verbal Auditory Agnosia**
  - Characterized by poor comprehension.
    - Phonological decoding/encoding and fluency are unimpaired; Anomia is common; Poor pragmatic language.

- **Comprehension-Phonological Syndrome**
  - Characterized by poor comprehension with poor speech.

- **Severe Expressive Syndrome**
  - Characterized by adequate comprehension, but not speech.
Neurolinguistic Syndromes

- **Semantic-Pragmatic Syndrome**
  - Characterized by poor phonological decoding precluding the development of normal speech. Visually presented language can be processed normally*.
  - *must be carefully differentiated from deafness.

- **Phonological-Syntactical Syndrome**
  - Characterized by very poor speech.
  - Problems associated with articulation, syntax, and anomia are common.
  - Comprehension likely variable, but always better than expression.

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### Diagnosis of Language Disorders

<table>
<thead>
<tr>
<th>Summary of Concerns</th>
<th>Diagnostic Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Word-finding difficulties (Anomia)</td>
<td>• The differential diagnosis of a language disorder depends upon the combined efforts of specialists in audiology/speech and language pathology using formal and informal measures.</td>
</tr>
<tr>
<td>Unintended words or phrases (paraphasia)</td>
<td></td>
</tr>
<tr>
<td>Loss of grammar and syntax</td>
<td>The psychologist:</td>
</tr>
<tr>
<td>Inability to repeat aurally presented material</td>
<td>• Makes a preliminary delineation of a child's language functions</td>
</tr>
<tr>
<td>Low verbal fluency</td>
<td>• Makes appropriate referrals</td>
</tr>
<tr>
<td>Inability to write (agraphia)</td>
<td></td>
</tr>
<tr>
<td>Loss of tone in voice (aprosidia)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Language Domain</th>
<th>Differential Diagnostic Considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral hearing loss or central deafness</td>
<td>➢ Defective physiology for speech</td>
</tr>
<tr>
<td>Defective physiology for speech</td>
<td>➢ Severe environmental deprivation</td>
</tr>
<tr>
<td>Severe environmental deprivation</td>
<td>➢ Autism Spectrum Disorder (ASD)</td>
</tr>
<tr>
<td>Autism Spectrum Disorder (ASD)</td>
<td>➢ Psychosis</td>
</tr>
<tr>
<td>Psychosis</td>
<td>➢ Nonpsychotic behavioral disorder</td>
</tr>
<tr>
<td>Nonpsychotic behavioral disorder</td>
<td>➢ Low cognitive functioning</td>
</tr>
<tr>
<td>Low cognitive functioning</td>
<td>➢ Nonlanguage based reading and writing disturbance</td>
</tr>
<tr>
<td>Nonlanguage based reading and writing disturbance</td>
<td>➢ Being from Mississippi</td>
</tr>
<tr>
<td>Being from Mississippi</td>
<td></td>
</tr>
</tbody>
</table>
Speech Disorders

- Speech disorders are frequent among the children referred for psychological evaluation.
  - Students with auditory processing difficulties may look similar to those with attention deficits. This may result in misdiagnosis and treatment for ADHD.
    - It is useful to consider auditory or receptive language characteristics when considering an ADHD.
  - Using your knowledge of neurocognitive characteristics and developmental expectations to identify atypical speech patterns and clarify or rule out underlying factors is a valuable contribution to remediation.
Speech Disorders in Children

- Speech disorders in children tend to be more subtle than those in adults
  - Consistent with the general differences between adults and children with respect to brain dysfunction and previous speech experience/practice

- Developmental factors must be considered when a speech disorder is suspected.

- Inhibited Language development including aspects of Disarticulation, Dysfluency, Voice quality

Apraxia Disorders

- In articulation disorders, the underlying problem is commonly associated with dysfunction in the peripheral nerves, the motor cortex/systems, or physical structures (e.g., tongue).
  - A disturbance in the motor programming aspects of speech
  - Often referred to as oromotor apraxia.

- May involve a poor ability to initiate nonverbal and/or verbal movements of the speech musculature (e.g., tongue protrusion, opening and closing the jaw).
Apraxia Disorders

- When the disturbance is limited to verbal movements it is called *verbal apraxia*.
- Associated with dysfunction of a small region of Broca’s area.
- Articulation errors in verbal apraxia are different from those seen in articulation disorders.
  - Errors are inconsistent and usually substitution errors, not sound distortions errors.
  - Errors are apparent in purposeful, but not automatic speech.

Fluency Disorders

- Disturbances in speech prosody (e.g., stuttering).
  - *Normal developmental sequence in young children*
    - Beyond 6-years old is likely a disorder
- Characterized by the repetition or prolongation of sounds, syllables, or words. Long pauses (or “blocks”) often occur.
**Fluency Disorders**

- May be associated with stress and anxiety.
- There is no universally accepted explanation for stuttering although there are a number of theories (e.g., air pressure, basal ganglia).
- Explanations also come from learning theory, psychoanalytic theory, and brain-behavior relations.

**Voice Disorders**

- Disturbances in voice quality (e.g., hoarseness), loudness, pitch (e.g., too high, monopitch), or all three.
  - may be associated with neurological dysfunction or with functional causes (e.g., hearing loss, emotional disorder).
- The sudden changes in pitch that occur in boys during puberty are called *transient*. 
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Auditory Processing and the Integrated SNP/CHC Model

- Cognitive Processes:
  - Visuospatial
  - Auditory
  - Learning and Memory
  - Executive

- Acquired Knowledge:
  - Acculturation Knowledge
  - Language Abilities
  - Reading Achievement
  - Written Language Achievement
  - Mathematics Achievement

- Basic Sensorimotor Capabilities:
  - Sensory Functions
  - Fine Motor Functions
  - Visual-Motor Integration Skills
  - Visual Scanning
  - Gross Motor Functions

- Social-Emotional, Cultural, and Environmental Factors
Auditory Processing & Language Classified in the Integrated SNP/CHC Model

<table>
<thead>
<tr>
<th>Subcomponent</th>
<th>Location in the Conceptual Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sound Discrimination</td>
<td>• Auditory Processing</td>
</tr>
<tr>
<td>• Auditory/Phonological</td>
<td></td>
</tr>
<tr>
<td>Processing</td>
<td></td>
</tr>
<tr>
<td>• Oral Expression</td>
<td>• Acquired Knowledge: Language Abilities</td>
</tr>
<tr>
<td>• Receptive Language</td>
<td></td>
</tr>
</tbody>
</table>

Importance of Assessing Auditory Processing

- Students with deficits in auditory/phonological processing will have difficulties with reading acquisition using only phonological instruction.

- Students with severe deficits may learn to read by visually memorizing the whole word rather than using typical phonics.
Auditory Processing and the Integrated SNP/CHC Model

Language as Acquired Knowledge

- Much of what is taught in school has a language base.
- Language enables us to share our experiences with each other and pass our knowledge gained from those experiences onto others (Carlson, 2010).
  - Thus, language skills are essential for a child to achieve academic and social success.

- Within the Integrated SNP/CHC Model, language abilities are viewed as a distinct, but equivalent broad classification of acquired knowledge.
  - Language development (LD) is considered to be a narrow ability within Gc in CHC Theory (Schneider & McGrew, 2012).
## Language and the Integrated SNP/CHC Model

<table>
<thead>
<tr>
<th>Broad Classification</th>
<th>2\textsuperscript{nd} Order Classification</th>
<th>3\textsuperscript{rd} Order Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acquired Knowledge: Language Abilities</td>
<td>• Oral expression</td>
<td>• Vocabulary knowledge • Qualitative behaviors</td>
</tr>
<tr>
<td></td>
<td>• Receptive language</td>
<td>• Receptive language with a verbal response • Receptive language with a nonverbal motor response • Qualitative behaviors</td>
</tr>
</tbody>
</table>

## Major References