

Learning Disabilities

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Overview

- **General Information**
 - Definition
 - Statistics
 - Causes
 - Basic Characteristics
 - Diagnosis
 - Language processing
 - Neuroscience of Arithmetic
- **Neuroscience**
 - Dyslexia
 - *Anatomical correlates of dyslexia: frontal and cerebellar findings (2003)*
 - Dyscalculia
 - *Developmental cognitive neuroscience of arithmetic: implications for learning and education (2010)*
 - *Neuroanatomical correlates of developmental dyscalculia: combined evidence from morphometry and tractography (2009)*

General Definition

- at least average intellectual capacity
- a significant (and unexplained) discrepancy between achievement and expected potential
- the exclusion of mental retardation, emotional disturbance, sensory impairment, cultural differences or lack of opportunity to learn
- central nervous system dysfunction as the basis of the presenting problem(s)

Causes

- Strong genetic component
 - 35-45% of families
- Some are congenital in nature
- Familial and heritable
- Product of neurological “damage” during development or early in childhood
- In adults, may be traced to neurological conditions in childhood that were not addressed

- **Heredity**
- **Problems during pregnancy and birth**
 - Illness or injury during or before birth
 - Drug and alcohol use during pregnancy
 - Low birth weight
 - Lack of oxygen
 - Premature/prolonged labor
- **Incidents after birth**
 - Head injuries
 - Poor nutrition
 - Exposure to toxins

General Characteristics

- Learning disabilities affect the brain's ability to receive, process, store, respond to, and communicate information
- Distinct gap between a person's level of expected achievement and what he or she is actually achieving
- Can differ at various stages of development
- It is possible to have more than one learning disability
- About 1/3 of people with a learning disability also have ADHD

Areas Commonly Affected

- Listening
- Speaking
- Reading
- Writing
- Spelling
- Reasoning
- Mathematics

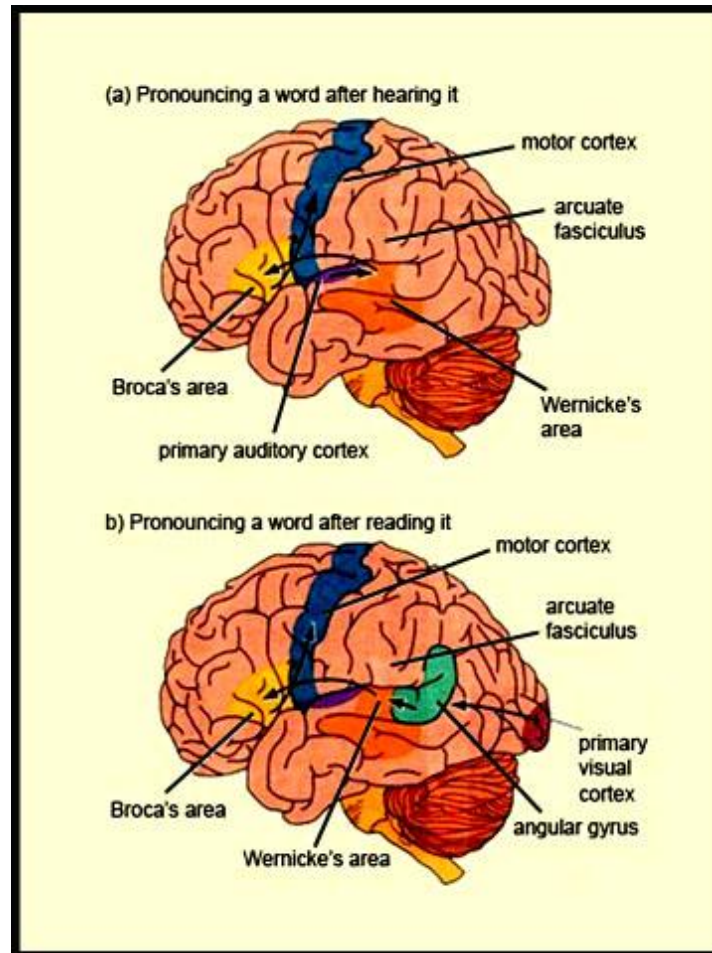
Diagnosis and Accommodation

- Observation
- Early Identification
- IDEA/ADA
 - Extended time
 - Readers
 - Note-takers
 - Abbreviated tests
 - Alternate assignments

Language Processing

- Hearing
 - Primary auditory cortex
 - Wernicke's area
 - Broca's area
- Reading
 - Primary visual cortex
 - Angular gyrus
 - Wernicke's area
 - Broca's area

Language Processing

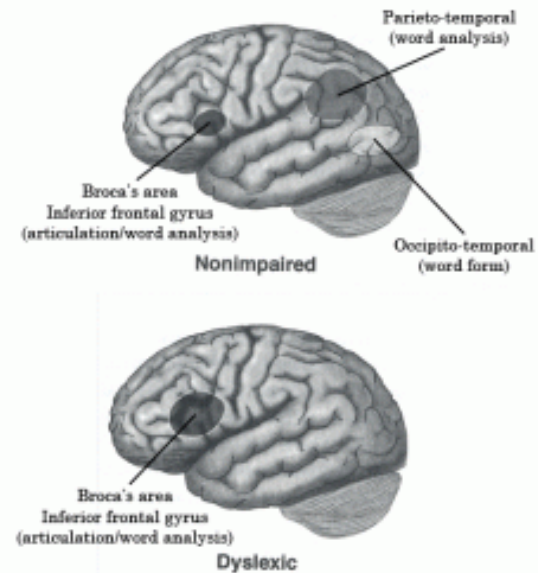


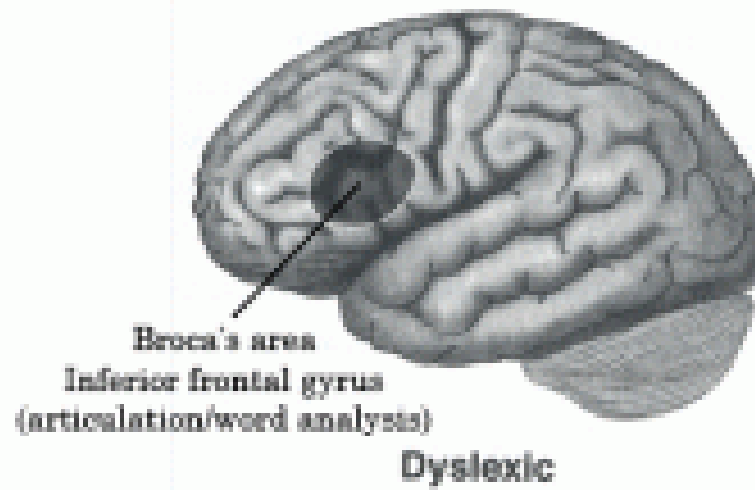
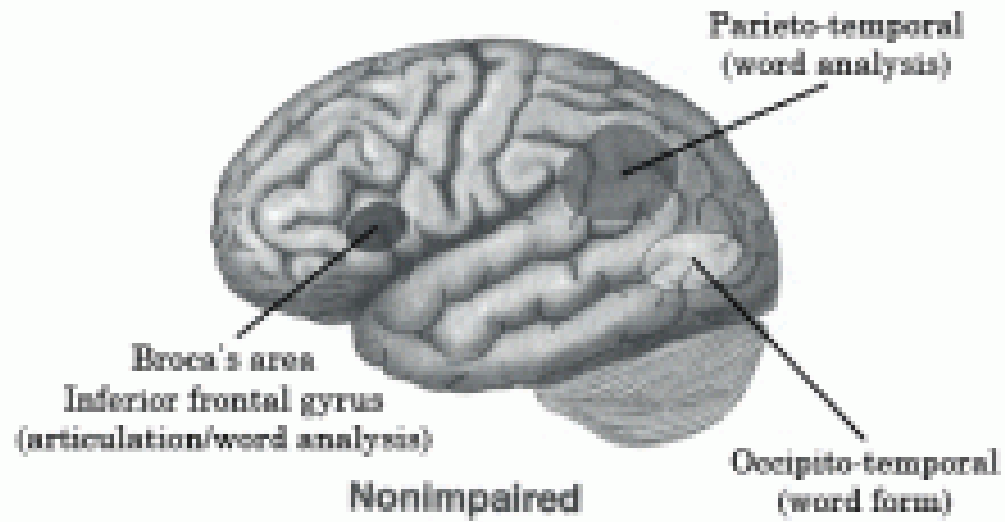
Dyslexia

- No longer considered a purely visual reading disorder; now viewed as a phonological difficulty
 - Problems with phonological awareness and with phonetics
- Phonemes
- Not a lag but a different mode of brain organization

Findings

- A single anatomical marker is unlikely
- Cerebellar involvement in linguistic performance
- Compensation in adults with dyslexia who were not diagnosed as children





Neuroscience of Arithmetic

- Aspects of arithmetic processing
 - Retrieval
 - Computation
 - Reasoning and decision making about arithmetic relations
 - Interference resolution

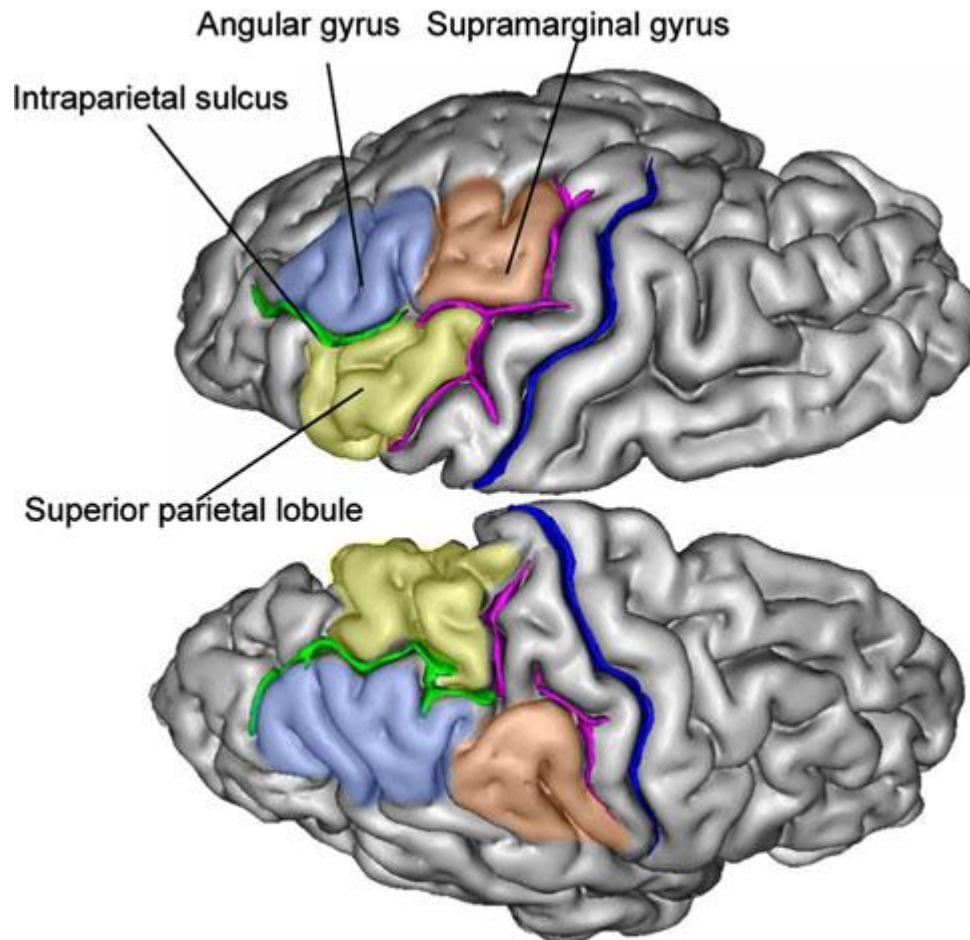
Neuroscience of Arithmetic

- Cognitive processes
 - Working memory
 - Memory encoding and retrieval
 - Decision making
 - attention
- Working memory
 - Poor working memory leads to greater reliance on immature problem-solving strategies in children
 - Posterior parietal cortex, prefrontal cortex and basal ganglia
- New synaptic connections

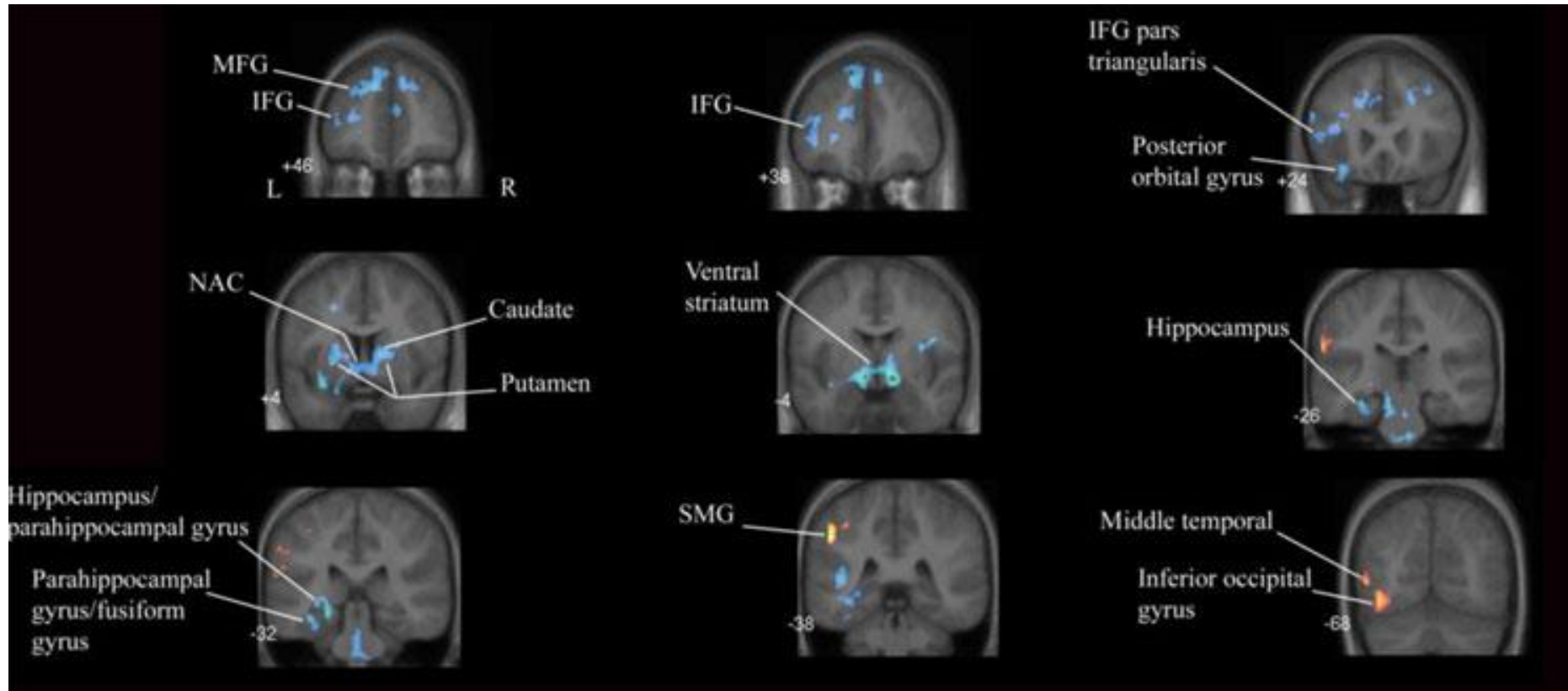
Associated Brain Regions

- Posterior parietal cortex
- Hippocampus
 - Encoding and retrieval of facts
- Dorsal basal ganglia
 - Procedural memory

Posterior Parietal Cortex Regions Involved in Arithmetic



Children Compared to Adults



Dyscalcula

- A disorder of numerical competence and arithmetic skill which is manifest in children of normal intelligence who do not have acquired neurological injuries
- Deficits in basic number processing skills thought to be the core abnormality in this disorder
- Dissociations between retrieval and calculation

Findings

- Grey matter and white matter deficits in key brain areas
- May be a “disconnection syndrome”
- Differential processing of incorrect vs. correct equations

Conclusions

- Learning disabilities have a neurological basis and are often genetic
- Learning disabilities have no cure but accommodation is extremely beneficial
- Early diagnosis and detection is key
- A single anatomical marker of either dyslexia or dyscalculia is unlikely

Resources

- <http://ncld.org/ld-basics/ld-explained/basic-facts/what-are-learning-disabilities>
- <http://ncld.org/ld-basics/ld-explained/basic-facts/checking-up-on-learning-disabilities>
- <http://ncld.org/ld-basics/ld-explained/basic-facts/the-neurobiology-of-learning-disabilities>
- <http://www.ncld.org/ld-talks/transcript/talk/9>
- <http://www.nichd.nih.gov/news/releases/dyslexianews.cfm>
- <http://docsbrainblocks.com/dyslexia.asp>
- <http://www.dana.org/news/brainwork/detail.aspx?id=23408>
- <http://brain.oxfordjournals.org/content/126/2/482.full.pdf+html>
- <http://www.springerlink.com/content/bw1256w554038276/>
- <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2796911/>