



HARVARD
MEDICAL SCHOOL



MassGeneral Hospital
for Children



SPAULDING
REHABILITATION NETWORK

NEUROPSYCHOLOGICAL EVALUATION FOLLOWING PEDIATRIC STROKE

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OVERVIEW

- What is a neuropsychological evaluation?
- Why is it helpful after a child has had a stroke?
- How does a stroke affect my child's learning and brain development?
 - Example: Spoken language
- How does a stroke affect my child's behavior and emotional functioning?
 - Example: Social pragmatics
- How do the results inform treatment recommendations?

WHAT IS A NEUROPSYCHOLOGICAL
EVALUATION?

NEUROPSYCHOLOGY

- Examines the impact of brain functioning on a broad range of cognitive, emotional, and behavioral functions (American Academy of Clinical Neuropsychology, 2007)
- Licensed psychologist with specialized training in neurological basis of behavior (American Academy of Clinical Neuropsychology, 2007)
- Additional training for pediatric neuropsychology in order to understand brain-behavior relationships in the context of neurodevelopment

GOALS OF ASSESSMENT

- Describe the cognitive, emotional, and behavioral profile of the child
- Determine strengths and weaknesses
- Assist in diagnosis
- Provide information and documentation to families
- Help parents, educators, and services providers understand learning style
- Recommend treatment interventions to facilitate development
- Monitor progress and development over time

DOMAINS OF FUNCTIONING ASSESSED

- General Intelligence
- Attention
- Executive Functioning/Problem Solving
- Language
- Visual-Spatial / Visual-Motor
- Learning and Memory
- Adaptive Abilities
- Emotional, Social, and Behavioral Functioning
- Academic Achievement

WHAT DOES THE EVALUATION ENTAIL?

- Record review and consultation with referral source
- Interview with the parents and completion of questionnaires (1 – 2 hours)
- Direct testing with the child (1- 6 hours depending on age)
- Obtain collateral information from physicians, treatment team, educators
- Score and analyze the data obtained
- Generate written report documenting findings and treatment plan
- Review of results with family (1 hour meeting)
- Re-evaluate to assess progress and update recommendations

**WHY IS THIS NEEDED
AFTER A STROKE?**

NEUROLOGICAL CHANGES

- Childhood stroke can impact:
 - Integrity of the brain at the time of injury
 - Hypoxia, acute necrosis, apoptosis, excess glutamate, neuroinflammation (Kirton, 2018)
 - Future development of the brain
 - Course of myelination (Max, 2004), re-lateralization (Allman, 2011)
- Developing brains react very differently than adult brains
 - Neuroplasticity helps to preserve most salient cognitive functions (Allman, 2011)
 - Weaknesses due to early stroke may emerge later in childhood (Westmacott et al., 2009)

PERSONALIZED PROFILE

- Helps to answer the questions of how did the stroke impact MY CHILD and what can we do to help them develop?
- Delineates cognitive strengths and weaknesses of the child
 - Relative to the general population & themselves
- Analysis takes into consideration important medical factors that may influence developmental outcomes
 - Age at stroke, time since stroke, lesion location and volume, lateralization
 - Co-morbid conditions (e.g., epilepsy, hemiplegia, etc.)

THE IMPACT OF STROKE ON LEARNING AND COGNITION

POTENTIAL COGNITIVE CHANGES

- Intellectual functioning
- Language functioning
- Visual-spatial processing
- Memory and learning
- Attention, working memory, & executive functioning
- Social cognition
- Academic skills

POSSIBLE CLINICAL DIAGNOSES

- Neurodevelopmental Disorder due to Medical Condition
- Cognitive Disorder due to Medical Condition
- Attention-Deficit/Hyperactivity Disorder (ADHD)
- Learning Disabilities- Reading, Writing, Mathematics
- Autism Spectrum Disorder (ASD)/Social (Pragmatic) Communication Disorder

EXAMPLE: LANGUAGE

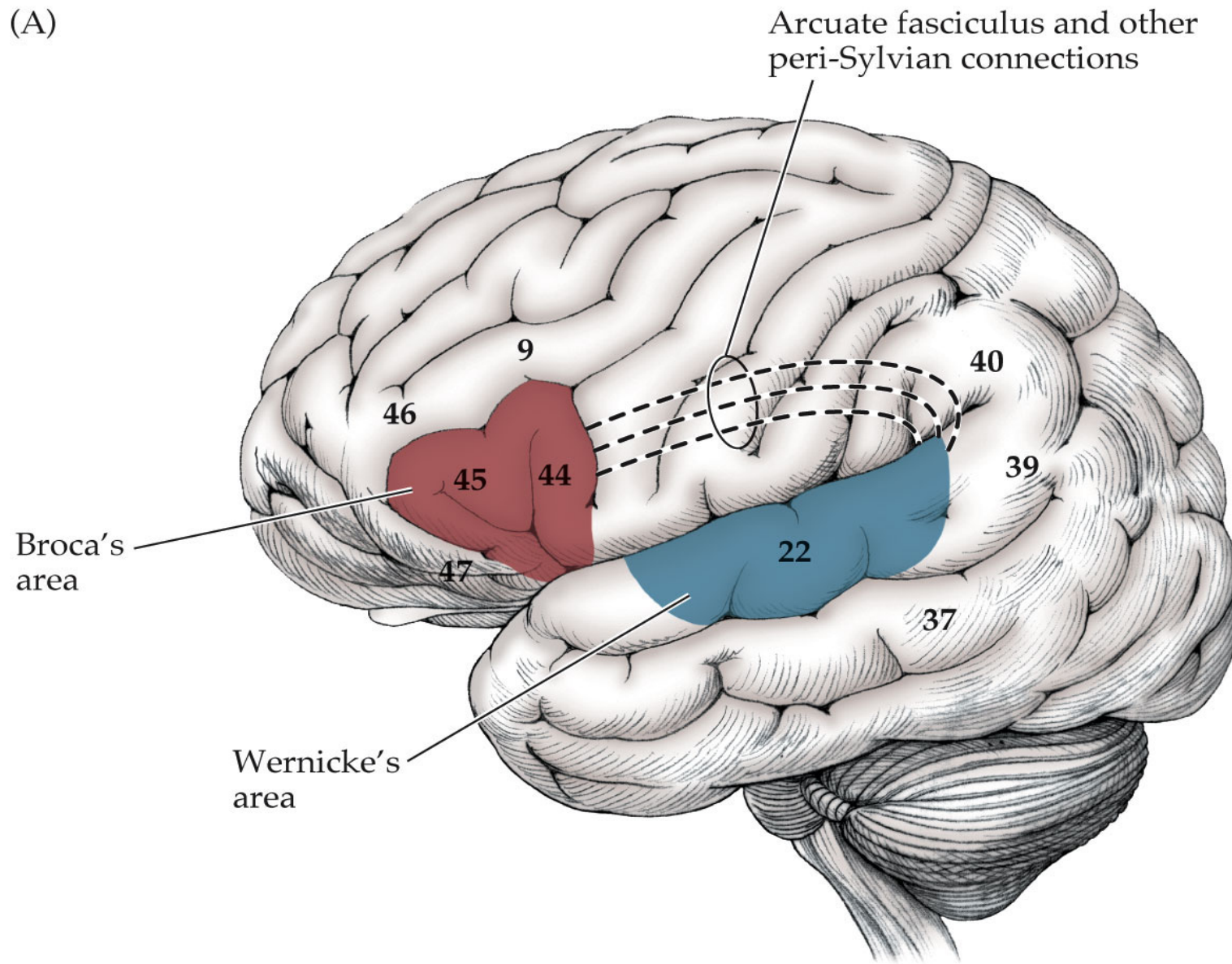
- _ Language - Communication of thoughts and feelings through a system of arbitrary signals, such as voice sounds, gestures, or written symbols
 - _ Spoken
 - _ Expressive
 - _ Receptive
 - _ Written
 - _ Reading
 - _ Writing

SPOKEN LANGUAGE

- Phonemes: Individual sound units
- Morphemes: smallest meaningful units of a word –allow words to be formed into other words (destroy – destruction)
- Lexical items (words): meanings relate to objects, actions, properties and logical connections.
- Sentences: syntactic structures relate words to each other to convey meanings; depict thoughts, events, emotional states
- Prosody: intonational contours; modify literal meaning of words and sentences
- Discourse: linking sentences into narrative
- Pragmatics: way context and nonverbal aspects contribute to meaning

Complex system—each level of system interacts to determine meaning of utterances

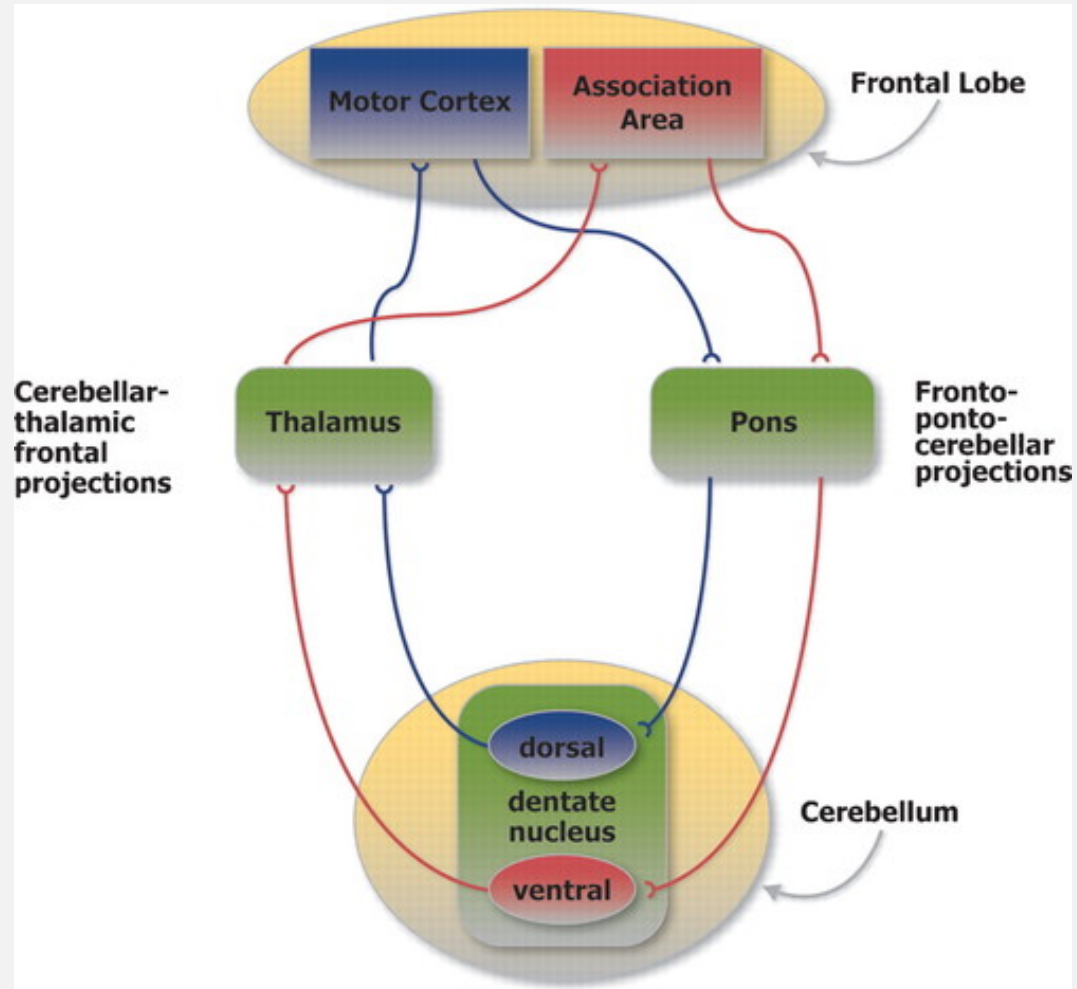
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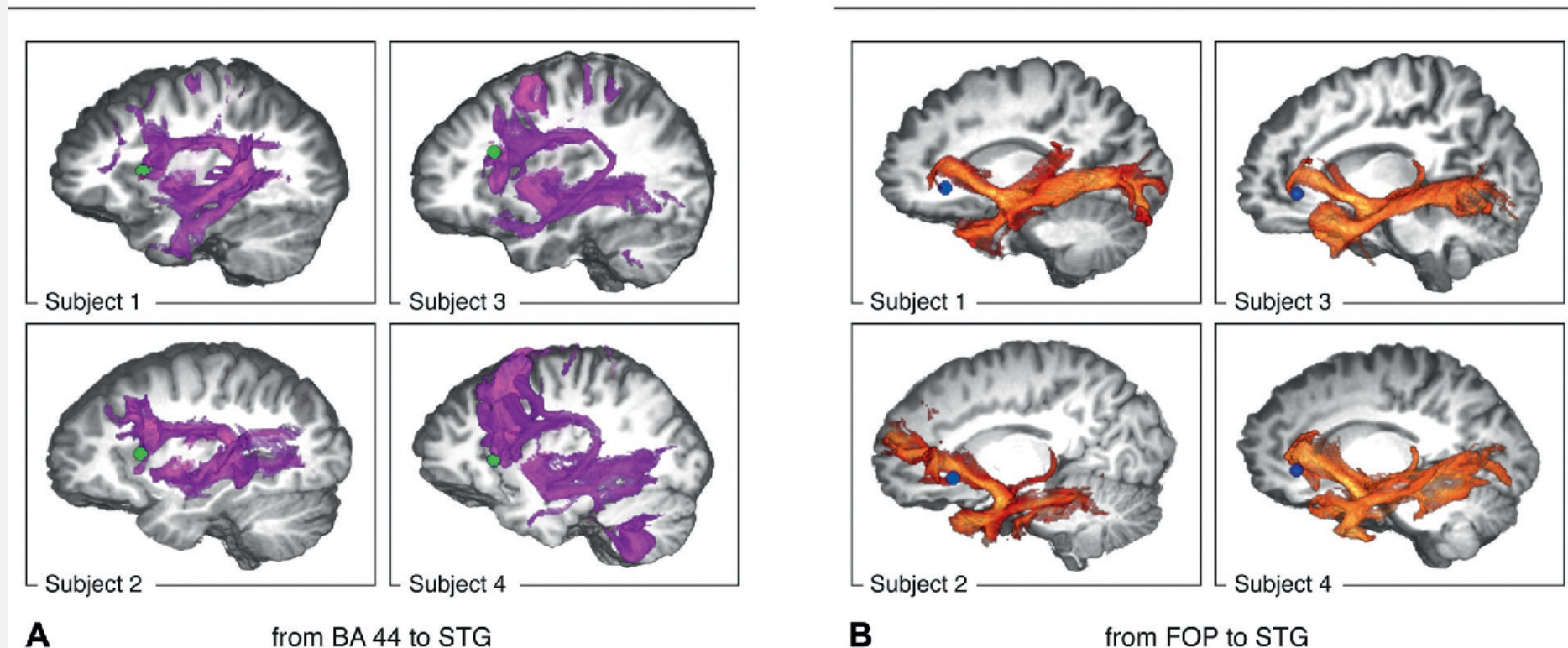
Blumenfeld, 2002

FRONTAL LOBE & CEREBELLUM



- Frontal Lobe
 - Motor Cortex
 - Motoric planning & movements of mouth to produce sounds
 - Association Areas
 - Prefrontal cortex- semantic processing/analysis, pragmatics
- Cerebellum
 - Right hemisphere & dentate nucleus
 - Verbal fluency (semantic and conversational)
 - Grammatical processing (expressive & receptive)
 - Identify and correct errors in language

WHITE MATTER CONNECTIVITY

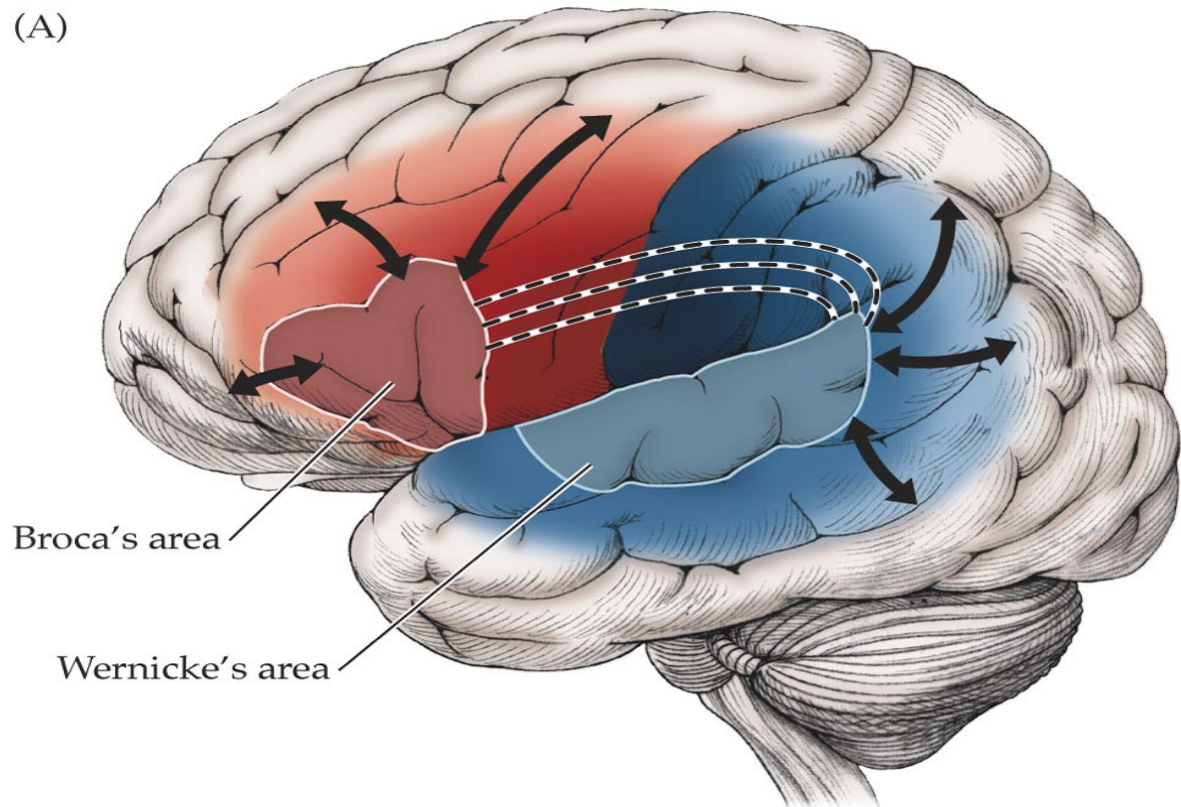


BA, Brodmann's area; STG, superior temporal gyrus; FOP, frontal operculum. (Adapted from Friederici et al., 2006; 2015.)

Anterior temporal lobe, superior temporal lobe, Broca's area,
fasciculus uncinatus, longitudinalis superior fasciculus

LOCATION OF THE STROKE

(A)



Broca's area

Wernicke's area

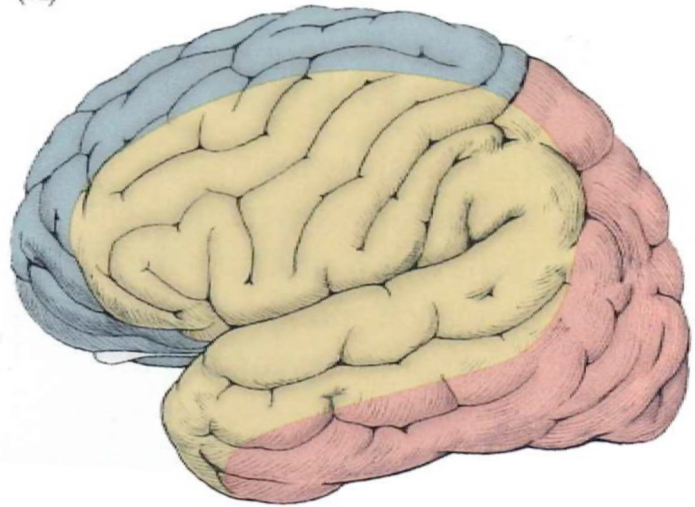
Key

■ = MCA superior division territory

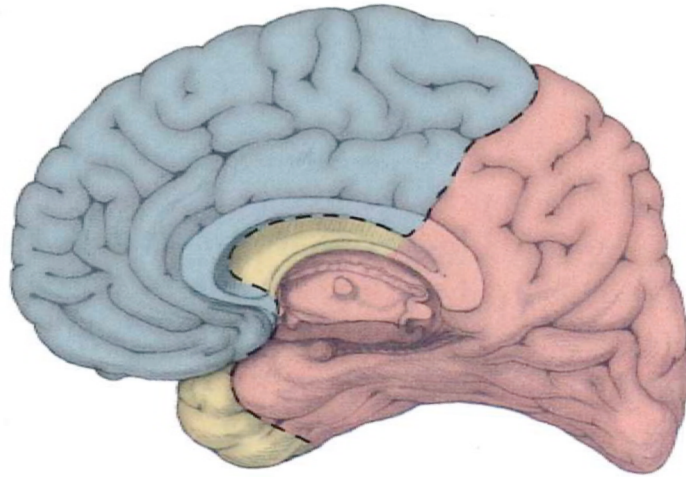
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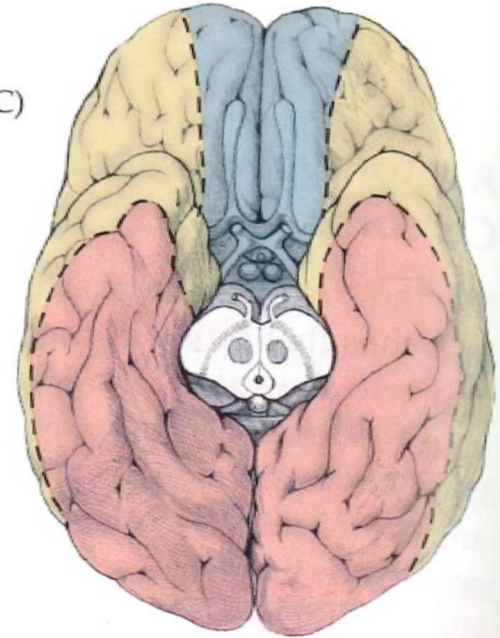
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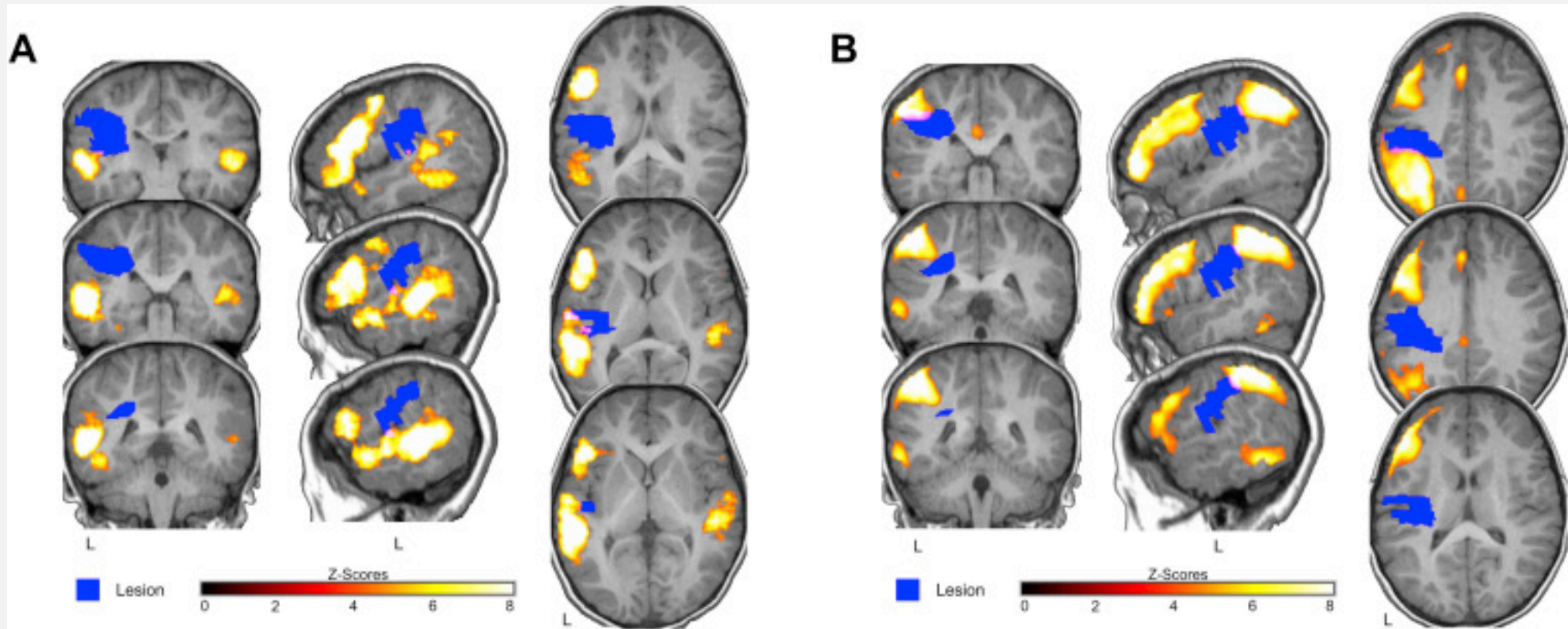


- Key
- Anterior cerebral artery
 - Middle cerebral artery
 - Posterior cerebral artery

FIGURE 10.5 Regions of Cortex Supplied by the Anterior Cerebral Artery (ACA), Middle Cerebral Artery (MCA), and Posterior Cerebral Artery (PCA) (A) Lateral view. (B) Medial view. (C) Inferior view.

TIMING OF STROKE

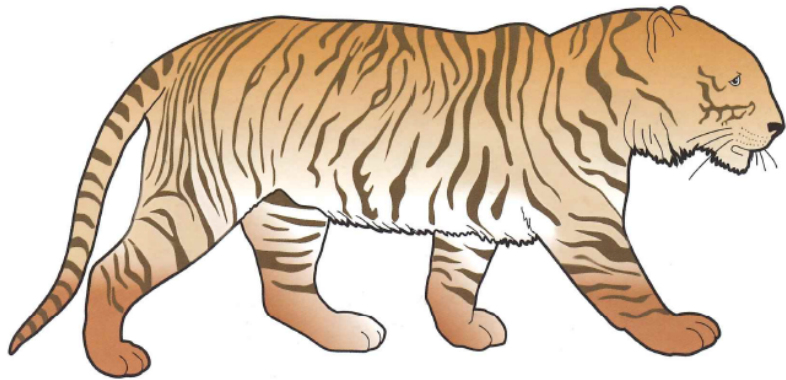
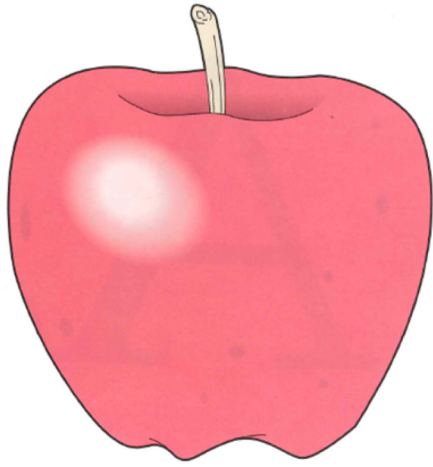
- _ Loss of specific skills due to injury to areas specialized for these functions
 - _ Aphasia – Loss of spoken language
 - _ Agraphia- Loss of written expression
 - _ Alexia- Loss of reading
- _ Very young children's brains re-organize specialized areas
 - _ Can preserve most salient abilities, often language
 - _ Most nuanced aspects can be impacted
 - _ Crowding can impact other less frequently needed skills, often visuospatial processing

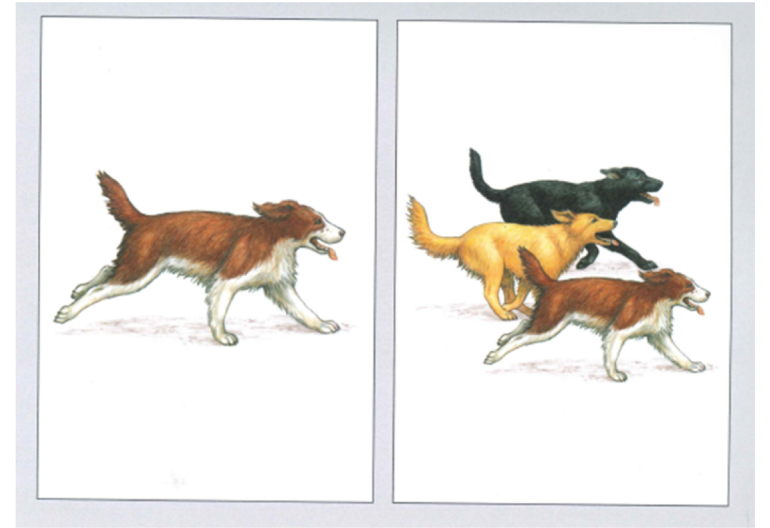
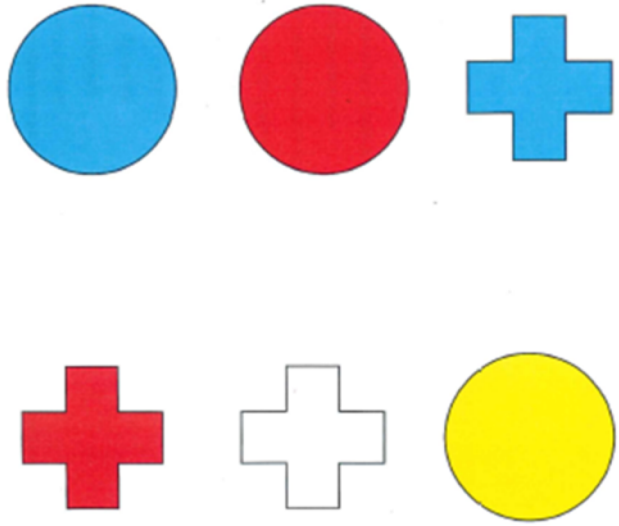


Francois et al., 2016- Language learning and brain reorganization in a 3.5-year-old child with left perinatal stroke revealed using structural and functional connectivity

ASSESSMENT

- Language tasks
 - Single word vocabulary
 - Comprehension
 - Grammar
 - Syntax
 - Fluency
 - Observation





ADDITIONAL TASKS

- Word Generation
- Sentence Repetition
- Grammatical Judgement
 - Yesterday, she rided her horse.
 - There is two dogs.
- Inference
 - Mom said, “Be sure to bring your bathing suit, and don’t forget your bucket and shovel.” Where were they going?

THE IMPACT OF STROKE ON
BEHAVIOR, EMOTIONS, &
SOCIALIZATION

COMMONLY REPORTED SYMPTOMS

- Emotional lability
- Outbursts
- Hyperactivity
- Impulsivity
- Withdrawal
- Anxiety
- Noncompliance/refusal
- Difficulty making/keeping friends

HIGHER RATES OF CLINICAL DIAGNOSES

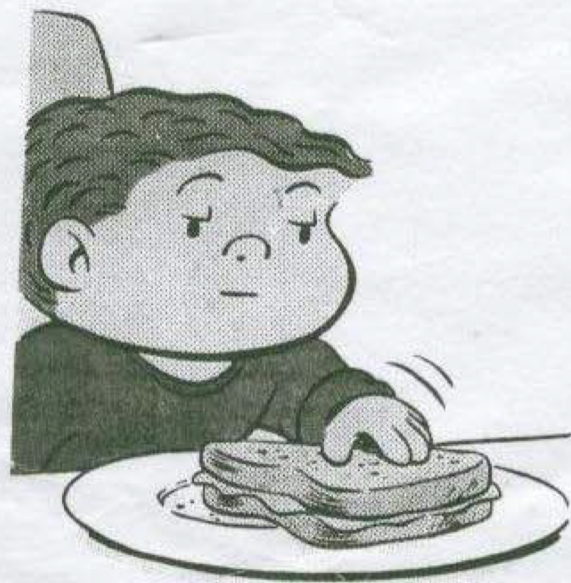
- Attention-Deficit/Hyperactivity Disorder (ADHD)
- Mood Disorders (including depression)
- Anxiety Disorders
- Autism Spectrum Disorder
- Social (Pragmatic) Communication Disorder



EXAMPLE:
SOCIAL
PRAGMATICS

SOCIAL PRAGMATICS

- Ability to understand another speaker's intended meaning
 - Requires knowledge of semantics and grammar
 - Relies on context of situation
 - Attention to nonverbal cues; "read the room"
 - Inference and intention
- Use of pragmatics
 - Gaze, gesture, facial expression, body language



NEUROLOGICAL BASIS OF PRAGMATICS

- Broca's and Wernicke's areas- use of and comprehension of semantics
- Prefrontal cortex- integration of multiple cues, self-referencing, judgement
- Cerebellum- conversational fluency and identification of errors
- Frontal-parietal regions- inference and theory of mind
- White matter connectivity
- Non-dominant hemisphere

ASSESSMENT

- Behavioral Observation
- Structured questions
 - Sarah give Brian half of her candy bar. What does Ben say to Mia?
 - Your friend is on the basketball team and his team just lost a close game. What should you say?
- Semi-structured activities targeting pragmatics
 - Free play, telling a story, completing a puzzle, prompted conversation, Birthday party
- Questionnaires for parents and teachers

HOW DO RESULTS INFORM
TREATMENT PLANNING?

RECOMMENDATIONS

- General information about how to help child develop optimally
- Educational placement, services, and accommodations
- Emotional and behavioral therapy services
 - Psychology, psychiatry, behavioral therapies
- Service provision
 - Speech, occupational, and physical therapies
- Additional evaluation
 - Assistive technology, augmentative communication, etc.

GENERAL PRINCIPLES

- Recommendations are not prescriptive
 - Be flexible and try different approaches
- Integrate a child's interests into therapies whenever possible
 - Child's mental well-being sets the stage for progress
- Utilize a strength-based approach
 - Integrate skills that are challenging with those that come easy to the child
- Practice newly acquired skills in variety of environments
 - Repetition alone does not help children generalize skills

RE-EVALUATION

- Track developmental progress over time
- Assess the efficacy of current level of service provision or intervention
- Update and revise recommendations for services
- Key transition periods
 - Early Intervention to Preschool
 - Preschool to Early Elementary
 - Elementary to Middle School
 - Middle to High School
 - Post-Secondary

QUESTIONS?

Thank you!