

Transdisciplinary Assessment and Treatment of Language-based Learning Disabilities: The Theoretical Importance of Sensory Processing



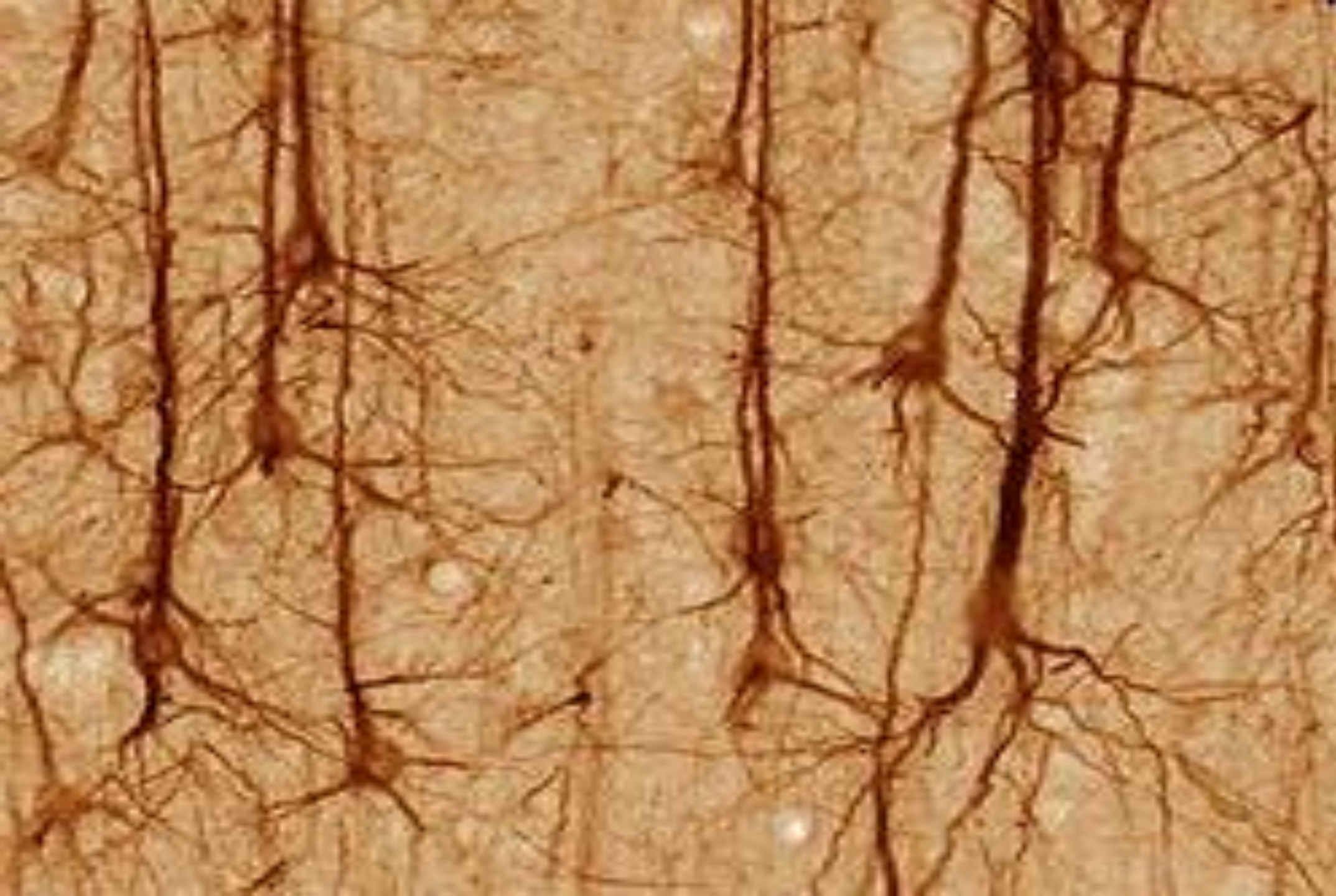
www.TheMorrisCenter.com

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Neurons - How the Brain Works

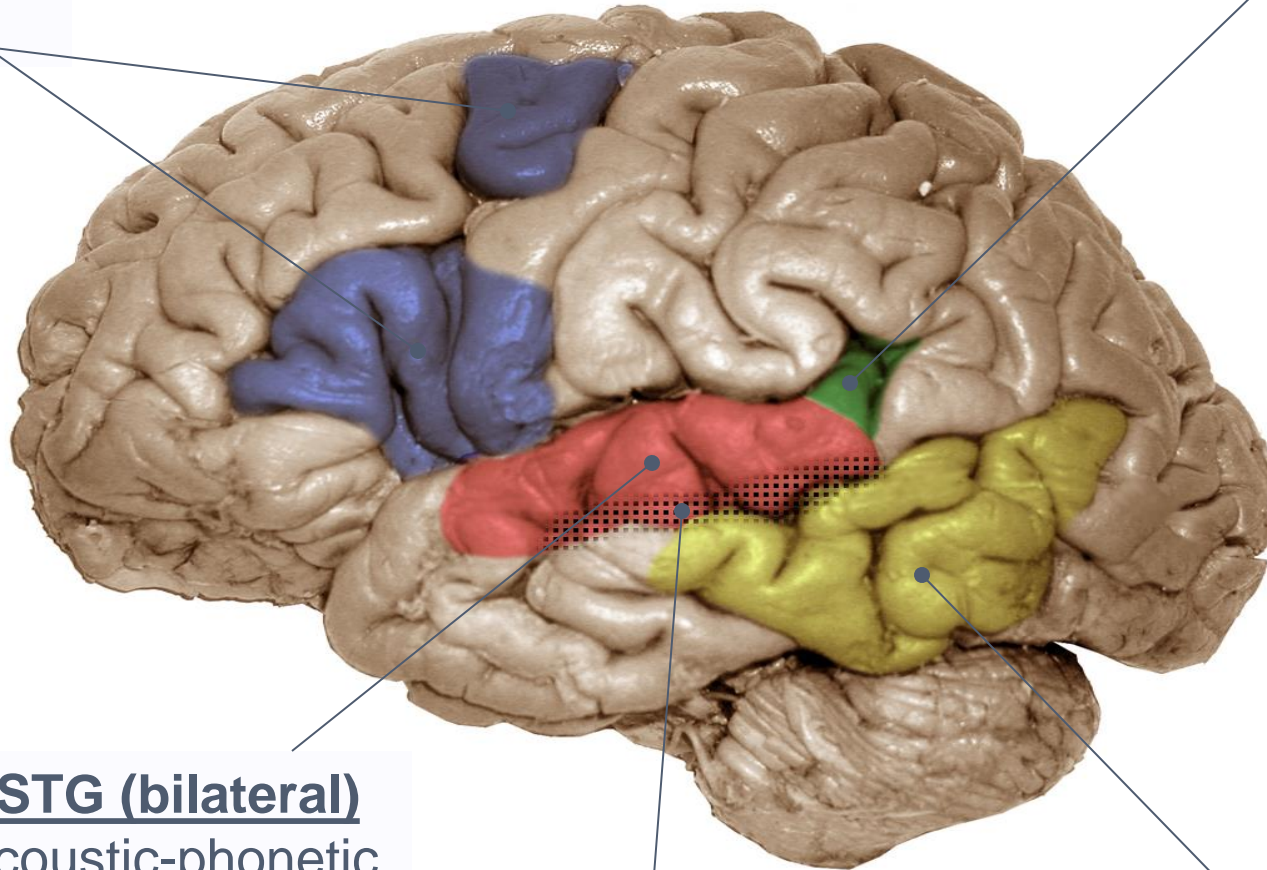
- How many neurons In the brain?
 - ~ 100 Billion
- How many connections exist in the neural networks formed in the brain?
 - ~ 100 Trillion
- How many “connections” from one neuron?
 - ~ 40,000
- The brain is specifically designed for learning and behaviors. It is ready and willing to create neural networks.
- Learning to drive?
- Driving to Ft. Lauderdale.....

pIFG/dPM (left)

articulatory-based
speech codes

Area Spt (left)

auditory-motor interface



STG (bilateral)

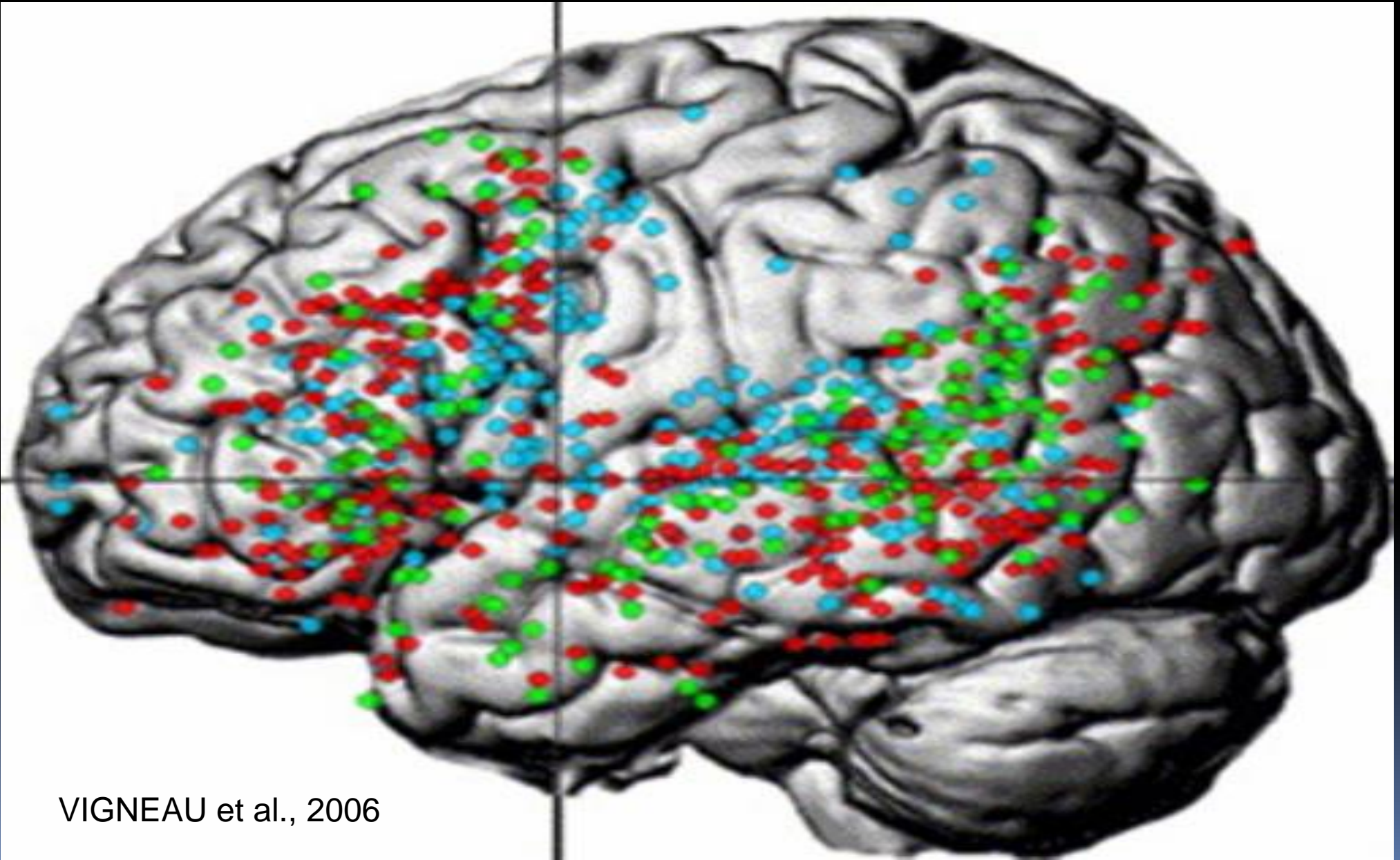
acoustic-phonetic
speech codes

STS phoneme
representations

pMTG (left)

sound-meaning interface

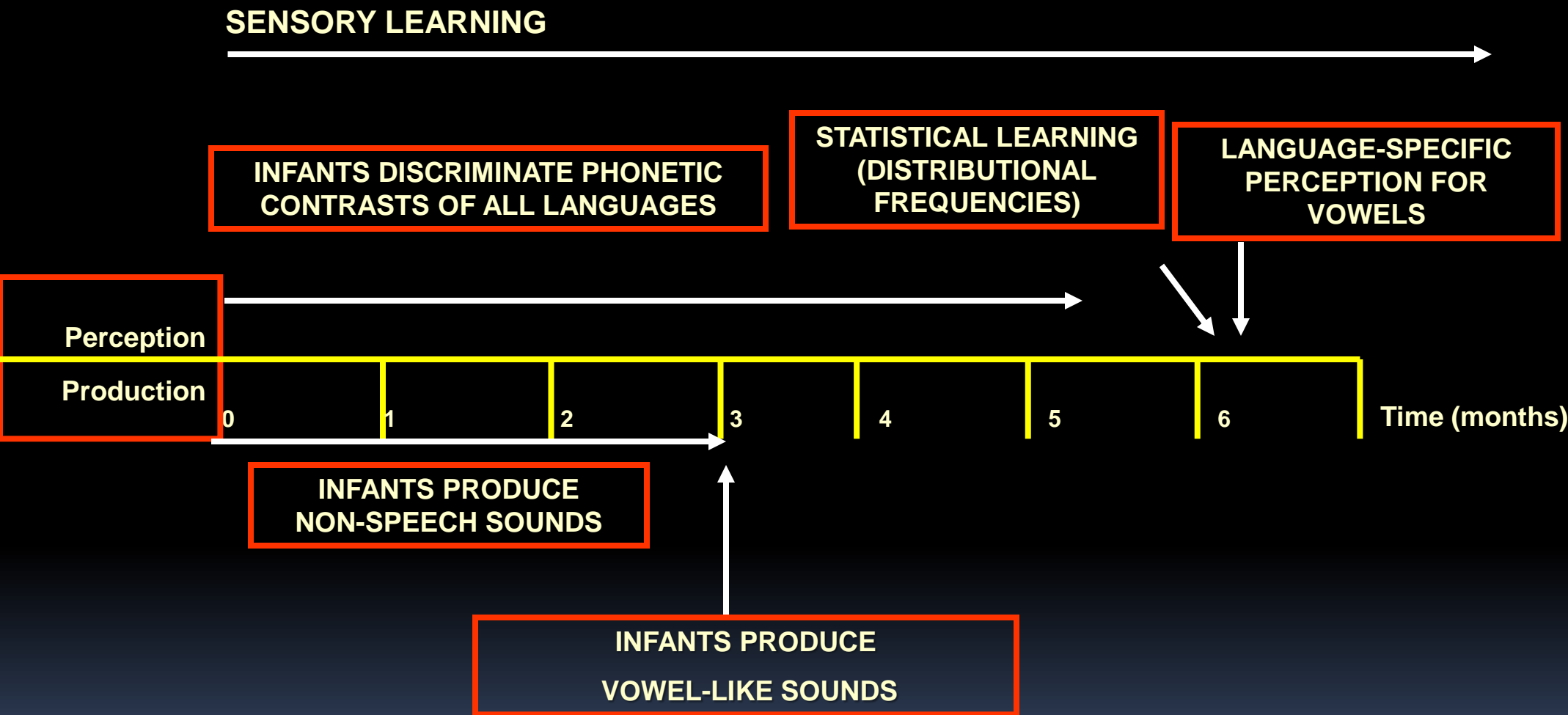
UNIQUE AND OVERLAPPING NETWORKS SENTENCE/SYNTACTIC, SEMANTIC, PHONOLOGICAL



VIGNEAU et al., 2006

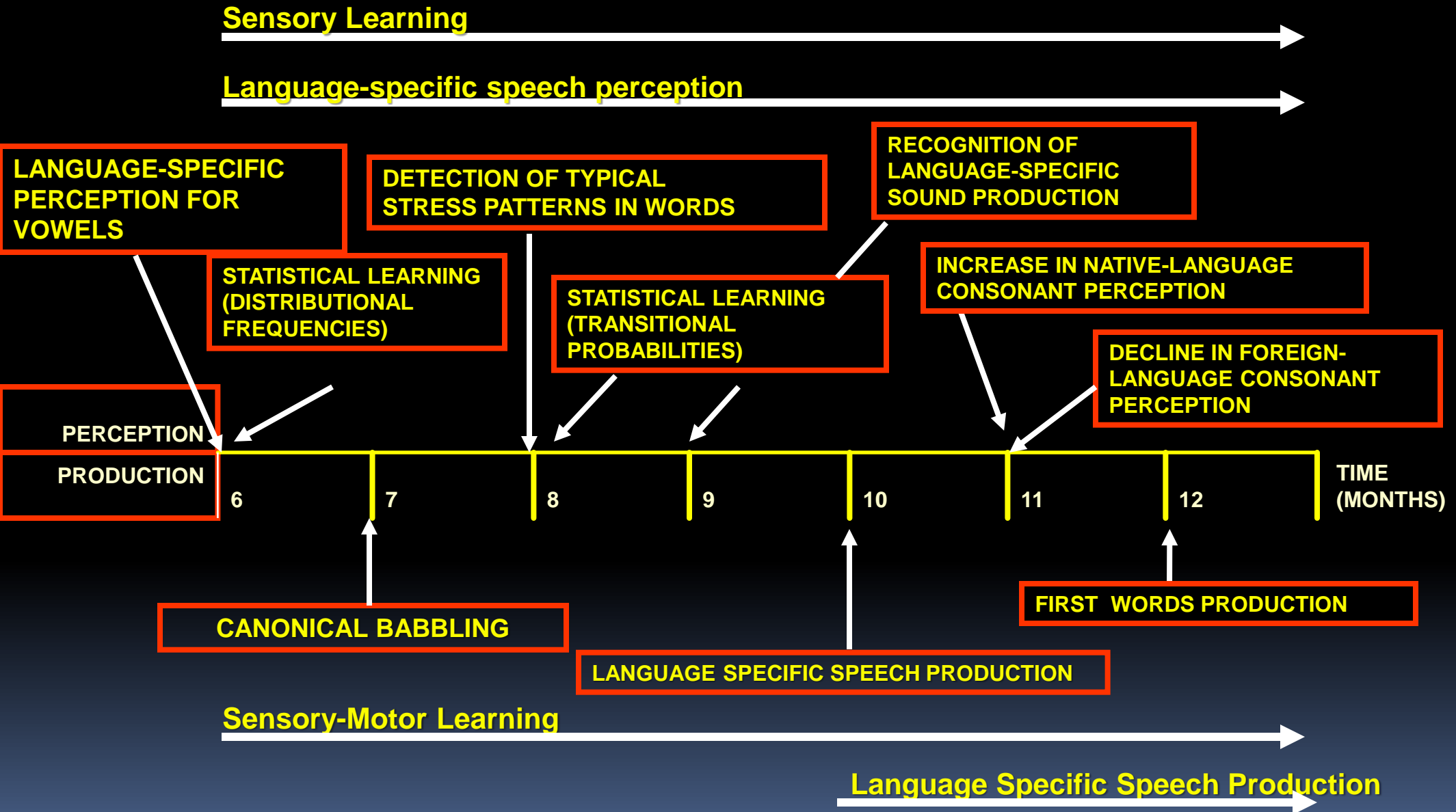
How does the brain develop these distributed networks of sensory and cognitive abilities?

UNIVERSAL SPEECH PERCEPTION: 0-6 MONTHS



UNIVERSAL SPEECH PRODUCTION: 0-6 MONTHS

UNIVERSAL SPEECH PERCEPTION: 6-12 MONTHS

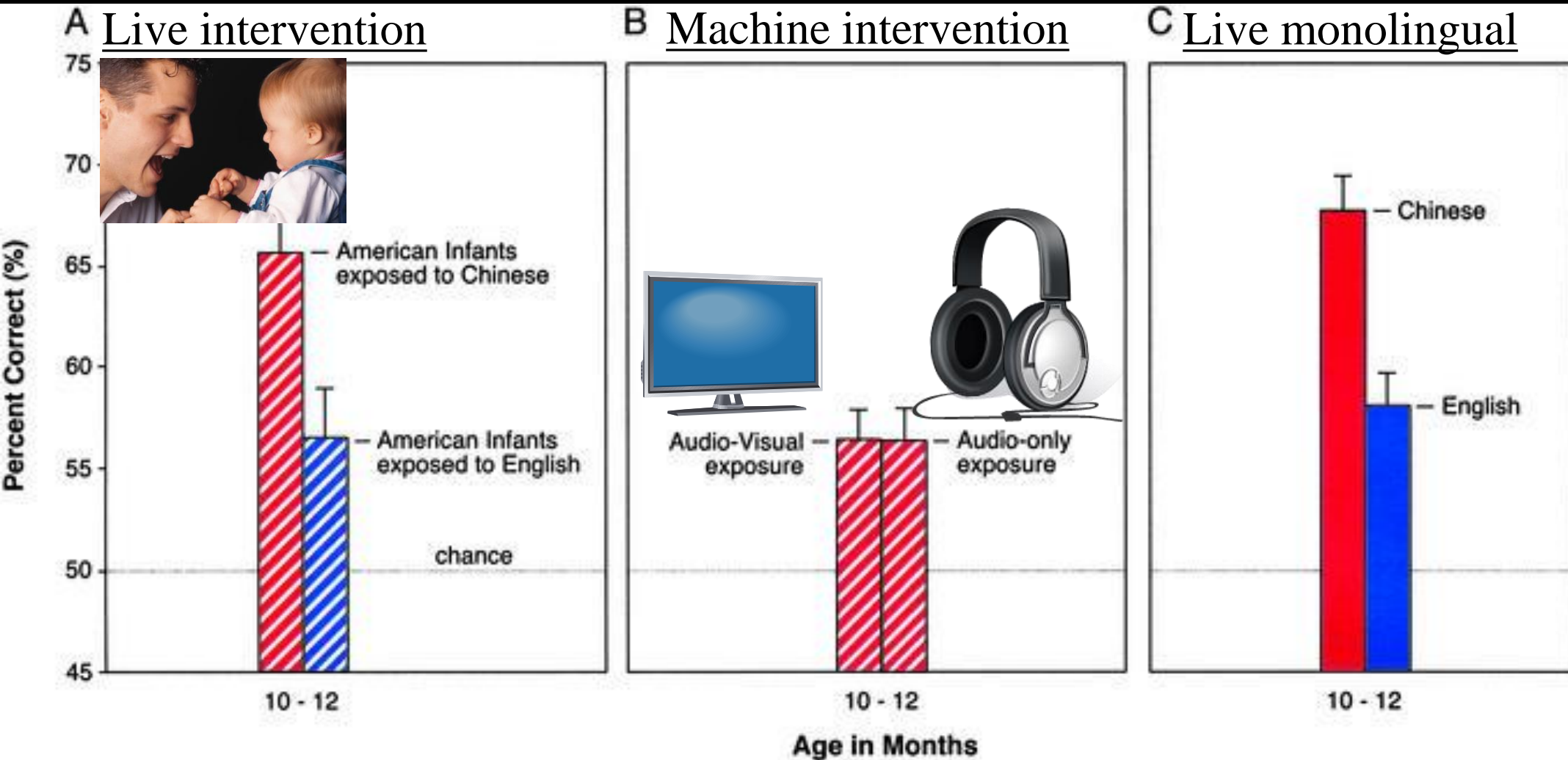


(Kuhl, 2004)

Multisensory = any senses?

- To promote language development, does it matter what sensory systems or how the sensory systems are engaged/experienced?

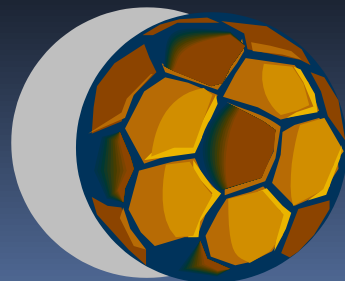
Sensory Systems & Speech Perception



(Kuhl et al., 2003)

Sensory Systems & Language

- Why did live / invivo experience with a parent improve 2nd language discrimination when TV and Headphone experience didn't?
- What sensory systems are engaged by live experience and NOT by recorded experiences?
- What do you do when you teach a baby a new word and he/she has trouble saying all the word's sounds, e.g. "ba" versus ball?



Early Language Development

- Brain is tuned to parents' language
- What systems do newborn's integrate for speech?
 - Oral-facial movements – **visual**
 - Speech sounds – **phonology**
 - Speech/babble – **oral motor tactile kinesthetic**
 - Social-emotional – (non verbal tones & gestures) – **pragmatics**
- Newborns speech perception is affected by multisensory experiences during language development.

Sensory Systems & Language Development

Is an adult's well-developed speech perception affected by multisensory experiences?

<http://www.youtube.com/watch?v=eQoYKuNcCpU&feature=fvwrel>

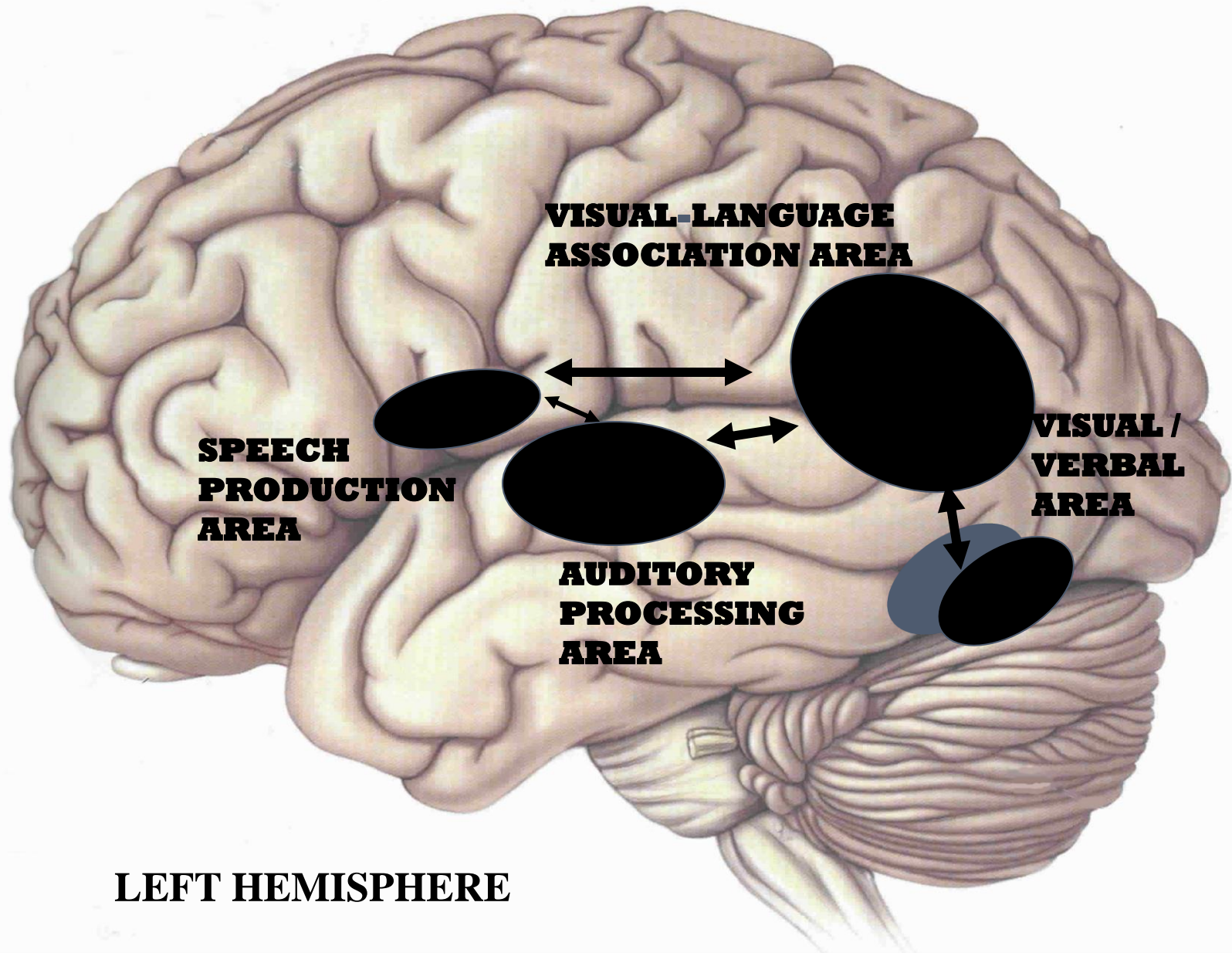
Spell pseudo words

How does the brain develop these distributed networks of sensory and cognitive abilities?

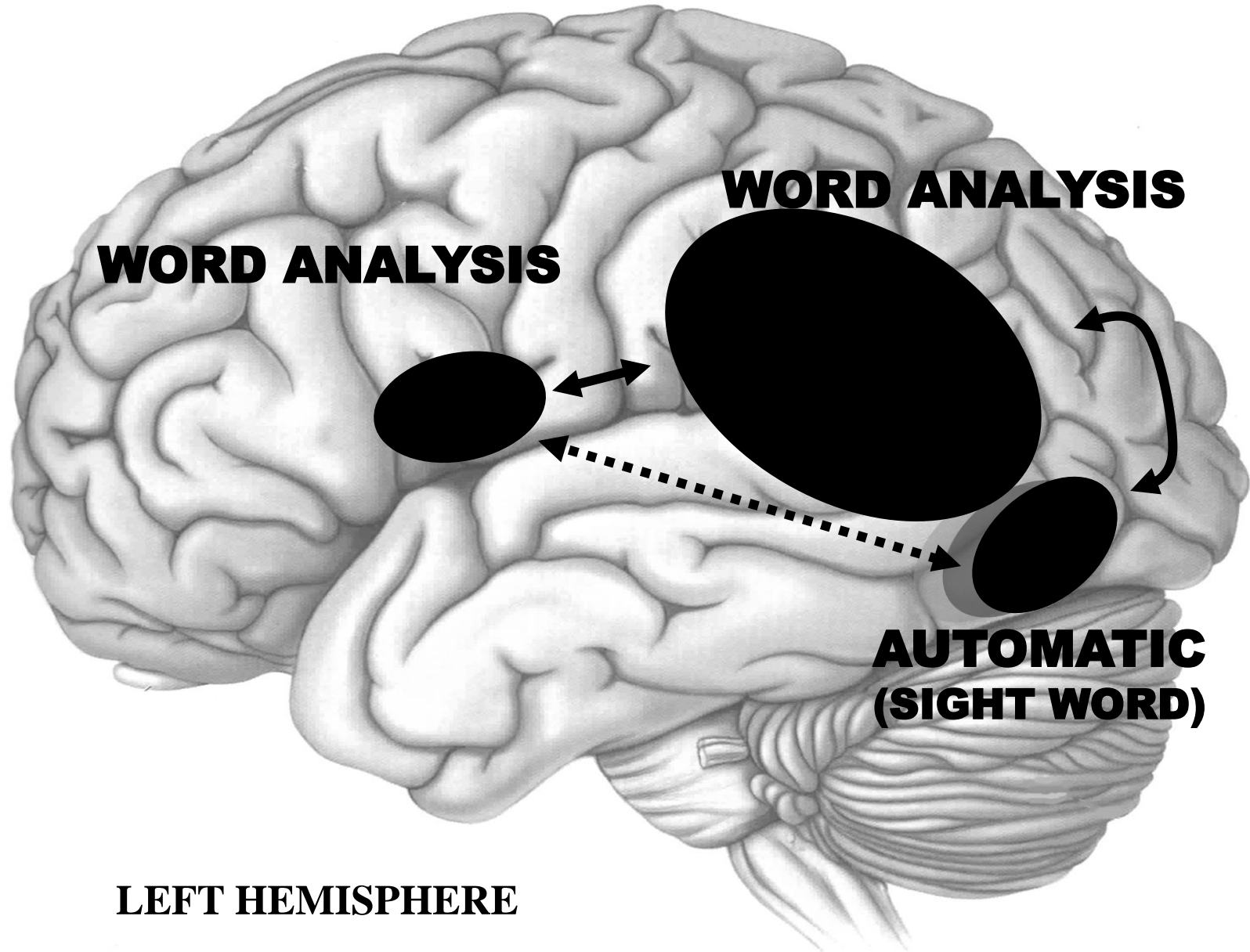
Sensory and motor systems that fire together wire together to form functional neural networks in a typically developing brain.

Which sensory systems are firing during development of speech perception?

Typical LANGUAGE Networks



Typical READING Areas



“CHANGES IN SYNAPSES?”

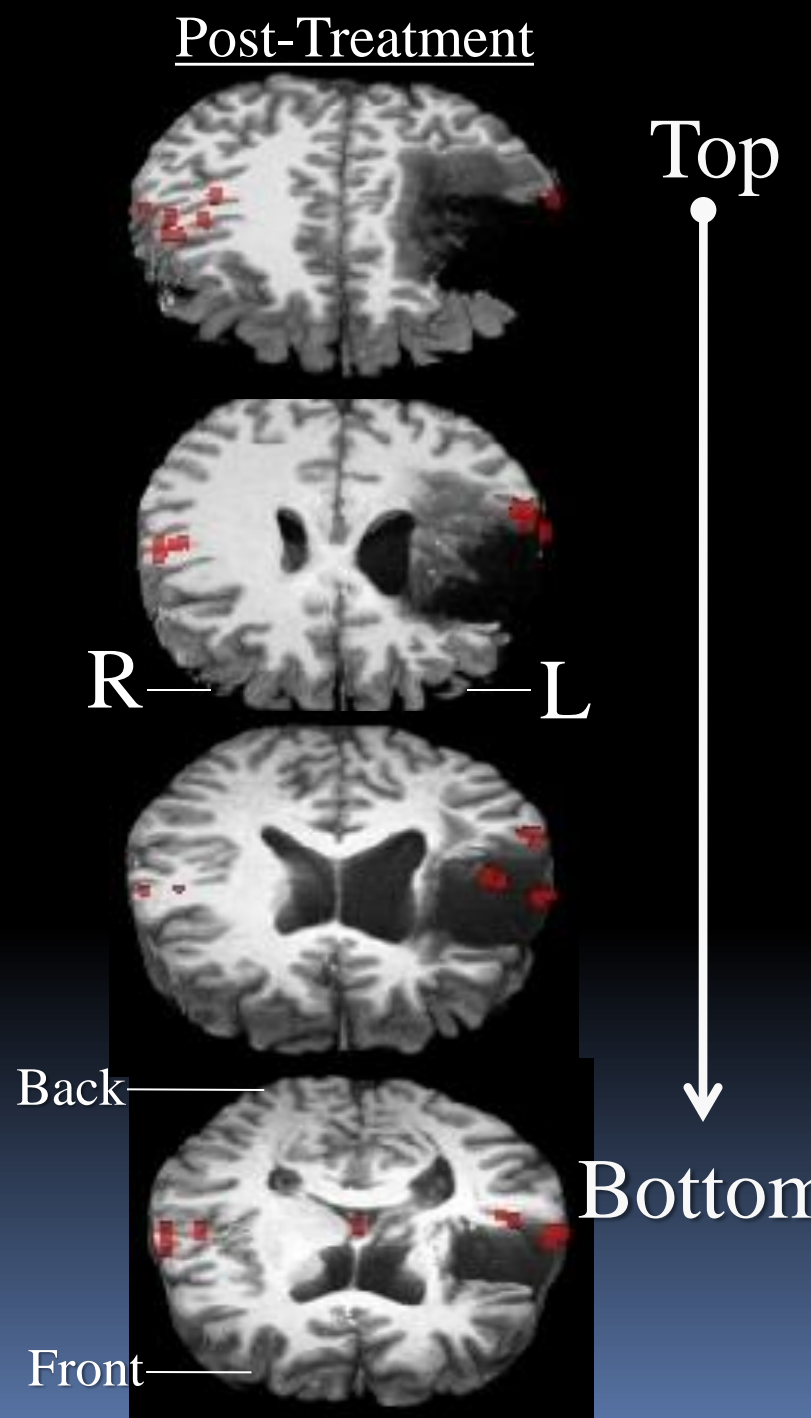
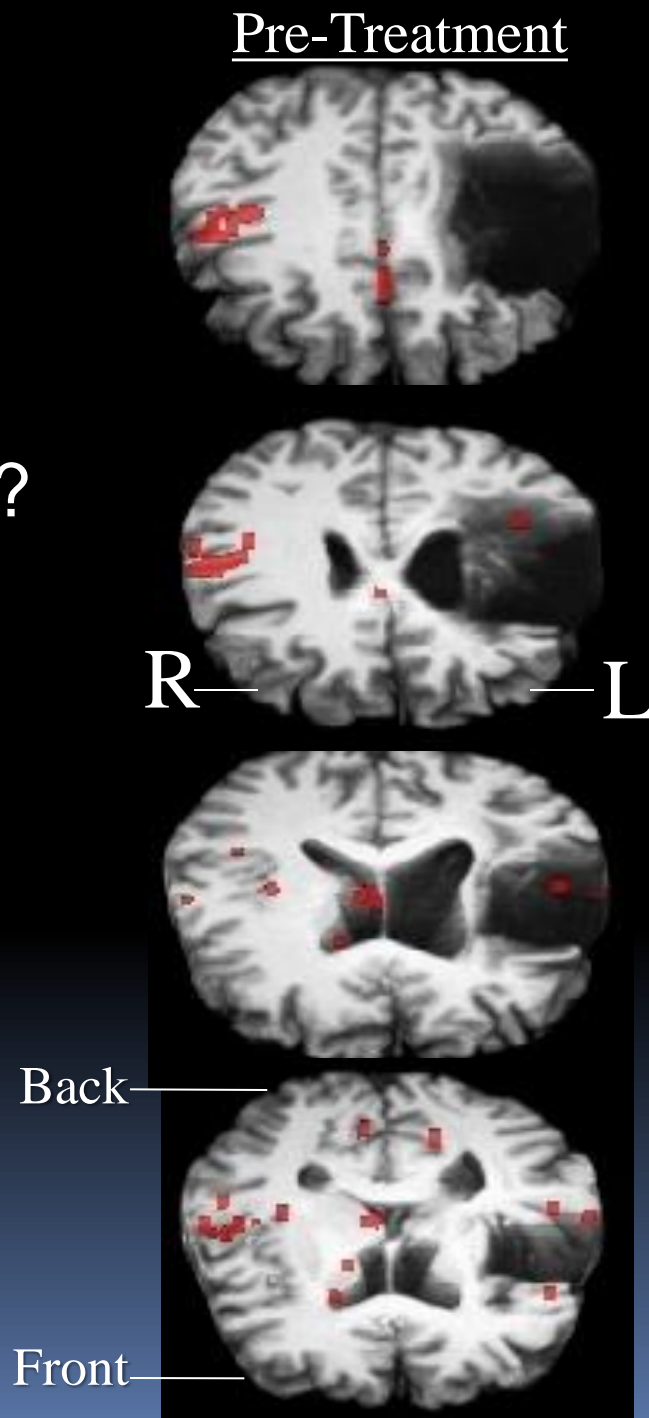
At what chronological age do neurons lose the ability to make new connections (synapses) or networks?

Can neural networks make new connections even after documented brain injury?

Following a stroke,
can partially
damaged brain
areas be re-
activated by
neurorehabilitation?

YES! New activity
and improved
behaviors occur in
some patients.

(Chang, et al. 2006)



Principles Of Neural Plasticity

- Neurons that fire together - wire together
 - Multiple, salient sensorimotor inputs that wire together can strengthen neural networks
- Optimal arousal and attention
- Consistent input/learning experiences
- Learning experiences drive neural plasticity:
 1. SALIENCE – specificity of instruction/experience
 2. FREQUENCY - hour(s) per day
 3. INTENSITY - days per week
 - practice, practice, practice

(Heilman and Alexander, 2003; Kleim and Jones, 2008)

Variability in Neural Plasticity?

- Why don't neural networks all form the same for each person's brain?
- Why do some brains work “differently” than others?

Visual, auditory & oral sensory systems – Are they integrated well in dyslexia?

Articulation Accessing scores of subjs in sample 2

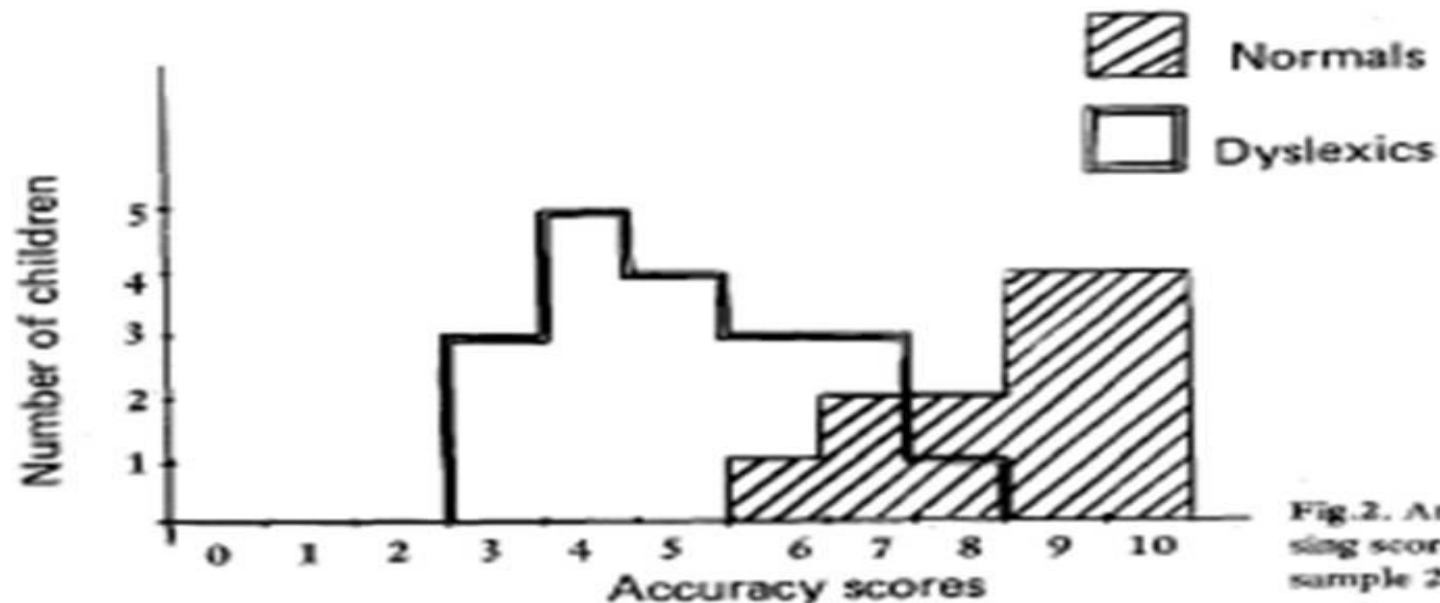


Fig.2. Articulation accessing scores of subjects in sample 2

Montgomery, 1981

WHAT DYSLEXIA IS NOT

DYSLEXIA...

- .. is **NOT** A VISUAL PROBLEM
- .. is **NOT** A LACK OF INTELLIGENCE
- .. is **NOT** DUE TO LACK OF EFFORT
- .. is **NOT** A DEVELOPMENTAL LAG
- .. is **NOT** UNCOMMON: 5–17.5 % OF POPULATION
- .. is **NOT** RESPONSIVE TO STANDARD READING INSTRUCTION

DYS = trouble ***LEXIA*** = words

Dyslexia is...

- Neurologic in origin – genetic
- Lifelong – but environment may alter course
- Reading comprehension > word reading skills

Dyslexia may include accompanying challenges

- ADHD 50-70%
 - Behavioral problems
 - Sensory motor difficulty
- = More challenging to remediate

THE PICTURE OF DYSLEXIA

(ALL STRENGTHS DO NOT OCCUR FOR EVERYONE)

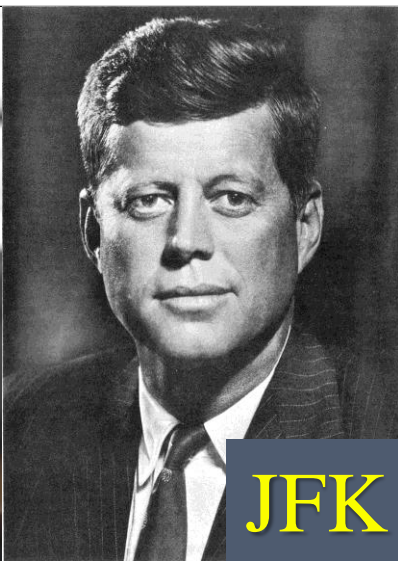
(Alexander & Conway, 2007)

STRENGTHS

LEADERSHIP SKILLS



CHURCHILL



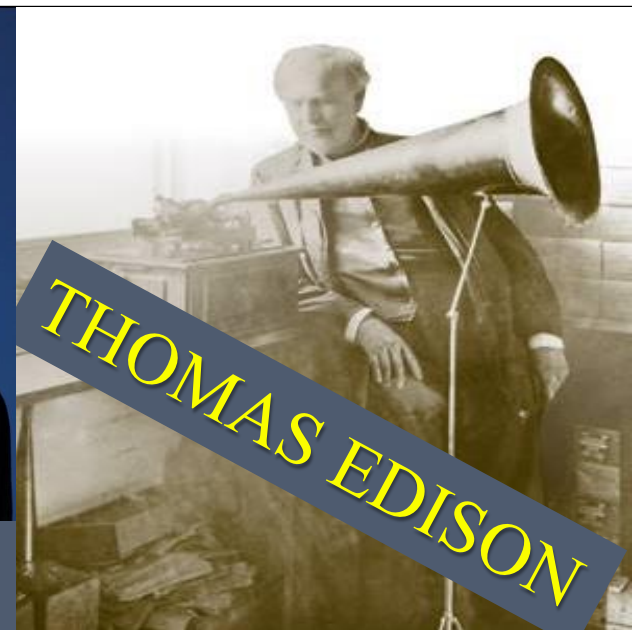
JFK

POLITICAL
&
MILITARY

THINKING “OUT OF THE BOX”



TED TURNER
BUSINESS



THOMAS EDISON

SCIENTISTS &
INVENTORS

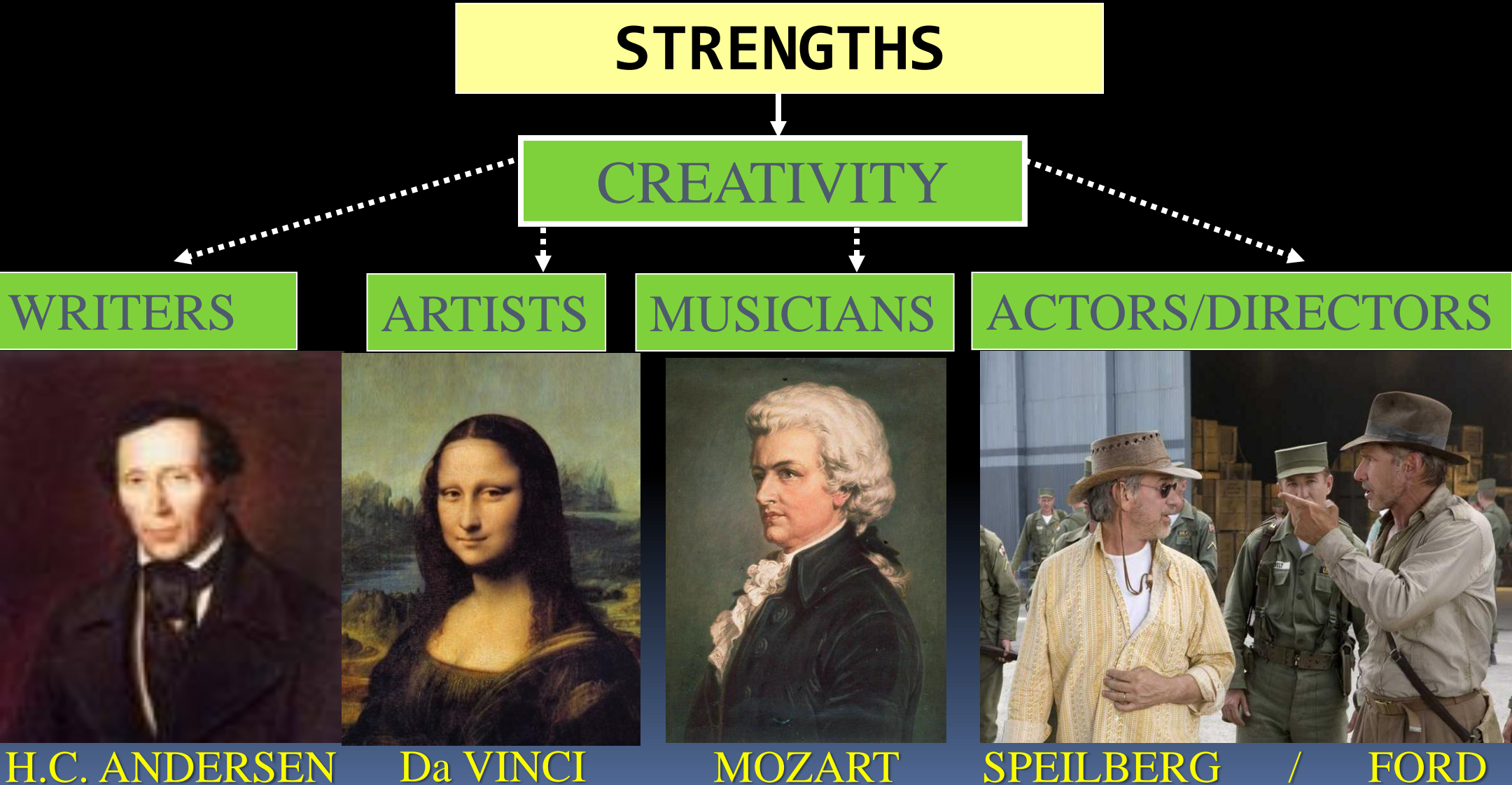


PATTON

THE PICTURE OF DYSLEXIA

(ALL STRENGTHS DO NOT OCCUR FOR EVERYONE)

(Alexander & Conway, 2006)



THE PICTURE OF DYSLLEXIA

(ALL STRENGTHS DO NOT OCCUR FOR EVERYONE)

(Alexander & Conway, 2006)

STRENGTHS

VISUOSPATIAL / MOTOR SKILLS

SURGEONS



NEUROSURGERY

ATHLETES



MUHAMMAD ALI



NOLAN RYAN

THE PICTURE OF DYSLLEXIA

(ALL SYMPTOMS DO NOT OCCUR WITH EVERYONE)
(Alexander & Conway, 2006)

ORAL LANGUAGE CHALLENGES

```
graph TD; A[ORAL LANGUAGE CHALLENGES] --> B[LISTENING]; A --> C[SPEAKING]; B --> D[Phonological Awareness]; B --> E["Auditory Memory  
(word sequences, phone numbers,  
remembering directions)"]; B --> F[Foreign Language]; C --> G[Word Finding]; C --> H[Multi-syllable Words]; C --> I[Sequencing Ideas]; C --> J[Foreign Language]
```

LISTENING

Phonological Awareness

Auditory Memory

(word sequences, phone numbers,
remembering directions)

Foreign Language

SPEAKING

Word Finding

Multi-syllable Words

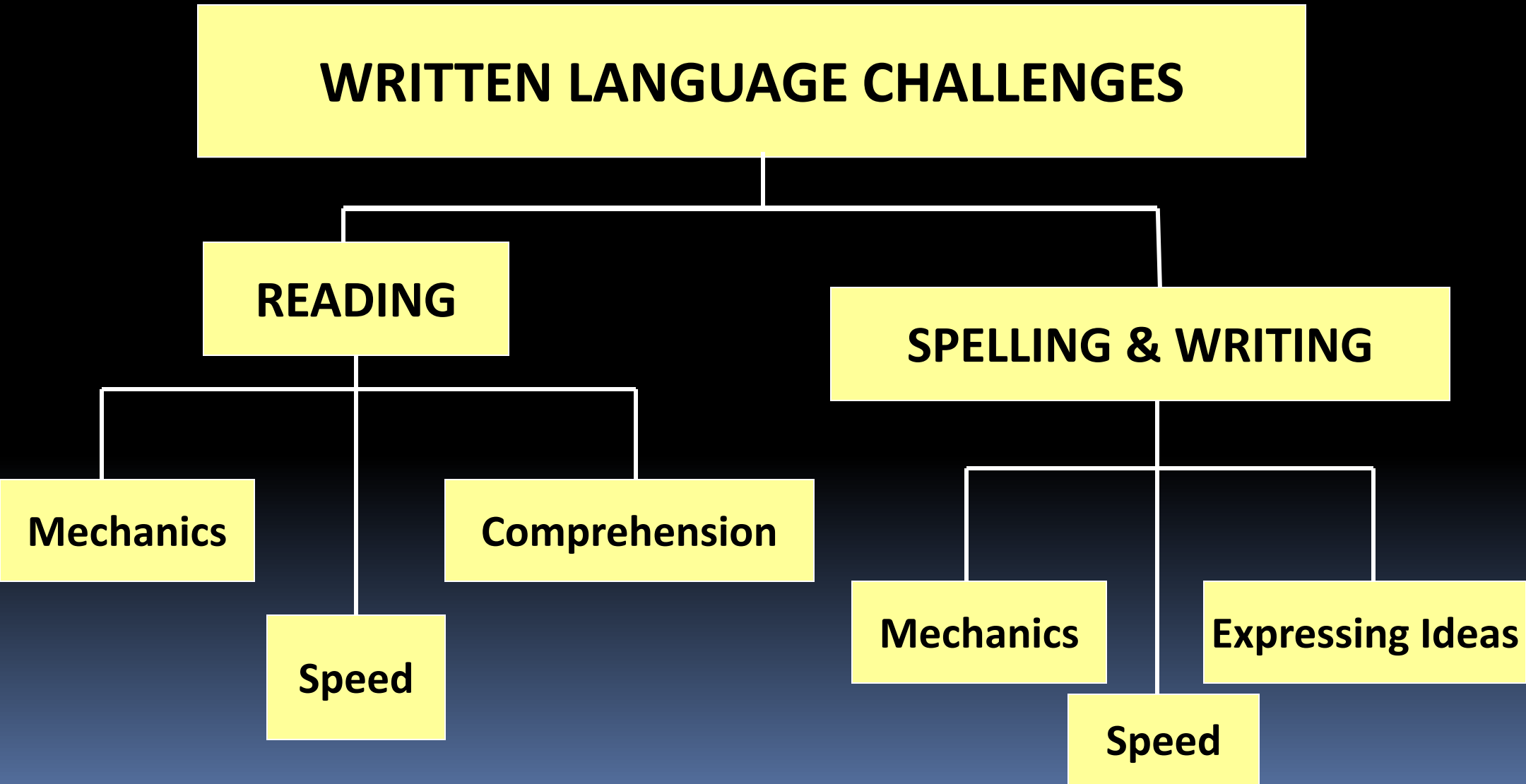
Sequencing Ideas

Foreign Language

THE PICTURE OF DYSLLEXIA

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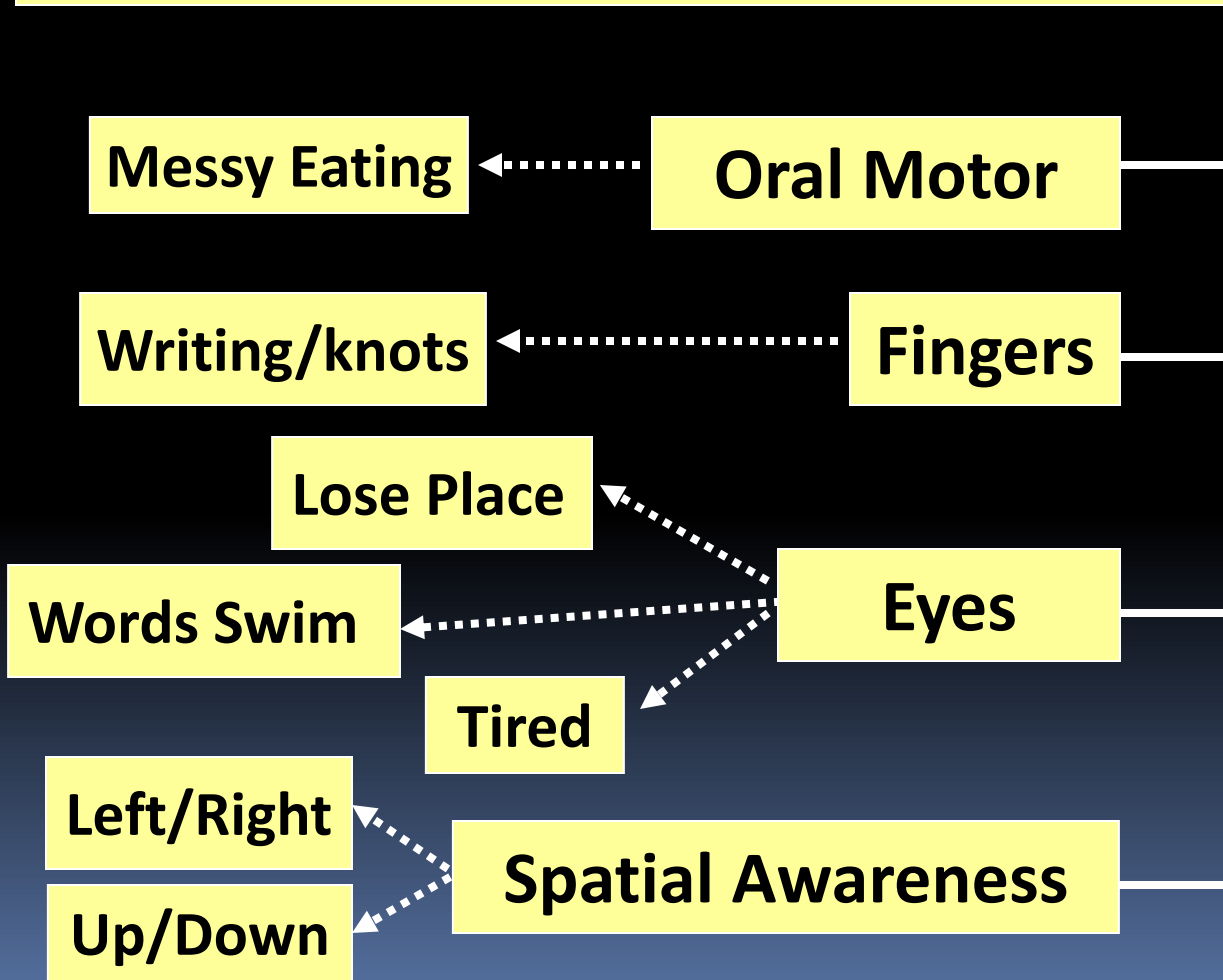


THE PICTURE OF DYSLEXIA

(ALL SYMPTOMS DO NOT OCCUR WITH EVERYONE)

(Alexander & Conway, 2006)

ACCOMPANYING SENSORIMOTOR CHALLENGES

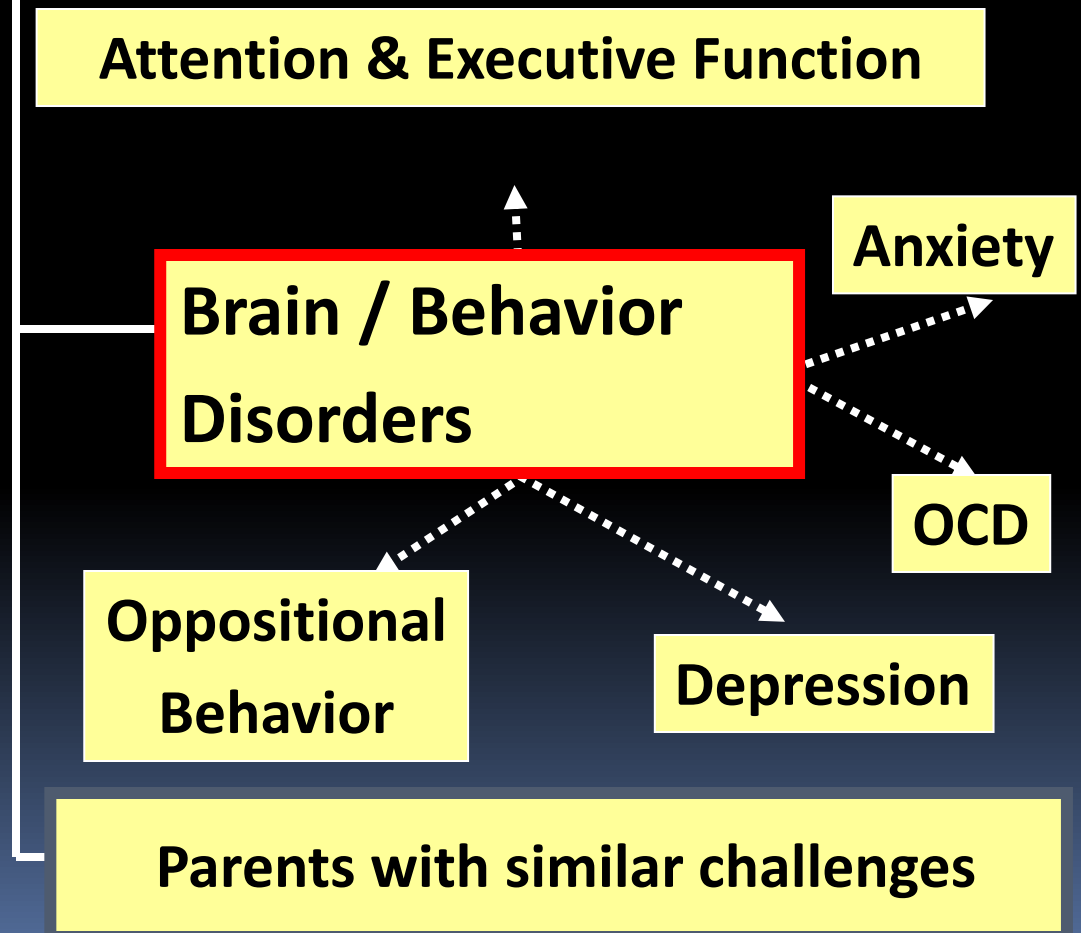


THE PICTURE OF DYSLLEXIA

(ALL SYMPTOMS DO NOT OCCUR WITH EVERYONE)

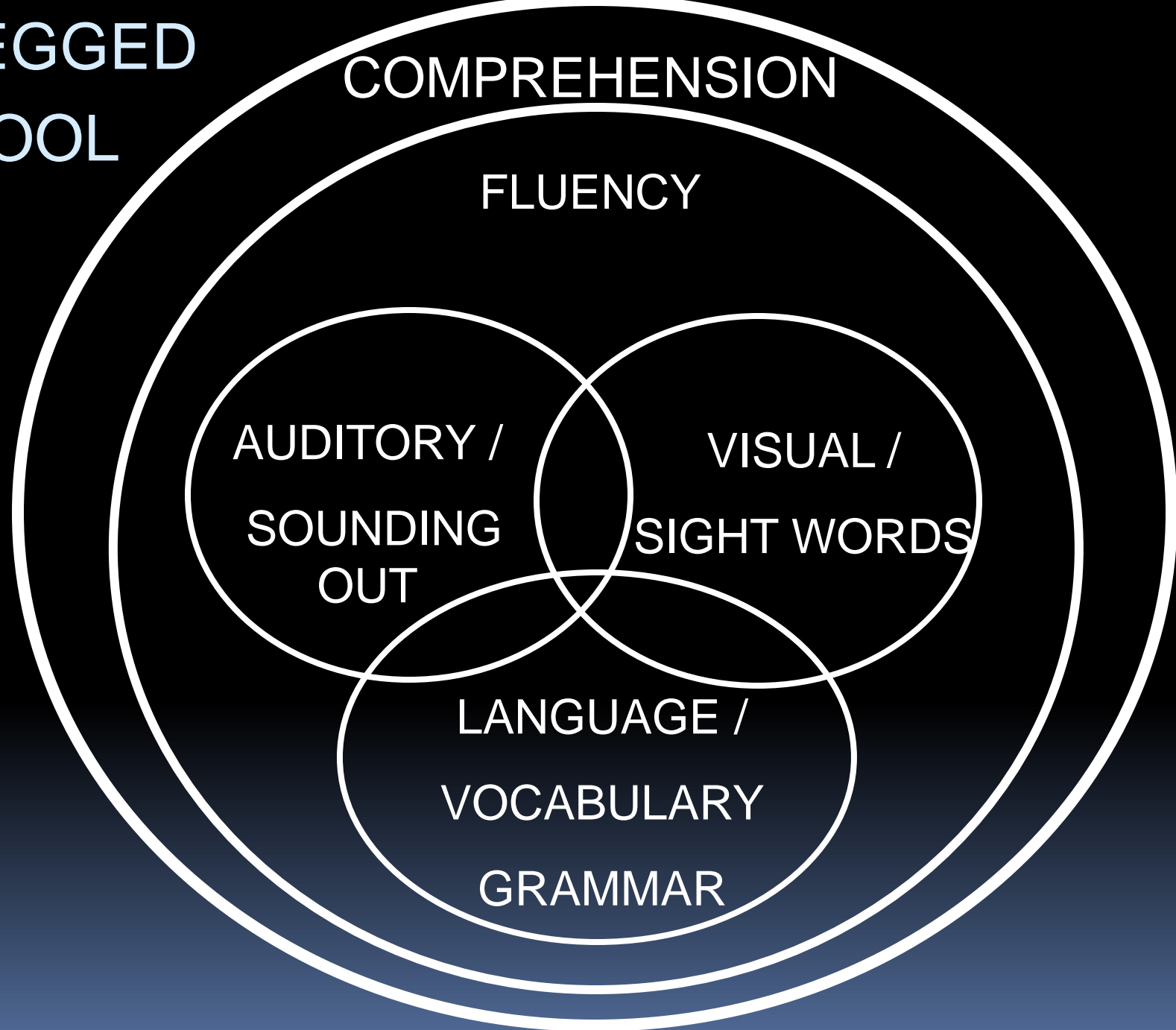
(Alexander & Conway, 2006)

ACCOMPANYING CHALLENGES (BEHAVIORAL)



Dyslexia – really, what is it?

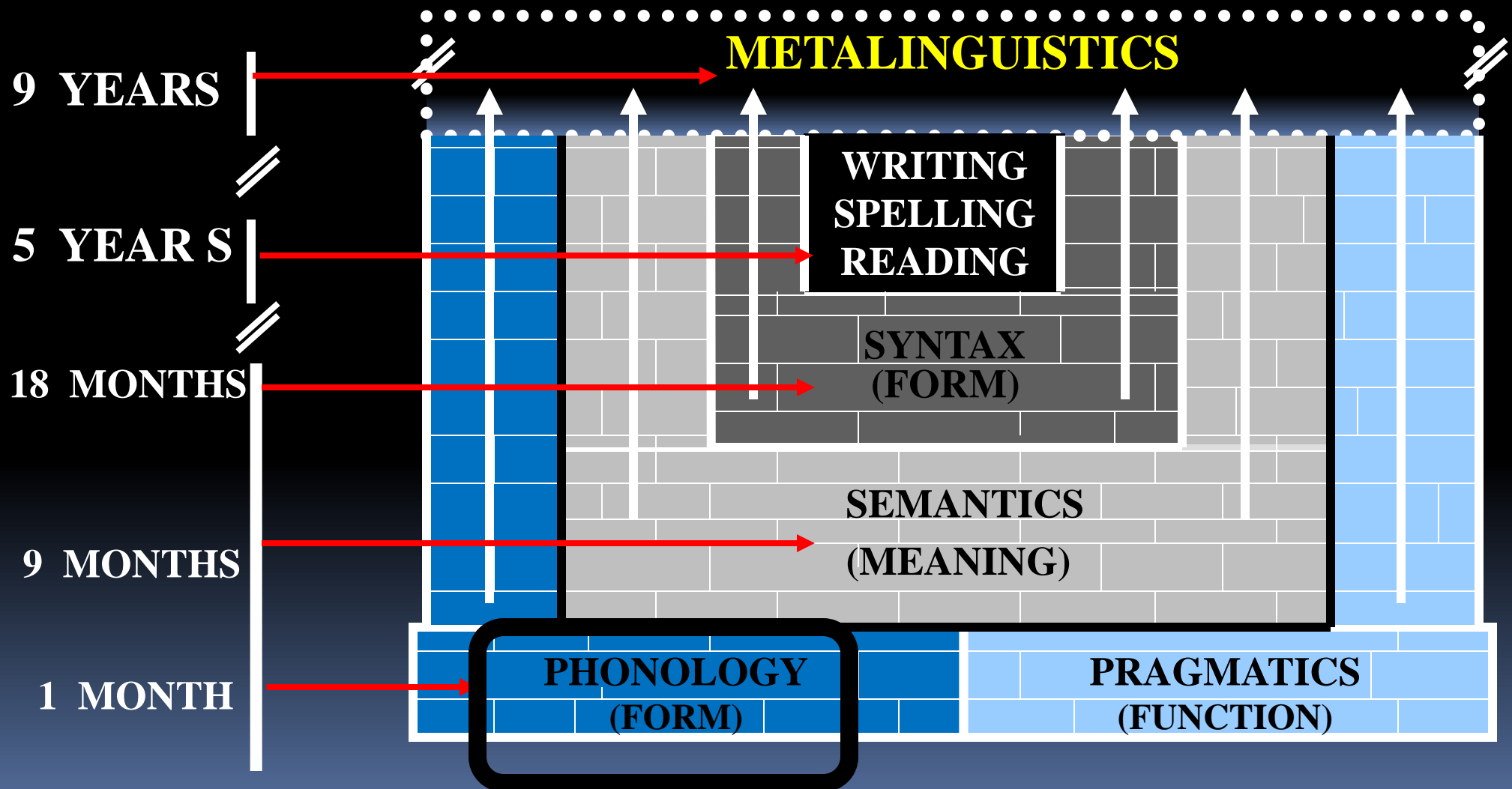
3 – LEGGED STOOL



If Phonology Is So Important, Then When Does It Begin Developing?

At what age do children begin to learn
the sounds of their native language?

Developmental Building Blocks for Language

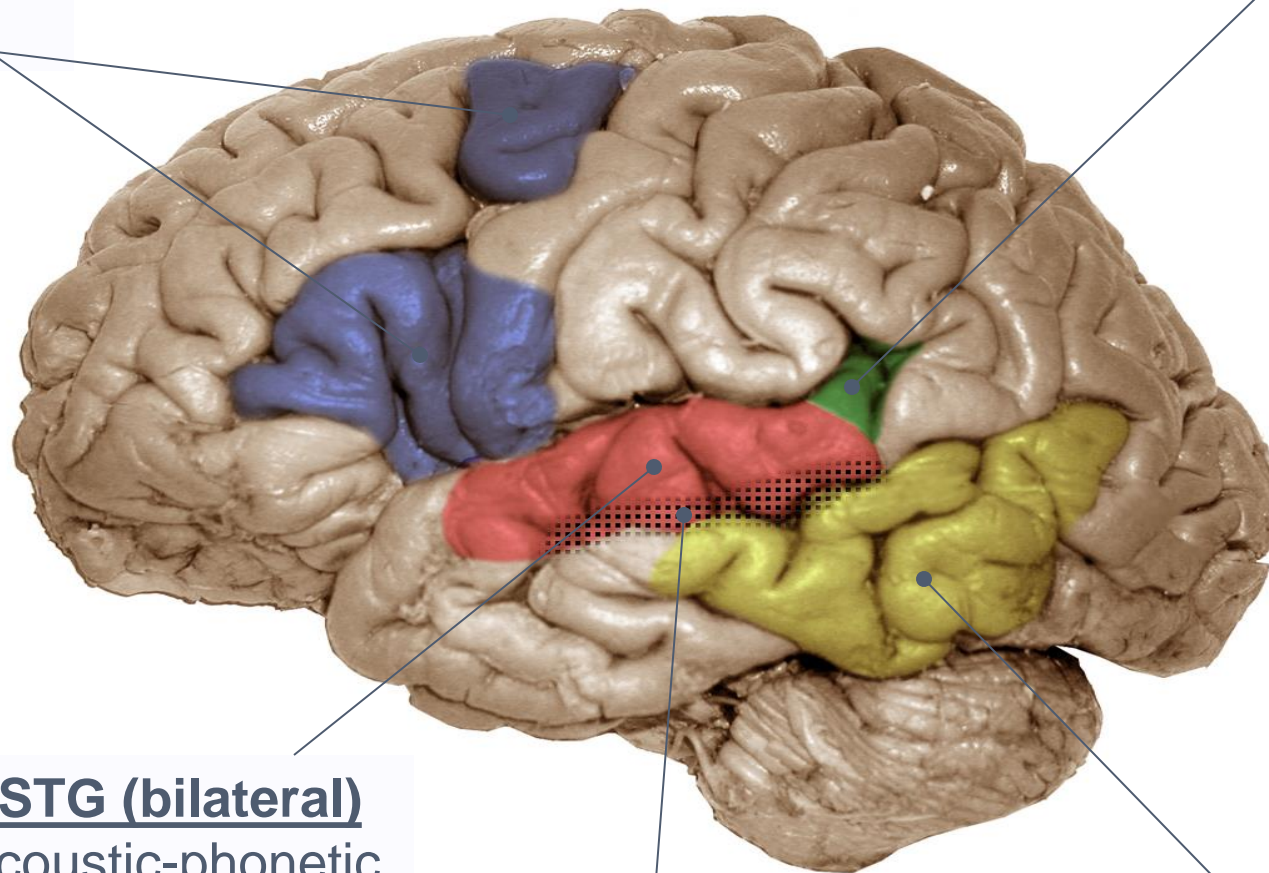


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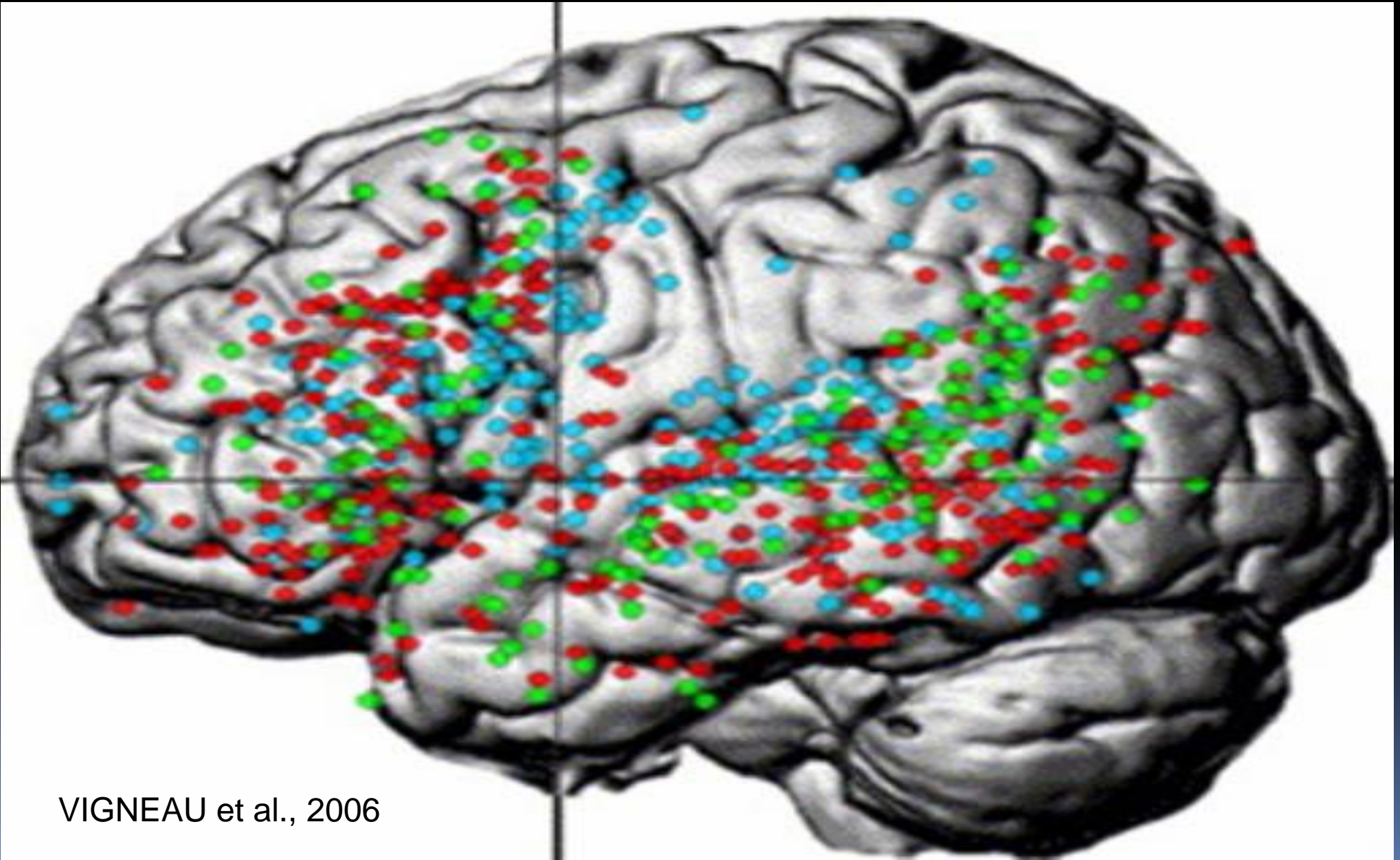
pMTG (left)

sound-meaning interface

Hickok & Poeppel (2000), Trends in Cognitive Sciences

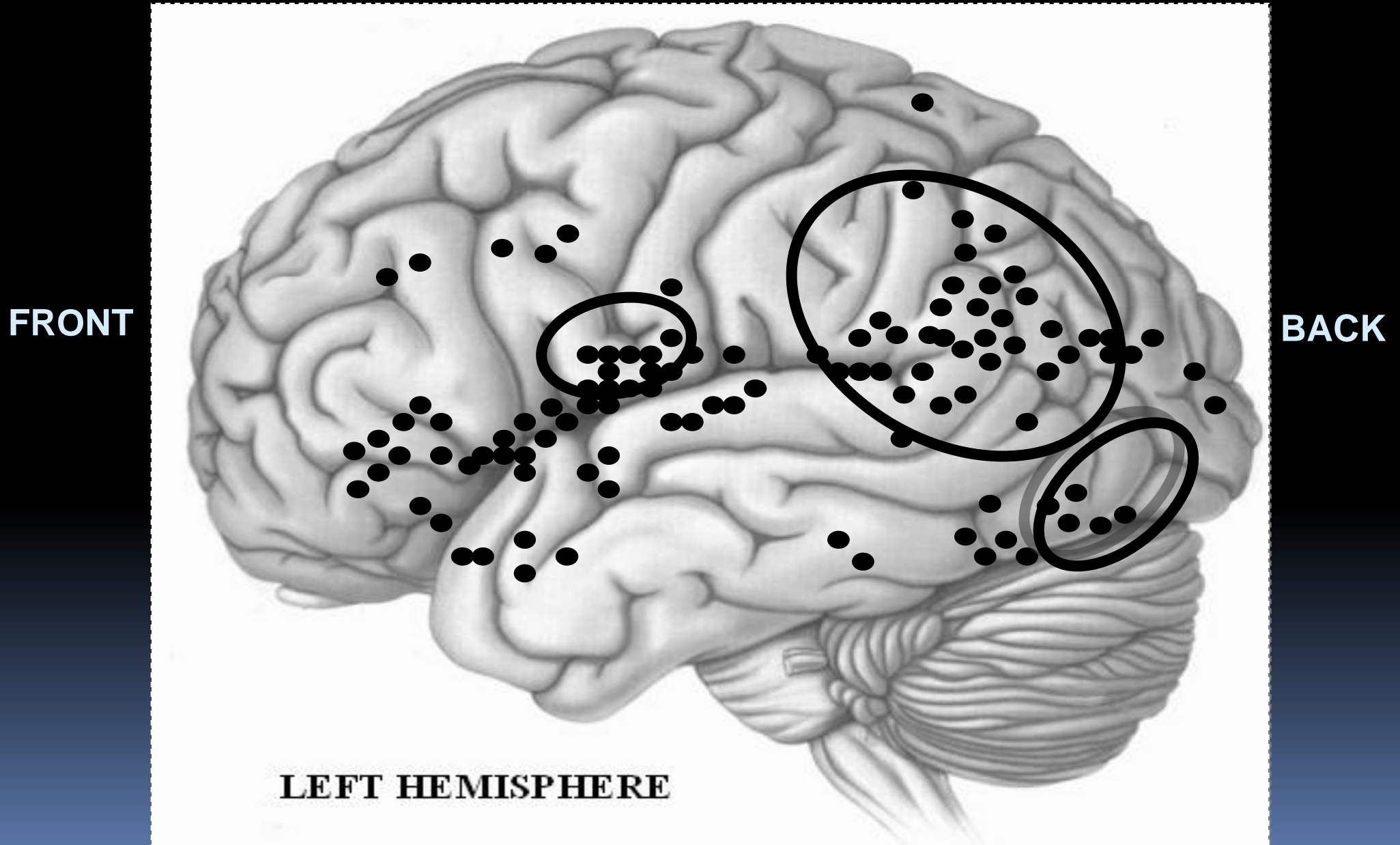
Hickok & Poeppel (2004), Cognition

UNIQUE AND OVERLAPPING NETWORKS SENTENCE/SYNTACTIC, SEMANTIC, PHONOLOGICAL

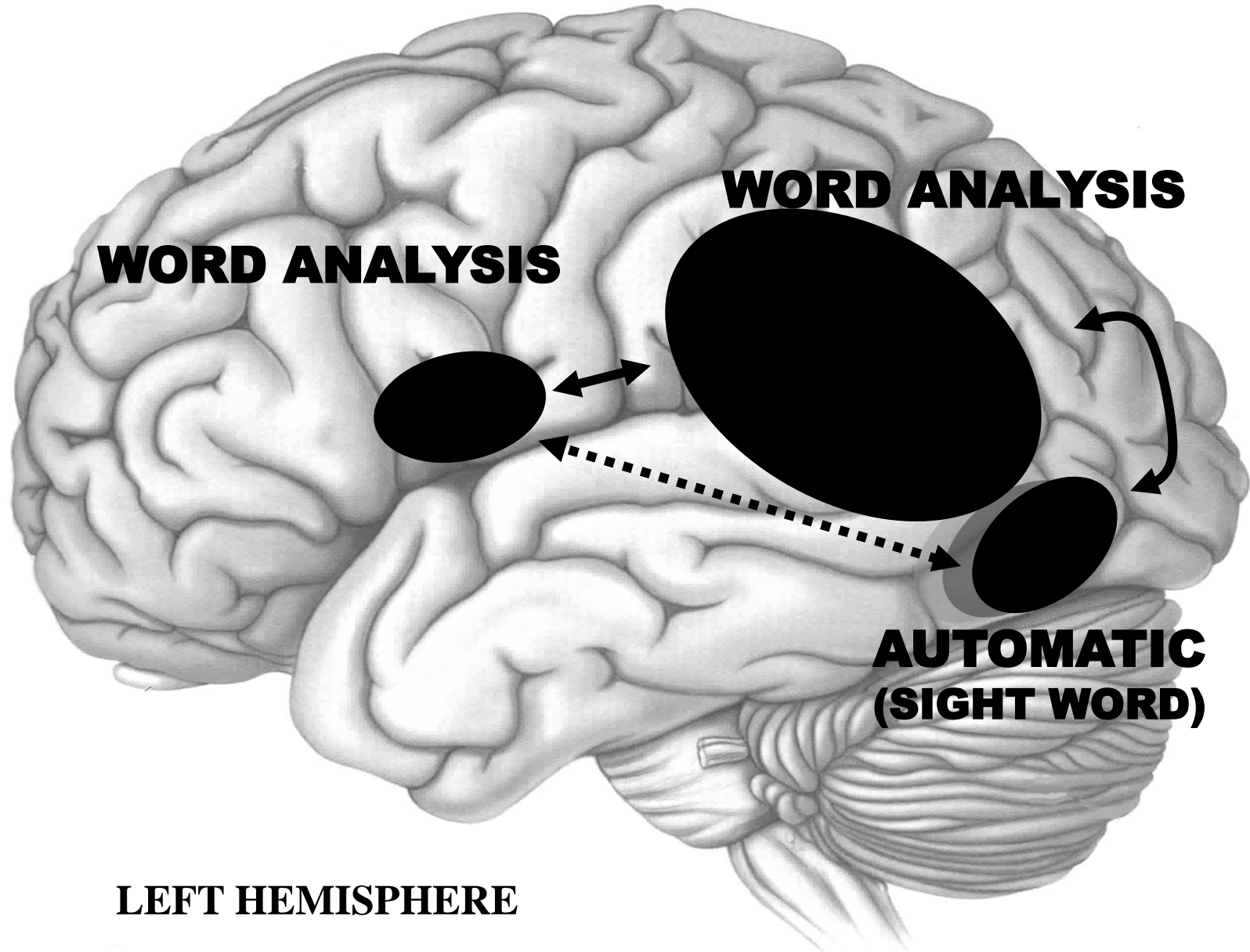


VIGNEAU et al., 2006

“OUT OF LINE NEURONS” (ECTOPIAS)

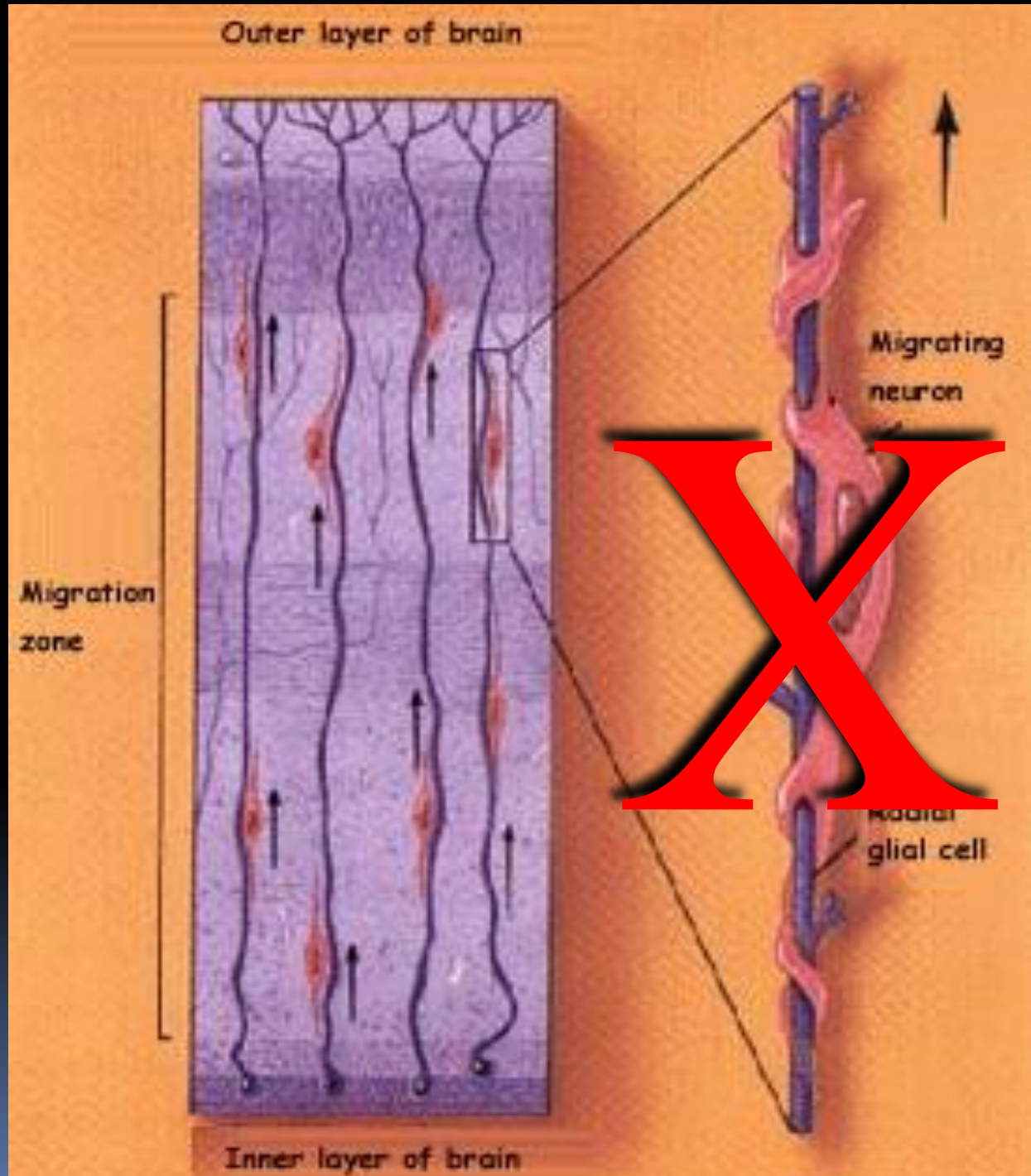


Typical READING Areas



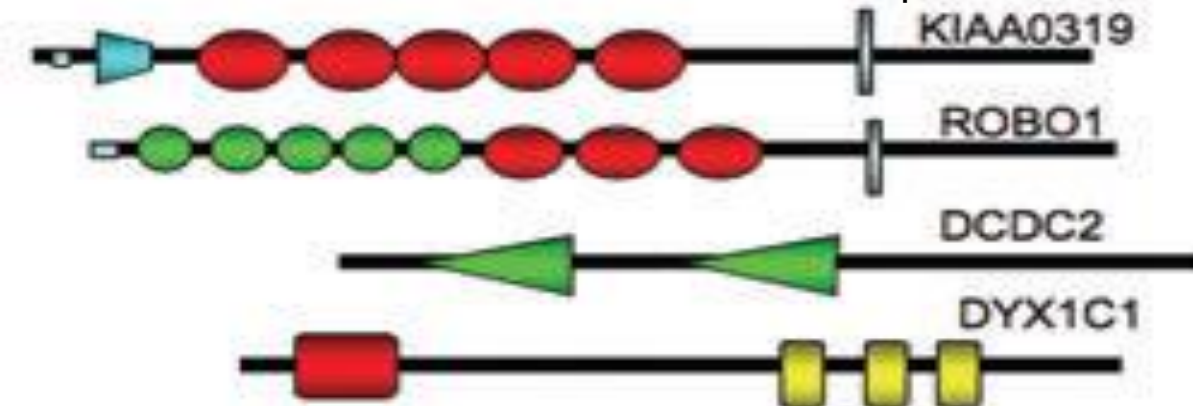
NEURONAL MIGRATION

Neuronal migration
goes awry in
developmental dyslexia?

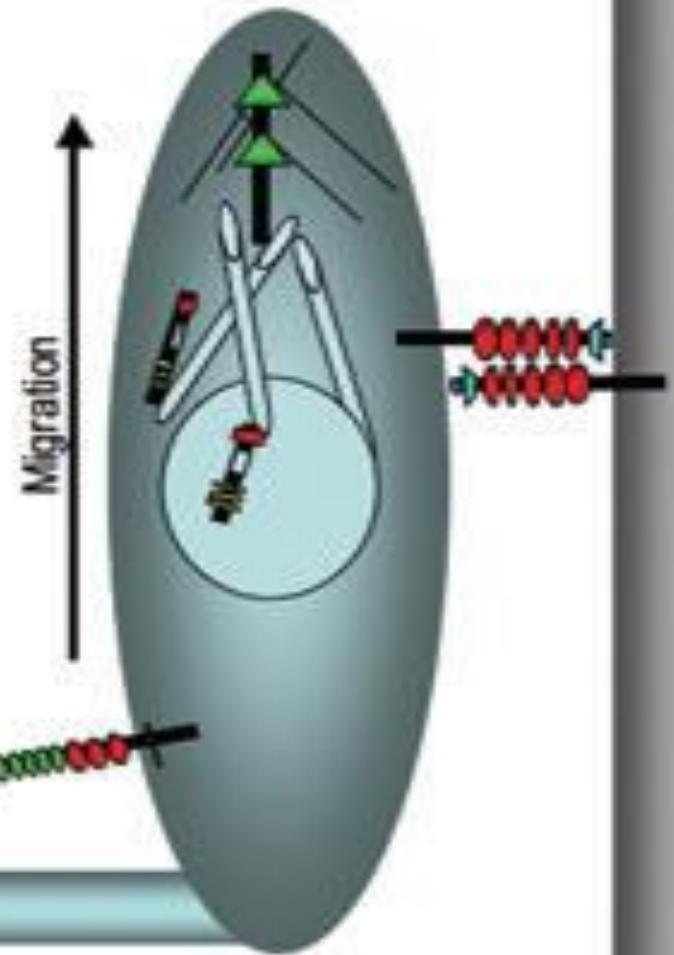
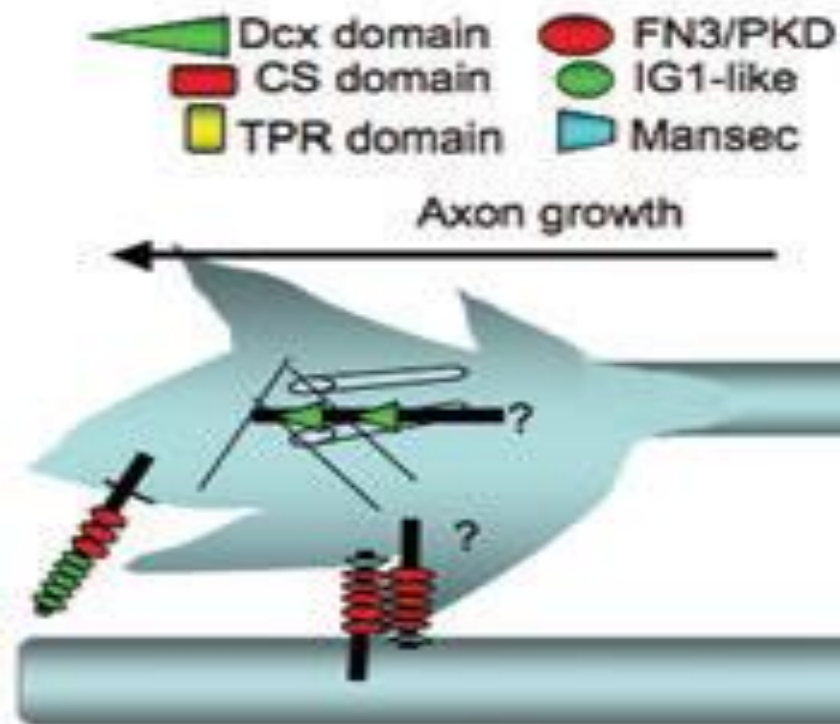


NEURONAL MIGRATION

*transmembrane adhesion molecules and receptors

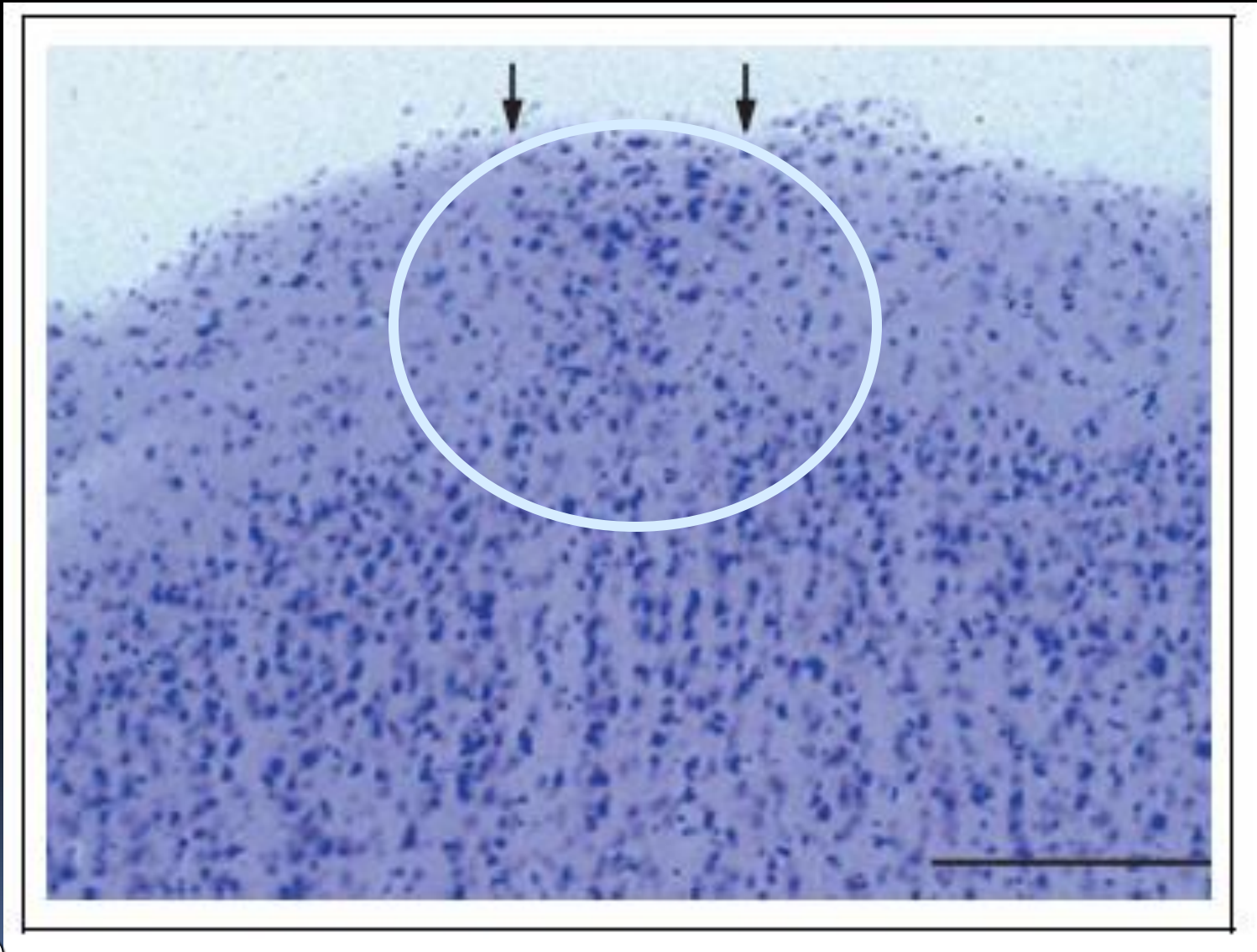


*downstream targets: change cytoskeletal processes & neuron motility

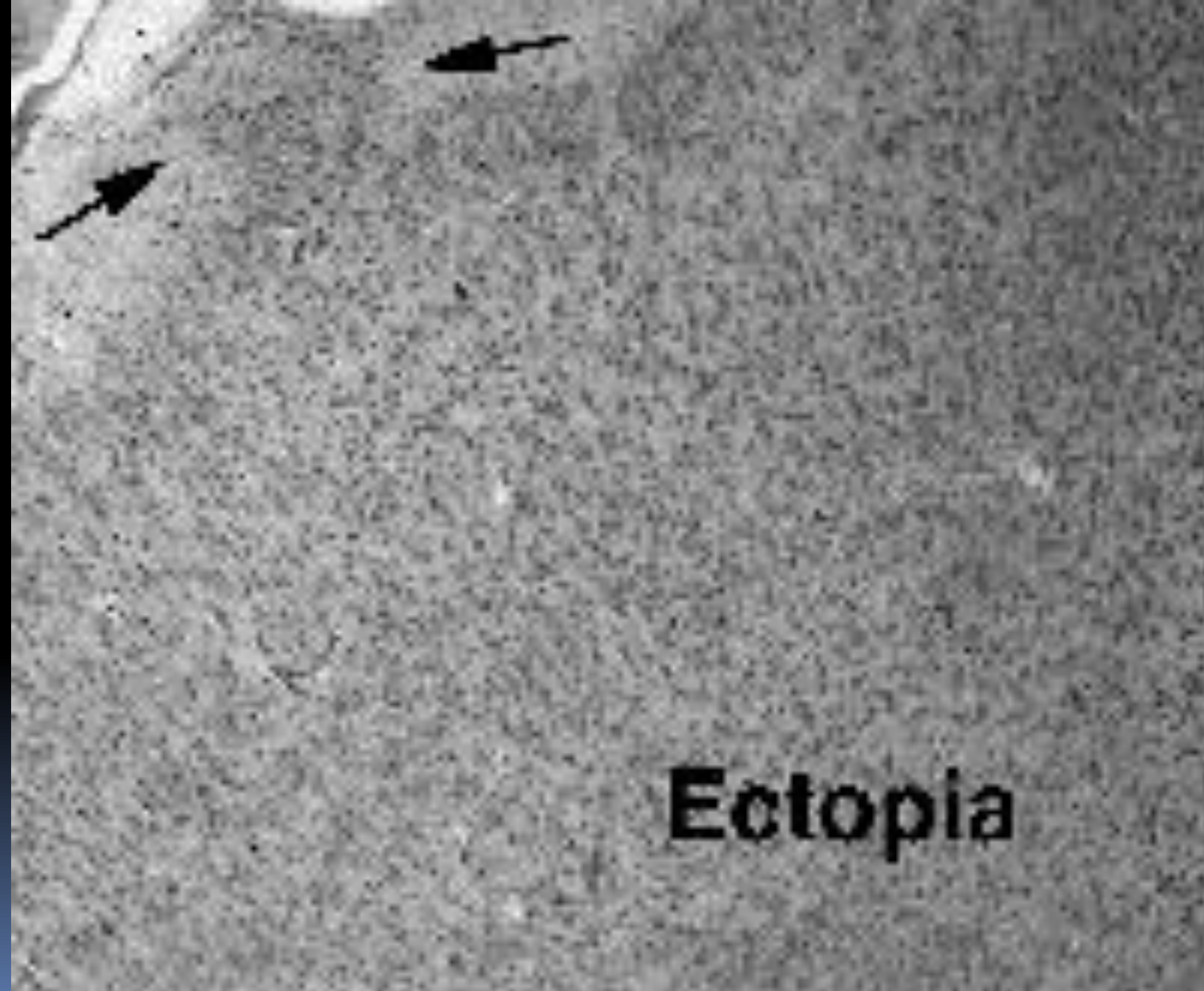


(Galaburda, et al., 2006)

Neuronal Ectopia



(Ramus, 2004)



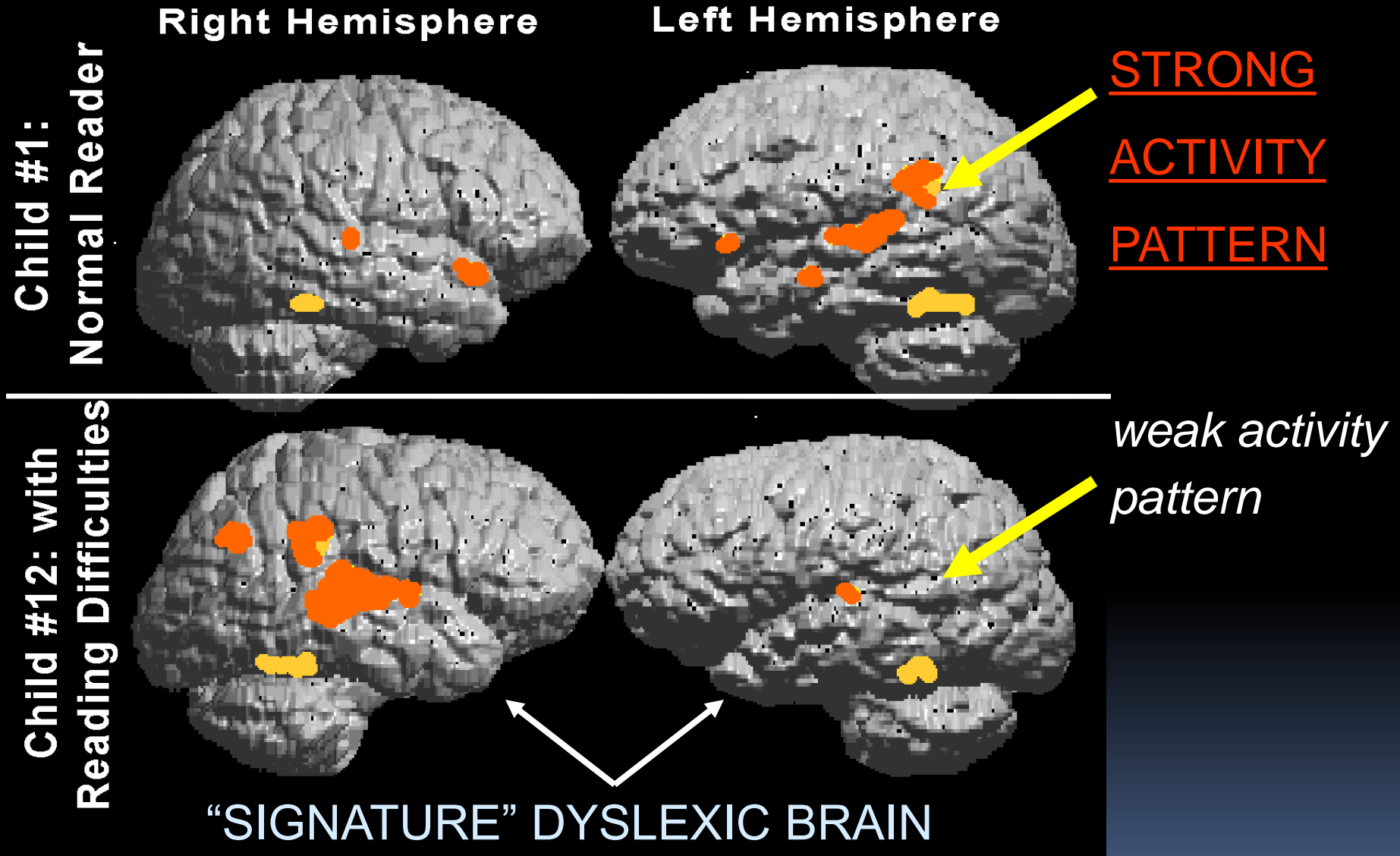
What effects on brain function might ectopias have?

Functional MRI (fMRI)

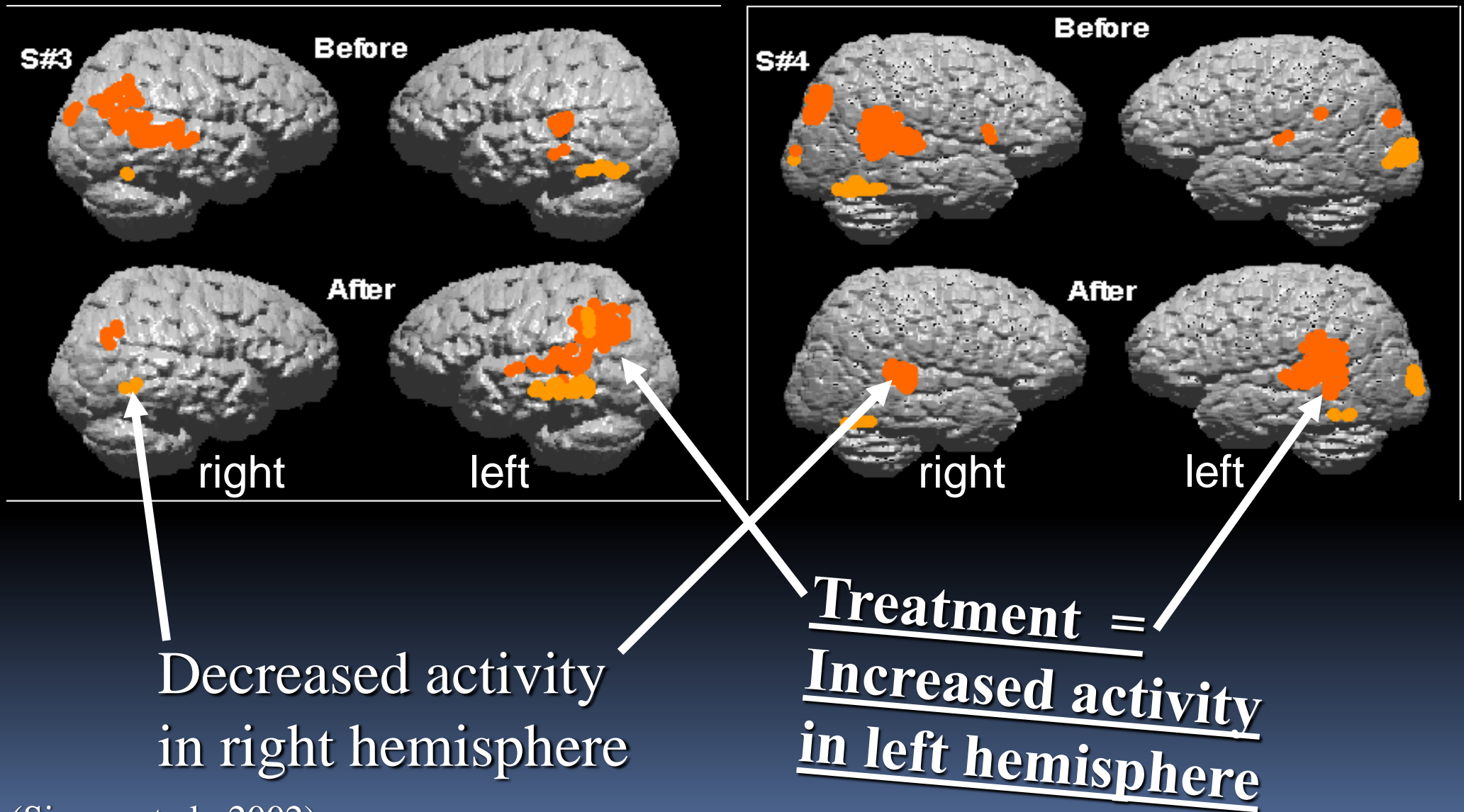
- same machine as clinical MRI
- additional measure of blood oxygenation levels in brain
- shows brain's active areas when doing some behavior/task



BRAIN ACTIVITY DURING READING



TREATMENT CHANGES the BRAIN'S ACTIVITY



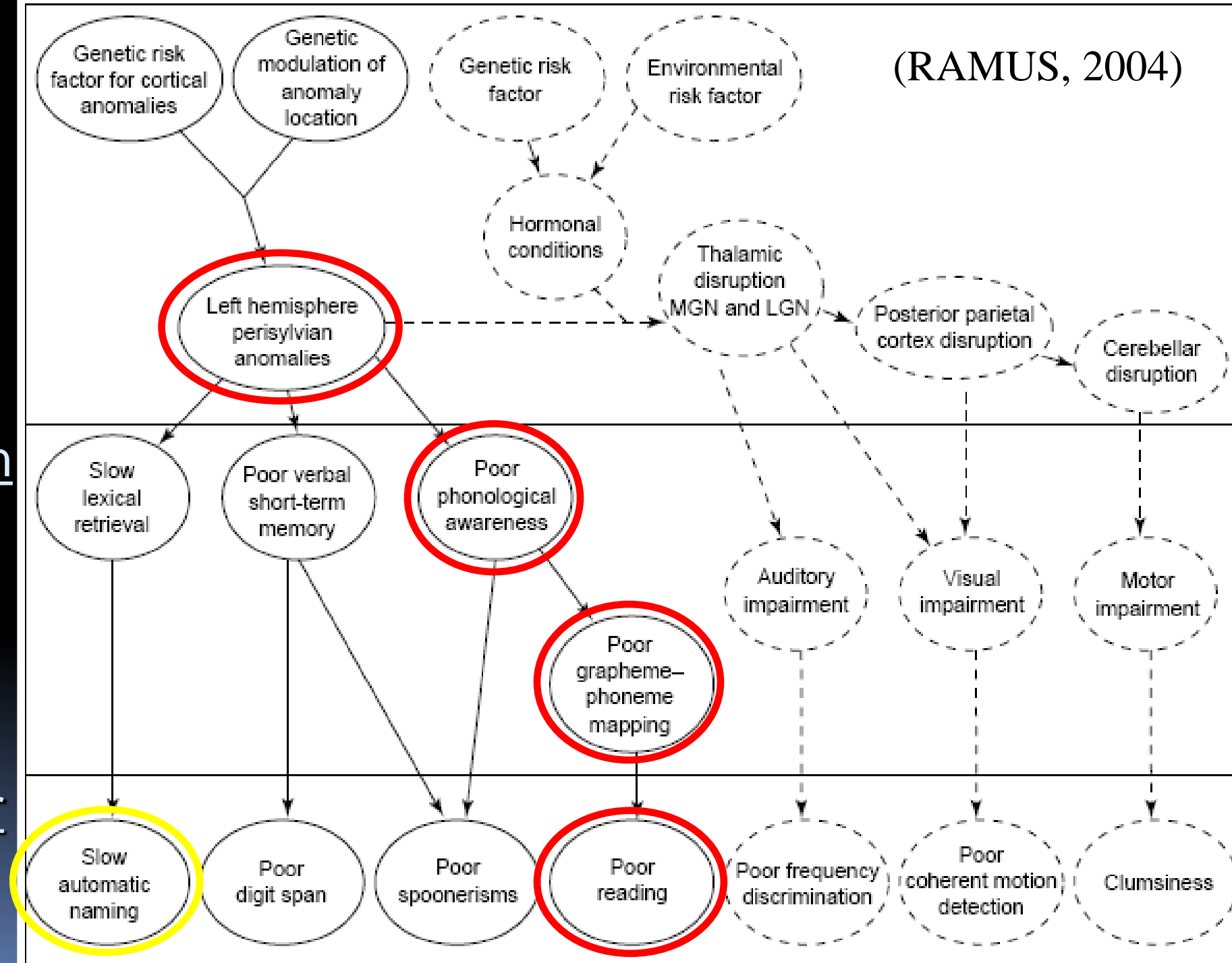
(Simos, et al., 2002)

Biology

(RAMUS, 2004)

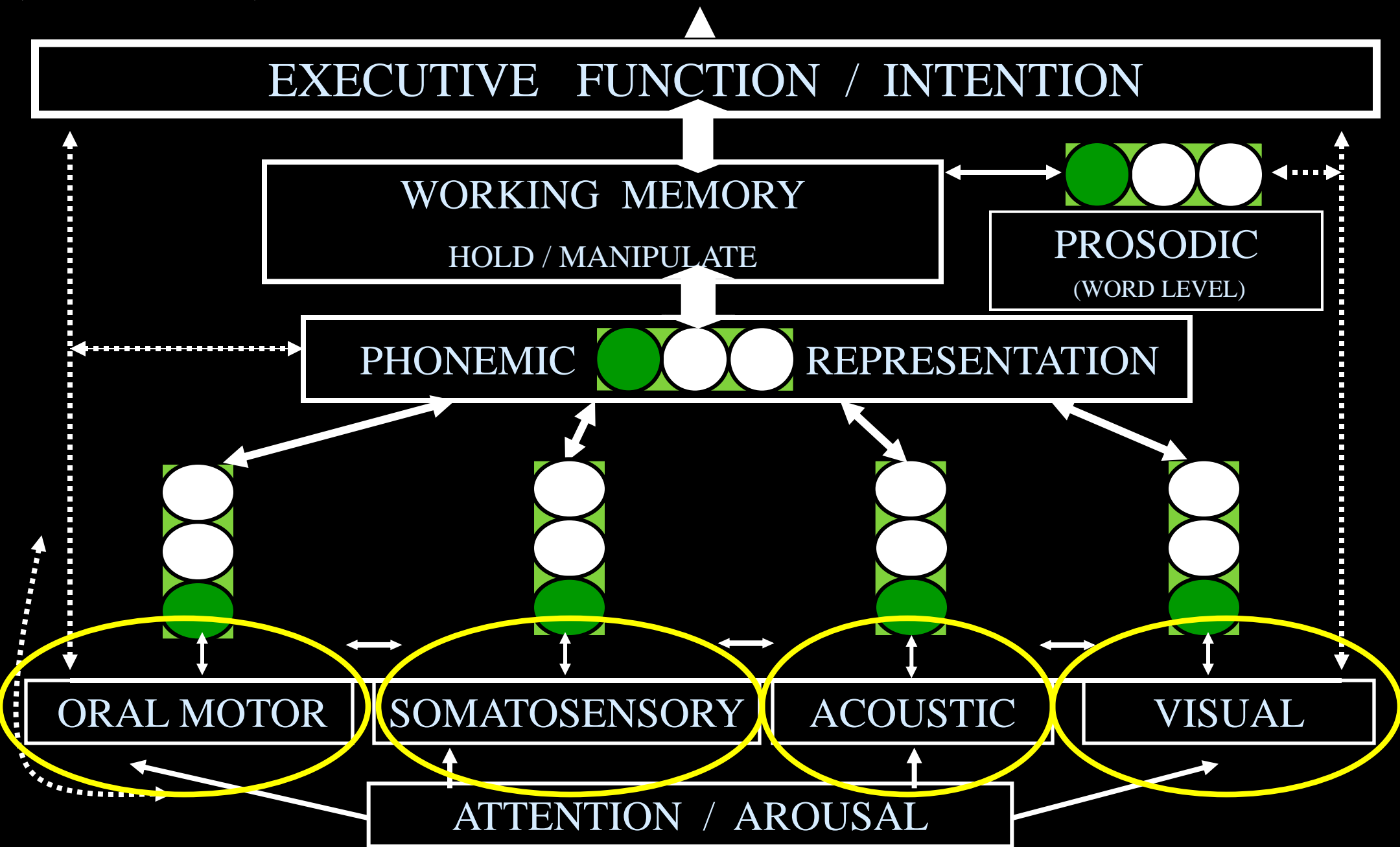
Cognition

Behavior

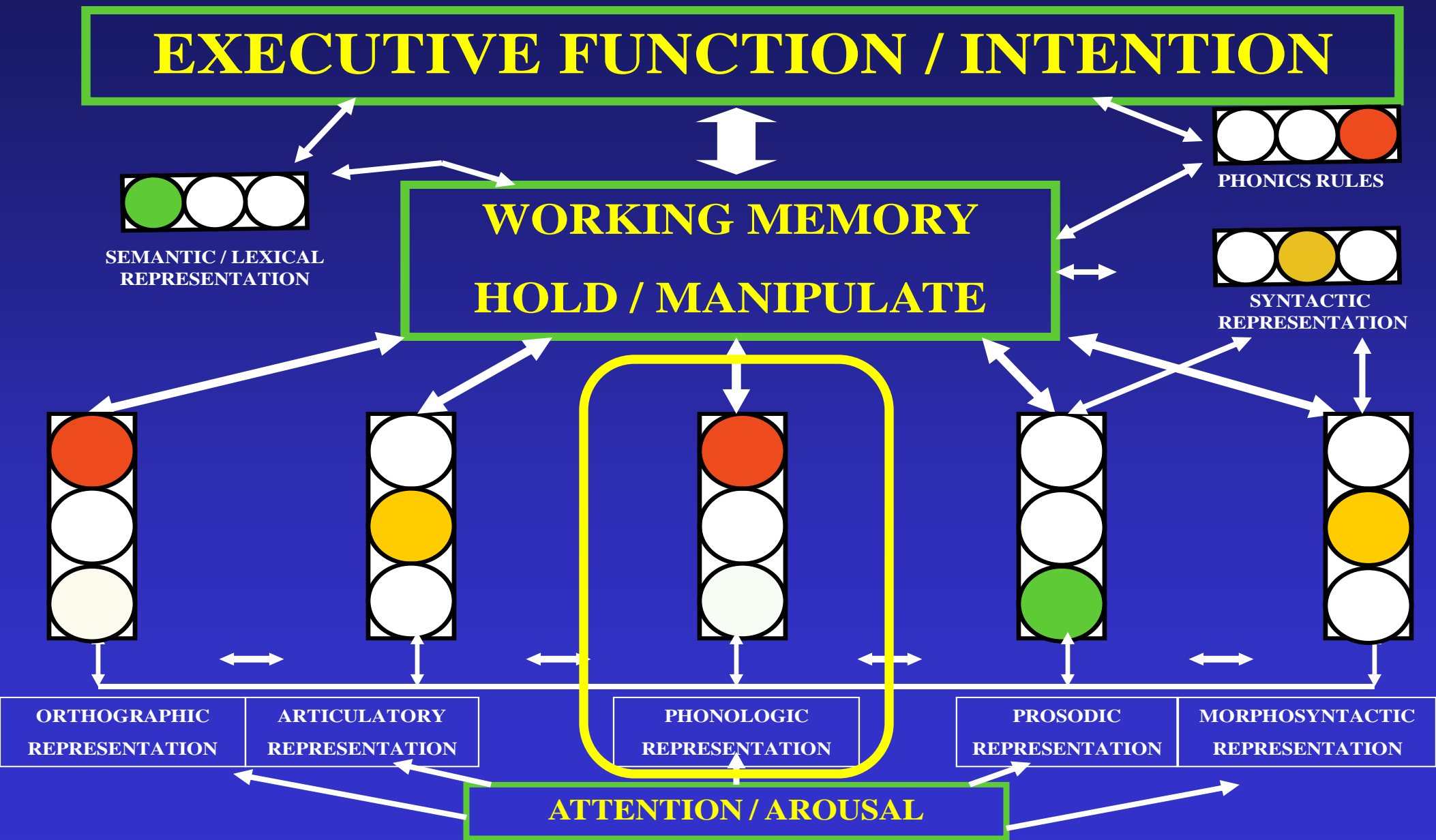


(Alexander, 2006)

PHONOLOGY (PERCEPTION & PRODUCTION)



READING
(PERCEPTION / PRODUCTION)



Theory

Developmental Dyslexia: A Motor-articulatory Feedback Hypothesis (Heilman, Voeller, Alexander, 1996)

“The inability to associate the position of their articulators with speech sounds may impair the development of phonological awareness and the ability to convert graphemes to phonemes. Unawareness of their articulators may be related to programming or feedback deficits.”

Interdisciplinary Team for Assessment & Treatment

Disciplines:

- Neuropsychology
- Psychiatry
- Nursing/Nurse Practitioner
- Clinical Psychology
- Occupational Therapy
- Speech-Language Pathology
- Education

Multidisciplinary vs Interdisciplinary

- Multidisciplinary – more than one discipline individually evaluates and treats
 - Each discipline **retains its methodologies and assumptions, without change** or development from other disciplines
 - Cooperation may be mutual and cumulative, but is not interactive
- Interdisciplinary – several disciplines evaluate and treat together
 - Each discipline is trained in some tenets of the other disciplines
 - Shared theoretical models that integrate perspectives from several disciplines
 - **Blends the practices and assumptions of each discipline involved**

Case Study

- High school student
- History of dyslexia since elementary school
- Parent is a school teacher
- Years of school-based academic intervention and specialized tutoring at franchised centers...
- Starting athlete with scholarship potential, but he has body function and academic deficits in...

Case Study - Assessment Findings

Deficits in:

- Attention

- ADHD-Inattentive

- Language

- Phonological
- Reading
- Writing
- Spelling
- Written comprehension
- Expression

- Sensory Processing Disorder

- Visual vigilance
- Visual tracking
- Vestibular
- Visual perceptual
- “Low Registration” on Sensory Profile
- Poor balance with eyes closed
- Poor supine flexion

Case Study: Interdisciplinary Treatments

Psychology:

- Individual therapy
- Therapy with mother

Speech-Language:

- Phonological Awareness (LiPS Program®)
- Mental Imagery
(Visualizing & Verbalizing®)
- Written Composition
(Visual-Kinesthetic Sentence Structure)

OT w/ SI focus

- Sensory modulation & processing - esp. vestibular
- Oculomotor skills
- Joint stability
- Visual perceptual skills
- Balance
- Movement perception
- Sequencing

Case Study:

Interdisciplinary Treatment of Dyslexia

Treatment Schedule:

- Daily
- 4-6 hours treatment per day
 - ~1 hour of OT-SI
 - ~3-5 hours language
- 5 days per week
- ~12 weeks

Treatment Hours:

- Phonological/Cognitive: ~150 (neurodevelopmental LiPS®)
- Semantic/Memory (V/V®): ~50
- Syntax/Cognitive (VKSS): ~50
- Physical Medicine (OT-SI): ~45.

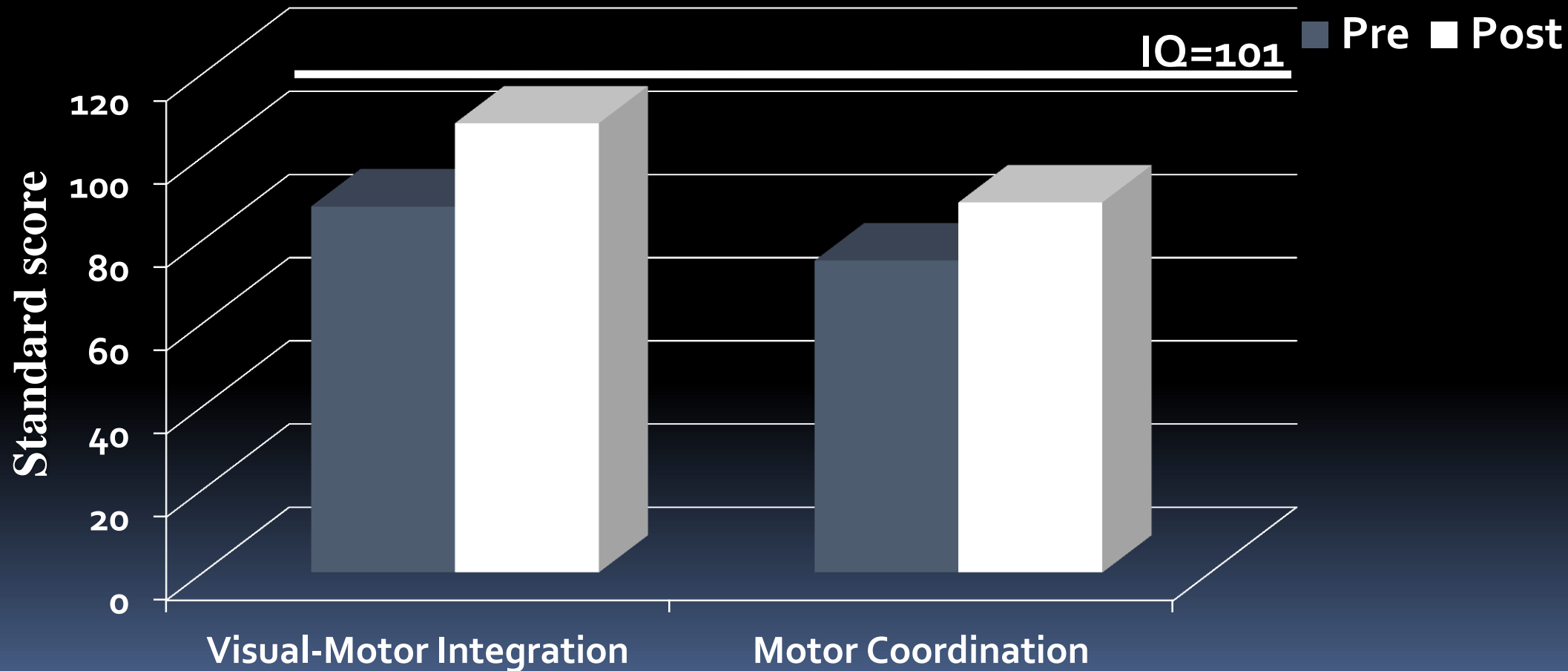
Sensory Processing Disorder (SPD)

- "...difficulty taking in and interpreting sensory information so that an appropriate response can be generated." (Bialer & Miller, 2011, pg 20)

Treatment of SPD

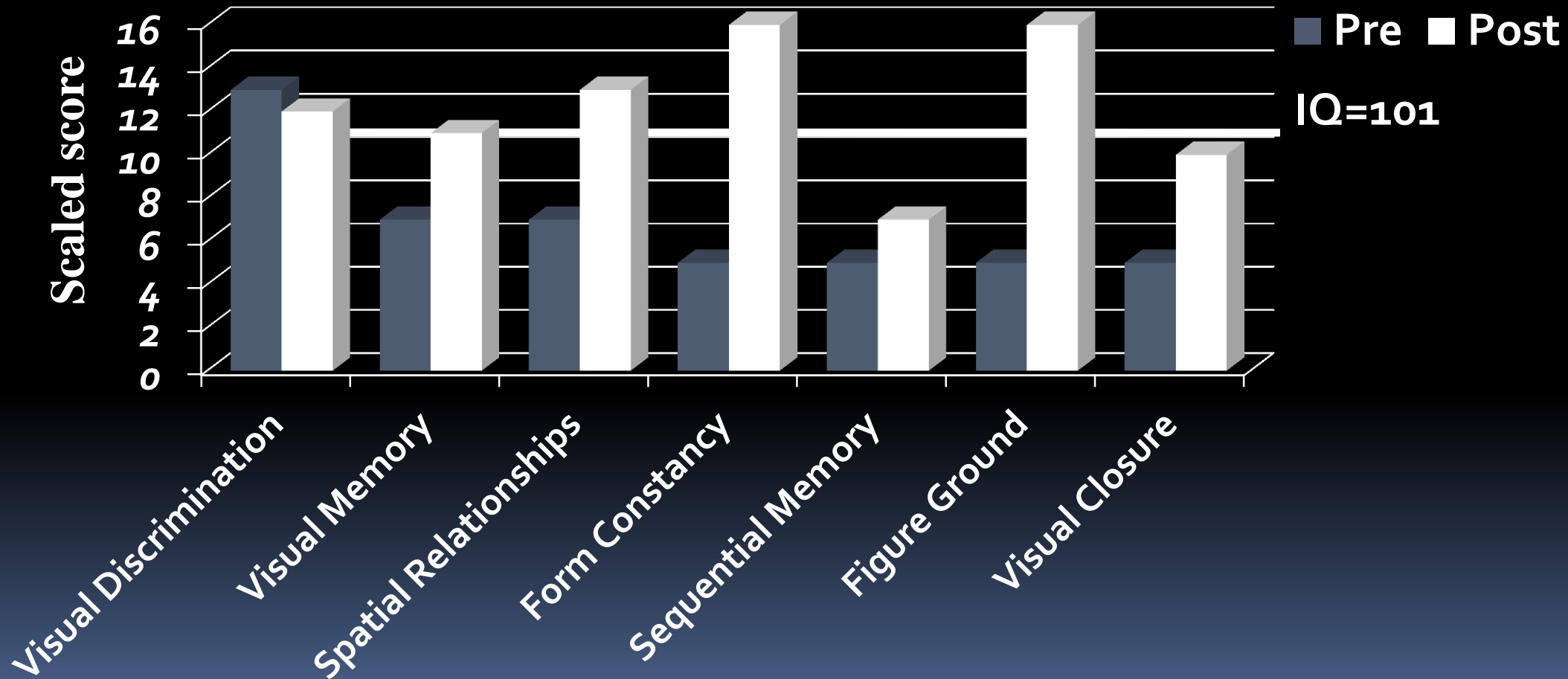
- “So, to be able to design and implement helpful treatment activities for kids with sensory challenges, it is important on a behavioral level to have some understanding about how sensory input either supports or challenges a child.” (Bialer & Miller, 2011, pg.20)

Body Functions: Visual-Motor Integration (VMI)



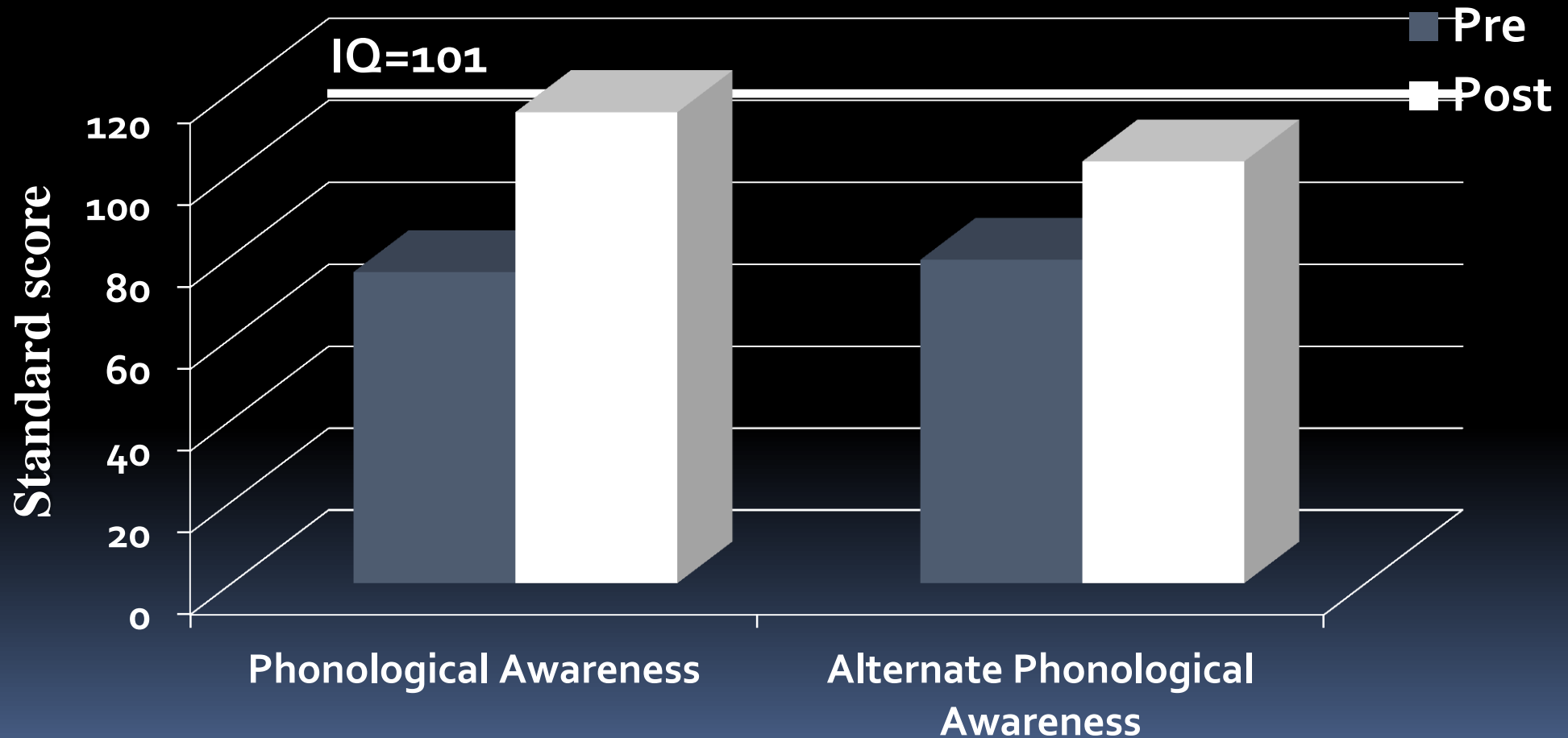
Body Functions:

Test of Visual Processing Skills-3



Body Functions:

Comprehensive Test of Phonological Processing (CTOPP)

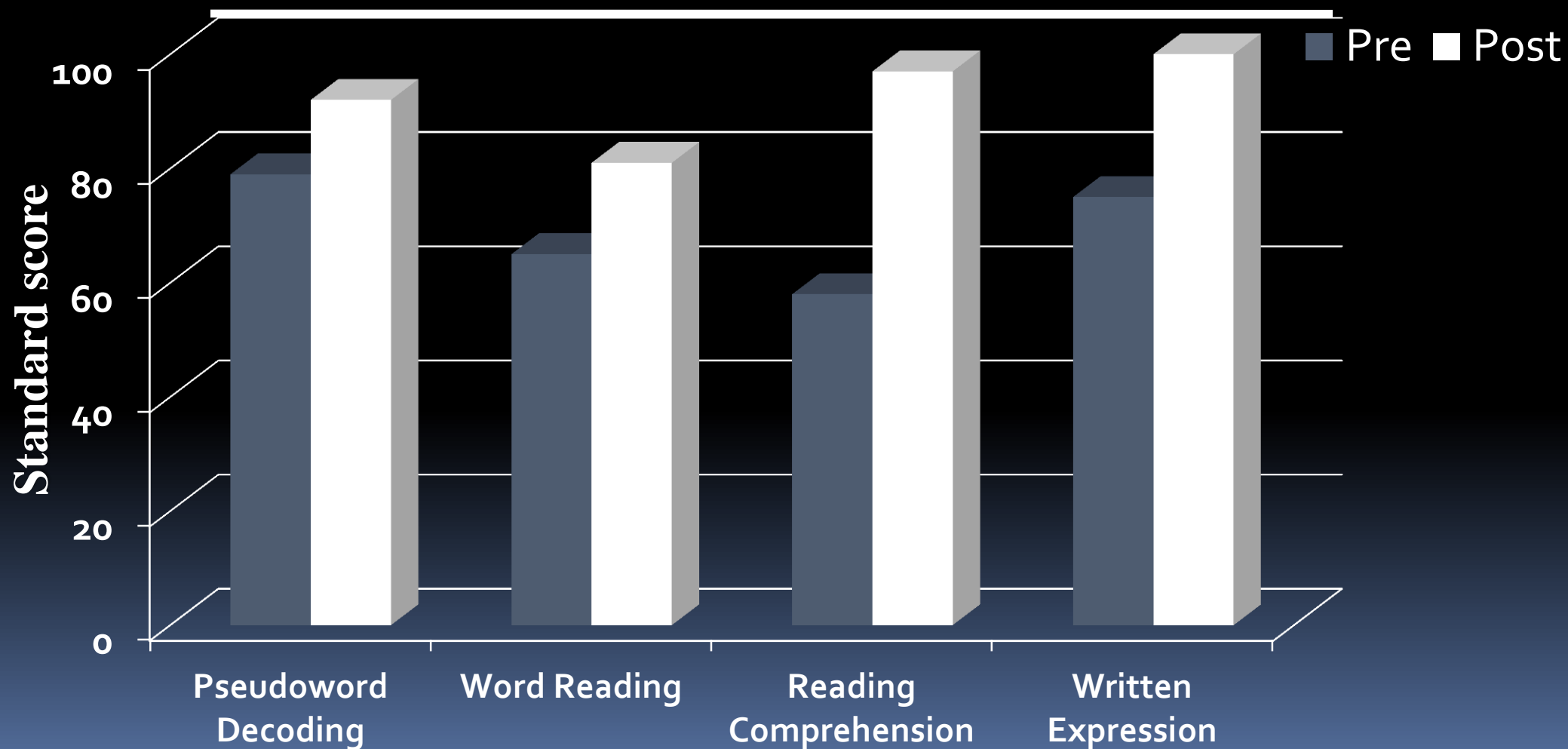


Improved Body Functions

- Sensory Processing – “Low registration” was improved with OT-SI, medication and arousal strategies for use at home and school.
- Processing/ Modulation of Vestibular Information - R & L LE balance without vision = 4 and 7 secs, improved to 21 and 18 secs; impaired supine flexion improved to 90 seconds while counting (without holding shoulders); depressed post rotary nystagmus was improved
- Oculomotor Skills - losing his place during reading and poor visual endurance (blinked excessively during visual tasks/testing), both visual tracking and endurance were improved and excessive blinking was markedly decreased
- Visual Perception -TVPS=83 SS (below average) to TVPS=110 (high average)
- Graphomotor Skills - VMI Motor Coordination = 75 SS improved to 89
- Oral Motor Skills - trouble with his oral-motor “feeling” was improved

Academic Functions:

WECHSLER INDIVIDUAL ACHIEVEMENT TEST (WIAT-II)



Conclusions and Future Directions

Participant01 Demonstrated:

- Improved Body Functions,
- Improved Academic Functions
- Improved School Performance
 - **passed high school proficiency tests (including written exam)**
 - **earned a standard high school diploma**
- **Follow-up report: He has completed his first year of college**

Future Directions:

- More “Single-Subject Research Design” and RCT studies need to be published to document the specific impact of OT-SI treatment on body functions and academic functions for children with LD’s.
- OT is an essential part of an interdisciplinary assessment and treatment for children and young adults with LD’s, but more empirical data is needed.

Future Perspectives: Interdisciplinary Treatment

Complimentary Interventions (adapted from Doreit & Miller, 2011)

- Language
- Sensory processing/integration
- Interpersonal relationships
- Social engagement
- Auditory processing
- Cognitive behavioral strategies
- Regulating mood/affect
- Executive functioning
- Academic performance
- Parent & client education/training

Thank You

Questions & Comments

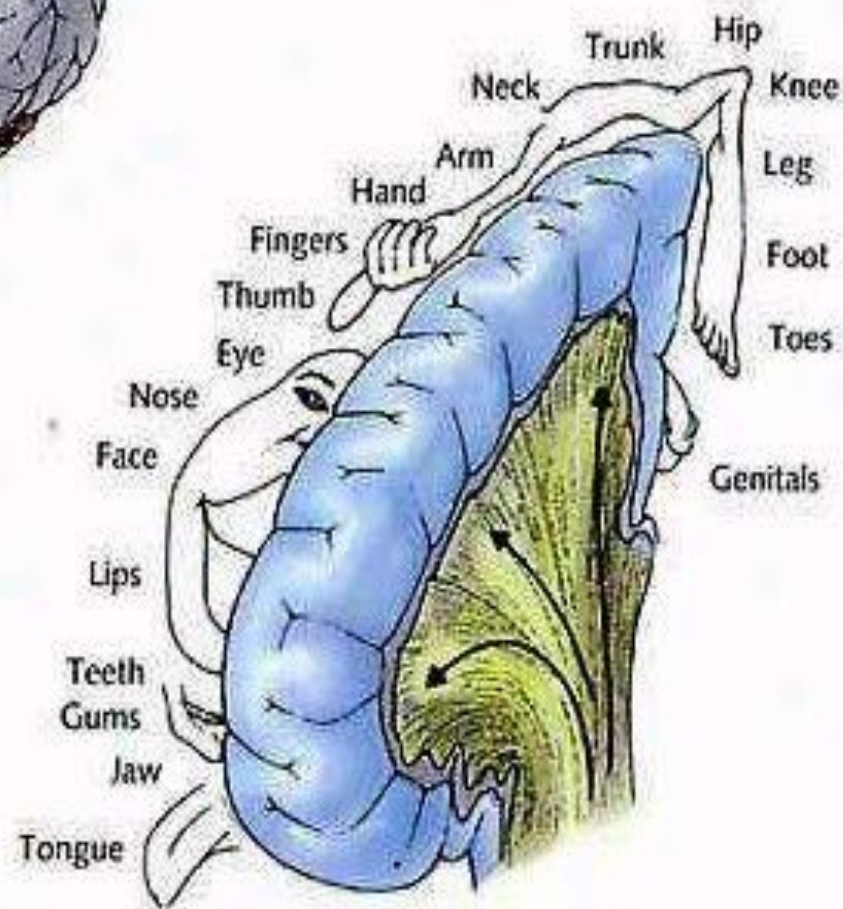
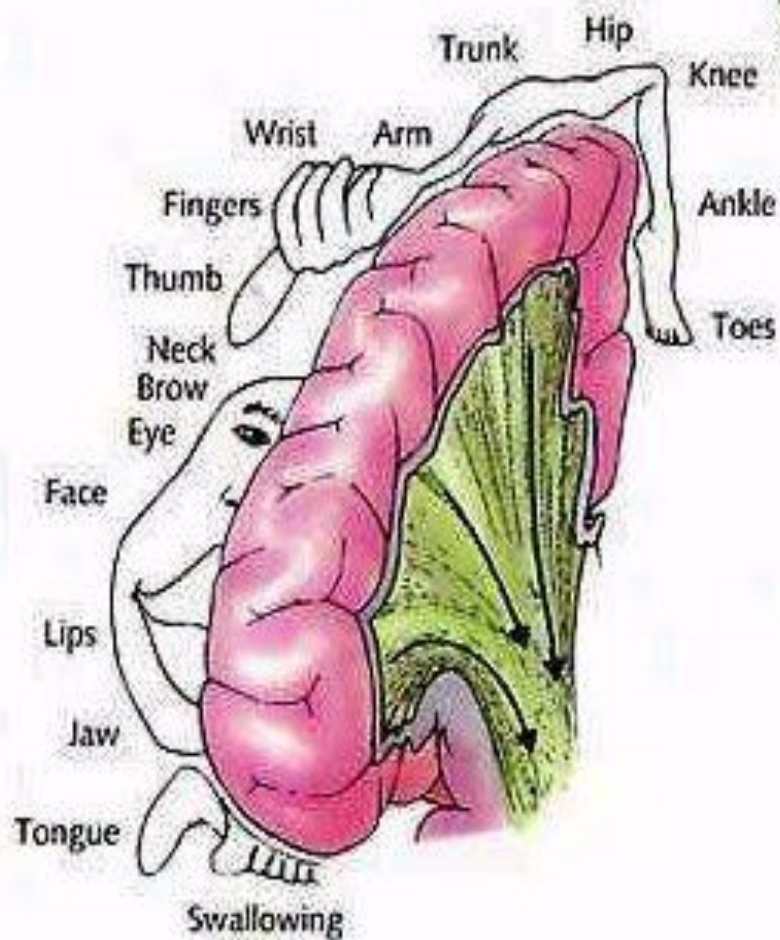
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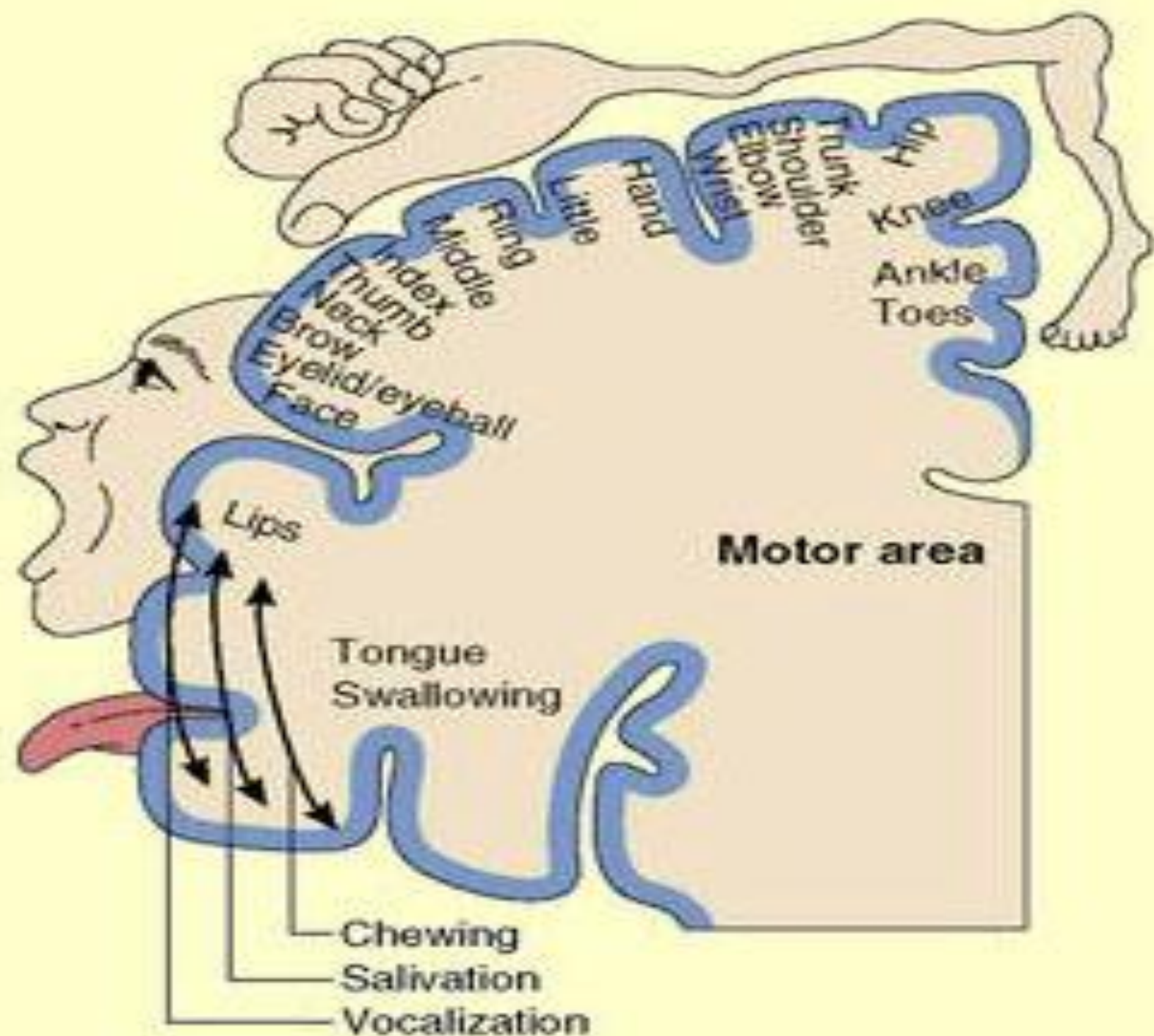
twc@morriscenters.com

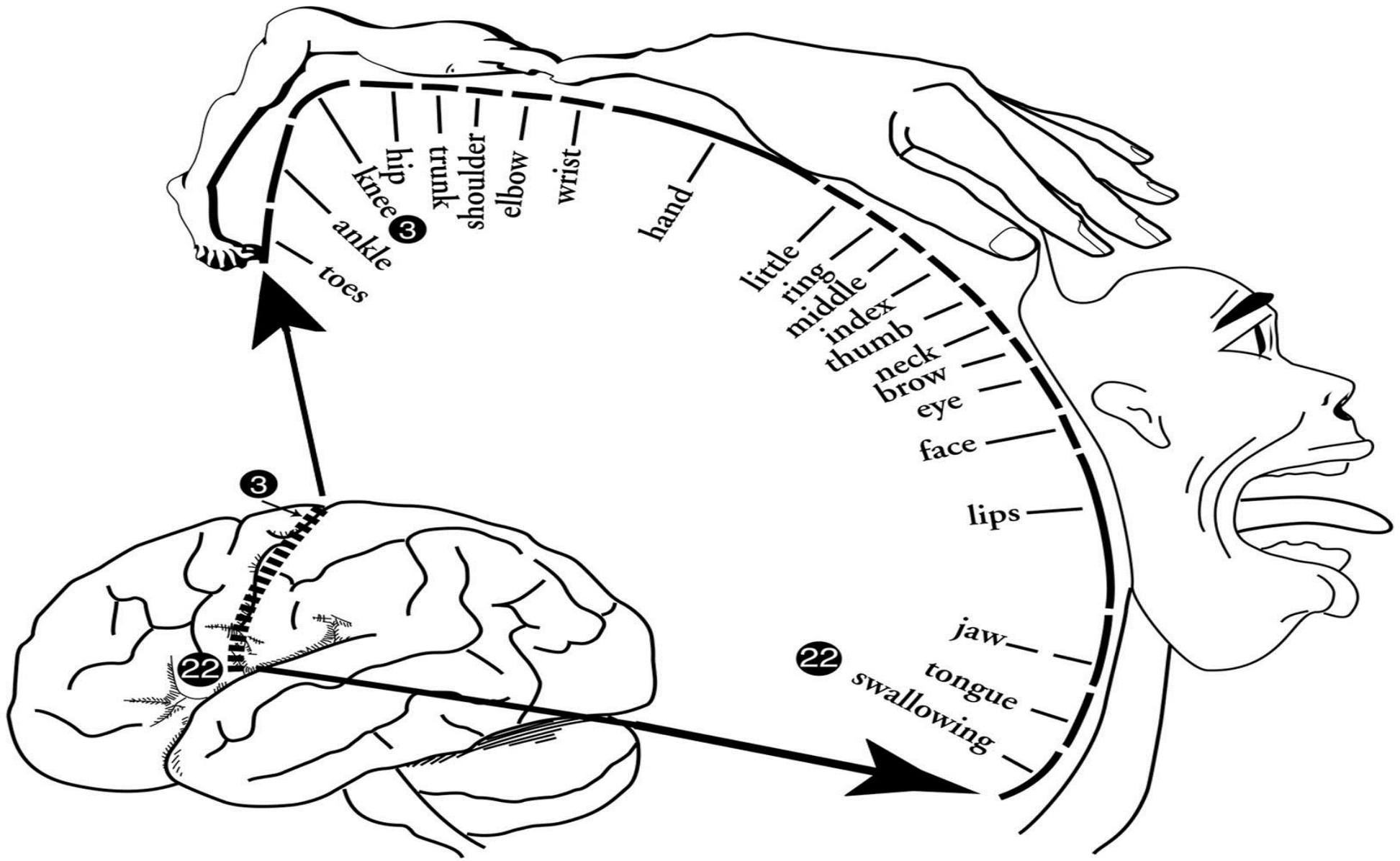
www.TheMorrisCenter.com

Output: Motor cortex
(Left hemisphere section controls the body's right side)

Input: Sensory cortex
(Left hemisphere section receives input from the body's right side)







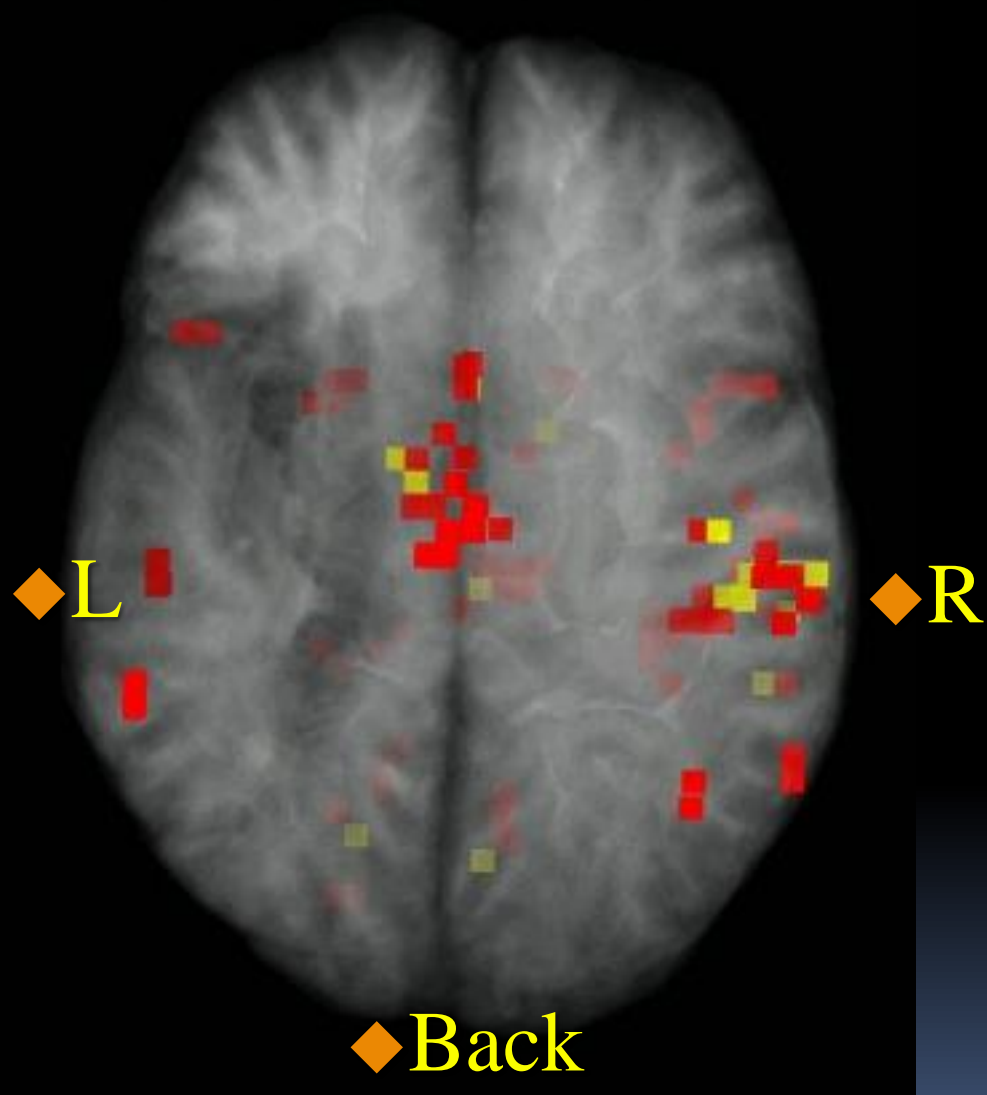
Human Sensory Systems

- Visual
- Gustatory
- Olfactory
- Auditory
- Tactile

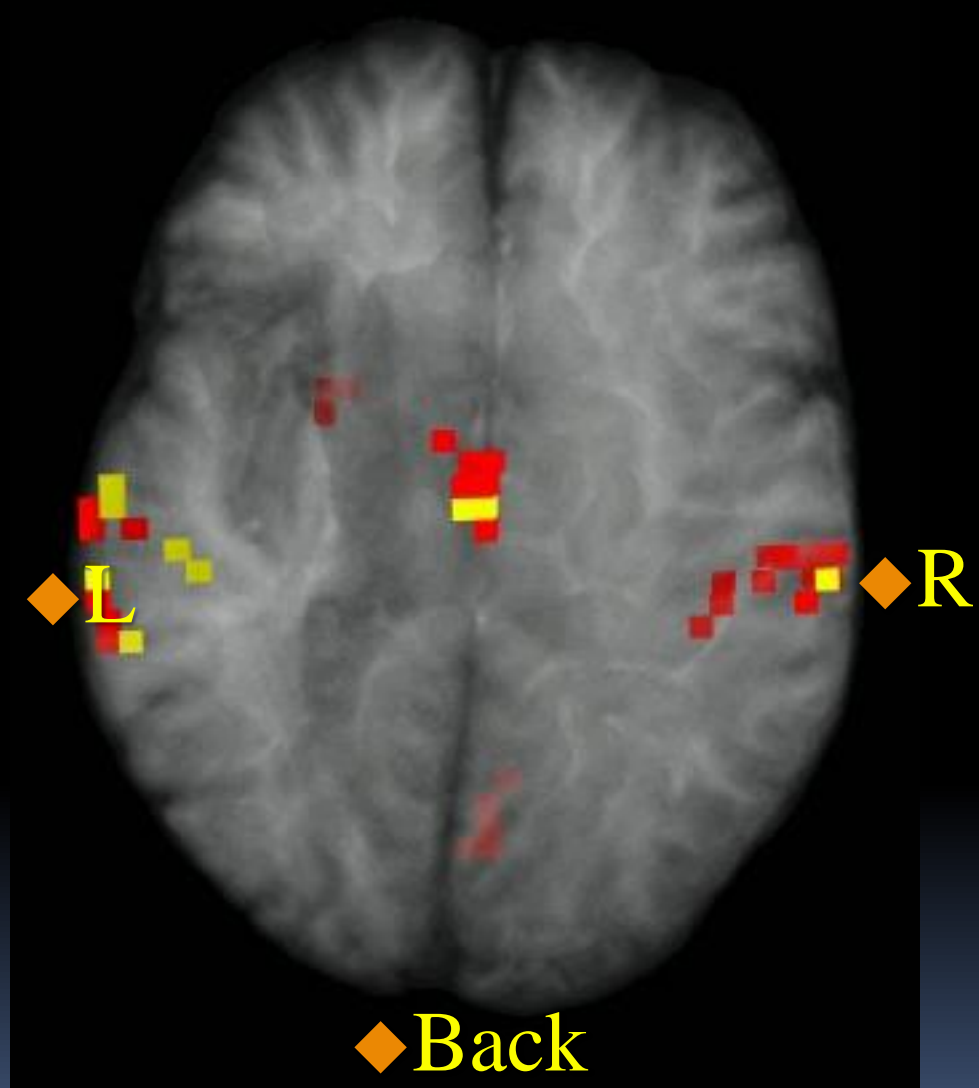
Also:

- Vestibular – movement of the head in relation to gravity
- Proprioception – pressure in the muscles and joints
- Interoception – awareness of body organs, hunger, thirst...

◆Pre-treatment 3D

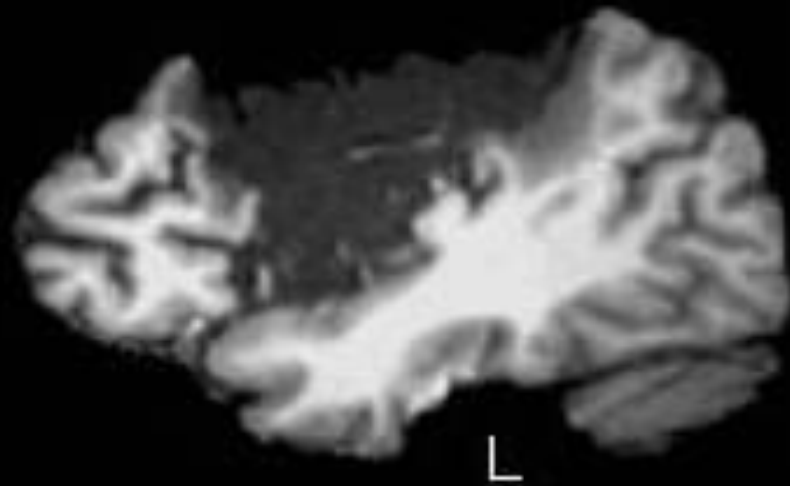


◆Post-treatment 3D



R

L

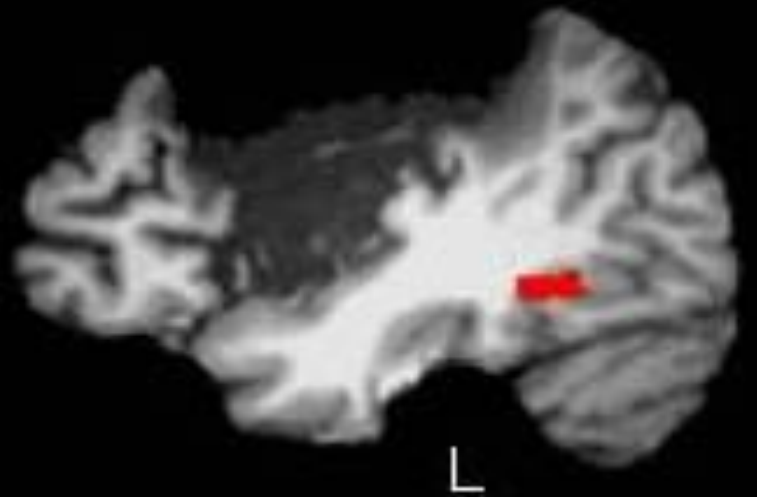


Pre-Treatment

◆ Front

R

L



Post-Treatment