The Neurobiology of Reading

DEFINITION OF READING

- in light of the readers’ own background of experience, and as such, is regarded as an ability “the meaningful interpretation of printed symbols to attach meaning to words, phrases, sentences, and longer selections.”

ISSUES TO CONSIDER

- Teaching approach and quality
- Word Identification, Fluency, Comprehension
- Acquisition versus Accomplished Reading
- Stage of Acquisition
- Matthew effects

DECODING

- Letter identification
- Word identification - sight vocabulary
- Word Attack
  - Phonological processing
  - Orthographic processing
  - Morphological processing
- Fluency

PHONOLOGICAL PROCESSING

ORTHOGRAPHIC PROCESSING
READING STAGES (Chall/Willows)

- **Stage 0:** emergent literacy - Pre-school, K
  - Growth of aural/oral language & concepts of print as a foundation for reading & writing acquisition
- **Stage 1:** decoding/encoding - K-1
  - Learning the symbols (letters, orthographic patterns, & words) & hooking them up to aural/oral language
- **Stage 2:** Fluency/automatization - 2-3
  - Consolidating decoding/word recognition and encoding/spelling for effortless reading & writing
- **Stage 3:** Literacy for learning 4+
  - Reading & writing as extensions of aural/oral language for development & expression of feelings & ideas

EVIDENCE FOR A BIOLOGICAL BASIS OF DYSLEXIA

- **Universal**
  - All countries and languages
  - Languages with irregular phonological structures have increased incidence
- **Brain Structure**
  - Unusual symmetry in the posterior temporal lobe
- **Functional Organization of Brain**
  - Abnormal excessive left temporoparietal or angular gyrus activation
  - Abnormal reading performance has a different specific mechanism from pattern in normal reading
  - Phonological processing is rooted in the temporal gyrus area of brain
- **Twin Studies**
  - Increased concordance of dyslexia in monozygous vs dizygous twins - 84%-100% for MZ vs. 20%-55% for DZ
  - Reading recognition, spelling, digit span and phonological processing show considerable heritability whereas reading comprehension, perceptual speed and orthographic coding do not
  - No consensus on mode of genetic transmission
  - Most common findings suggest some genes on chromosomes 34 or 14

Reading Disability

For many years there has been ongoing controversy about:

1. The core deficit in RD.
2. Whether this is neurobiological or the result of environment and lack of exposure to print.
3. Where and how interventions should be targeted.
4. Whether there are subtypes of RD.

Current Findings in RD

1. RD is neurobiological. (Künber et al., 2000)
2. There is a failure of left hemisphere posterior brain systems to function properly during reading in RD. (Brunsewoldt et al. 1999; Helenus et al. 1999; Horwitz et al. 1998; Paulus et al. 2001; Rumsey et al. 1992, 1997; Salmelin et al. 1996; Shaywitz et al. 1998)
3. This neurobiological evidence of dysfunction is already present in reading-disabled children and cannot be ascribed simply to a lifetime of poor reading (Sekietal., 2001; Shaywitz et al., 2002).

Current Findings in RD

4. The nature of the remedial educational intervention is critical to successful outcomes in children with reading disabilities.
Three Developmental Stages in Reading Acquisition

1. The Brain Reading
2. Three Developmental Stages in Reading Acquisition
3. Implications for Dyslexia

Implications for Dyslexia

- Failure to establish connections between these three neural regions will likely result in the reading problem called Dyslexia.
- The earlier aggressive intervention measures are taken, the better the prognosis for full development of reading competence.

Interventions for Dyslexia

Preventative - RTI.

PHAST Program - Lovatt, M.
- Small group instruction
- Intensive training in phonemic awareness, decoding and strategy instruction.

1. There is reduced activation in left hemisphere posterior brain systems.

2. A failure to reliably engage LH temporo-parietal and occipito-temporal regions.

3. Heightened activation of right hemisphere (RH) posterior and bilateral frontal regions. (Sarkar et al., 2002; Pugh, Mencl, Jenner et al., 2000)

4. The systems are weakened but not wholly dysfunctional in even severe older RD readers. Repetition and imageability support reading. (Pugh, et al., 2008).

**COGNITIVE PROCESSES & READING DISABILITIES**

- **Phonological Processing Deficits**
  - Phonemic awareness
  - Auditory discrimination
  - Elision
  - Blending
  - Sound/symbol correspondences
  - Morphological skills
- **Rate and Accuracy Deficits**
  - Processing speed
  - Rapid Automated Naming
  - Visual memory
  - Orthographic skills
- **Double Deficit**

**COGNITIVE PROCESSES & READING DISABILITIES**

- **Receptive and Expressive Language Deficits**
  - Phonological Processing & Articulation
  - Syntax
  - Vocabulary
  - Verbal Reasoning
  - Space, time and number concepts
  - Language of Instruction
  - Concreteness
  - Metaphors & Humour
  - Conversation (Pragmatics)
- **Working Memory**
MATTHEW EFFECTS (Stanovich)

- Some of the differences in cognitive processes that are linked with reading ability (e.g., vocabulary development, verbal IQ) may be the effects of reading efficiency.
- Reading skill differences in comprehension strategies may be the consequences of overall reading levels. Better readers could be decoding words more efficiently and thus have more cognitive resources available to allocate to comprehension.
- If reading instruction provided to less skilled readers is suboptimal, then a Matthew effect is being created whereby a child who is for whatever reason poorly equipped to acquire reading skill may evoke an instructional environment that will further inhibit learning to read.

ASSESSMENT SKILL HIERARCHY

- Reading Decoding Difficulties
  - Oral Reading Fluency
  - Reading Fluency
  - Pseudoword Decoding
    - WJ-III Word Attack, Word Identification
  - RAN, Processing Speed
    - WISC-IV Processing Speed
  - Visual Memory
    - CMS, Slingerland
    - WJ-III Visual Auditory Learning
  - Elision, Blending, Phonological Memory
    - CTOPP
    - Slingerland

READING & WRITING ASSESSMENT:

Stage 0/1
- Decoding
- Identify/Print upper and lower case letters of alphabet
- Word Attack – Woodcock
- Written language - picture + dictate and read back story or sample
- Print/identify name, identify family names
- Dolch Word List
- Listening comprehension -
- Shared reading of a patterned book

CHILD READING ASSESSMENT: Stage 2-3

- Behavioural Level
  - Decoding
  - Word Attack
  - Passage Comprehension
  - Reading Comprehension
  - Reading Fluency
  - Spelling

ADOLESCENT/ADULT READING ASSESSMENT

- Behavioural Level
  - Decoding
  - Word Attack
  - Adolescent
  - Passage Comprehension
  - Reading Fluency –
  - Comprehension

PREVENTION OF READING PROBLEMS

- The 4 D’s (Weiner, 1969)
  - Defect
  - Disruption
  - Deficiency
  - Difference

- The great debate
  - Top-Down - Whole language approaches
  - Bottom-Up - Phonics approaches

- Whole language casualties
BALANCED LITERACY DIET (Willows)

- Systematic introduction and repetition of a sight vocabulary of high frequency words
- Phonemic awareness training
- Systematic instruction in sound symbol correspondence
- Teaching decoding strategies using scaffolding
- Exposure to interesting and linguistically enriching stories - read to children and use a constructivist approach to questioning to foster reading comprehension skills
- Direct teaching of vocabulary (Biemiller)
- Silent reading practice
- Process writing

PREVENTION OF MATTHEW EFFECTS

- Read books to child at comprehension level
- Shared reading
- Reading buddy
- Speech to Text (e.g., Kurzweil reader)
- Direct teaching of vocabulary
- Comprehension work through media, theatre, and oral reading

REMEDIAITON FOR STAGE 1

- Jolly Phonics (if age 7 or below)
- Synthetic phonics (e.g., Glass Clusters)
- Additional Cues for learning sight vocabulary (e.g., Bridge)
- Stauffer’s language experience
- Word Box - hospital or garage
- VAKT - Multiple sensory approaches
- Reading Mastery

REMEDIAITON FOR STAGE 2

- Synthetic phonics (e.g., Glass Clusters)
- Reading Mastery
- Repeated Reading
- Cloze
- PHAST - Phonological and Strategy Training

COMPREHENSION

- Literal
  - Getting the facts
  - Locating the answer
  - Following directions
  - Detecting the sequence
- Inferential
  - Identifying the main idea
  - Drawing conclusions
  - Using the context
- Interpretive/critical
  - Analysis of characterization, plot, style, theme

FUNCTIONAL COMPREHENSION

- Visual
  - How do you do it?
  - What did you do?
  - Where did you go?
  - Why did you do it?

- Auditory
  - What is the story about?
  - What are the characters doing?
  - What is happening in the story?
ASSESSMENT SKILL HIERARCHY

READING COMPREHENSION DIFFICULTIES

- Decoding Difficulties
- Nonverbal Learning Disabilities
- Intact rote memory processes
- Problems with inferences, characters, pragmatics

Receptive and Expressive Language Difficulties
- PPVT, CELF
- Oral Language Sample
- Listening Comprehension

Decoding Difficulties

Working Memory Difficulties

REMEDIATION FOR STAGE 3

- Reading and Spelling Mastery
- Repeated Reading
- Cloze
- PHAST
- KWL - Know - Want - Learn
- Graphic Organizers - Semantic Webs
- Reciprocal Teaching

RECIPROCAL TEACHING

- Involves a dialogue between teachers and students for the purpose of jointly constructing meaning from text
- Theoretical Basis - scaffolding and active involvement in learning
- Strategies - most effective if explicitly taught initially
  - Questioning
  - Summarizing
  - Clarifying
  - Predicting
- Research
  - Increases reading comprehension in good decoders and poor comprehenders - grade 4-adult
  - Generalize to social science and science courses

References

