School Neuropsychology of Reading and Reading Disabilities

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Manitoba Association of School Psychologists
14-15 November 2013
Psychological Processes and Reading SLD Subtypes

• WISC-IV Indices or Cattell-Horn-Carroll (CHC) psychological processes predictive of reading (see Flanagan & Kaufman, 2004; Keith et al., 2006)

• Possible reading SLD subtypes (see Fiorello et al. 2006):
  ➔ Auditory/Phonological (Ga)
  ➔ Visual/Orthographic (Gv)
  ➔ Sound (Phoneme) – Symbol (Grapheme) Association (Coding?)
  ➔ Rapid Naming/Fluency (Gs)
  ➔ Working Memory/Comprehension-Retrieval (Gsm-MS; possible Gf)
  ➔ Syntactic, Receptive (Comprehension), Expressive (Articulation/Language Formualation), Lexical/Semantic (Vocabulary), Syntactic Knowledge (Gc)
# The Neuropsychology of Reading Disorders

## Word Recognition
- Phonological awareness
- Symbolic representation
- Phoneme-grapheme correspondence
- Sequencing
- Word attack vs. sight word Strategies

## Reading Comprehension
- Timing/automaticity
- Semantics
- Receptive language
- Syntax
- Working memory
- Pragmatics
- Explicit-factual vs. implicit-inferential Comprehension

→ **Identify subtype to develop intervention**
Identifying Reading Disabilities - Differential Diagnosis

Subtest Scaled Scores

Average Readers

SI  VO  CO  IN  WR  DS  DSF  DSB  LNS  AR  BD  PCS  MR  PCO  CD  SS
The Three Axes Interpretation

Left Hemisphere
- Routinized/Detailed/Local
- Convergent/Concordant
- Crystallized Abilities

Right Hemisphere
- Novel/Global/Coarse
- Divergent/Discordant
- Fluid Abilities

Anterior/Superior
- Executive Regulation and Supervision
- Motor Output

Posterior
- Sensory Input
- Comprehension

Inferior
- Executive Efficiency
- Precision of action
<table>
<thead>
<tr>
<th>Brain Area</th>
<th>Possible Effects of Left Hemisphere Damage?</th>
<th>Possible Effects of Right Hemisphere Damage?</th>
</tr>
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<tbody>
<tr>
<td>Dorsal Stream</td>
<td>Poor left/right orientation, sound-symbol association (alphabetic principle), and letter reversals</td>
<td>Poor handwriting and math from spatial deficits; poor awareness of self and environment during social interactions</td>
</tr>
</tbody>
</table>
Regions More Active Reading Pseudowords vs. Real Words
Mechelli, Gorno-Tempini, & Price, 2003
Activation Differences Between Dyslexics and Controls
Hoeft et al., 2007
The Brain Basis of the Phonological Deficit in Dyslexia Is Independent of IQ (Tanaka et al., 2011)
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<td>Ventral Stream</td>
<td>Difficulty recognizing sight words, poor reading fluency; object naming limited</td>
<td>Difficulty with sight words and perception of affect and faces</td>
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<td>Occipital-temporal-parietal crossroads and Wernicke’s Area</td>
<td>Difficulty connecting sounds (phonemes) with symbols (graphemes); difficulty connecting numbers with quantity and math algorithms, limited comprehension of explicit language</td>
<td>Poor math problems solving and comprehension of implicit language, complex language, poetry; difficulty with new learning and integrating different types of information; poor understanding of humor</td>
</tr>
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<td>Broca’s Area</td>
<td>Halting speech with little output and difficulty with articulation and syntax, even impulse control</td>
<td>Poor verbal prosody and word substitutions; verbose, but limited pragmatics</td>
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Reading Comprehension

Other Structures:
ALL Previous Word Reading and Reading Fluency Structures
Temporal and Frontal Systems in Speech Comprehension
(Tyler, Stamatakis, Post, Randall & Marsel-Wilson, 2005)

- Bilateral temporal lobe activation for speech and phonological processing
- Superior temporal activity suggests accessing lexical representations
- Self-talk important for self management and understanding

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<td>Superior Temporal Lobe</td>
<td>Frequent requests for repetition, poor word reading, poor auditory and phonological processing</td>
<td>Poor perception of rate and pitch or prosody, difficulty with complex sentence processing</td>
</tr>
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<td>Lateral/Medial Temporal Lobe</td>
<td>Can’t remember facts and words due to difficulty with long-term memory, poor categorization</td>
<td>Limited understanding of context, metaphor, multiple word meanings, and humor</td>
</tr>
</tbody>
</table>
**Language Brain Activation Patterns**

(Glasser & Rilling, 2008)

**Left**
- Alphabetic principle
- Fluency
- Temporal
- Phonological Processing
- Explicit Language
- Speech (Articulation)
- Dysfunction in word reading & explicit comprehension common

**Right**
- Rate
- Pitch
- Spectral
- Complex Language
- Implicit Language
- Speech (Prosody)
- Difficulty with implicit comprehension common yet good word reading
Alexis and Single Word Reading

**Referral:** Alexis’ teacher reported that she reads fairly well, but makes errors that are phonetically accurate, such as saying “rig-hut” for the word right. Her reading speed is very poor despite intervention efforts to increase fluency. Alexis often looks back in the passage to find answers to comprehension questions. Alexis has some difficulty with learning facts and details in other classes too, such as social studies. However, she understands what is asked of her and follows oral directions well. What is the possible problem?

**Hypotheses:** Alexis has good phonological (sound), orthographic (symbol), and alphabetic skills (sound-symbol association), so good dorsal stream functioning; however, she lacks reading fluency and automaticity. Given her memory problems, she may have difficulty with ventral stream and temporal lobe functioning. Because she decodes all the words presented, she spends all of her mental energy on word reading, which taxes her working memory. Because working memory is consumed with single word reading, there is little chance for reading comprehension, so she must go back to search the text for the answers when asked questions in class.
Reading Interventions: The National Reading Panel

- **Analytic/Analogy Based Phonics** Compare known to unknown words
- **Synthetic Phonics** Convert letters to sounds then blend
- **Onset-Rime Phonics** Onset (consonants) before rime (vowel)
- **Embedded Phonics** Problem-Solving model during reading of text
- **Phonics Through Spelling** Teaches students to segment words into phonemes and write letters
Explicit Phonics Instruction

• Lowercase Letters
• Frequent Sound-Letter Associations (/c/ /p/ /t/)
• Easy Sound-Letter Associations (/m/ /s/ /a/)
• Assure Acquisition/Proficiency Before Introduction of More Complex
• Teach Consonants First, But Introduce Vowels Early
• Teach Continuous Sounds (/e/ /r/ /l/) Before Stop Sounds (/d/ /g/ /k/)
• Teach Sound Blending Early (VC/CVC/CVCC/CCVCC)
• Introduce Consonant Digraphs (/ch/ /ph/ /gh/) Before Vowel Digraphs (/ai/ /ee/ /ou/)
• Introduce Dipthongs (/au/ /ey/ /ow/)
• Introduce Regular Before Irregular Words
• Read Connected Text
Phonological Training: WinABC

(Spironelli, Penolazzi, Vio & Angrilli, 2010)

- ERP Study: N150 – word recognition
- 6 months phonological training
- Pre-Intervention Dyslexic children showed more bilateral activation
- Post-Intervention Dyslexic children developed left posterior lateralization
Corrective Reading, Wilson Learning System, Spell Read Phonological Auditory Training, and Failure Free Reading (Keller & Just, 2009)

Pre-Intervention Differences Among Good vs. Poor Readers

Increased Myelination in Poor Readers
Interventions for Word Recognition

• “Talking Letters” (Berninger, 98) Teaches phonemic awareness and processing through pseudowords

• Orthographic/Phonemic/Fluency Instruction (Berninger, 01) Repeated readings, precision teaching, metacognitive instruction

• Fluency Instruction (Breznitz, 97) Repeated reading and self-monitoring/charting of rate

• Sight Word Instruction (Browder, 91) Increasingly difficult discriminations of sight words through stimulus control and fading
Interventions for Word Recognition

- **Synthetic Phonics** (Carnine, 97) Teaches sound-symbol association and phonological assembly (letter → sound → words)
- **Corrective Reading** (Engelmann, 99) Synthetic phonics, sound-symbol, sequencing, blending, and comprehension through direct instruction
- **Glass Analysis** (Glass, 78) Read and combine morphemes (not phonemes)
- **DISSECT** (Lenz, 90) Discover Content; Isolate Prefix; Separate Suffix; Examine Stem; Check; Try Dictionary
Demonstrating Neuropsychological Response to Intervention
Aylward et al., 2003

BASELINE: Before Treatment Activation Controls > Dyslexics
Demonstrating Neuropsychological RTI: Aural Repeat/Match
Richards et al., 2007

BEFORE TREATMENT

Dyslexic Treatment Group (Muir)

CONTROL GROUP

AFTER TREATMENT

Left Postcentral Gyrus

Left Supramarg. Gyrus
Demonstrating Neuropsychological RTI: Intensive Phonics
Simos et al., 2007
BEFORE TREATMENT  AFTER TREATMENT
Interventions for Reading Comprehension

- **Beginning to Read** (Adams, 90) Phonics, connected text, repeated readings
- **Story Mapping** (Beck, 81/Idol 87) Graphic representation of setting, characters, goal, plot, action, resolution, theme
- **Interactive Learning** (Bos, 91) Link prior knowledge to current text and prediction
- **Vocabulary Instruction** (Carnine, 85) Define, examples, review/rehearse
- **Metacognitive Training** (Chan, 86) Student self-questioning and underlining
- **RIDER** (Clark, 84) Read, Image, Describe, Evaluate, Repeat
Interventions for Reading Comprehension

• POSSE (Englert, 91) Reciprocal teaching format for Predict, Organize, Search, Summarize, Evaluate
• PALS (Fuchs, 97) Peer tutoring for reading, summarizing, prediction
• SCROLL (Grant, 93) Surveying, Connecting, Reading, Outlining, Looking for comprehension
• Story Grammar (Gurney, 90) Identify conflict, characters, resolution, theme
• Restating Stories (Jenkins, 87) Student reads story, restates, and writes
• High Interest/Low Vocabulary (Mercer, 01) Uses Fry Readability Formula to ensure success/interest
Interventions for Reading Comprehension

• Reciprocal Teaching (Palinscar, 88) Comprehension monitoring through prediction, questioning, summarizing, clarifying
• SQ3R (Robinson, 61) Survey, Questioning, Reading, Reciting, Reviewing
• DRA (Sachs, 83) Directed reading activity using student experience to foster interest
• MULTIPASS (Schumaker, 82) Survey Pass, Size-Up Pass, Sort-Out Pass for self-questioning, paraphrasing, and visual imagery
• QAR (Simmonds, 92) Question-Answer Relationships: Explicit vs. implicit questions
• RAVE-O (Wolf, 00) Retrieval, Automaticity, Vocabulary, Elaboration, Orthography
SNAP-FIT (Student Neuropsychological Assessment Profiles for Innovative Teaching) Jerry Case Study
THANK YOU!

QUESTIONS? COMMENTS?

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