The Neuropsychology of Reading Comprehension Disorders: A Framework for Effective Interventions

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PRESENTATION GOALS

1. Review four basic subtypes of reading disorders from a brain-behavioral perspective, and discuss children most vulnerable to deficits with reading comprehension skills.

2. Explore specific neural pathways and brain regions associated with reading comprehension.

3. Examine the relationship between executive functioning skills, working memory skills, and language development skills in comprehension.

4. Discuss specific classroom strategies and interventions for children with reading comprehension skills.

5. Discuss specific CHC factors related to the reading comprehension process.

Further Reading Materials

www.schoolneuropsychpress.com
Billy is a 12 year old student with an attention-deficit-disorder. He needs accommodations due to difficulties with poor planning and organizational skills. He struggles to take notes in class, has difficulty with reading comprehension skills, and frequently turns in assignments late.

Sam is a 9 year-old student with Asperger's Syndrome. His academic skills are fairly strong though he struggles comprehending more abstract text. Sam has few friends, seems socially awkward and immature, and has difficulty reading social cues from others.

Joe is a 16 year-old junior in High School with an IQ of 135. He is performing poorly in most academic classes, puts forth minimal effort and rarely turns in assignments. He tends to bring multiple books from home to school, and reads them under his desk.

Martin is an 11 year-old student in 6th grade. He has extreme difficulty managing his emotional impulses and has been suspended numerous times for fighting and using inappropriate language. His grades are extremely poor despite numerous interventions.

8-10% of all school aged children have adequate decoding skills but struggle with reading comprehension (Cutting et al., 2009). The types of children who struggle most with reading comprehension include:

- ADHD
- Hyperlexia
- ESL students
- High IQ/Poor Executive Function
- Emotional Disorders
- Poor reading fluency
- Lower verbal IQ
- Poor working memory
DEVELOPMENTAL DYSLEXIA

Learning Disabilities

Reading Disorders

Dyslexias

Subtypes

Disability Categories (2009)

Special education students by disability category, 2009

- Autism: 6%
- Emotional Disturbance: 7%
- Intellectual Disability: 8%
- Other Health Impairments: 11%
- Speech/Language Impairments: 19%
- Learning Disabilities: 42%
- All Others: 7%

Source: www.idea.gov, 2009 Child Count, April 21
National Center for Learning Disabilities

School Neuropsychological Assessment

- A neuropsychological approach to assessment attempts to identify the core underlying processes responsible for learning as opposed to boxing kids into diagnostic categories.
- Reports based upon a brain-behavioral paradigm which attempts to describe how a child learns and processes information.
- Focus on why the child has not been successful in school as opposed to IQ scores.
- Examine the cognitive and emotional strengths and weaknesses of the child and link to specific educational strategies and interventions.
Forest Grove School District case reached the Supreme Court in June, 2009. The local school psychologist evaluated a child and concluded there was no disability.

- The parents sought a private school neuropsychological assessment that was more comprehensive and found evidence of a disability. The Due Process Hearing Officer concluded the school district failed to provide FAPE and the school district was liable for private school services.

- Supreme Court justice John Paul Stevens agreed with the Due Process Hearing Officer and ruled the school had overlooked a disability by not completing a more comprehensive evaluation in all areas of the suspected disability. Cost of tuition...$5200 per month.

Four Subtypes of Reading Disorders

1. **Dysphonetic Dyslexia** – difficulty sounding out words in a phonological manner.

2. **Surface Dyslexia** – difficulty with the rapid and automatic recognition of words in print.

3. **Mixed Dyslexia** – multiple reading deficits characterized by impaired phonological and orthographic processing skills. Most severe form of dyslexia.

4. **Comprehension Deficits** – mechanical side of reading is fine but difficulty persists deriving meaning from print.

UNDERSTANDING THE NOTION OF SUBTYPING

- Inferior Frontal Gyrus
- Supramarginal Gyrus
- Heschl's Gyrus
- Angular Gyrus
- Superior Temporal Gyrus
- Fusiform Gyrus
Superior Temporal Gyrus – modulating the 44 phonemes of the English language.
Angular Gyrus – cross modal association area underlying mapping symbols to sounds (orthography).
Supramarginal Gyrus – cross modal association area underlying the spatial appreciation and positioning of sounds.
Inferior Frontal Gyrus – end point for inner articulation region.
Fusiform Gyrus – automatic word recognition skills and the development of fluency in reading.

**Reading Comprehension Constructs**

1. **Content Affinity** - attitude and interest toward specific material. Developing an emotional connection.
2. **Working Memory** - the ability to temporarily suspend new information with previously read information.
3. **Executive Functioning** - the strategies used to self-organize information to facilitate retrieval.
4. **Language Development** – most children enter kindergarten with 3000 – 5000 words, though graduate from high school with 60,000 words (Pinker, 1994).
Reading Comprehension

Working Memory Skills

1. **Writing** - the ability to simultaneously plan and organize our thoughts, remember spelling rules and boundaries, recall grammar rules, concentrate on penmanship, word choice selection, and holding ideal in mind when proofreading.

2. **Mathematics** – involved in remembering longer math algorithms when problem solving, as well as holding facts in memory while problem solving.

3. **Reading** – involved in the comprehension process linking up new information with previous read information and background knowledge and experience.

Working Memory and Learning

**Working Memory Systems**

A) Phonological Loop (left)

- [Diagram of Phonological Stage (inner voice)]

B) Visual-Spatial Sketch Pad (right)

- [Diagram of Visual-Spatial Sketch Pad]
Working Memory and Reading

- Working memory is a learning facilitator for executive functioning when reading. It holds information in conscious awareness to allow for the strategic manipulation and storage for later recall.
- Most ADHD kids and LD kids have significant working memory deficits.
- WISC IV is not a comprehensive measure of working memory skills.
- There is an inverse relationship between anxiety and working memory skills.

Working Memory Measures

- WISC IV Integrated: Working Memory Scale
- PAL II Verbal Working Memory Subtests
- Stanford Binet Intelligence Scales: Verbal Working Memory
- California Verbal Learning Test: Children’s Version (CVLT-C)
- NEPSY II: List Memory
- KABC II: Word Order
- WRAML-2: Symbolic Working Memory
- TAPS 3 Sentence and Word Memory
- WJIII Auditory Working Memory

Reading Comprehension Constructs

EXECUTIVE FUNCTIONING SKILLS
What Are Executive Functions?

- Directive capacities of the mind.
- Multiple in nature, not a single capacity.
- Cue the use of other mental abilities.
- Direct and control perceptions, thoughts, actions, and emotions.
- Part of neural circuits that are routed through the frontal lobes.
- The concept of executive functions is not synonymous with the concept of intelligence or “IQ”.

Frontal Lobe Functions

- Orbital frontal cortex is end point for ventral stream
- Dorsal-lateral cortex is end point for dorsal stream

Executive Functioning and Reading Comprehension

Planning Skills - read with a specific question or purpose in mind when seeking specific information. In other words, plan a strategy!!

Organizational Skills – stitch together text in a cohesive manner and slot information appropriately (i.e. characters, setting, main idea, central problems, details, etc.)

Working Memory – temporarily suspend previously read information in mind while simultaneously linking new information being read.

Concept Formation – depth of understanding of the text.
Executive Functioning and Reading Comprehension

Response Inhibition - refrain from jumping ahead when reading text and missing salient aspects of the passage.

Sustained Attention – the ability to stay focused on the text for prolonged periods of time and resist distractions.

Cognitive Flexibility – shifting patterns of thought processes to the organizational parameters of the text being read, and not just perseverating on the same material over again.

Self-Monitoring – staying aware and engaged in what you are reading while you are reading.

Reading Comprehension Interventions

1. Stop & Start Technique – student reads a passage out loud and every 30 seconds “stop” to ask questions.
2. Directional Questions – ask questions at the beginning of the text instead of the end.
3. Read Aloud – reading out loud allows student to hear their own voices and facilitates working memory.
4. Story Maps – pre-reading activity where graphic organizers are used to outline and organize the information.

Story Mapping Technique

Story Map

- Main Characters
- Setting
- Title & Author
- Problem
- Resolution
Reading Comprehension Interventions

5. Narrative Retelling – have the child retell the story after reading aloud in their own words.

6. Multiple Exposures – encourage students to skim the material prior to reading, with emphasis on chapter and text headings.

7. Active Participation – encourage active, not passive reading, by having children take notes or putting an asterisk next to important information. Also, multiple colors for highlighting.

8. Reduce Anxiety – anxiety inhibits working memory and leads to ineffective recall. Be weary of having children read out loud in class.

9. Medication Management – ADHD students in particular can better focus and sustain their attention if appropriately medicated.

10. Practice Terminology – review vocabulary terms and concepts prior to reading the text.

11. Classroom Discussions – introduce new topic areas with a discussion aimed at capturing a student’s interest, providing them with background knowledge, and engaging an emotional connection with the text.

12. Fluency Building – for younger students, greater reading fluency allows for greater automaticity to free up cognitive resources to concentrate on the passage.

Lindamood Visualization and Verbalization for Language Comprehension and Thinking

* Created by Nanci Bell
* Recommended 3-5 times per week for 60 minutes.
* 12 week program- whole class or individual.
* Based upon 12 structure words (i.e. what, size, color, shape, etc..) used to provide a framework to create visual images. The student begins with picture imaging, word imaging, sentence imaging, multiple sentence imaging, and paragraph imaging.
* Pacing is determined by student progress.
* Researched based (Johnson-Glenberg, 2000; Sadoski & Wilson, 2006).
* Consideration for students with Autism, Hyperlexia, ELL, and students with lower verbal abilities.
SOAR to SUCCESS

A comprehension program for grades 3-6.
• 30-35 minute lessons…18 weeks.
• 4 Key Strategies:
  a) Summarize
  b) Clarify
  c) Question
  d) Predict
• 5 Key Aspects of Program.
  1) Revisiting – re-read previous story with a partner.
  2) Reviewing – graphic organizer used to summarize.
  3) Rehearsing – preview text and make predictions of book to be read that day.
  4) Read and Reciprocal Teaching – silent reading and practicing strategies.
  5) Reflecting – discussing story.

Read 180 (Dr. Ted Hasselburg)

A 90 minute per day balanced literacy program.
• Designed for grades 4th – 12th.
  1) 20 minute whole group instruction where teachers model fluent reading skills.
  2) Students then move to three-20 min stations.
     a) Teacher Station – small group differentiated instruction to reinforce previous concepts.
     b) Computer Station:
        - Reading Zone (phonics, fluency, vocab)
        - Word Zone (automaticity of decoding)
        - Spelling Zone
        - Success Zone (comprehension strategies)
     c) Library Station – read silently and written language activities.
• Software adapts level of instruction to learner.
• Expensive, but research based…recommended for most struggling readers.

Measuring Executive Functions?

Generic Measures: Reading Measures
• BRIEF
• CEFI
• DKEFS
• WCST
• TEC
• NEPSY II
• CVLT
• KTEA-II (Inferential vs. Literal)
• PAL II (Morphological Coding, Sentence Sense)
• GORT 5 (Oral Rdg) vs WIAT III (Silent Rdg)
At birth, human brain weighs 25% of adult weight (compared to chimpanzee’s brain, which is 46% of adult weight), thereby leaving more room for the environment to shape brain growth more than any other species.

Thus, experience at critical junctures in a child’s development can greatly influence neural connections.

Human brain volume 95% of its adult weight by age 5 (Stahl, 2000).

Average number of words spoken daily in a professional household ..........1500 - 2500 3.5 million words by age three

Average number of words spoken in a middle class household .....................1000 - 1500 2.0 million words by age three

Average number of words spoken by welfare mothers ............................500 - 800 1.0 million words by age three
TIME SPENT READING AFTER SCHOOL
(Shaywitz, 2003)

VOCABULARY DEVELOPMENT

The typical child enters school with a receptive vocabulary of 13,000 words and an expressive vocabulary of 5000 words (Eliot, 1999).

- Vocabulary is enhanced by reading and by conversing!!
- Practice terminology before reading text. Very important for science and mathematics.
- Enhance depth through experiential learning and field trips.
- Differentiate between details and inferences.
- Classroom discussions to put words in context, not just memorize them.

_The brain craves context!!_

Fluency and Comprehension??

- According to a research at an English university, it doesn’t matter in what order the letters in a word are, the only important thing is that the first and last letter is at the right place. The rest can be a total mess and you can still read it without problem. This is because we do not read every letter by itself but the word as a whole.
Cattell-Horn-Carroll (CHC) – Flanagan and colleagues (2013) propose the following cognitive abilities are associated with reading comprehension:

- **Fluid Reasoning (Gf)** – inductive and sequential reasoning play a moderate role in reading comprehension. Best measured in a classroom by the ability to generate synonyms and antonyms to given words, and complete analogies to both verbal and nonverbal tasks.

- **Crystallized Knowledge (Gc)** – lexical development and verbal knowledge is the strongest predictor of reading comprehension. Specifically, knowledge of word meanings.

- **Short-Term Memory (Gsm)** - working memory consistently shows moderate correlations with comprehension after the age of 6. Increasingly more important as text demands increase in length.

- **Visual Processing (Gv)** – visual memory is moderately consistent with reading comprehension for older children between the ages of 14-19. Broad Gv scores not generally related to passage comprehension skills.

- **Auditory Processing (Ga)** – auditory processing is moderately associated with reading comprehension at younger ages between 6-8. However, Ga is more correlated with phonemic awareness, so not a strong predictor of comprehension once this is mastered.

- **Long-Term Memory (Glr)** – long term retrieval moderately consistent with reading comprehension between the ages of 9-13 years of age. Specifically, associative memory (pairing verbal tag with visual stimulus) has strongest correlations.
90 Minute Dyslexia Evaluation

- Intelligence tests (Gc)
- Phonemic/Phonological Awareness (Ga)
- Rapid Naming (Glr)
- Verbal Memory Tests (Gsm)
- Reading Fluency (Gs)
- Orthographic Skills (Gv)
- Attention (Gs)
- Executive Functioning (Gf)

* INTEGRITY NOT DISCREPANCY

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Case Review

Bobby - 6th grade - anxiety-adhd-poor rdg

<table>
<thead>
<tr>
<th>WISC IV SCORES</th>
<th>COMPOSITE</th>
<th>CONFIDENCE INTERVAL</th>
<th>RANK</th>
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<tr>
<td>Verbal Comprehension</td>
<td>Index (Gc)</td>
<td>102</td>
<td>95 – 109</td>
</tr>
<tr>
<td>Perceptual Reasoning</td>
<td>Index (Gf/Gv)</td>
<td>106</td>
<td>98 – 113</td>
</tr>
<tr>
<td>Working Memory</td>
<td>Index (Gsm)</td>
<td>83</td>
<td>77 – 92</td>
</tr>
<tr>
<td>Processing Speed</td>
<td>Index (Gs)</td>
<td>85</td>
<td>78 – 96</td>
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<tr>
<td>Total Scale Score</td>
<td>95</td>
<td>90 – 100</td>
<td>Average 37%</td>
</tr>
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Bobby's Neurocognitive Profile

| CTOPP-2 | Phonological Awareness = 90 (Ga) | Phonological Memory = 93 |
| PAL II | Rapid Naming = 90 |
| CBR | Morphological/Syntactical Coding (Gc/Gf): |
| GORT | Does it Fit? 6 |
| CVLT | Sentence Structure 5 |
| BRIEF | Sentence Sense 6 |
| GORT | Verbal Working Memory (Gam): Letters 4 |
| GORT | Words 4 |
| CVLT | 96 words per minute correct |
| BRIEF | Oral Reading Quotient 62 |
| CVLT | Fluency 7 (Gs) |
| BRIEF | Comprehension 5 |

* INTEGRITY NOT DISCREPANCY
Bobby’s Recommendations

- Bobby needs a balanced literacy model focusing on teaching both reading fluency and specific strategies for comprehension. He also needs to develop greater self-confidence with his skills.
- Recommend:
  - Read Naturally
  - Soar to Success
  - Great Leaps (develop confidence)
- Classroom strategies: extra time, reduced distractions, story maps, vocabulary, practice terminology, teach skimming techniques, daily reading log to ensure practice.