Using Neuropsychology to Guide Interventions for Children with Learning Challenges

Steven G. Feifer, D.Ed, ABSNP
feifer@comcast.net
www.schoolneuropsychpress.com

Learning Objectives

1. Examine literacy rates in the United States and explore how neuroscience can enhance learning opportunities for all children.

2. Explore four key stages of brain development that pave the way for developing a school ready brain.

3. Explore the notion that educators can actually change brain chemistry for students with developmental dyslexia.

4. Discuss the importance of “timing” when implementing specific reading and written language interventions.

Further Reading Materials

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Only 35% of 4th graders reading at or above proficient level in 2013 (NAEP, 2013). In 1992, this figure was 28%.

Only 36% of 8th graders reading at or above proficient level in 2013 (NAEP, 2013). In 1992, this figure was 29%.

32 million adults (14% of population) in the U.S. have significant reading deficits, with 21 percent of adults reading below a 5th grade level, (U.S. Dept of Education and the National Institute of Literacy, 2014).

70 percent of inmates in America’s prisons cannot read above a fourth grade level (U.S. Department of Justice).

The educational careers of 25 to 40 percent of American children are imperiled because they don’t read well enough, quickly enough, or easily enough.

The graduation rate for students receiving a regular diploma with SLD is just 64%, well below that of non-SLD students.

Children who have not developed some basic literacy skills by the time they enter school are 3-4 times more likely to drop out in later years.

Developmental dyslexia occurs in approximately 5-12% of the population (Lyon, et al., 2003).
6.4 million students receive special education services in 2011–12, or about 13 percent of all public school students.

36 percent of the students receiving special education services have specific learning disabilities (80% due to reading disorders).

Total students in SPED declining since 2005-2006.

Specific learning disabilities are endogenous in nature and are characterized by neurologically based deficits in cognitive processes.

These deficits are specific; that is, they impact particular cognitive processes that interfere with the acquisition of academic skills.

Specific learning disabilities are heterogeneous—there are various types of learning disabilities, and there is no single defining academic or cognitive deficit or characteristic common to all types of specific learning disabilities.

Relying upon an ability–achievement discrepancy as the sole means of identifying children with specific learning disabilities is at odds with scientific research and with best practice (Gresham & Vellutino, 2010).

There is no universal agreement on what the discrepancy should be.

A discrepancy model of reading disabilities precludes early identification.

Intelligence is more a predictor of school success, and not necessarily a predictor of successful reading.

A discrepancy model promotes a ‘wait and fail’ policy, forcing interventions to come after the fact.

Side note: Do you really think human intellectual functioning can be captured by one unitary value?
School Neuropsychology

Neuropsychology: An analysis of learning and behavior which examines brain-behavior relationships. The underlying assumption is that the brain is the seat of ALL behavior; therefore, knowledge of cerebral organization should be the key to unlocking the mystery behind most cognitive tasks.

- Reports based upon a brain-behavioral paradigm which attempts to describe how a child learns and processes information...not label.
- Takes a scientific, not a political, paradigm toward solving student achievement issues.
- Evidence based interventions require evidence based assessments!!

3-Headed Monster of Reading

- **DECODING**
  - Selective Attention
  - Phonemic Awareness
  - Phonological Processing
  - Alphabet Knowledge

- **FLUENCY**
  - Visual Scanning
  - Rapid Orthography
  - Sustained Attention
  - Motivation

- **COMPREHENSION**
  - Language Development
  - Working Memory
  - Executive Functioning
  - Content Affinity

Four Universal Truths of Reading

1. In all word languages studied to date, children with developmental reading disorders (dyslexia) primarily have difficulties in both recognizing and manipulating phonological units at all linguistic levels (Goswami, 2007).

<table>
<thead>
<tr>
<th>Lowest Incidence</th>
<th>Highest Incidence</th>
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</thead>
<tbody>
<tr>
<td>Slovakia 1-2%</td>
<td>China 5-8%</td>
</tr>
<tr>
<td>Italy 1-5%</td>
<td>United States 5-10%</td>
</tr>
<tr>
<td>Czech Republic 2-3%</td>
<td>Russia 10%</td>
</tr>
<tr>
<td>Britain 4%</td>
<td>Israel 10%</td>
</tr>
<tr>
<td>Poland 4%</td>
<td>Finland 10%</td>
</tr>
<tr>
<td>Belgium 5%</td>
<td>Nigeria 11%</td>
</tr>
<tr>
<td>Greece 5%</td>
<td>Australia 16%</td>
</tr>
<tr>
<td>Japan 6%</td>
<td>India 20%</td>
</tr>
</tbody>
</table>

(Smith, Everatt, & Salter, 2004)
2. The English language is not a purely phonological language. In fact, one letter may map to as many as five distinct phonemes or sounds. English speaking children tend to develop phonemic processing more slowly (Goswami, 2007).

- The English language includes over 1,100 ways of representing 44 sounds (phonemes) using a series of different letter combinations (Uhry & Clark, 2005). By contrast, in Italian there is no such ambiguity as just 33 graphemes are sufficient to represent the 25 phonemes.

- Therefore, 25% of words are phonologically irregular (i.e. "debt", "yacht", "onion", etc.) or have one spelling but multiple meanings (i.e. "tear", "bass", "wind", etc.).

**Summary:** We need to develop orthography!!

3. Specific neuroimaging techniques have demonstrated that phonological processing and orthographic processing is a by-product of the functional integrity of the temporal-parietal junctures in the left hemisphere of the brain (Pugh et al., 2000; McCandliss & Noble, 2003; Shaywitz, 2004; Sandak et al., 2004).

### Six Syllable Subtypes

The six types of syllables that compose English words must be directly taught. These syllable subtypes help to develop orthographical patterns in words and include:

- a) Closed syllables (just one vowel..."cat")
- b) Open syllables (ends in long vowel..."baby")
- c) Vowel-Consonant ESyllables (silent *e* elongates vowel..."make")
- d) Vowel-Team Syllables (two vowels make one sound..."caution")
- e) R-Controlled Syllables (vowel followed by "r" changes sound..."hurt")
- f) Consonant-<le>Syllables (end of word ending in "le"..."turtle")

### Four Universal Truths of Reading

3. Specific neuroimaging techniques have demonstrated that phonological processing and orthographic processing is a by-product of the functional integrity of the temporal-parietal junctures in the left hemisphere of the brain (Pugh et al., 2000; McCandliss & Noble, 2003; Shaywitz, 2004; Sandak et al., 2004).
According to the National Reading Panel (2000), and modified by Grizzle et al. (2009), the 5 big ideas of the reading process include:

**Four Universal Truths of Reading**

- **COMPREHENSION**
- **LANGUAGE**
- **FLUENCY**
- **PHONICS**
- **PHONEMIC AWARENESS**

**NEURAL CIRCUITRY OF DYSLEXIA**
(Shaywitz, 2003)

- Nonimpaired readers activate primarily posterior portions of left hemisphere.
- Impaired readers under-activate posterior regions and activate primarily frontal areas.

**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.
Do Interventions Change the Brain?

Research is beginning to show two specific brain changes with LD kids as a result of reading interventions:

1. Hemispheric "normalization" – the left hemisphere begins to assert dominance after just four weeks of intervention.

2. Hemispheric "compensation" – children with reading difficulty also activate brain structures in the frontal lobe following intervention, suggesting greater text attention and working memory engagement (IFG), and enhanced error detection and EF skills (ACC).


33 children with reading disorders 8-12 years-old.
RAP training – 4 weeks...20 min daily...fluency and comprehension
Computer presentation of sentences...which dissipate based on response accuracy...and students select correct answer.
Do Interventions Change the Brain?

- Composite fMRI image on left reveals increased ACC (error detection) and IFG (working memory) for reading disabled children as measured by GORT IV contextual reading rate.
- Composite fMRI image on right reveals increased fusiform gyrus activation (automatic word rec) and occipital gyrus as measured by TOWRE-II word/pseudoword task.

BUILDING THE RIGHT INTERVENTION

1. The younger the child, the better the outcome.
2. The "at-risk" child responds best to small group instruction (3:1), with phonological awareness training being combined with explicit phonics.
3. Highly trained teachers achieve the best results.
4. Frequency of instruction (4-5 days per week) was more effective than sporadic instruction (2 days per week).
5. Older children are less responsive to explicit phonological instruction, and therefore more intensive work for a longer duration is required.

*Auditory Pruning*- children who have not developed phonological awareness by age 9 or 10 probably lost the capacity to do so (Rourke & Del Dotto, 1994).

REMEDICATION STRATEGIES FOR DYSPHONETIC DYSLEXIA

- **Under Age 7**: Fast Forward II, Tallal, Photo-Graphs, Saxon Phonics Program, Success for All, Ladders to Literacy, Fundations, Road to the Code, SIPPS, Scott Foresman Early Intervention Reading
- **Ages 7-12**: Alphabetic Phonics (Orton-Gillingham), SRA Corrective Reading, Exelexis II, LEAPs, LEXIA Primary Reading, Horizons
- **Over Age 12**: Wilson Reading System, SRA Corrective Reading & REACH System, Read 180, Houghton Mifflin, Kaplan Spell/Read, LEXIA Strategies for Older Students
REMEDIATION OF SURFACE DYSLEXIA

Over Age 12:
- Academy of Reading
- Wilson Reading System
- Laubach Reading Series
- Read 180

Ages 7–12:
- Read Naturally
- Great Leaps Reading
- Quick Read
- RAVE-O
- Fast Track Reading

Under Age 7:
- Destination Reading
- Reading Recovery
- Early Success
- Fluency Formula

TIME SPENT READING AFTER SCHOOL
(Shaywitz, 2003)

Building Text Automaticity

- 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 are in 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.

- http://www.spritzinc.com
4 Components of Reading Comprehension

1. **Content Affinity** - attitude and interest toward specific material.

2. **Working Memory** - the ability to temporarily suspend information while simultaneously learning new information. The amount of memory needed to execute a cognitive task.

3. **Executive Functioning** - the ability to self-monitor performance and organize information on a given problem solving task.

4. **Language Foundation** – most children enter kindergarten with 3000–5000 words, though graduate from high school with 60,000 words (Pinker, 1994).

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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.

5. **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.

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**Written Language: A Survival Skill!**

“Why! Why! Can’t that.... I guess it was ‘HELP’...”
### Executive Functioning and Written Language

#### Classification

<table>
<thead>
<tr>
<th>(1) Initiating</th>
<th>Writing Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Poor idea generation</td>
<td></td>
</tr>
<tr>
<td>* Poor independence</td>
<td></td>
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<table>
<thead>
<tr>
<th>(2) Sustaining</th>
<th>Writing Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Lose track of thoughts</td>
<td></td>
</tr>
<tr>
<td>* Difficulty finishing</td>
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<table>
<thead>
<tr>
<th>(3) Inhibiting</th>
<th>Writing Dysfunction</th>
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<tbody>
<tr>
<td>* Sentences disjointed</td>
<td></td>
</tr>
<tr>
<td>* Impulsive/Distractible</td>
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</table>

<table>
<thead>
<tr>
<th>(4) Shifting</th>
<th>Writing Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Perseverations</td>
<td></td>
</tr>
<tr>
<td>* “Stuck” on topic</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>(5) Poor Organization</th>
<th>Writing Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Frequent erasers</td>
<td></td>
</tr>
<tr>
<td>* Forget main idea</td>
<td></td>
</tr>
<tr>
<td>* Disjointed content</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>(6) Poor Planning</th>
<th>Writing Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Poor flow of ideas</td>
<td></td>
</tr>
<tr>
<td>* Incorrect spacing</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>(7) Poor Self Monitor</th>
<th>Writing Dysfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>* Lack of cohesive ties</td>
<td></td>
</tr>
<tr>
<td>* Spelling miscues</td>
<td></td>
</tr>
<tr>
<td>* Sloppy work</td>
<td></td>
</tr>
<tr>
<td>* Careless errors</td>
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</tr>
</tbody>
</table>
Prefrontal Cortex Development and Writing

Growing a Grown-up Brain

Scientists have long thought that the human brain was formed in early childhood. But by scanning children’s brains with an MRI a year after year, they discovered that the brain undergoes radical changes in adolescence. Extra gray matter is pruned out, making brain connections more specialized and efficient. The parts of the brain that control physical movement, vision, and the senses mature fast, while the regions in the frontal cortex that control higher thinking don’t finish the pruning process until the early 20s.

Writing and Effortful Control

Cognitive Constructs Involved with Written Language

Motor Output Speed

<table>
<thead>
<tr>
<th>Grade Levels</th>
<th>Handwriting Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade 1</td>
<td>15 - 32 letters per minute</td>
</tr>
<tr>
<td>Grade 2</td>
<td>20 - 35 letters per minute</td>
</tr>
<tr>
<td>Grade 3</td>
<td>25 - 47 letters per minute</td>
</tr>
<tr>
<td>Grade 4</td>
<td>34 - 70 letters per minute</td>
</tr>
<tr>
<td>Grade 5</td>
<td>38 - 83 letters per minute</td>
</tr>
<tr>
<td>Grade 6</td>
<td>46 - 91 letters per minute</td>
</tr>
</tbody>
</table>

BRAIN REGION – Basal Ganglia (Pollack et al., 2009)
5 Major Steps of Writing Process (Ray, 2001)

1. Prewriting - use graphic organizers.
2. Drafting – use model to take notes and model how to organize in a text form using topic sentences.
3. Revising – second draft emphasizing content, and elaboration of ideas and making connections.
4. Editing – re-read for capitalization and punctuation errors.
5. Publishing – peer assisted strategies and teaching students to give and receive feedback.

The Timing of Learning

1. The younger the child, the better the outcome.
2. The “at-risk” child responds best to small group instruction (3:1), with phonological awareness training most effective for younger children, but a balanced literacy approach for older ones.
3. Highly trained teachers achieve the best results.
4. Frequency of instruction (4-5 days per week) was more effective than sporadic instruction (2 days per week).
5. Younger children do not generalize and transfer as well as older children (frontal lobes), so teach in context until ready for rule generalization.

Let’s Stay Connected!

Steven G. Feifer, D.Ed., ABSNP
Licensed Psychologist
Monocacy Neurodevelopment Center

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