The Neuropsychology of Learning Disabilities:
Developing Evidenced-Based Reading, Writing, and Math Interventions

The lobes of the cerebral cortex in the left cerebral hemisphere, shown in lateral view

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

1

Course Outline

➢ Six part webinar series on reading, writing, & math disabilities sponsored by Jack Hirose & Associates.
➢ Introduce a brain-based educational model of dyslexia, dysgraphia, and dyscalculia and classify each disability into distinct subtypes.
➢ Discuss targeted interventions for all students with academic learning issues.
➢ Questions and Comments?

➢ **Steven G. Feifer, D.Ed., ABSNP**
❑ 2008 MD School Psych of Year
❑ 2009 NASP School Psych of Year
❑ Authored 7 books
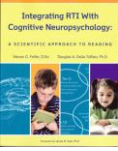❑ Authored 2 tests: FAR & FAM
❑ feifer@comcast.net

2

Reading Presentation Goals
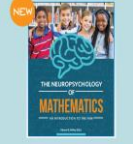
1. Discuss the prevalence of learning disabilities in both Canada and the United States.

2. Discuss the pitfalls of relying on an aptitude-achievement *discrepancy model* as the sole basis for identifying reading disorders in young children.

3. Introduce a *brain-based* educational model to effectively identify and classify four **subtypes** of reading disorders.

4. Discuss four universal truths with respect to reading in order to provide a foundation for linking each reading subtype with specific interventions.

5. Introduce the **FAR**, an innovative new assessment tool that allows educators and psychologists to better diagnose reading disorders in children.

3

Further Reading Materials

Integrating RTI With Cognitive Neuropsychology:

A SCIENTIFIC APPROACH TO READING

THE NEUROPSYCHOLOGY OF WRITTEN LANGUAGE DISORDERS

THE NEUROPSYCHOLOGY OF MATHEMATICS

www. schoolneuropsychpress.com
@schoolneuropsychpress

4

Dispelling Neuromyths

Macdonald, K., Germine, L., Anderson, A., Christodoulou, J., McGrath, L. (2017). **Dispelling the Myth: Training in Education or Neuroscience Decreases but Does Not Eliminate Beliefs in Neuromyths.** *Frontiers in Psychology,* 8, 1314.

1. VAK Learning Styles
2. Dyslexia and Reversals
3. Mozart Effect
4. We use just 10% of our Brains
5. Sugar causes ADHD
6. Right vs Left Brain Learners

General Public…………………..(m=68%)
Educators ……………………... (m=56%)
High Neuroscience Exposure…(m=46%)

5

Canadian LD Definition

LEARNING DISABILITY (Grades 1–12: Code 54)

This is the official definition adopted by the Learning Disabilities Association of Canada (LDAC) on January 30, 2002.

"Learning Disabilities" refer to a number of disorders which may affect the acquisition, organization, retention, understanding or use of verbal or nonverbal information. These disorders affect learning in individuals who otherwise demonstrate at least average abilities essential for thinking and/or reasoning. As such, learning disabilities are distinct from global intellectual deficiency.

Learning disabilities result from impairments in one or more processes related to perceiving, thinking, remembering or learning. These include, but are not limited to: language processing; phonological processing; visual spatial processing; processing speed; memory and attention; and executive functions (e.g., planning and decision-making).

Learning disabilities range in severity and may interfere with the acquisition and use of one or more of the following:
- oral language (e.g., listening, speaking, understanding)
- reading (e.g. decoding, phonetic knowledge, word recognition, comprehension)
- written language (e.g., spelling and written expression)
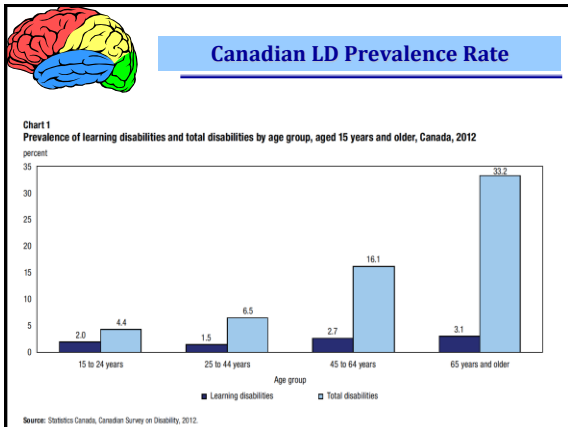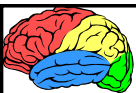- mathematics (e.g., computation, problem solving).

Prevalence of LD in Canada
Participation and Activity Limitation Survey (PALS, 2006)

▶ More Canadian children have a learning disability than all other types of educational disabilities combined.

▶ According to Statistics Canada, 3.2% of Canadian children have a learning disability – that's the equivalent of one child in every school bus full of children.

▶ More than half a million adults in Canada live with a learning disability, making it more challenging for them to learn in universities, and on the job.

▶ Learning disabilities have increased considerably between 2001 and 2006 among Canadians aged 15 and over by almost 40 per cent to 631,000 people, making it one of the fastest growing types of disabilities in Canada that isn't related to aging.

7

Canadian LD Prevalence Rate

Chart 1
Prevalence of learning disabilities and total disabilities by age group, aged 15 years and older, Canada, 2012

percent

Age group	Learning disabilities	Total disabilities
15 to 24 years	2.0	4.4
25 to 44 years	1.5	6.5
45 to 64 years	2.7	16.1
65 years and older	3.1	33.2

Source: Statistics Canada, Canadian Survey on Disability, 2012.
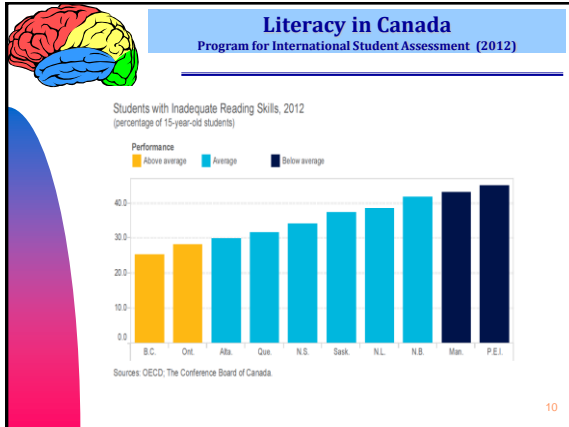

Canadian LD Prevalence Rate

Table 2
Effect of disability on educational experiences for adults with a learning disability, aged 15 years and older, Canada, 2012

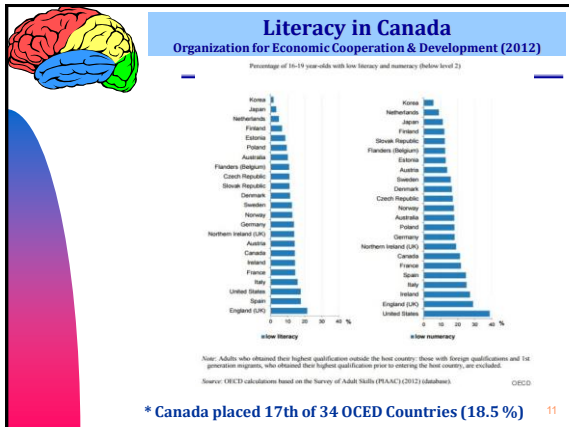| Effect of disability	Percentage
Took longer to achieve current level due to disability	64.6
Took fewer courses due to disability	63.5
Choice of courses/career influenced by disability	63.4
People avoided/excluded you in school due to disability	57.5
Bullied at school because of disability	49.8
Changed course of studies due to disability	49.0
Education interrupted due to disability	47.4
Attended special education classes in regular school	47.2
Discontinued education due to disability	41.4

Note: Learning disabilities includes those in school within the last 5 years and had disability while in school.
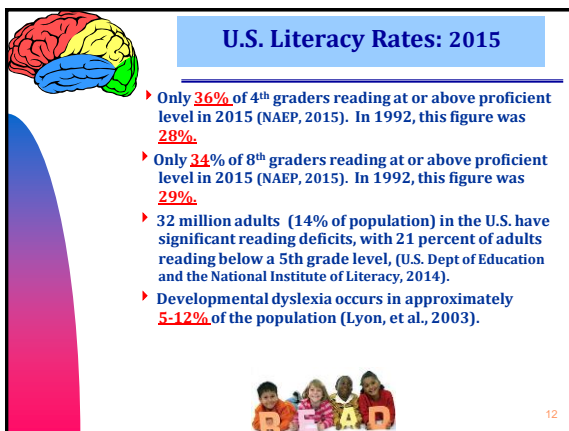**Source:** Statistics Canada, Canadian Survey on Disability, 2012.

9

3

Literacy in Canada
Program for International Student Assessment (2012)

Students with Inadequate Reading Skills, 2012
(percentage of 15-year-old students)

Performance
Above average   Average   Below average

Sources: OECD; The Conference Board of Canada.

10

Literacy in Canada
Organization for Economic Cooperation & Development (2012)

Percentage of 16-19 year-olds with low literacy and numeracy (below level 2)

Note: Adults who obtained their highest qualification outside the host country: those with foreign qualifications and 1st generation migrants, who obtained their highest qualification prior to entering the host country, are excluded.

Source: OECD calculations based on the Survey of Adult Skills (PIAAC) (2012) (database).

OECD

* Canada placed 17th of 34 OCED Countries (18.5 %)   11

U.S. Literacy Rates: 2015

- Only **36%** of 4th graders reading at or above proficient level in 2015 (NAEP, 2015). In 1992, this figure was **28%.**
- Only **34%** of 8th graders reading at or above proficient level in 2015 (NAEP, 2015). 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).
- Developmental dyslexia occurs in approximately **5-12%** of the population (Lyon, et al., 2003).

12

Defining Dyslexia??

IDA –deficits in accurate and/or fluent word recognition, decoding, spelling, with secondary effects on reading comprehension.

ICD-10- dyslexia is marked by reading achievement that falls substantially below that expected given the individual's chronological age, measured intelligence, and age-appropriate education.

WHO – a neurodevelopmental disorder hindering the acquisition of reading that cannot otherwise be explained by IQ, academic opportunities, motivation, or specific sensory acuity.

IDEA - a learning disability is a basic disorder of a psychological process used in understanding oral, spoken, or written language, and may manifest in the imperfect ability to listen, think, speak, read, write, spell, or do math. It may include conditions such as **dyslexia.**

DSMV – dropped the term and classifies reading issues under the generic term of specific learning disorder.
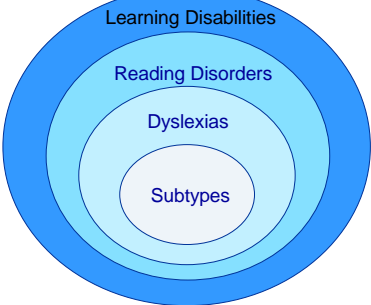
13

And the Winner Is.....

➢ *"Dyslexia is characterized by difficulties with **_accurate_** and / or **fluent** word recognition and by poor spelling and decoding abilities. These difficulties typically result from a deficit in the phonological component of language that is often unexpected in relation to other cognitive abilities and the provision of effective classroom instruction. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede growth of vocabulary and background knowledge."*

- International Dyslexia Association

14

DEVELOPMENTAL DYSLEXIA

Learning Disabilities

Reading Disorders

Dyslexias

Subtypes

15

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 <u>ALL</u> 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 <u>processes</u> information...not label.

▶ *Evidence based interventions require evidence based assessments!!*

16

NASP 2011 LD POSITION STATEMENT

▶ 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).
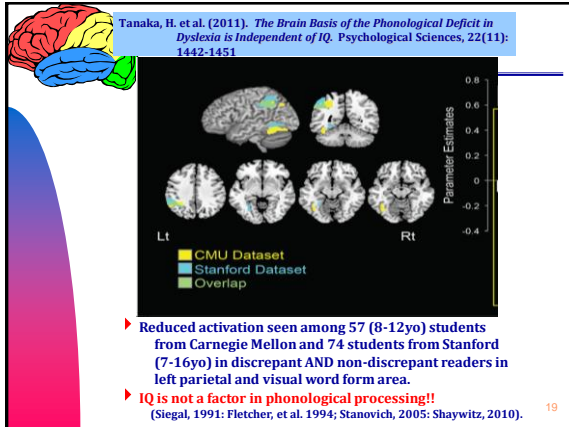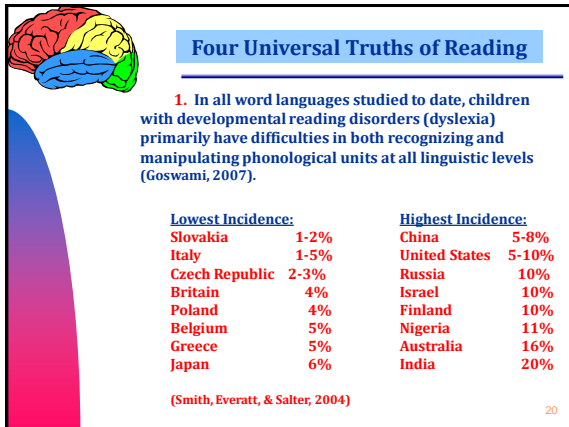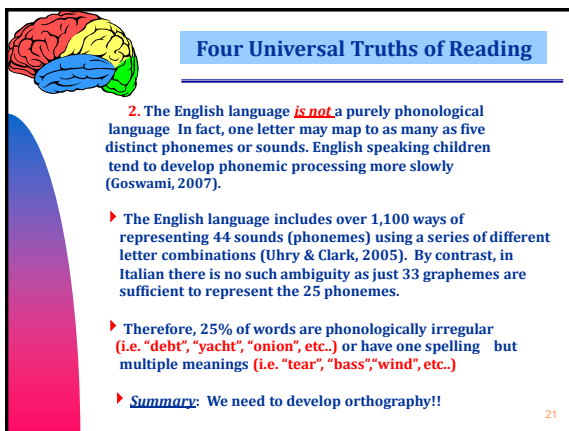
MAIN PITFALLS OF DISCREPANCY MODEL

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

2. A discrepancy model of reading disabilities precludes early identification.

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

4. 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?

18

Tanaka, H. et al. (2011). *The Brain Basis of the Phonological Deficit in Dyslexia is Independent of IQ.* Psychological Sciences, 22(11): 1442-1451

- Reduced activation seen among 57 (8-12yo) students from Carnegie Mellon and 74 students from Stanford (7-16yo) in discrepant AND non-discrepant readers in left parietal and visual word form area.
- IQ is not a factor in phonological processing!!
  (Siegal, 1991: Fletcher, et al. 1994; Stanovich, 2005: Shaywitz, 2010).

19

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).

Lowest Incidence:		Highest Incidence:	
Slovakia	1-2%	China	5-8%
Italy	1-5%	United States	5-10%
Czech Republic	2-3%	Russia	10%
Britain	4%	Israel	10%
Poland	4%	Finland	10%
Belgium	5%	Nigeria	11%
Greece	5%	Australia	16%
Japan	6%	India	20%

(Smith, Everatt, & Salter, 2004)

20

Four Universal Truths of Reading

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!!

21

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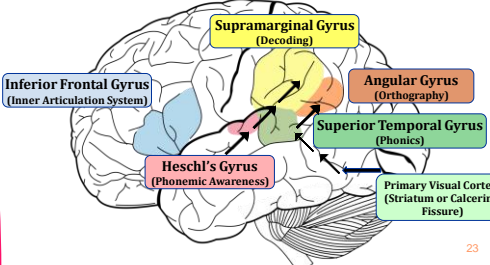
    a) Closed syllables (just one vowel…"cat")
    b) Open syllables (ends in long vowel…"baby")
    c) Vowel-Consonant **E** Syllables
    (silent **e** elongates vowel…"make")
    d) Vowel-Team Syllables (two vowels make one sound…"c**au**tion")
    e) R-Controlled Syllables (vowel followed by "r" changes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

22

The Reading Brain: How Words are Assembled

3. Specific neuroimaging techniques have demonstrated that **phonological** processing and **orthographic** processing are 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).*

- Supramarginal Gyrus (Decoding)
- Inferior Frontal Gyrus (Inner Articulation System)
- Angular Gyrus (Orthography)
- Superior Temporal Gyrus (Phonics)
- Heschl's Gyrus (Phonemic Awareness)
- Primary Visual Cortex (Striatum or Calcerine Fissure)
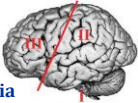
23

Three Functional Units of the Brain

Alexander Luria
(1902-1977)

*Unit #II: the unit for receiving analyzing, and storing information. Neurons arranged in hierarchical zones:
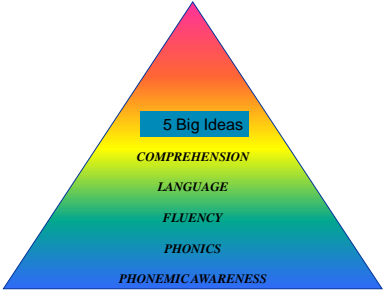
1) Primary zones are modality specific and receive input from sensory modalities (visual, auditory, tactile).

2) Secondary zones are associative or intermodal areas that integrate two different modalities (i.e. visual/auditory)

3) Tertiary zones are modality NONSPECIFIC and involved in higher order integration of organize human symbol systems. Posterior parietal regions.

24

Four Universal Truths of Reading

4. According to the National Reading Panel (2000), and modified by Grizzle et al. (2009), the **5** big ideas of the reading process include:

5 Big Ideas

COMPREHENSION

LANGUAGE

FLUENCY

PHONICS

PHONEMIC AWARENESS

25

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 <u>explicit phonics</u>.

(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.

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

26

Education Support Services (ESS) Teams

TIER 3 — Intensive, individual interventions

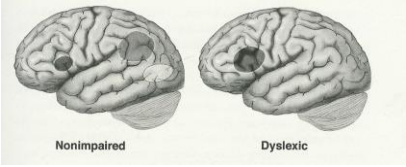TIER 2 — Targeted, small group interventions

TIER 1 — Core instruction for all students

➢ Problem solving and Action Planning Team

➢ Provides supports for all students and not just those requiring a personalized learning plan.

➢ Goal is positive outcomes for students with diverse learning needs.

27

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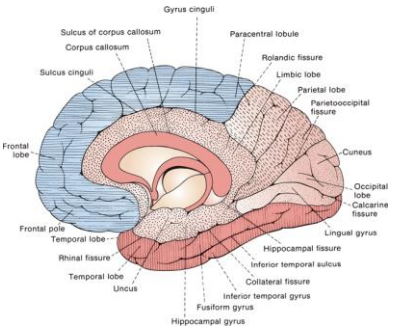### (Shaywitz, 2003)

Nonimpaired   Dyslexic

▸ **Nonimpaired readers activate primarily posterior portions of left hemisphere.**

▸ **Impaired readers under-activate posterior regions and activate primarily frontal areas.**

28

Left Fusiform vs Right Fusiform Gyrus

29

Do Interventions Change the Brain?

▸ **Barquero, L.A., Davis, N., & Cutting, L. E.(2014). Neuroimaging of reading intervention and activation likelihood estimate meta-analysis. Plos One, 9(1), 1-16.**

▸ **Research is beginning to show two specific brain changes with LD kids as a result of reading interventions:**
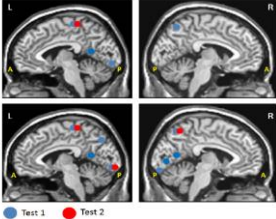
1. Hemispheric "normalization" – the left hemisphere begins to assert dominance after just four weeks of intervention.

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).

30

Do Interventions Change the Brain?

- Horowitz-Kraus, T., Vannest, J.J., Kadis, D., Cicchino, N., Wang, Y.Y. & Holland, S. K.(2014). Reading acceleration training changes brain children with reading disorders. *Brain and Behavior*, 886-902.
  - 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 answ
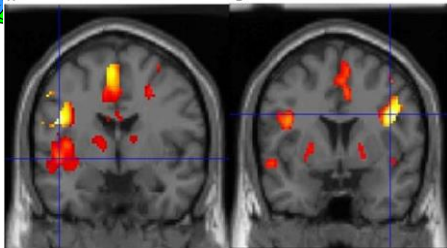

The Right Hemisphere Hypothesis

➢ Normal adults reading a list of nouns activating left superior temporal gyrus in hemisphere, whereas dyslexia adults activate right inferior frontal cortex.

Waldie K. E. (2002). "Reading with the right hemisphere: from normal development to dyslexia," in *Advances in Psychology Research* Vol. 9 ed. Shohov S. P., editor. (New York, NY: Nova Science Publishers, Inc;), 157–184. 32

Integrating Models of Dyslexia

Peterson, R. L., Pennington, B. F., & Olson R. K., (2014) Subtypes of developmental dyslexia: Testing the predictions of the dual-route and connectionist frameworks. *Cognition,* 126(1), 20-38.

1. **Simple Model of Reading** – reading decoding deficits lead to poor comprehension skills. Monolithic model leading to monolithic outcome.
2. **Dual Route Model of Reading** – Phonological and Orthographical pathways impact either lexical or sub-lexical systems.
3. **Connectionist Model of Reading** – All words are read via a single procedure, as phonological and orthographical systems become intertwined over time and with experience. The role of semantic processing is discussed as facilitating orthographic processing.
4. **Integrated Neuropsychological Model** * – (Feifer, 2015) integrates the role of phonology, orthography, and morphological processing to cue word recognition skills using a variety of psychological processes. The net result is 4 subtypes of reading disorders.
   * Type of imaging, age of child, type of reading task, smaller sample sizes lead to differing outcomes.

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.

34

Let's Stay Connected!

Steven G. Feifer, D.Ed., ABSNP
Licensed Psychologist

Workshops: feifer@comcast.net

Books: www.schoolneuropsychpress.com
@schoolneuropsychpress

Tests: FAR- 2015   FAM- 2016   FAW - 2019
Psychological Assessment Resources

35