The Neuropsychology of Reading Disorders: Diagnosis and Intervention

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Presentation Goals:
1. Discuss the pitfalls of relying on an IQ/Achievement discrepancy model, or a student’s Response To Intervention, as the sole basis for identifying reading disorders in young children.

2. Link brain functions to the reading process and introduce a brain-based educational model to effectively identify and classify subtypes of reading disorders.

3. Discuss four key brain concepts with respect to reading, and tie in appropriate remediation and educational strategies for each reading subtype.

4. Introduce the 90 minute dyslexia evaluation as a more comprehensive means to evaluate reading by measuring eight core constructs associated with reading disorders in children.

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5 Pitfalls of Aptitude/Achievement Discrepancies

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

2. It remains unclear as to which IQ score should be used to establish a discrepancy.

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

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

5. A discrepancy model promotes a “wait and fail” policy forcing intervention to come after the fact.

**Developmental Dyslexia:** The term refers to an inability to acquire functional reading skills despite the presence of normal intelligence and exposure to adequate educational opportunities. This term is often synonymous with the term "learning disabled", and assumed to represent 5 to 10 percent of all school-aged children.

**ALTERNATIVE ASSESSMENT METHODOLOGIES**

**Reauthorization of IDEA:**

* President Bush signed the IDEA bill into law in December, 2004.
* States may opt out of using a discrepancy model to identify learning disabilities, and replace by using a **Response-To-Intervention** model.
* Gives school districts flexibility to craft a policy whereby students who do not respond to scientifically-based early reading programs may be considered eligible for special education services.
* Requires districts with significant over-identification of minority students to consider eliminating IQ testing and establish procedures to reduce disproportional representation in special ed.
Six Components of an Effective RTI Model

(1) **Universal Screening** - for all students a minimum of three times per year.

(2) **Baseline Data** - using curriculum-based measurement as primary data gathering means.

(3) **Measurable Terms** - define problem areas numerically.

(4) **Accountability Plan** – monitor fidelity of selected intervention.

(5) **Progress Monitoring** – how, where, and when intervention results will be measured and recorded.

(6) **Data Based Decision Making** – ongoing analysis of data to drive future intervention decisions.

**RESPONSE TO INTERVENTION MODEL**

Figure 1. NRC Multi-tiered Interventions (figure adapted from Heartland AEA Program Manual, 2002).
COMMON MYTHS ABOUT RTI

(1) *The outcome and intent of RTI is identification* - The intent of RTI is to utilize evidenced based instruction and data based decision making.

(2) *“Tier IV is only special education”* - the last tier is simply the most intense level of intervention.

(3) *“RTI is only for pre-referral decision making”* - RTI is a model for assisting all learners, not just weeding out candidates for special education.

(4) *“RTI is best used to distinguish LD students from students not achieving due to poor instruction”* – The main benefit of RTI is prevention.

(5) *“RTI is only beneficial for reading”* – RTI has just as much research documenting its effectiveness for behavioral concerns.

**Curriculum-Based Measurement** – an assessment of reading fluency by selecting a random probe from the student’s basal reader, and the median number of words read correctly in one minute is recorded. Multiple measures in 3-minute intervals are administered throughout the year, instead of relying upon lengthy standardized tests.

RTI ADVANTAGES AND DISADVANTAGES

<table>
<thead>
<tr>
<th>Advantages:</th>
<th>Disadvantages:</th>
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<tbody>
<tr>
<td>* Better ecological validity than norm referenced testing.</td>
<td>* Not a diagnostic approach.</td>
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<tr>
<td>* Quicker and cheaper than norm referenced testing.</td>
<td>* Does not assess many other aspects of reading such as comprehension.</td>
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<tr>
<td>* Allows for earlier intervention opportunities.</td>
<td>* Does not address the core aspects of reading as put forth by the National Reading Panel (2000).</td>
</tr>
<tr>
<td>* Emphasis on discrepancy from peer performance, not IQ.</td>
<td>* Does not answer the most important question: <em>Why?</em></td>
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<tr>
<td>* Evaluation hi-lights reading, not bureaucratic categories</td>
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NATIONAL READING PANEL CONCLUSIONS

**Kindergarten through 1st grade**

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 instruction.
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. Gains were maintained in most children at long-term follow up.
6. The following characteristics of the child were associated with poor outcome:
   a) attention or behavioral concerns
   b) low socioeconomic status
   c) poor verbal skills
   d) poor rapid naming skills
NATIONAL READING PANEL CONCLUSIONS

2nd through 6th grades

(1) Readers at this age respond to explicit phonological instruction with improved word reading, the gains were not as strong as with younger children.
(2) These readers were less responsive to explicit phonics, though did better in one-to-one or small group instruction.
(3) More intensive work for a longer duration was required.
(4) Spelling and fluency did not improve very well, though some improvement was noted with reading comprehension.
(5) Gains were maintained in most children at long-term follow up.
(6) Computer instruction served as an effective aid, but was not effective by itself.
(7) The following characteristics of the child were associated with poor outcome:
   a) attention or behavioral concerns
   b) low socioeconomic status
   c) poor verbal skills
   d) poor rapid naming skills

NEUROPSYCHOLOGY: A BRAIN/BEHAVIORAL APPROACH

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.

Evolution of Reading: * Encompassed just the past 5000 to 6000 years
   * Approximately 1/3rd of world's population illiterate
   * Human beings seem pre-wired to acquire sound/symbol language code.
   * Some estimates suggest 75% of children will learn to read in spite of methodology (Mather, 1992).
   * 20% of children need a specific method (e.g. Alphabetic Phonics)
   * 5% may never acquire this skill at a functional level
GENERAL BRAIN STRUCTURES

**Brain:**
* Weighs approximately 1400 grams (3 pounds)
* 100 billion cells comprised of neurons (gray matter) and glial cells (white matter)
* Each neuron makes contact with as many as 10,000 other neurons.
* The firing rate of a neuron ranges from a few to several hundred per second.
* Makes up less than 2 percent of body weight, though uses up 25 percent of oxygen supply and 70 percent of glucose.
* DNA evidence suggests human brain has been evolving for approximately 5 million years.

**Neocortex:**
- **Frontal Lobes** - organizes and arranges information leaving the brain.
- **Parietal Lobes** - responsible for sensory and tactile functions.
- **Temporal Lobes** – houses acoustically based information and language
- **Occipital Lobes** - visual processing centers of the brain.
4 KEY BRAIN CONCEPTS WITH RESPECT TO READING

(1) At birth, the human brain weighs just 25% of its adult weight, thereby leaving more room for the environment to shape brain growth more than any other species (Chase, 1996).

Environmental Learning: (Kotulak, 1997)

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

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

* Average number of words spoken daily in welfare household………….  500 -800
  1.0 million words by age three

* Furthermore, children in welfare families hear negative remarks twice as often as positive ones (Kotulak, 1997).

* Human brain volume 95 % of its adult weight by age 5 (Stahl, 2000).
4 KEY BRAIN CONCEPTS WITH RESPECT TO READING

(2) Prenatal factors have been linked to brain development, as proteins are crucial in forming latticework of synaptic connections between brain cells.

Fast Facts:  * Prenatal malnutrition causes more permanent harm than postnatal malnutrition because it slows the proliferation rate of cells (Byrnes, 2001). Postnatal malnutrition hinders cell connections and myelination process. Enriching diet can ameliorate the problem.
* More synapses present in brain by age 6 than any other time (Stahl, 2000).
* 83 percent of dendritic sprouting occurs after birth (Berninger & Richards, 2002).
* Ectopias represent misplaced clusters of neurons along the left perisylvian regions modulating rapid sound and symbol processing. Ectopias may be related to prenatal alcohol and nicotine consumption, as well as genetic scripts. These focal malformations have been found in fMRI studies of the dyslexic brain (Galaburda & Cestnick, 2003).

STAGES OF BRAIN DEVELOPMENT:

I. **Proliferation** - cells proliferate and divide in the developing fetus from an inside to outside fashion. The cortex overproduces neurons, with production ending by 7th prenatal month – maybe 1 trillion formed at a rate of 250,000 cells per minute (Byrnes, 2001).

II. **Migration** - cells migrate to appropriate location in the brain.
   a) **Aggregation** - cells cluster into nuclei, like thalamus.
   b) **Arborization** - thickening of dendrites as cells interconnect.

III. **Differentiation** - First 2 or 3 years postnatally, neurons continue to subdivide forming an overabundance of synapses. This overproduction appears to help children recover from brain damage more easily than adults (plasticity).

**Pruning** - many more neurons create synaptic connections and functional circuits than are needed. For maximum efficiency on a task, cell death or axonal retraction is essential. Perhaps 50 to 90% eventually die (*apoptosis*) leaving the mature brain with 100 billion neurons.

**Auditory Pruning** - every child is born with the ability to discriminate all sounds. However, based upon exposure to cultural specific dialects, a child becomes tuned to only sounds from host language. Explains why children born in another country continue to have foreign accents if brought to the United States past age five.
4 KEY BRAIN CONCEPTS WITH RESPECT TO READING

(3) Wiesel and Hubel won the Nobel Prize for two landmark discoveries about the brain. (1) Sensory experience remains essential for teaching brain cells their jobs. (2) After a certain critical period, brain cells lose the opportunity to learn these jobs and seek out other duties to perform.

**SUMMARY:** There are certain windows of opportunity for learning based upon the developing nervous system, brain growth spurts, and subsequent myelination. Sensory experiences are essential for teaching brain cells their jobs, and after a certain critical period, brain cells lose their opportunity to learn their jobs (Kotulak, 1997). For instance:

**Vision:**  * If a child does not process visual experiences by age two, the sense of sight may never develop properly.

**Hearing:**  * If a child does not hear words by age 10, it becomes increasingly difficult to discriminate among the sounds of a language.

(4) Educators should synchronize instructional strategies with specific neuro-developmental windows to determine the most opportune time to offer a reading intervention.

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**THE TIMING OF LEARNING**

<table>
<thead>
<tr>
<th>AGE</th>
<th>SKILL</th>
<th>BRAIN REGION</th>
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</thead>
<tbody>
<tr>
<td>3 - 10 months</td>
<td>Attention &amp; Awareness</td>
<td>Reticular Formation</td>
</tr>
<tr>
<td>2 - 4 years</td>
<td>Language Acquisition</td>
<td>Temporal Lobes</td>
</tr>
<tr>
<td>6 - 8 years</td>
<td>Phonemic Development</td>
<td>Inferior Parietal and Temporal Lobes</td>
</tr>
<tr>
<td>10 - 12 years</td>
<td>Abstract Language</td>
<td>Inferior Parietal Lobes and Frontal Lobes</td>
</tr>
<tr>
<td>14 - 16 years</td>
<td>Judgement &amp; Planning</td>
<td>Frontal Lobes</td>
</tr>
</tbody>
</table>

* Increment in brain weight 5-10 percent over each 2 year period.
* Expansion not due to neuronal proliferation, but rather growth in dendritic processes and myelination.
NEUROIMAGING STUDIES OF DYSLEXIA

Shaywitz (2003)
* Nonimpaired readers activate primarily posterior portions of left hemisphere.
* Impaired readers under-activate posterior regions and activate primarily frontal areas.

CHARACTERISTICS OF READING DISABLED CHILDREN:
* Poor decoding skills
* Weak vocabulary development
* Inability to read strategically
* Poor spelling
* Few reading opportunities outside of school
* Poor motivation and confidence

3 WAYS TO IDENTIFY WORDS IN PRINT:
1. Phonological Code - using sound patterns to identify words.
2. Orthographic Code - using visual contour and shapes to identify words
SUBTYPES OF DYSLEXIA

1. **Phonological Subtype** - Great difficulty using phonological route in reading, so visual route to lexicon used. There is little reliance on letter to letter sound conversion. Instead, an over-reliance on visual cues to determine meaning from print.

**Anatomical Correlates:** Left temporal-parietal cortex

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KEY BRAIN REGIONS IN DYSPHONETIC DYSLEXIA

**Heschl’s Gyrus** – auditory perception and discrimination (phonemic awareness).

**Superior Temporal Gyrus** – modulating the 44 phonemes of the English language.

**Angular Gyrus** – cross modal association area underlying mapping symbols to sounds.

**Supramarginal Gyrus** – cross modal association area underlying the spatial appreciation and positioning of sounds.

**Inferior Frontal Gyrus** – end point for inner articulation region.

**Dorsal Stream** – all of the aforementioned structures involved in the ability to phonologically assemble a word. A relatively slower paced learning network.
PHONOLOGICAL DYSLEXIA INTERVENTIONS

REMEDIATION STRATEGIES FOR DYSPHONETIC DYSLEXIA

TOP-DOWN

**Over Age 12:**
- Wilson Reading System
- SRA Corrective Reading
- Read 180

**Ages 7 - 12:**
- Alphabetic Phonics (Orton-Gillingham)
- Recipe for Reading
- SRA Corrective Reading
- Earobics II
- SIPPS
- LIPS
- LEXIA
- Horizons
- Read Well
- DISTAR (Reading Mastery)

**Under Age 7:**
- Fast Forward (Tallal)
- Earobics I
- Phono-Graphix
- Lindamood Phoneme Sequencing Program (LIPS)
- Success for All
- Ladders to Literacy
- Fundations
- Road to the Code

BOTTOM-UP
SURFACE DYSLEXIA

2. **Surface Dyslexia** - these children tend to over-rely on sound/symbol relationships as the process of reading never becomes automatic. Words are broken down to individual phonemes and read very slowly and laboriously, especially where phonemes and graphemes are not in a 1 to 1 correspondence.

**Error analysis of Surface Dyslexia:**

<table>
<thead>
<tr>
<th>Word</th>
<th>Read as</th>
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<tbody>
<tr>
<td>island</td>
<td>izland</td>
</tr>
<tr>
<td>grind</td>
<td>grinned</td>
</tr>
<tr>
<td>listen</td>
<td>liston</td>
</tr>
<tr>
<td>begin</td>
<td>beggin</td>
</tr>
<tr>
<td>lace</td>
<td>lake</td>
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</tbody>
</table>

**Structural Explanations for Surface Dysgraphia:**

1. **Angular gyrus:** Goldberg (1989) reasoned that some reading and writing deficits may occur due to the disintegration of visual and spatial representations in our brains. Areas of the occipital lobe (processing vision) and the parietal lobe (processing spatial awareness) intersect in the inferior parietal region known as the **angular gyrus** (interface of occipital and parietal lobes). In the left hemisphere, this region of our brain allows for the appropriate visual-spatial mapping of linguistic information.

2. **Insular Cortex** - buried deep in the folds between parietal and temporal lobes. PET studies have suggested involvement in automatizing the reading process (Paulesu, et al, 1996) May serve as a “lexical checking” system to allow readers to double check for unique spelling of phonologically consistent words (Owen, Borowsky, & Sarty, 2004).

3. **Multiple Pathway Model** (Shaywitz, 2003) - there are multiple pathways in the brain which modulate various aspects of the reading process. The **occipital-temporal** (**Fusiform Gyrus**) region automatically recognizes word forms. Dyslexics tend to under-activate this region, also called **ventral stream**.

4. **Magnocellular pathway** deficits have been linked to speed of temporal lobe processing (Demb, Boynton, & Heeger 1997). Some studies suggest 27% fewer neurons in magnocellular pathways from retina to LGN to occipital lobes (Livingstone, et al., 1991).

* Some studies have linked deficits in this circuitry affects up to 75 percent of dyslexics (Ridder, Borting, Coope, McNeel, & Huang, 1997).

* Magno (large) cells are heavily mylinated meaning they have much higher conduction velocities than parvo cells, which process color and fine detail. Magno cells process visual motion, and motion sensitivity correlates strongly with reading and orthographic processing (Stein, 2000).
SURFACE DYSLEXIA INTERVENTIONS

* **Reversals:** According to Stein (2000), most dyslexic children complain that letters seem to jump around when reading. During the reading process, the eyes remain fixated on an individual word for just 300msec before saccading to the next. Even during these brief fixations, the eye moves approximately 1 degree, or the equivalent of 4 or 5 letters. The magnocellular system allows us to stabilize this movement, but many dyslexics cannot, therefore transposing letters when reading. This unintended eye movement varies in each eye, thus resulting in a high level of binocular instability. Since this instability causes the line of sight for each eye to cross into an unintended visual field, the letters seem to change places.

<table>
<thead>
<tr>
<th>Remediation Techniques</th>
<th>Under Age 7: Analytic or Embedded Phonics Approach (&quot;top down&quot; methodology)</th>
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<tbody>
<tr>
<td></td>
<td>Reading Recovery</td>
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<tr>
<td></td>
<td>Early Steps</td>
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<tr>
<td>Ages 7 - 12:</td>
<td>Great Leaps program</td>
</tr>
<tr>
<td></td>
<td>Read Naturally</td>
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<tr>
<td></td>
<td>Quick Read</td>
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<tr>
<td></td>
<td>RAV-O</td>
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<tr>
<td>Over Age 12:</td>
<td>Neurological Impress method</td>
</tr>
<tr>
<td></td>
<td>Wilson Reading System</td>
</tr>
<tr>
<td></td>
<td>Laubach Reading Series</td>
</tr>
<tr>
<td></td>
<td>Read 180</td>
</tr>
</tbody>
</table>
MIXED DYSLEXIA

3. **Mixed Dyslexia** - severely impaired readers with characteristics of both phonological deficits as well as visual/spatial deficits. These readers have nouseable key to the reading and spelling code. Very bizarre error patterns observed.

**Structural Explanations:**

1. Some studies (Hynd, Hall, Novey, Eliopulos, Black, Gonzalez, & Edmonds, Riccio, & Cohen, 1995) have suggested that the genu of the corpus callosum is much smaller in dyslexic individuals. Duara et al. (1991) noted the most posterior region of the corpus callosum, termed the splenium, (which maps directly to the plana temporale) was actually larger in dyslexic men than controls.

2. According to Bakker (1992), by the end of 1st grade there is a hemispheric shift of reading mediated primarily by the left hemisphere. Mixed dyslexia may reflect deficits in the ability of the brain to shift modes of operation.

3. Multiple breakdowns in both the phonological route (superior temporal gyrus), the automatic word recognition route (fusiform gyrus), and the semantic route (frontal lobes) may lead to mixed dyslexia.

4. According to Pennington et al., (1999) the insular cortex, which has been associated with the automatic retrieval of linguistic codes, is smaller in dyslexics. Neuroimaging studies have demonstrated that dyslexics do not activate this brain region when compared to controls (Corina, Richards, Serafini, Richards, Steury, Abbott, Echelard, Maravilla, & Berninger, 2001).

4 KEYS TO REMEDIATION

1. **Balanced Literacy** - An eclectic and approach capitalizing on the particular strengths of the child. Perhaps using a multi-sensory type of Orton-Gillingham program, coupled with a fluency model such as Read Naturally, and the computerized models of Read 180. Program depends upon the age, skill level, and neurodevelopmental profile of the child.

2. **Top Down Strategies** – Often atypical development in various regions along the left temporal-parietal cortices responsible for modulating the phonological aspect of reading, and mapping these sounds to the visual word form association areas (Temple, 2002; Shaywitz, et al, 2003; Noble & McCandliss, 2005).

3. **Socioeconomic Status** - According to Noble and McCandliss (2005), socioeconomic status (SES) is a very strong predictor of reading skills due primarily to the home literacy environment. Therefore, schools need to provide more reading opportunities.

4. **Motivation and Confidence** – Great Leaps, Read Naturally, and Neurological Impress tend to give immediate feedback to students that they are improving, and can be used as a confidence builder as well.
**READING COMPREHENSION**

4 Factors Associated with Reading Comprehension:

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

2. **Working Memory** – the ability to temporarily suspend old information while simultaneously learning new information. Working memory is the amount of memory needed to perform a cognitive task, and hindered most by anxiety.

3. **Executive Functioning** – the ability to self-monitor and guide performance on a given problem solving task. The strategy a student uses to decode words as well as to organize information in a meaningful manner.

4. **Language Skills** – most children enter kindergarten with 3000-5000 words, though graduate high school with 60,000 words (Pinker,1999). Since most children do not utter their first word until 12 months of age, that means the average high school senior has learned 10 new words per day since their first birthday.
READING COMPREHENSION INTERVENTIONS

(a) Stop and Start technique – the student reads a passage out loud, and every 30 seconds the teacher says “stop” and asks questions about the story. Eventually the time interval is lengthened.
(b) Directional Questions – ask questions at the beginning of the text instead of the end so students can become more directional readers.
(c) Story Maps – a pre-reading activity where graphic organizers are used to outline and organize information prior to reading the text.
(d) Narrative retelling – have the child retell the story after reading it aloud.
(e) Read Aloud – reading out loud allows students to hear their own voices and can facilitate working memory.
(f) Multiple Exposure – encourage students to skim the material upon reading for the first time, with emphasis on chapter and text headings. Read for detail on the second exposure of the text.
(g) Active Participation – encourage active reading by getting children in the habit of note-taking or putting asterisks next to important material in the text.
(h) Create Questions – have students write their own test questions about the material.
(i) Reduce Anxiety – anxiety inhibits working memory, and leads to ineffective recall. Children who are anxious about reading out loud in front of their classmates should be provided an opportunity to read in a “safety zone” in class. This may also help to eliminate distractions as well.
(j) Medication Management – often students with attention-deficit-disorder struggle with passage comprehension skills. Proper medication management of the disorder can help foster better comprehension.
(k) Practice Terminology – practice defining new terms and concepts prior to reading material with dense language. Vocabulary enrichment is often the key to improving comprehension.
(l) Classroom Discussions – introduce new topic areas with general classroom discussions to capture a student’s attention and interest prior to reading the material.
(m) Sequencing Tasks – present random words out of sequence and have children arrange them to make a sentence. Next, present sentences out of sequence and have children arrange them to make a paragraph. Lastly, present paragraphs out of sequence, and have children arrange them to make a story. This type of organization drill will facilitate sequencing linguistic material.
(n) Increase Fluency – for younger students, greater fluency allows for reading to become a more automatic process, thereby freeing up cognitive resources to concentrate on the passage itself, as opposed to mechanically decoding each word in the passage.
90 MINUTE DYSLEXIA EVALUATION

1. COGNITIVE FUNCTIONING:
   * WISC IV
   * WJ-III
   * Cognitive Assessment System
   * Stanford-Binet Intelligence Scale V
   * RIAS

2. PHONEMIC/PHONOLOGICAL AWARENESS:
   * DIBELS
   * NEPSY II (Phonological Processing)
   * WJ III (Sound Blending, Word Attack)
   * Phonological Awareness Test (Robertson & Satter)
   * Comprehensive Test of Phonological Processing (C-TOPP)
   * Process Assessment of the Learner II (PAL-II)
   * Lindamood Auditory Conceptualization Test (LAC)
   * KTEA II (Nonsense Word Decoding)
   * Test of Phonological Awareness Skills (TOPAS)

3. RAPID NAMING TESTS:
   * DIBELS (Letter Naming)
   * NEPSY II (Word Generation & Speeded Naming)
   * Controlled Oral Word Association (COWA) "FAS" test
   * Process Assessment of the Learner II (PAL-II)
   * Rapid Automatized Naming Tests (Denckla)
   * Comprehensive Test of Phonological Processing (C-TOPP)
   * KTEA II (Naming Facility)
   * WJIII (Rapid Picture Naming)

4. VERBAL MEMORY TESTS:
   * Test of Memory and Learning-2 (TOMAL-II)
   * Children’s Memory Scales (CMS)
   * California Verbal Learning Test-Children’s Version
   * Rey Auditory Verbal Learning Test
   * NEPSY II Memory Scales
   * WRAML-II

5. READING FLUENCY MEASURES:
   * Gray-Oral Reading Test –Fourth Edition (GORT-4)
   * Woodcock-Johnson III
   * WIAT II
   * KTEA II (Word Reading Fluency)
   * DIBELS (Oral Reading Fluency)
   * Curriculum Based Measurement
   * Informal Reading Inventories
90 MINUTE DYSLEXIA EVALUATION

6. VISUAL SPATIAL SKILLS:
* NEPSY II (Arrows, Design Copy)
* Jordan Left Right Reversal Test
* Bender Gestalt II
* Beery Visual Motor Integration Test (VMI)
* RIAS (NIX Index)
* Rey-Osterrieth Complex Figure Test
* WJ III (Spatial Relations, Visual Matching)
* SB V (Visual-Spatial Processing)
* KABC II (Gestalt Closure)

7. ATTENTION:
* Tea-CH
* NEPSY II (Auditory Attention and Response Set)
* CAS (Number Detection, Receptive Attention)
* WJIII (Numbers Reversed, Auditory Attention)
* KABC II (Number recall)
* Behavior Scales (ACTers, ADDES, Brown, BASC II, Conners’)

8. EXECUTIVE FUNCTIONING:
* BRIEF
* Wisconsin Card Sort Test
* Delis-Kaplan Executive Functioning Scale (D-KEFS)
* NEPSY II Subtests
* Category Test
* Stroop Test
* Cognitive Assessment System

9. FAMILY HISTORY:
* Strong Genetic Component
* Chromosome 6 and 15 possible candidates.
* 40% of first degree relatives affected.
* Colorado Twin Study:
  70% identical twins
  48% fraternal twins
References


