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The Role of Neuropsychological Assessment in Understanding Learning Disabilities

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What is NYSAN? Who are we?

www.the-nysan.org

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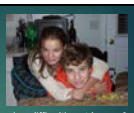
Introduction



- Imagine this scenario:
  - A school-aged child is having difficulties at home & school
    - Teachers say he is unfocused, easily frustrated & often daydreams
    - He has problems w/reading comprehension & spelling
    - At home hours are spent on homework
    - He can be forgetful & oppositional

What is causing these difficulties: a learning disorder, ADHD? What about anxiety?

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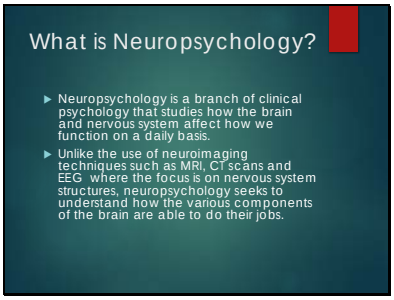

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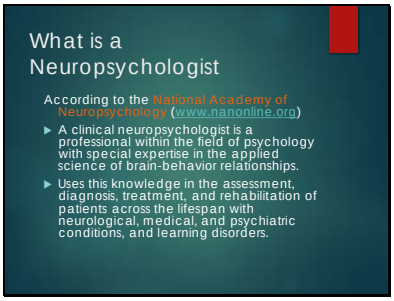

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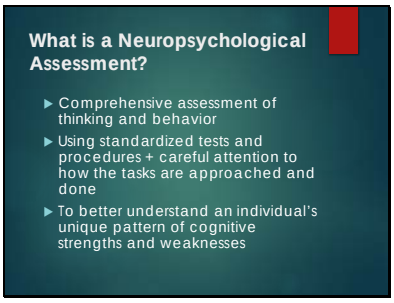

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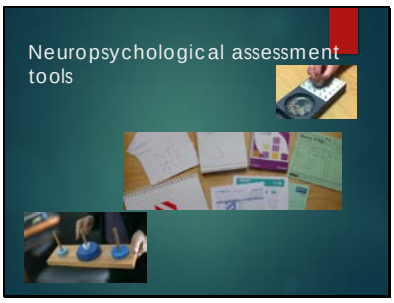

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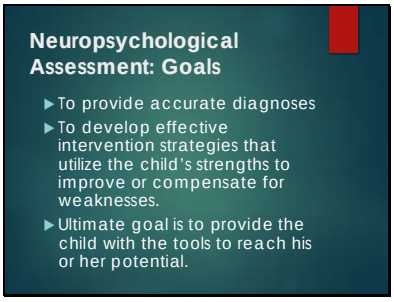

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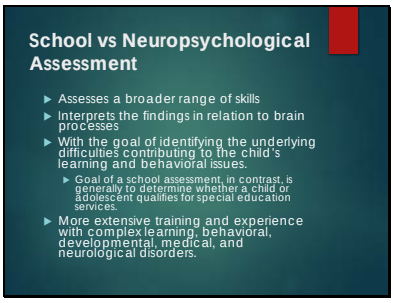

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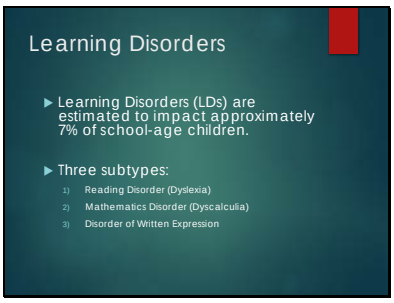

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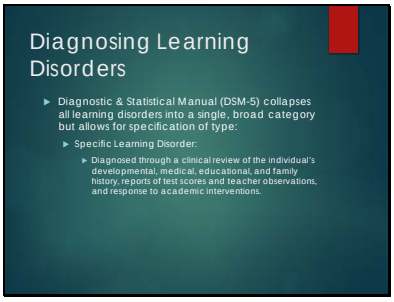

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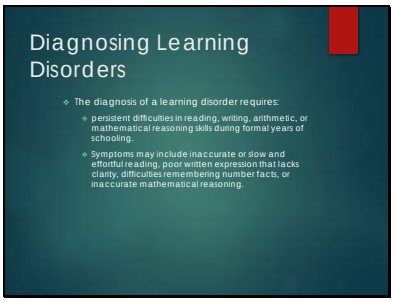

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Categories of Learning Disorders

- Impairment in reading:
  - Word reading accuracy
  - Reading rate or fluency
  - Reading comprehension
- Impairment in written expression:
  - Spelling accuracy
  - Grammar and punctuation accuracy
  - Clarity or organization of written expression
- Impairment in mathematics:
  - Number sense
  - Memorization of arithmetic facts
  - Accurate or fluent calculation
  - Accurate math reasoning

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Severity:

- Mild
- Moderate
- Severe

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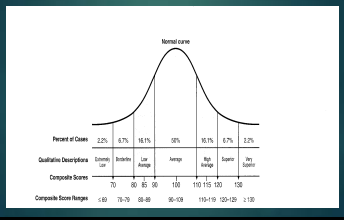
Dimensional disorder:



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Reading Disorders

- Approximately 5% of school children have a Reading Disorder (RD) or dyslexia.
- These children account for half of the special education population.
- Critically, over half of these children also have a second or co-morbid disorder and many have more than one making diagnosis and treatment more challenging.

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Reading Disorders

- DSM-5 Diagnostic Criteria (APA, 2013)
  - Current academic skills must be well below the average range of scores in culturally and linguistically appropriate tests of reading, writing, or mathematics.
  - The individual's difficulties must not be better explained by developmental, neurological, sensory (vision or hearing), or motor disorders and must significantly interfere with academic achievement, occupational performance, or activities of daily living.
- Impairment in reading:
  - Word reading accuracy
  - Reading rate or fluency
  - Reading comprehension

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Reading Disorders

Problem: IQ-Achievement discrepancy model. Research has consistently shown that this is an ineffective method that misses up to 50% of learning disordered children. (Stuebing et al., 2002)

- Horowitz, Sheldon H. (1999 The Discrepancy Formula-How the Aptitude-Achievement Formula Keeps Educators from Doing Their Jobs. (Adapted from a presentation by Dr. Horowitz at the 49th Annual Conference of The International Dyslexia Association.) "The standard that opens the gates to remedial and support services in schools, the 'discrepancy formula,' has undermined the ability of teachers to provide timely and effective assistance for students with learning disabilities. It virtually requires that students 'crash and burn' academically before they can gain access to special education services and it reinforces failure, ultimately making remediation much more difficult."

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Reading Disorders

What are the causes of reading disorders?

- Can be caused by:

1) Genes:

An analysis of 300 families from Wales and the West of England where at least one child suffered from the disorder showed a defect in a gene called KIAA0319. *ScienceDaily (Mar. 20, 2005)*

- KIAA0319 is a gene associated with neuronal migration during the brain's fetal development. (Parachinni et al., 2006).
- It is likely that multiple genes are involved.

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Reading Disorders

Causes continued

2) Environmental Factors

- Poor educational opportunities – coming from a lower socioeconomic background with poor schooling
- Exposure to toxins such as lead & mercury
- Little reading done at home

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Reading Disorders

3) Traumatic Brain Injury:

When a reading disorder is the result of brain injury it is referred to as alexia.

How does research on brain injured individuals help us understand how the brain reads?

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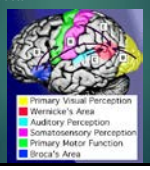
Reading Disorders

- Research on individuals with brain injuries has helped us isolate regions that are involved in the reading process.



Slide obtained from:
http://braincampus.learnpsychology.com/npsych/aphasia.html

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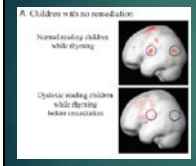
Reading Disorders



- Dyslexic children show
  - Less activation in areas involved in language comprehension.
  - Less activation in areas associated with speech production.

Image obtained from:
http://pages.slc.edu/~ebj/educ-cog04/dyslexia/PETimages.htm

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Reading Disorders

When a child is referred for an evaluation of reading abilities, one of the primary complaints is:

»Poor comprehension

But comprehension of written material comes toward the end of the reading process. What factors precede and are necessary for comprehension?

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Reading Disorders

- Competent reading skills depend on:
  - Phonological Processing
  - Grapheme/Morpheme/Orthographic Processes
  - Fluency, Timing & Retrieval Speed Processes
    - *School Neuropsychology: A Practitioner's Handbook*. James B. Hale & Catherine A. Fiorello

Psychologists need this book!

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Reading Disorders

- *Phonological Processing*
  - Refers to the child's understanding of the sounds of the language and ability to manipulate those sounds.
    - e.g., knowing when the letter *A* makes an *ay* sound versus an *ah* sound.
  - The child often has normal audiological exams, but presents with a history of *otitis media* (i.e., ear infections).
  - Receptive language is weak.
  - Struggles with word attack and nonsense syllables.
    - HED → HEB
  - Poor understanding of sound-symbol relationships.
  - Rely on compensatory reading methods such as sight words.

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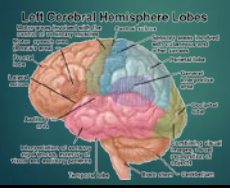
Reading Disorders

- Brain regions associated with phonological processing deficits:



1. Wernicke's Area
2. Angular Gyrus
3. Supramarginal Gyrus
4. Superior temporal gyrus

http://www.cs.iastate.edu/~baojie/acad/current/hnn/brain.gif

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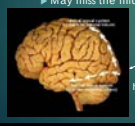
Reading Disorders

- Grapheme/Morpheme Processing:
  - Children with this variant are able to decode words that make phonemic sense (e.g., same), but struggle with irregular phonemic combinations (e.g., some).
  - They are slow & laborious readers.
  - Letters may be transposed (e.g., moved from one position to another: *ask→aks).*
  - Letters may be misidentified (e.g., b, d, q, p, s, z…)
  - May miss the middle parts of words.



The left ventral stream is associated with this type of reading deficit. Implicates the relationship between the occipital & temporal cortices: visual information & the "what system" of the brain.

http://www.undergrad.ahs.uwaterloo.ca

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Reading Disorders

- Fluency, Timing & Retrieval Speed
  - Refers to how quickly and efficiently the child is able to process letters & letter sounds.
  - When processing is slow, a log jam occurs and the brain becomes unable to take in and manipulate the information.
  - This impacts working memory and how effectively the child can learn when viewing written material.

Brain areas involved in this aspect of reading:

1. Cerebellum
2. Thalamus
3. Prefrontal Cortex
4. Broca's Area (not shown)

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Neuropsychological Assessment of Reading

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Neuropsychological Evaluation of Reading Disorders

- The role of the neuropsychologist when evaluating a child for a possible RD is to determine
  - Which aspects of reading are impacted
    - Phonological Processing
    - Fluency
    - Comprehension
  - Other factors that may be involved
    - ADHD or other neurocognitive disorders
    - Environmental issues such as poor educational opportunity
    - Mental health issues such as anxiety, depression or psychosis.
    - Working memory
    - Processing speed
    - Visual processing
    - Auditory processing
    - Receptive & Expressive language

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If the child has trouble with reading, is it always a reading impairment?

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Possible alternative or co-morbid conditions:

- ADHD
- Math Disability
- Speech/Language impairment
- Developmental coordination disorder
- Social/emotional disorders

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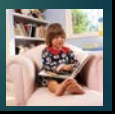
Rule out other explanations – Language Disorders

- Can the child understand stories that are read to him/her?
  - If yes, reading difficulties are likely.
  - If no, language comprehension difficulties are suggested.



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Rule out other explanations – Attention Problems

- Can the child pay attention when a story is read to them?
  - If yes, reading difficulties
  - If no, attention or anxiety difficulties

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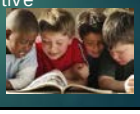
Rule out other explanations – Executive Functioning

- Can the child do mental math?
  - If yes, reading difficulties
  - If no, difficulties with working memory or executive functioning



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Is it always Reading Impairment?

- Another disorder causing secondary difficulties with reading
- Difficulties with reading and with something else, often making the child's difficulties more severe and resistant to intervention.

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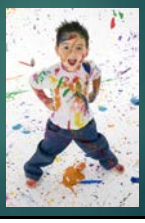
Why is it so important to get it right?



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Importance of Comprehensive Assessment and Getting it Right

- Appropriate, targeted treatment
- Improved effectiveness

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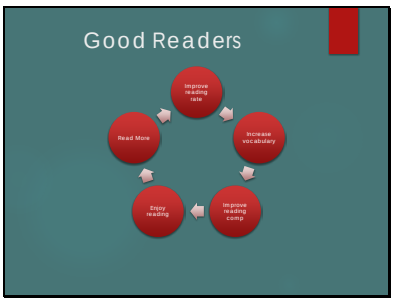

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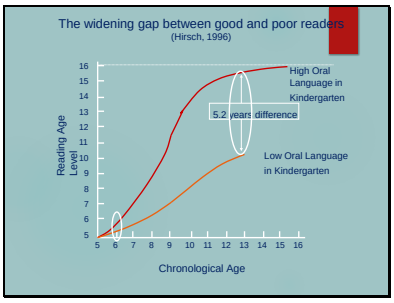

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Overcoming Dyslexia

If you don't have this book buy it!

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Questions so far?

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Mathematics Disorder (MD)

MDs occur in about 6% of the population.

- MDs and RDs have a comorbidity (i.e., occur together in the same individual) of 40%.
- MDs are often referred to as *dyscalculia* when they are developmental in nature & *acalculia* when they are acquired, for example, as a result of stroke or TBI.

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Mathematics Disorder

- Traumatic brain injury, strokes and tumors in the left inferior parietal lobe often result in impaired math abilities.
- Research has shown that MD run in families, implicating genes:
  - Shalev et al. (2001), in a study of the relatives of children with MD, found that 66% of mothers, 40% of fathers, 53% of siblings, and 44% of second-degree relatives also had MD.

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Mathematics Disorder

- DSM-5 Diagnostic Criteria (APA, 2013)
  - Current academic skills must be well below the average range of scores in culturally and linguistically appropriate tests of reading, writing, or mathematics.
  - The individual's difficulties must not be better explained by developmental, neurological, sensory (vision or hearing), or motor disorders and must significantly interfere with academic achievement, occupational performance, or activities of daily living.
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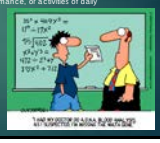
  - Accurate or fluent calculation
  - Accurate math reasoning



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Mathematics Disorder

- Although the research is not conclusive, there is a growing consensus that three types of Mathematics Disorder exist:
- *Semantic-memory subtype*
- *Procedural*, &
- *Visual-spatial* subtype.

(Hale & Fiorello, 2004)

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Mathematics Disorder

The *semantic-memory subtype*

- Commonly co-occurs with Reading Disorders
- Is characterized by deficits in the ability to recognize the symbolic nature between the Arabic numbers and the quantities they represent.
  - Why does the symbol 4 represent ♦ ♦ ♦ ♦ and not ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ♦ ?
- Individuals with this subtype of MD have poor automaticity that is associated with inadequate learning of math facts and retrieving them from memory.

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Mathematics Disorder

- The *procedural subtype* is characterized by:
  - Adequate quantitative knowledge and symbol-quantity relationships;
  - Inadequate strategy use and reliance on more immature strategies;
  - They tend to work slowly and are prone to calculation errors;
  - This subtype is often associated with the inattentive subtype of ADHD.

51-33=84

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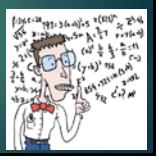
Mathematics Disorder

- The *visual-spatial subtype* is characterized by:
  - Problems with alignment of numbers in columns and place values
    - This is due to poor visuospatial organization associated with right hemisphere dysfunction
  - Children with Autism Spectrum Disorder likely to have this subtype of math disorder.



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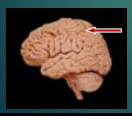
Mathematics Disorder

- The brain regions associated with math functions:
  - The semantic-memory subtype is similar to an acquired syndrome of *acalculia with alexia and agraphia* (i.e., involves deficits in math that are associated with impaired ability to read and write numbers).
  - It is associated with left hemisphere, particularly parietal areas.



http://www.brainstationtutoring.com/brain.jpg

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Mathematics Disorder

- The brain regions associated with math functions:
  - The spatial subtype is associated with right hemisphere dysfunction.

Fragile X is an X-linked disorder that is associated with autism and mental retardation in boys. In girls, intellectual functioning can range from average to mild mental retardation.

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Mathematics Disorder

- The neuropsychological evaluation needs to focus on:
  - Specific math skills
    - Number skills (e.g., solving number problems)
    - Word problems
  - Skills associated with math functioning
    - Attention
    - Working Memory
    - Spatial Reasoning
    - Ability to understand the meaning of the numerical and operational symbols (e.g., much in the way sound-symbol relationships are assessed in the reading domain).

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Disorders of Written Expression (DWE)

- Writing disorders are the least studied of the learning disorders. Likely because of the complexity of the skills involved.
- DWEs do not typically occur in isolation.
  - More often, they occur within the context of other learning and language-based disorders.
- The prevalence rates are quite high for DWEs:
  - 4% of school children show deficits in handwriting.
  - As many as 17% show problems with syntactic skills (i.e., grammar).

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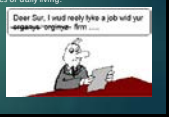
Disorders of Written Expression

- DSM-5 Diagnostic Criteria (APA, 2013)
  - Current academic skills must be well below the average range of scores in culturally and linguistically appropriate tests of reading, writing, or mathematics.
  - The individual's difficulties must not be better explained by developmental, neurological, sensory (vision or hearing), or motor disorders and must significantly interfere with academic achievement, occupational performance, or activities of daily living.

Impairment in written expression:
- Spelling accuracy
- Grammar and punctuation accuracy
- Clarity or organization of written expression



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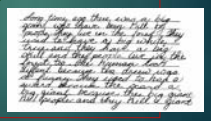
Disorders of Written Expression

- What are the components required for writing:
  1) Spelling
  2) Handwriting
  3) Syntax/grammar
  4) Organization



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Disorders of Written Expression

- Development of Spelling goes through a 5 step progression:
  1) Children produce letter-like forms, but show little understanding of phoneme-grapheme relations.
  2) Children begin to use abbreviations, such as *CT* for *cat*.
  3) Around 1st grade, children spell in a way that makes phonemic sense (e.g., *loaf → lofe).*
  4) By the 2nd or 3rd grade, conventional spelling begins, but children continue to struggle with unconventional words.
  5) By age 8 or 9, children begin to spell according to orthographic rules, recognize exception words, and check spelling accuracy.

Note: These stages are not exact in their timing.

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Disorders of Written Expression

- When assessing spelling abilities it is important to look for the following types of errors:
  - Additions: *hoped → hoeped*
  - Omissions: *sharp → shap*
  - Reversals: *dad → bab*
  - Sequencing errors: *girl → gril*
  - Consonant substitutions: *circle → sircle*
  - Vowel substitutions: *up → op*

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Disorders of Written Expression

- Brain regions associated with spelling:

Damage to these areas is associated with impaired grapheme production.

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Disorders of Written Expression

- Handwriting requires recruitment of motor areas of the brain into the writing process.
- The following attributes of handwriting should be examined when problems are suspected:
  - Letter shape (e.g., do the letters contain the appropriate slant)
  - Letter size (e.g., are letters too large/small)
  - Letter spacing (e.g., are letters crowded together or far apart)
  - Letter alignment (e.g., are letters aligned on the page)
  - Line quality (e.g., are the lines of the letters straight or wavy)
- Dysgraphia is often used to denote deficits in letter production.

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Disorders of Written Expression

- Because handwriting requires a combination of motor skills, phonological processing, orthographic processing, & visual and auditory processing, many brain regions are involved.

Frontal eye fields – involved in visual perception, coordination of eye movements. This information is then sent to the thalamus and superior colliculus & from there to the visual cortex.

From visual cortex, information is then sent to the Primary and Supplementary Motor areas of the left frontal lobe, which control muscle movement.

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Disorders of Written Expression

- Syntax refers to the rules that govern how the components of a language are put together in order to convey meaning.
- Research has shown that Broca's area, located in the left frontal lobe and the homologous area in the right frontal lobe is responsible for the syntactic components of language (and music too).
- Deficits in syntax result in written language that is difficult for the reader to comprehend.
  - *The ball catch to me.*

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Disorders of Written Expression

- The neuropsychological evaluation needs to focus on:
  - Spelling skills
  - Phonological processing
  - Grammar
  - Language skills
  - Fine Motor skills
  - Executive functions
  - Memory

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Learning Disorders

- When dealing with children and adults who have learning disorders it is important to keep in mind emotional & psychological factors such as self-esteem, depression & anxiety.
- Learning disorders are often comorbid with one another and with ADHD, therefore, an evaluation must take each of these possibilities into account.
- Assessment cannot focus only on the specific skill or area of concern, but on brain functions that contribute to it. Only in this way can we develop an effective intervention plan.

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Learning Disorders

- Follow-up Evaluations
  - In order to determine whether or not an intervention has led to improvement, it is necessary to compare test results over time.
  - The initial neuropsychological evaluation should serve as a baseline of functioning prior to implementation of an intervention plan.
  - Subsequent evaluations can then be used to determine how much progress has been made since the plan was implemented.

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Learning Disorders

- For proper follow-up testing, it is not always necessary to complete a full neuropsychological evaluation.
  - This is particularly the case when LD is the concern, as testing can be more focused (e.g., assessment of phonological processing in reading disorders).
- Need to keep practice effects in mind:
  - Repeated testing is likely to result in better performance because the child has learned how to take the test.
  - Tests should have reliable and well validated alternative forms to reduce practice effects.

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When is a Neuropsychological Evaluation needed?

- When the child is having difficulty in many areas
- When current interventions do not appear to be working, or the individual's response to interventions is less than expected
- When there is a disease, developmental problem, or injury affecting the brain in some way

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Questions?

Thank you!!

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