UNPACKING DYSLEXIA: ASSESSMENT AND DIAGNOSIS FROM A BRAIN-BEHAVIOR PERSPECTIVE

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WHAT IS DYSLEXIA

• Dyslexia is a specific learning disability that is neurobiological in origin. It is characterized by difficulties with accurate and/or fluent word recognition and 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 . . . (Lyon, Shaywitz, & Shaywitz, 2003, p. 2)
WHAT IS DYSLEXIA?

• It is a neurobiological disorder because the difficulty learning to read and spell is caused by differences in brain function.

• Manifested in difficulties at the word-level reading skills.

• It affects decoding (pronouncing printed words) and encoding (spelling words).

• It affects people of all backgrounds: ethnicity, race, English language learners, and income background.

Mather & Wendling, 2012
PHONOLOGICAL AWARENESS: IMPORTANT TO READING

• **Phonological awareness**: Refers to perceive and manipulate the sounds that make up words in a person’s language.

• Contributes to accurate acquisition of word reading and spelling skills in 3 ways. It helps individuals:

  1. understand the alphabetic principle or how spoken words are represented in print
  2. Recognize the ways that letters represent sounds in words, reinforcing knowledge of letter-sound correspondence
  3. Determine a word when it is only partially sounded out.
SKILLS IMPORTANT TO READING

• **Phonological coding** (using knowledge of letters-sound correspondence to read words) and **orthographic coding** (using letter and word patterns to help in pronunciation). Dyslexia is characterized by deficit in both types of coding.
DYSLEXIA AND OTHER LANGUAGES

• Dyslexia is found in individuals who speak different languages. However it may present differently based on the characteristic of the language.

• The nature of the writing system of a language, its orthography impacts the reading process.

E.g., Shallow or transparent written languages such as Spanish, Finnish, or German have more predictable sound (phoneme)/letter (grapheme) correspondence is more easily developed in these languages. The best predictor of dyslexia in these languages is slow reading rate and not phonological processing.

Proctor, Mather, Stephens-Pisecco & Jaffe (2017)
**DYSLEXIA AND SPECIFIC LEARNING DISABILITY**

- **Specific Learning Disability (SLD):**

"Specific learning disability" means a disorder in one or more of the basic psychological processes involved in understanding or in using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell or to do mathematical calculations, including conditions such as perceptual disabilities, brain injury, minimal brain dysfunction, dyslexia and developmental aphasia. The term does not include learning problems that are primarily the result of visual, hearing or motor disabilities, of mental retardation, of emotional disturbance, or of environmental, cultural or economic disadvantage.
DYSLEXIA AND SPECIFIC LEARNING DISABILITY

• Specific Learning Disability: It is a broad category that includes several different types of learning disorders including dyslexia.

Specific Learning Disability includes: Dyscalculia, dysgraphia, reading comprehension difficulties, etc.

Dyslexia is a member of the family of learning disabilities
DYSLEXIA SYMPTOMS

- Difficulty learning to rhyme words
- Difficulty learning letter names and letter sounds of the alphabet
- Confusion of letters and words with similar visual appearance (e.g., b/d)
- Confusions of letters with similar sounds words (e.g., /f/, /v/)
- Reversals and transpositions of letters and words that persist past the age of 7 (e.g., p/q and on/no)
- Trouble arranging letters in the correct order when spelling
- Difficulty retaining the visual representation of irregular words for reading and spelling (e.g., once)
- Spelling words the same words in different ways (e.g., wuns, wunce for once)
- Spelling words the way they sound rather than the way they look (e.g., sed for said)
- Difficulty pronouncing some multisyllabic words correctly (e.g., multiblication)
- Slow word perception that affects reading rate and fluency.

Not all students who have difficulties with these skills have dyslexia.
**DYSLEXIA**

**Rapid Automatized Naming (RAN):** is the ability to rapidly name familiar objects or symbols. It has been connected to reading accuracy and automaticity. In addition to phonological awareness, RAN has been identified as another core area associated with dyslexia.

**Double Deficit:** Individuals who have problems with both areas (RAN and phonological awareness)

**Processing Speed:** automaticity and reading rate appear to be impacted by individual’s cognitive processing speed. Individuals with dyslexia seems to process information more slowly. Domain-general.

**Working Memory:** Ability to hold information in immediate memory while manipulating that information. It is domain-general because it impacts many areas of functioning. Individuals with dyslexia and co-occurring problems show working memory deficit.
• Many students with dyslexia have areas of strength that may include: math, science, oral language, listening comprehension.
• Students with dyslexia may have higher achievement in areas not involving reading.
• Reading is a reasonable predictor of intelligence for most individuals, but not for individuals with dyslexia.
• Some individuals with dyslexia are identified in first grade and others later in their school experience.
• Many famous people have dyslexia: Orlando Bloom, Whoopi Goldberg, Stephen Spielberg, Kiera Knightley. Albert Einstein and Patrick Dempsey.
TYPES OF DYSLEXIA

• **Phonological / Dysphonetic:** Individuals have great difficulty using phonological route in reading, so visual route to words is used. These readers do not rely in letter to sound conversions (mapping), but rather over-rely on visual cues to determine meaning from print.
DYSLEXIA: PHONOLOGICAL / DYSPHONETIC

- Trouble detecting rhyming words
- History of reading difficulty in family
- Inaccurate oral reading
- Difficulty decoding nonwords
- Dysphonetic spelling
- Mispronunciation of multisyllabic words
- Trouble remembering sound-symbol relationships
- Overreliance on whole-word and context cues when reading
- Difficulty sequencing sounds in words when spelling
- Confusions between similar-sounding sounds
- Tendency to rely on the visual appearance of words when spelling rather than on the phoneme-grapheme relationships
SURFACE DYSLEXIA

• An over-reliance on sound symbol relationships as the process of reading never becomes automatic. These children break every word down to its phonetic base, and read very slowly and laboriously.

• Over-reliance on auditory cues for comprehension as visual system disconnected from semantic system to determine meaning from print.

• Extreme difficulty reading words where phonemes and graphemes are not in 1 to 1 correspondence: *yacht, busy, debt*
DEEP DYSLEXIA

• It describes a severe impairment in nonword reading. It is also called acquired reading disorder due to stroke or other brain injury.

• It is a rare form of reading comprehension disorder characterized by impairments reading words with abstract meanings, but reading more concrete, easily imagined words are in tact. According to McCarthy & Warrington (1990), deep dyslexia can be characterized by semantic errors such as:

  “watch” for “clock”

  “play”  for “act”

• “food”  for “dinner”
PREVALENCE

• Current estimates suggest that 5% to 8% of school age population have dyslexia.
• It is estimated that 1 in 10 people have dyslexia.
• About 13–14% of the school population nationwide has a disability that qualifies them for special education. Of that percentage, roughly 80% have a reading disorder.
• 52% of children with dyslexia also have features of dyspraxia.
• Experts used to think that dyslexia was more common in boys than girls, but current research shows that it affects girls and boys equally.
• Dyslexia occurs in people of all backgrounds and intellectual levels.
• Dyslexia runs in families; parents with dyslexia are very likely to have children with dyslexia.

American Dyslexia Association; Shaywitz, 2003; Kaplan, et al., 1998
CO-OCCURRING DISORDERS

• Many individuals with dyslexia may also have other specific learning difficulties. These are called co-occurring difficulties and they many learning conditions such as dyspraxia, dyscalculia, attention deficit disorder (ADHD). Like dyslexia, co-occurring difficulties can vary in severity, and this is one of the reasons why the impact of dyslexia varies very much from person to person.
WHAT CAUSES DYSLEXIA?

• The exact causes of dyslexia are still not completely clear, but anatomical and brain imagery studies show differences in the way the brain of a person with dyslexia develops and functions.

• Family history: genetic component

• The development of brain imaging has provided the most consistent data on the location of the neural system for reading.

• Neural imaging has allowed us to see that there are multiple brain areas affected in individuals with dyslexia.

• Three neural systems critical for reading are found in the left hemisphere
UNDERSTANDING THE POWER OF THE BRAIN

Frontal Lobe
- Planning
- Reasoning
- Problem solving
- Morality
- Personality
- Social Skills
- Recognising and Regulating Emotions
- Motor Functions
- Motor speech area of Broca

Parietal Lobe
- Recognising sensation, body position and objects
- Sense of time and space
- Reading and Comprehension area
- Association between functions of other lobes

Temporal Lobe
- Understanding
- Language
- Hearing
- Speech
- Memory
- Learning
- Sensory speech area of Wernicke

Occipital Lobe
- Vision and Integrating visual information (colour, shape and distance)

Brain Stem
- Regulation of heart beats, respiration, body temperature and other essential body functions

Cerebellum
- Balance
- Muscular co-ordination
BRAIN AND READING

• Studies from around the world using brain imaging indicate that there are a number of interrelated neural systems used in reading: Two in the posterior brain regions as well as distinct and related systems in anterior regions. There are referred to as systems because each area of the brain associated with reading generally encompasses more than a single brain region (Shaywitz & Shaywitz, 2008)
THREE NEURAL SYSTEMS FOR READING

• **Parietotemporal system** in reading: involved in word analysis-individual units of words (e.g., phonemes) – Phonological processing

• **Occipitotemporal System**: important for skilled and fluent reading. Also called the visual word form area. Orthographic processing

• **Broca’s Area / Inferior Frontal Gyrus System**: involves in articulation, serves an important function in silent reading and naming.
Figure 1. Neural systems for reading. Three neural systems for reading are illustrated for the surface of the left hemisphere: an anterior system in the region of the inferior frontal gyrus (Broca’s area), which is believed to serve articulation and word analysis, and two posterior systems, one in the parietotemporal region, which is believed to serve word analysis, and a second in the occipitotemporal region (the word-form area), which is believed to serve for the rapid, automatic, fluent identification of words. Adapted from Overcoming dyslexia: A new and complete science-based program for reading problems at any level, by S. Shaywitz, 2003. New York: Alfred A. Knopf. Copyright 2003 by S. Shaywitz. Adapted with permission.
Figure 2. Neural signature for dyslexia. A neural signature for dyslexia is illustrated in this schematic view of left hemisphere brain systems in (left) nonimpaired and (right) dyslexic readers. In nonimpaired readers, the three systems provided in Figure 1 are shown. In dyslexic readers, the anterior system is slightly overactivated compared with systems of nonimpaired readers; in contrast, the two posterior systems are underactivated. This pattern of underactivation in left posterior reading systems is referred to as the neural signature for dyslexia. Adapted from Overcoming dyslexia: A new and complete science-based program for reading problems at any level, by S. Shaywitz, 2003. New York: Alfred A. Knopf. Copyright 2003 by S. Shaywitz. Adapted with permission.
NEURAL SIGNATURE FOR DYSLEXIA

• Neural signature for dyslexia refers to the disruption of posterior reading systems during the reading of real words and pseudowords and often what is described as a compensatory overactivation in other parts of the reading system (inferior frontal gyrus and of the right occipitotemporal area).

• Basically: There is a failure of the left hemisphere posterior brain systems to function properly during reading.

Shaywitz & Shaywitz, 2008
IMPLICATIONS

• The brain has dual pathways for engaging in the same task. During the learning phase of a new reading task, many more brain regions are activated than during mastery phase. The brain goes into automatic with learned task, but it appears that with children with dyslexia, the brain’s automatic pathways never becomes engaged, making the reading process always a novel task that requires more cognitive energy.

https://youtu.be/ArWqrssuwKM

Feifer & De Fina (2000)
The goal of the assessment is to determine what process or processes are not working properly and how they are affecting and slowing reading and spelling development.

- Cognitive Abilities
  - Phonological Awareness
  - Rapid Naming
  - Orthographic Processing
  - Working Memory
  - Processing Speed

- Achievement Tests: Reading, writing, math

- Family history

- School history: Type of reading instruction the student has received, informal work sample
ASSESSMENT IN READING

• The main characteristics typical of dyslexia are: weakness in letter-sound associations, basic reading skills (sight words identification and phonics), reading fluency (rate and accuracy), and spelling.

• Latter-sound association

• Basic reading skills (word identification)

• Reading fluency

• Spelling

• Reading comprehension

• Written expression
1. **Phonological Awareness:**
   Test ability to manipulate sounds

2. **Rapid Automatic Naming:**
   Test the ability to perceive a visual symbol & retrieve the name; it tells us how fast the brain integrate visual and language processes

3. **Developmental History**
REFERENCES


