LEARNING DISORDERS

- I have no disclosures.
Learning Disorders

- Definition
- A case study
- Dyslexia
- Dysgraphia
- Dyscalculia
Learning Disorder - Definition

- Normal intelligence, educ. access
- An **aptitude deficit** with problems in processing information or generating output
- A non-talent (*e.g.* language, reading, math, visual motor)
Case study – 15 y.o. boy

**Med Hx:** Normal pre/perinatal dev’t
Freq ear infections (12-18 mo)
Late talker – 18-24 mos
Misarticulations, gestures

**Fam Hx:** Father & relatives –
poor readers/spellers
Right & Left Hemisphere Dysfunctions

Left

1. Speech-Sound
2. Dyslexia
3. Language Impairment

Right

1. ↓ Social Skills
2. In-coord’n
3. Dysgraphia

Dyscalculia
Language Learning Disorders

Dyslexia

Speech-Sound Disorder

Language Impairment
Speech-Sound Disorder

- Expressive speech delay
  - r/o hearing deficit
  - r/o global delay
- Receptive language may be normal
- Misarticulations vs. Oral motor apraxia
- Speech-Language therapy
The “1-2-3” of Language Development

- **Single** words by 1 y.o.
- Combine **2** words - 2 y.o.  
  (”Daddy car”)
- Combine **3** words - 3 y.o.  
  (”I want cookie.”)
Language Learning Disorders

Dyslexia

Speech-Sound Disorder
Language Impairment
Dyslexia

Makes up 80% of learning disorders
School reports of “learning disorder” may actually be dyslexia
In 5-17% of U.S. school children
- 2-5% have severe form
Case Study – Educ. Hx (2)

- 1st grade – learning difficulties noted
- 2nd grade – IEP: pull-out reading & academic support till 4th grade
- Late 4th grade: diagnosed with dyslexia & ADHD
Dyslexia – definition

- A specific learning disability that is neurological in origin
- Characterized by difficulties with accurate and/or fluent word recognition,
- Poor spelling & decoding abilities
- Typically result from deficit in the phonological component of language
- Unexpected in relation to other cognitive abilities & provision of effective classroom instruction.
Dyslexia is NOT

- Writing backwards or reversal of letters
  (some reversal of letters/numbers can be normal up to 1\textsuperscript{st} grade)
- A developmental lag – child with dyslexia will not “catch up” in reading without intervention
Dyslexia

- A brain-based condition
- Genetic basis - polygenic
- Males = Females (research-identified) M:F 2:1 recognized by schools
- Weakness in phonological processing
The Heritability of Dyslexia

- 27-49% Parents
- 23-65% Children
- 40% Siblings

Dyslexic Person
Genes in Dyslexia

- From family linkage studies and genome wide association studies (e.g. Dutch Dyslexia Programme)
- 9 risk loci (DYX1-DYX9) on 8 different chromosomes
- 14 candidate genes
Mouse / Rat Studies

- Gene knock-out models (DYX1C1 on 15q21; DCDC2 & KIAA0319 on 6p21; ROBO1 on 3p12-q12)

- Neuronal migration defect
  - Human – cortical ectopias (Galaburda et al, 1985)

- Axonal guidance → gray/white matter structural abn.
  - Human – loss of asymm of planum temporale
Imaging-Genetics

- Correlate risk gene variants with neuro-imaging
- MRI – structural changes (vol; ectopias)
- fMRI – when reading - ↓ active L.temp/par area; cerebellar activation
- Diffusion Tensor Imaging – WM connectivity
- PET – abn. Broca’s area activation
Phonological Deficit in Dyslexia

- Dyslexics have **trouble** "breaking the reading (alphabetic) code"

- Lack of phonemic awareness
The Reading Code

- Phoneme is smallest discernible segment of speech.
  - “c-a-t” has 3 phonemes ("cuh"-"aah"-"tuh")
- Syllables are made up of phonemes
- Words are made up of syllables
Decoding (reading)

- Symbol $\rightarrow$ Sound
- Grapheme $\rightarrow$ Phoneme
- Requires attention, short-term memory & sequencing skills
Encoding (spelling)

- Sound → Symbol
- Phoneme → Grapheme
- Requires attention, visual motor memory, sequencing skills
English Language is hard

- 26 letters in the alphabet, but 44 different sounds (eg call, cell)
- Inconsistent orthography
  “F” sound in “Fan”, “Phone”, “Rough”
  Different “ou” sounds in “our”, “thought”, “through”
- “\textbf{Read} the \textcolor{red}{red} book that we \textbf{read} earlier.”
Neuroanatomic Regions for Reading

Adapted from Sally Shaywitz, MD, 2002
To Read a Word

See the word Occip/Temp Visual form (Orthography)

Symbol → sound Temp/par Phonol. proc.

Pronounce word Inf. Frontal Articulation
Reading a Word (e.g. "FLAT")

Adapted from Sally Shaywitz, MD, 2002
Decreased Brain Activity in Dyslexic Readers

Temple, 2001, CONB
Phonological Processing in Normal Readers
Phonological Processing in Dyslexic Readers

Rhyme versus Match
Dysfluency in Dyslexia

Choppy (& slower) reader

Deficit in Rapid Automatic Naming speed (affects reading fluency)

Rapid digit & letter naming tests
Neuroanatomy of Dysfluency

Weak connectivity between pre-frontal lobes and cerebellum

White matter dysfunction (DTI studies)
⇒ Lack of automaticity
Genes to Behavior

Gene expression → abn neuron migration
→ Abn grey/white structure
→ abn brain connectivity/circuitry
→ abn brain activation
→ decr ability to integrate lang stimuli
→ deficit in reading & language
Clinical Features of Dyslexia

- Slow to learn the alphabet
- Poor rhyming
- Mispronunciations
- Poor speller
- Choppy reader
- Slow naming speed
Clues for Dyslexia in K and 1st Grade

- Language delay
- Family history of dyslexia
- Poor knowledge of letter sounds
- Poor blending of sounds
- Trouble naming letters rapidly
- +/- left-handed
Dyslexia in later grades

- 2nd Gr.: oral reading fluency
- 4th Gr +: word recognition +/- comprehension
- [K-3 : learning to read]
- [Gr 4 +: reading to learn]
EARLY intervention is key

- If intervention started in 1\textsuperscript{st} grade, incidence of dyslexia drops from 12-18\% to 1.5 – 6 \%

- If intervention started in 3\textsuperscript{rd} grade, 74 \% have reading problems in HS
Remediation for Dyslexia

- Explicit, systematic, rule-based phonics instruction (Nat’l Reading Panel, 2000)
- Orton-Gillingham, Project READ, Wilson, Fundations, LindaMoodBell, RAVO
- Individual or small group instruction (< 3:1)
- Guided oral reading, vocab dev’t
Case Study – Educ. Hx (3)

- 5th-6th grade – Language-based class
  Orton-Gillingham instruction
  5 X 42 min 1:1
- Priv tutor since 2nd grade;
  O-G after 4th grade
- Reading level improved 21 months in 14 calendar months
Case Study – Educ. Hx (4)

- 7th - 8th grade: Inclusion classes & academic support
- 8th grade: concerns about following directions, reading fluency & comprehension, organization of expressive language, writing skills
Language Learning Disorders

- Dyslexia
- Speech-Sound Disorder
- Language Impairment
Language Impairment

- Expressive +/- Recep. lang
- Higher order skills: Figurative lang.; Ambiguous lang.
- Listening/Reading comprehension
- Written expression
- Rx: S & L therapist
Co-Morbidities with Dyslexia

- 10% have Language impairment (listening/reading comprehension)
- 15% have ADHD
- 35% of those with ADHD have dyslexia
- 25% have both dyslexia & dyscalculia
Dysgraphia

- 2-5% of school children
- Types:
  - Dyslexic - weak orthographic spelling
  - Weak motor handwriting
Dysgraphia with Dyslexia
(8th grade boy)

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<table>
<thead>
<tr>
<th>DATE</th>
<th>TIME</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/14</td>
<td>1:44</td>
</tr>
</tbody>
</table>
```

```
I like to play football. I like going out side. I like TV

Blind Sland girl fighting brother head puppy
```
Help for Dysgraphia

- Occupational Therapy
- Tape stories & essays (Scribe)
- Alpha-Smart/Laptop/iPAD in class
- Word-processing; spell-checker
- Vertically-lined or large graph paper for Math calculations
Dyscalculia

- Difficulty understanding & learning number concepts /number facts
- Weak numerosity – understanding of sets
- 5-6.5% school children; M=F
- Genetic predisposition
- Inefficient calculation methods
- Co-morbidities in 2/3: dyslexia, ADHD, language delay
Neuro-anatomical sites for calculations

From: Butterworth, B  *Science* 1999; 284:928-9
Case Study - Conclusion

Academic success

Honor Roll status in 9th grade!
Final Thoughts

Studying the neurobiological substrates of learning disorders can elucidate basic brain developmental processes.

**Early** diagnosis / **specific** interventions critical for better outcomes (academically, emotionally, socially)
Celebrate Success!
Learning Disorders — General


Dyslexia & Language Learning Disorders


Kere J. The molecular genetics and neurobiology of developmental dyslexia as model of a complex phenotype. *Biochem Biophys Res Commun* (2014);452(2):236-43.

Learning Disorders — References  F. Lai, MD

Dyslexia & Language Learning Disorders (cont’d)


Zoccolotti P, Friedmann N. From dyslexia to dyslexias, from dysgraphia to dysgraphias, from a cause to causes: at look at the current research on developmental dyslexia and dysgraphia. *Cortex* 2010;46(10):1211-5.

Dyscalculia


