The Brain’s Role in Dyslexia: A True Story with a Happy Ending

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Dyslexia
What Is It?

Reading skills occur along a continuum, with reading disabilities representing the lower tail of a distribution of reading abilities.

Dyslexia, Reading Disabilities and “poor reading” are labels used to reflect impaired decoding (word reading), fluency (reading speed) and comprehension (understanding).
Dyslexia Definition
National Institute of Neurological Diseases and Stroke

“Dyslexia is a brain-based type of learning disability that specifically impairs a person’s ability to read. These individuals typically read at levels significantly lower than expected despite having normal intelligence. Although the disorder varies from person to person, common characteristics...are difficulty with spelling, phonological processing (the sensitivity to and manipulation of speech sounds), and/or rapid visual-verbal responding”
Dyslexia Definition

The result of abnormal learning during the normal course of development despite adequate opportunities for learning, good instruction, and normal intelligence.

Note emphasis on **learning opportunities**
Note emphasis on **good instruction – the importance of evidence based instruction**
Note emphasis on **normal intelligence – dyslexia is not all about IQ.**
Dyslexia
What Is It?
"dys" (poor or inadequate) "lexis" (words or language)

A persistent, chronic condition
Not a developmental “lag” (Francis et al, 1996)
Children with dyslexia do not just catch up
Chronic - although children and adults can improve their reading skills

Affects boys and girls equally
It is a myth that boys are affected more than girls (Shaywitz, Shaywitz, Fletcher, & Escobar, 1990); boys may be referred more due to behavior problems
Dyslexia
What Is It?
"dys" (poor or inadequate) "lexis" (words or language)

People with dyslexia can read – up to a point.

Decoding problems are seen when sight words become more complex; simple sight words are “read”

Difficulties in sounding out words (remembering letter-sound associations) makes decoding effortful and spelling difficult

Inaccurate and slow rate of decoding (fluency) are problems for reading comprehension
Dyslexia Misconceptions

Myths about dyslexia

People with dyslexia have visual problems: reversal of letters seen or in written letters; special colored or filtered glasses are needed.

These vision problems are not defining characteristics of dyslexia, nor are they true of all people with dyslexia.
Dyslexia Misconceptions

Myths about dyslexia

Dyslexia is defined by a gap – discrepancy – between IQ and reading achievement.

The focus is on *reading*. If people can not read, they need special instructional supports to enable them to learn to read – regardless of their IQ.
Dyslexia
What Is It?

Studies of dyslexia reveal a heritability factor

Children with one or both parents with dyslexia, or with siblings or close relatives with dyslexia have a higher risk of dyslexia.

Familial Risk

The heritability factor is not 100% - The environment plays an important role in the genetic expression of dyslexia.
Dyslexia Risk

"dys" (poor or inadequate) "lexis" (words or language)

Rates of dyslexia

23 - 65% of children who have a parent with dyslexia
40% of siblings of people with dyslexia
27 - 49% of parents of people with dyslexia

6-15% of people in all countries, regardless of language

non-alphabetic languages – rate is 3-10%

Interesting in light of differences between languages in orthography
Reading Acquisition in English

Learning to read English is hard

   Harder than other languages

English has many speech sounds (at least 40 phonemes) with speech sounds represented in different (sometimes inconsistent) ways in print because we only have 26 letters

There are 176 ways different common phonemes are spelled be, see, sea, scene, key.....

A writing system was *invented* to represent speech sounds as symbols but there are multiple ways to spell the same phonemes and multiple ways to decode letters and letter sequences
Reading Acquisition in Other Languages

Other alphabetic languages (Finnish, French, German, Greek, Italian...) are easier to learn.

Have nearly 1 to 1 correspondence between phonemes and the letter or letter pairs used to represent the sound.

Poor readers in these languages can decode and spell words very well, but they have slow reading speed (fluency).

Poor readers in these languages have fluency problems.
Dyslexia & Reading Acquisition

Often, dyslexia or poor reading skills are identified in grade school as reading demands increase. Identification in 3rd or 4th grade is common.

But parents, children, and teachers often recognize much earlier when reading skills are not at grade or age level.

We can see poor reading performance in early grades just by looking at data – we don’t even need statistics!
Growth in word reading ability of children who begin first grade in the bottom 20% in Phoneme Awareness and Letter Knowledge  
(Torgesen & Mathes, 2000)

![Graph showing growth in reading ability with labels for Low PA and Ave. PA.](image-url)
Projected growth in “sight vocabulary” of normal readers and disabled children before and after remediation

From Joseph Torgesen

Size of “sight vocabulary”

Grade in School

2nd Year follow-up

Normal

Dyslexic

Intervention
The Effects of Weaknesses in Oral Language on Reading Growth
(Hirsch, 1996) From Joseph Torgesen

The graph shows the growth of reading age in relation to chronological age, comparing high oral language in kindergarten with low oral language in kindergarten. It indicates a 5.2-year difference between the two groups.
A Story: The Lincoln County Reading Study

School District initiated contact

New reading program was planned

Teachers, families and children with different reading levels wanted to understand how reading skills could be impacted by the new program
## Children Participating  \( N = 27 \)

<table>
<thead>
<tr>
<th>School Identified</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Above (2 years +)</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>At Grade Level</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Below (2 years -)</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Ages: 9 yrs. 3 mo. - 12 yrs. 1 mo.
Word & Non-word Reading Task

+  BAG +  ?

+  KAT +  ?

+  DAK +  ?

Molfese et al, 2005
One Boy’s Insight

After viewing movies of brain processing during the reading tasks – This child’s insight was about his experiences

He was using his whole brain, just like his parents were telling him to.

Using your “whole brain” is not what is needed for reading
So - What Does the Brain Tell Us About Dyslexia?
Event-Related Potential - ERP

EEG

ERP ->

Stimulus Onset

AMPLITUDE

Time 1 Second
Event-Related Potential - ERP

Rapid Temporal Information
(1/1000 Second)
Sensitive to Developmental Changes
Correlates with Cognitive Abilities
Predictor of Later Development
Correlates with Intervention success
Reading Ability & The ERP Responses

Children: Ages 9 - 12 years (n=27)

$F(2, 42) = 4.56, p < .016$, power = .744: $t(26) = 3.143, p < .004$, and $t(26) = 3.422, p < .002$
Newborn Responses to Speech Predict Later Reading Skills

Grand Averages

**Newborns**

**PERFORMANCE at 8 Years of Age:**

- **WRAT3 ~ 104**
  - WISC FSIQ ~ 111
  - N = 24
  - Accuracy: 79.2%

- **WRAT3 ~ 81**
  - WISC FSIQ ~ 110
  - n = 17
  - Accuracy: 82.4%

- **WRAT3 ~ 85**
  - WISC FSIQ ~ 97
  - n = 7
  - Accuracy: 85.7%

Molfese & Molfese, 1985
Molfese & Molfese, 1997
Molfese, 2000
8-Year Olds’ Responses to Speech & Later Reading Skills

PERFORMANCE at 8 Years of Age:

- **WRAT3 ~ 104**
- **WISC FSIQ ~ 111**
- **N = 24**

- **WRAT3 ~ 81**
- **WISC FSIQ ~ 110**
- **n = 17**

- **WRAT3 ~ 85**
- **WISC FSIQ ~ 97**
- **n = 7**

**Processing of speech sounds takes ~100 ms longer**

That leaves 100 ms less for doing something else (working memory, comprehension?)
Intervention
Begin Intervention And Track Effectiveness of The Intervention

14-Month-Old Infants (n=14)

PRETEST

POSTTEST

Molfese, Morse & Peters, 1990
Rhyming Task

+  cat  +  hat  ?
ERPs for Typical Readers, Responders to Intervention & Non-Responders

Peter J. Molfese, 2008
Response to Intervention

Response to Rhyming Stimuli
Differentiates between all three groups

P.J. Molfese, 2008
STUDY 1
ERPs in 5-Year-Old Preschool SLI Children Predict Subsequent Language Gains Following 6-Week Intervention

With P. Yoder, 2003
ERPs in 2 to 4-Year-Old Preschool SLI Children Predict Subsequent Language Gains Following 4 Month Intervention

Ability to discriminate /da/ from /ga/

Yoder, Molfese & Camarata, In Press
Model For Intervention That Incorporates Early Identification

1. Identify Risk At Birth/Infancy

2. Choose & Monitor Effectiveness of Early Intervention

3. Normal Development
Model For Acquisition
Normal Learning Development

Normal: Time 1

Brain Tissue Activated

Time of activation

1 2 3 4 5 6
Normal: Time 2
Normal: Time 3
At-Risk Learning Development

Impaired: Time 1
Impaired: Time 2
1. Slow or No Transition to Fewer Areas.
2. Areas Activated Change From Trial-to-Trial.
3. Unstable Temporal Links Between Areas.

**Impaired: Time 3**
QUESTIONS ???

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