The Science of Dyslexia and Implications for Teacher Education
Presentation to the Connecticut Dyslexia Task Force

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University of Connecticut
Overview

• Background about us
• Understanding reading comprehension
• Understanding word recognition
Background about us

Why you would possibly want to hear us talk about dyslexia
Cabrie’s older brother
Mr. Kearns

teacher, literacy coach, and reading remediation specialist

Lourdes, Sergio, Rosa, Francisco

Adolfo, Jaime, Maggie, Blake
Fumiko Hoeft, M.D., Ph.D.

- Professor @ UConn Psychological Sciences | Psychiatry | Neuroscience | IBACS
- Member of Board of Directors & Co-Chair of Scientific Advisory Board @ IDA
  - Member of Professional Advisory Board @ NCLD
  - Director @ UConn Brain Imaging Research Center (BIRC)
- Professor @ UCSF Psychiatry | Weill Inst. for Neurosci. | Dyslexia Cntr.
  - Exec. Director @ Univ CA-Stanford Precision Learning Center (PrecL)
  - Co-Director @ Haskins Global L² Innovation Hub
Understanding Reading Comprehension

Fitting dyslexia into the big picture
Once upon a time there were four little Rabbits, and their names were Flopsy, Mopsy, Cotton-tail, and Peter. They lived with their Mother in a sand-bank, underneath the root of a very big fir-tree.

“Now my dears,” said old Mrs. Rabbit one morning, “you may go into the fields or down the lane, but don’t go into Mr. McGregor’s garden: your Father had an accident there; he was put in a pie by Mrs. McGregor.”
Reading Comprehension

• Constructing a situation model from the textbase
Once upon a time there were four little Rabbits, and their names were Flopsy, Mopsy, Cotton-tail, and Peter.
Situation model

This is a fairy tale about four bunnies.
Tools to construct the situation model:
The simple view of reading

Word recognition

Language comprehension

Hoover & Gough, 1990
Word recognition

Phonological awareness

Decoding skill

Recognizing words by sight

Reading Comprehension

Language comprehension

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Reading Comprehension

Word recognition

Language comprehension

Background knowledge

Vocabulary knowledge

Verbal reasoning

Skill in using syntax and language structure

Ability to apply effective strategies

Reading Comprehension

Reading Comprehension

Word recognition

Language comprehension

Phonological awareness

Decoding skill

Recognizing words by sight

Background knowledge

Vocabulary knowledge

Verbal reasoning

Skill in using syntax and language structure

Ability to apply effective strategies

fluency

### Key Idea

<table>
<thead>
<tr>
<th>Concept</th>
<th>Instructional Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dyslexia prevents the reader from constructing the situation model because they cannot access the print</td>
<td>Students with dyslexia require instruction that focuses on helping them access print</td>
</tr>
</tbody>
</table>
Individual Differences in Word Recognition Development

Value of differing degrees of emphasis
Connectionist framework for word recognition

Seidenberg & McClelland (1989)
Word recognition in the brain

- Decoding by linking letters & sounds
- Motor production & processing unfamiliar words
- Visual word recognition
- Visual wordform area

Regions:
- Broca’s area
- Wernicke’s area
- Parietal Lobe
- Superior temporal gyrus (STG)
- Precentral gyrus (PrG)
- Middle temporal gyrus (MTG)
- Occipital Lobe

Pathways:
- Dorsal/decoding pathway
- Ventral/sight recognition pathway

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Implications of connectionist framework

• Saying the word correctly depends on
  • Early in reading acquisition: Phonological awareness and decoding letters to sounds
  • Later: Sight recognition letters to meaning

• Strong vocabulary knowledge supports word recognition
  • This knowledge is especially useful once readers have established decoding skills
  • This can provide some support for students with reading difficulty
Individual differences in word recognition

In a connectionist framework

• The value of different ways of learning depends on the learner

• This raises the questions:
  • Should we include meaning instruction in phonics instruction?
  • Should we teach students less about phonics?
Some students will learn to read without extensive phonics instruction

- Foorman et al. (1998) found that in first-grade classrooms
- with explicit phonics instruction, 84% of students made reading progress
- without explicit phonics instruction, 56% of students made reading progress
Processing in dyslexia

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Decoding by linking letters & sounds

Motor production & processing unfamiliar words

visual word recognition

visual wordform area

Broca’s area

Parietal Lobe

Wernicke’s area

more activation
(still lower than typical)

underactivation

dorsal/decoding pathway

ventral/sight recognition pathway

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Underactivation in the temporo-parietal region

Successful adult readers

Kindergarteners at-risk for dyslexia

Adapted from presentations by Trynia Kaufman & Joanna Christodoulou

Yamada et al. (2011)
Not all learners with reading difficulty need the same kinds of intervention
Not all readers need the same kind of tasks
Matching instruction and student is important

• National RTI Evaluation did not show success
  • Students at the 40\textsuperscript{th} percentile were given additional phonics instruction
  • This may have been less effective for them

• Leveled Literacy Intervention is a good example
  • It is controversial when considered for teaching students with dyslexia because it has less focus on explicit systematic phonics
  • It has some evidence of success in randomized controlled trials
  • The effects appear to be best for students with less difficulty
Students with dyslexia need intensive phonics

• Examination of long-term effects of phonics (Suggate, 2015) showed the greatest long-term benefits for students with the most serious reading difficulty

• Value of phonics for students with serious reading difficulty has been shown repeatedly (e.g., Wanzek, 2013)
Neural effects of phonological intervention in children with dyslexia

Pre-Intervention

Post-Intervention

After intervention, metabolic brain activity of children with dyslexia more closely resembles that of typical readers.

Adapted from presentations by Trynia Kaufman & Joanna Christodoulou

Temple et al. (2003) PNAS
What are intervention programs?

- Standardized, research-based interventions designed for students who do not meet grade-level expectations
- Programs referred to as
  - Strategic interventions
  - Word reading interventions
  - Basic-skills program
  - Foundational skills programs
- “Examples”
  - *Let’s Learn to Read*: Beginning Reading Support Program
  - *Words Everywhere*: Literacy Fundamentals
- The key is for programs to meet the criteria
Characteristics of a standardized program

• Research-based:
  • Has been studied using rigorous methods
  • Has been shown to be effective in those studies

• Explicit:
  • provides instructions for the teacher (maybe scripted)
  • uses a model and practice instructional approach

• Systematic:
  • reflects the entire continuum of target skills
  • has enough lessons to be valuable

• Focused on foundational skills:
  • addresses standards or skills underpinning standards
  • supports (but is likely not the same as) grade-level standards
Research-based:
Has good evidence of good effects

• If a program is really research-based
  • It has evidence of working
  • There are programs that have been research-based
  • The Institute for Education Sciences Practice Guide provides guidance

• But maintain healthy skepticism
  • These days, every program has a tab on their website that says “research” or “evidence”
    • An evidence review saying this type of instruction works
    • Testimonials from educators or families
    • Unpublished internal studies
    • Poorly designed studies presented somewhere (not found in a journal)
Explicit

<table>
<thead>
<tr>
<th>Clear Objective</th>
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<tbody>
<tr>
<td>• Important focus</td>
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<tr>
<td>• Specific learning outcome</td>
</tr>
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</table>

I Do

<table>
<thead>
<tr>
<th>Modeling</th>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear</td>
<td>Guided Practice</td>
</tr>
<tr>
<td>Explanation</td>
<td>Independent</td>
</tr>
<tr>
<td>Planned</td>
<td></td>
</tr>
<tr>
<td>Examples</td>
<td>Practice</td>
</tr>
</tbody>
</table>

Supporting Practices

• Using effective methods to elicit frequent responses
• Providing immediate specific feedback
• Maintaining a brisk pace

We Do

You Do
Tapping and Sounding Out

Direct the student to the Decodable Words section of the lesson page. We’re going to tap and sound out words together. We’ll tap once for each dot. Me first. Give this instruction only for the first word. Mat is used in this example; substitute with the different words given for each lesson.

I’ll tap the sounds in this word (point to mat).
Tap one finger under the first dot. /m/
Tap under the next dot with the same finger. /a/
Tap under the last dot. /t/

I’ll sound it out. Slide your finger slowly under the word in an arc. /maaaat/

I’ll say it fast. Slide your finger quickly under the word in a straight line. mat
## Graphemes and Corresponding Phonemes
Based on Devlin's Program and Words in the EWI TC for Grades 1-5

<table>
<thead>
<tr>
<th>Grapheme</th>
<th>Corresponding Phonemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>/a/ 21</td>
</tr>
<tr>
<td>i</td>
<td>/i/ 35</td>
</tr>
<tr>
<td>au</td>
<td>/au/ 245</td>
</tr>
<tr>
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<td>/th/ 123</td>
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</tr>
<tr>
<td>z</td>
<td>/z/ 361</td>
</tr>
<tr>
<td>/z/ 361</td>
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</tbody>
</table>

- **u-e**
- **/oo/ 70**
- **/yoo/ 42**
- **p**
- **/p/ 2673**
- **ph**
- **/f/ 126**
- **/er/ 244**

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**Notes:**
- The table lists graphemes and their corresponding phonemes for Grades 1-5.
- The phonemes are represented with their International Phonetic Alphabet (IPA) symbols.
- The table includes entries for vowels, diphthongs, and consonants.
- The system is designed for educational use in phonics instruction.

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**Systematic Phonics:**

- The systematic approach to phonics emphasizes the consistent use of phonograms and the recognition of phoneme sequences in the decoding process.
- It helps students to read and write by focusing on the underlying sound patterns in words.
Focused on foundational skills

• Phonics skills underlie all other English Language Arts standards in the Common Core State Standards
• For students with dyslexia, the critical foundation is phonics
An example: The Nashville Early Reading Project

Designed by Fuchs, Kearns et al. (2012) for first graders

- Tested in a large-scale randomized control trial
- Had positive effects on word reading and comprehension

- Included structured lessons with scripts and materials

- Organized in a linear way reflective of development and the nature of English

- Tested with students needing intensive intervention one-to-one

- Involves instruction in...
  - Decoding and sight word reading
  - Spelling
  - Reading level-appropriate texts
Checklist:
The Nashville Early Reading Program

- Research-based
- Explicit
- Systematic
- Focused on foundational skills

- We did the research and it worked
- We used very structured lessons
- We created a clear sequence
- It focuses on foundational skills
Students with dyslexia—but perhaps not always others—need intensive phonics instruction

- Students with less severe reading difficulty benefit from less intensive interventions focused somewhat less on phonics
- Students with dyslexia benefit from more intensive interventions focused specifically on word recognition skills
## Key Idea

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<tr>
<td>• Word recognition skills develop as a result of letter, sound, and meaning knowledge</td>
<td>• Students with dyslexia should receive highly explicit systematic phonics instruction</td>
</tr>
<tr>
<td>• The need for word recognition instruction varies by degree of difficulty</td>
<td></td>
</tr>
</tbody>
</table>

Devin Kearns (devin.kearns@gmail.com)
Thank you
Dyslexia is *not* a visual processing problem

<table>
<thead>
<tr>
<th>Hebrew speakers</th>
<th>Non-Hebrew speakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>good readers</td>
<td>poor readers</td>
</tr>
<tr>
<td>good readers</td>
<td>good readers</td>
</tr>
</tbody>
</table>

Hebrew words were shown briefly on a screen. Then, children drew/wrote the words from memory.

<table>
<thead>
<tr>
<th>best memory</th>
<th>worst memory</th>
<th>good memory</th>
</tr>
</thead>
<tbody>
<tr>
<td>best memory</td>
<td>same memory</td>
<td></td>
</tr>
</tbody>
</table>

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Vellutino, Steger, DeSetto, & Phillips (1975)

Devin Kearns (devin.kearns@gmail.com)
Dyslexia is *not* a visual processing problem

Fischer, Liberman, & Shankweiler (1978)
Errors Made

- All errors
- Reversals
But...it’s a similar percentage of errors

Errors Made

- Good readers
- Poor readers

- All errors
- Reversals