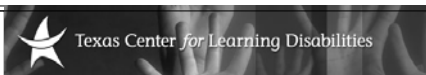


Learning for SUCCESS  
www.texasidcenter.org

The Texas Center for Learning Disabilities (TCLD) investigates the classification, early intervention, and remediation of learning disabilities.



## Dyslexia: The Evolution of a Scientific Concept

*Jack M. Fletcher, Ph.D.*  
*Department of Psychology*  
*University of Houston*

*HELPS, Oct 1, 2010*

*jackfletcher@uh.edu*  
Funded by NICHD P50 HD052117

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### Dyslexia is a Neurogenetic Disorder of Childhood

<b>Congenital</b>	<b>Developmental</b>
▪ PKU	▪ Dyslexia/Learning Disabilities
▪ Downs Syndrome	▪ ADHD
▪ Fragile X	
▪ Spina Bifida	
▪ Turners Syndrome	
▪ Williams Syndrome	
▪ Velocardiofacial Syndrome	

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### Genes, Brain, and Behavior

- Rapid advances in scientific understanding in all domains
- Interdisciplinary, international collaborations- Not parallel play
- Advances in one domain fuel another domain
- Reading is an elegant example of neural plasticity

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### Dyslexia and Neural Plasticity

- Reading is not a natural process and is not constructed by result of exposure to language or words
- Good instruction is always brain-based and involved in the development of dyslexia
- The process of learning to read *rewrites* the organization of the brain
- The neural signature of this process may vary depending on the type of language in which it occurs
- Disorders occur through development and through injury/disease with varying effects on reading and writing

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### Learning Disabilities :Major Shifts in Scientific Understanding

- Early views "of constitutional origin" (bad gene-bad brain) have shifted to interactions of genes, brains, and environments
- Prominent view instantiated in public policy: discrepancies in IQ and achievement as a marker for unexpected underachievement
- Classification research showed limited validity; focus on academic deficits as necessary but not sufficient for identification

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### Learning Disabilities :Major Shifts in Scientific Understanding

- Progress in understanding cognitive mechanisms underlying different academic skills, esp. reading and dyslexia
- Greater understanding of appropriate samples for neurobiological studies (began to study same kinds of children), fueling interdisciplinary approaches
- Emergence of noninvasive technologies for brain imaging and application of modern genetic methods to large samples of LD focusing on academic deficits
- Intervention studies take advantage of the emerging research base. Many children poorly taught (add intractability to identification); stop treating processes.

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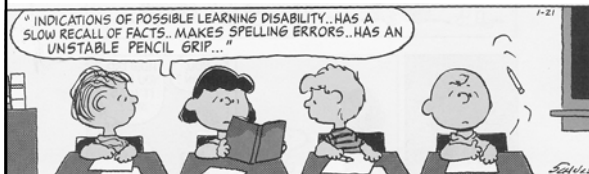
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### What is a Learning Disability?



Is Charlie Brown LD? 1968 View of LD as a constitutional disorder of psychological processes...

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### 1968 US Federal Definition

The term "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, which may manifest itself in an imperfect ability to listen, speak, read, write, spell, or to do mathematical calculations. The term includes such conditions as perceptual handicaps, brain injury, minimal brain dysfunction, dyslexia, and developmental aphasia. The term does not include children who have learning disabilities which are primarily the result of visual, hearing, or motor handicaps, or mental retardation, or emotional disturbance, or of environmental, cultural, or economic disadvantage.

(USOE, 1968)

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I. Concept of Cerebral Dysfunction  
(Satz & Fletcher, 1980)

- Still (1902): Disorder of Morbid Control
- Kahn and Cohen (1925): Organic Driveness Syndrome
- Strauss and Lehtinen (1948): Minimal Brain Injury
- Bender (1952): Bender Gestalt
- Easter Seals/NINDS (1962): Minimal Brain Dysfunction
- Dept of Education (1968): Specific Learning Disabilities
- DSM III (1980): Academic Skills Disorders, ADHD

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II. Concept of Dyslexia/LD

- Hinshelwood, Morgan, others (1896): congenital word blindness- disorder of left angular gyrus
- Orton (1925): strephosymbolia (dyslexia)- disorder of hemispheric organization (cerebral dominance)
- Kirk (1963): Specific Learning Disabilities (constitutional origin)
- Dept of Education (1968): Specific Learning Disabilities

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Traditional Approaches to LD:  
Historical Focus 1

- Models focused on domains beyond academic skills because of the interest in brain dysfunction
- Poor academics another sign-not the main focus of the research question
- Understanding the academic problem does not explain the problem at the level of the brain
- Treatment stems from an understanding of brain dysfunction

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Cognitive Correlates of Dyslexia.  
"Defects" in...

- Visuoception (spatial processing)
- Directional sense (right-left discrimination)
- Audioperception (speech sound discrimination)
- Intersensory integration (matching auditory and visual input)
- Oral language (generalized language disorder)
- Sequencing and finger recognition
- Cerebral dominance (hand preference)
- CNS function (associated motor disorders)

Benton, 1975

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Earlier Neural Theories of  
Dyslexia

- Focal Maldevelopment: Angular Gyrus, Incomplete Parietal Lobe Development
- Disturbance of Brain Organization: Cerebral Dominance (Orton, 1925)
- Maturation lag (Satz & Sparrow, 1968)
- Some Models Imply Particular View of Reading Process: Disconnection Syndrome (Color Naming; Geschwind), Intersensory Integration; Birch)

Benton, 1975

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Benton, 1975

"...a neurological basis for developmental dyslexia has not been established, the empirical evidence...inconsistent and circumstantial." (highlighted relevance of parietal lobes)

"One striking deficiency...is the failure to provide an adequate description of the behavioral disability."

"Continued investigation of dyslexia as an expression of more basic linguistic disability is also indicated."

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Theories of Dyslexia/LD:  
Historical Focus 2

- Children are heterogeneous
- Search for subtypes based on patterns of cognitive strengths and weaknesses
- Focus on minor signs and correlates
- Subtypes should reflect more homogeneous groups associated with distinct etiologies

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Traditional Theories of Learning  
Disability: Strengths

- Identified CNS factors as fundamental cause of LD
- Recognized the need to address the heterogeneity of LD
- Identified precursors of LD that could form the basis for screening
- Evaluated many skills and abilities associated with LD

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Traditional Approaches to LD:  
Problems

- Focus on tests, not constructs
- Stem from an interest in etiology as a precursor to treatment
- Don't link closely to knowledge base on the development of academic skills
- Don't lead to effective intervention (little evidence that focus on minor signs, correlated deficits, or cognitive processes generalizes to improved reading, math, or writing)

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### Traditional Theories of Dyslexia/LD: Problems

- Major problem: Imposition of clinical model of assessment onto a common set of difficulties that impact adaptive functioning in relatively narrow contexts (components of school, work)
- Clash of models: Academic vs. Brain Function
- Most reliable subtypes at the level of academic skills
- How can dyslexia/LD be explained if the academic component is not central?

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### Theories of Dyslexia/LD: Progress

- Work across disciplines
- Abandon exclusionary definitions- look for identification criteria that are inclusionary and systematically address sampling issues
- Integrate cognitive theory on academic skills development- language and reading- with research on genes and brains
- NICHD- LD initiative (1980's)- definition and classification, cognitive correlates, neurobiological factors, intervention fueled an international, interdisciplinary effort

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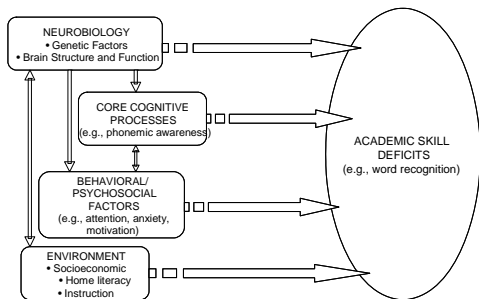
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### A Comprehensive Model of LD (Fletcher, Lyon et al., 2007)



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### Dyslexia/LD are Dimensional Constructs

- All disabilities have biological and social realities that vary with “disorder” and “person”
- Epidemiological studies in New Zealand, United Kingdom, US: Learning disabilities are dimensional- variation on normal development
- Classification model is obesity or hypertension, not measles and mumps
- Measurement error and cut point are huge problems- children close to cut point are more similar than different (it’s a continuum)
- Same theory explains success and failure (☺)

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### Low Achievement is Necessary but Not Sufficient

- Homogeneity is at the level of the academic skill
- Processing subtypes duplicate academic subtypes because they are correlated deficits and don’t explain independent variability
- Define academic subgroups based on inherently arbitrary criteria tied to a dimension
- Leads to coherent classification that is reliable and valid
- Simplifies identification process; fueled research in other domains
- Now we need to add intractability

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### Hypothetical Classification of LD: Marker Variables involving:

1. Word Recognition (Dyslexia)
2. Reading Fluency
3. Reading Comprehension
4. Math Computations (Dyscalculia)
5. Math Problem Solving
6. Written Expression (Handwriting, Spelling, Text Generation?)

Occur in isolation and concurrently, but basis for defining samples

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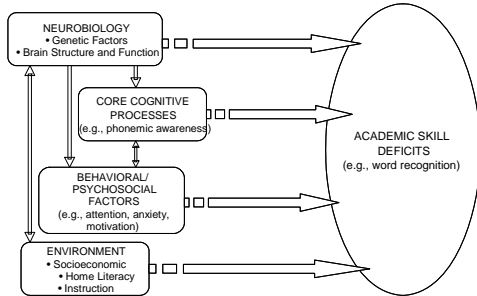
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## A Comprehensive Model of LD (Fletcher, Lyon et al., 2007)




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### Core Cognitive Processes

- Vary with academic domain
- Supports validity of the hypothetical classification
- Do not require assessment for identification, but do represent precursors
- Don't add value to intervention (aptitude X treatment interaction)
- Do help understand neural mechanisms and essential for comprehensive understanding of LD

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### Traditional Definition of Dyslexia

**A disorder manifested by difficulties in learning to read despite conventional instruction, adequate intelligence, and socio-economic opportunity. It is dependent upon fundamental cognitive disabilities which are frequently of constitutional origin.**

Critchley, 1970, p.11

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## IDA DEFINITION OF 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 by 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. Secondary consequences may include problems in reading comprehension and reduced reading experience that can impede the growth of vocabulary and background knowledge.

Adopted by the Board of Directors: November 12, 2002

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Identification of dyslexia does not require an extensive assessment

- Specify Low Achievement: Word Recognition (Real Words, Pseudowords) and Spelling (depending on language)
- Response to Instruction must be measured and is an inclusionary criterion
- Consider the exclusions

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## Cognitive Correlates of Dyslexia

- Phonological Awareness
- Rapid naming
- Verbal Working Memory

"Tangled web of behavioral research" (Doehring, 1978): children with and without LD differ on virtually every dimension assessed. A univariate difference doesn't validate a hypothesis

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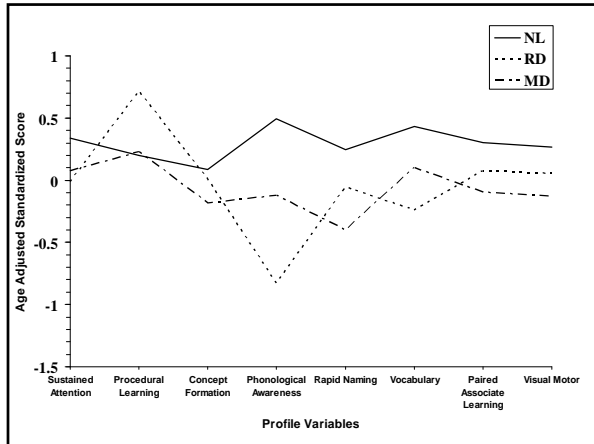
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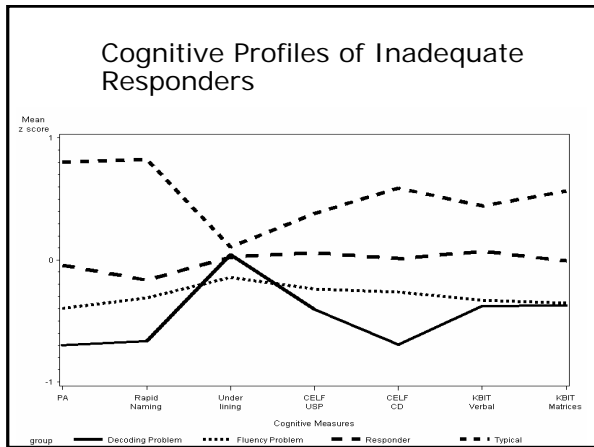
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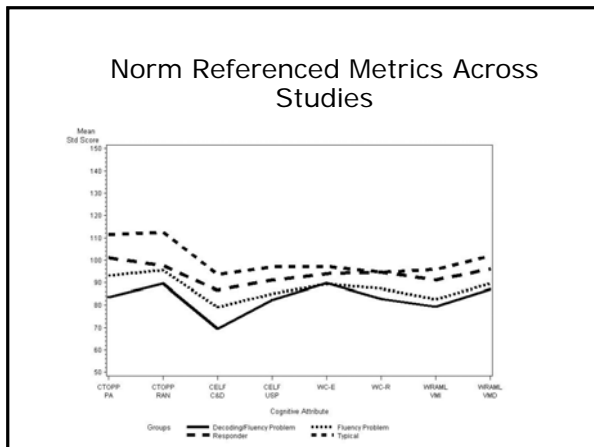
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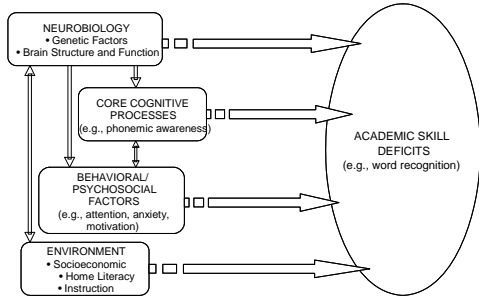
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## A Comprehensive Model of LD (Fletcher, Lyon et al., 2007)



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### Behavioral/Psychosocial Factors

- Comorbid associations, especially ADHD
- Experience of failure
- Reaction of peers and family
- Motivation

Major source of heterogeneity in research. Must be assessed in order to plan treatment, but not part of identification.

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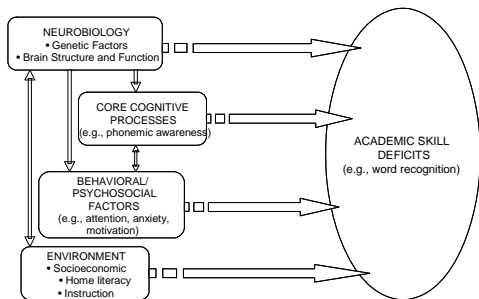
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## A Comprehensive Model of LD (Fletcher, Lyon et al., 2007)



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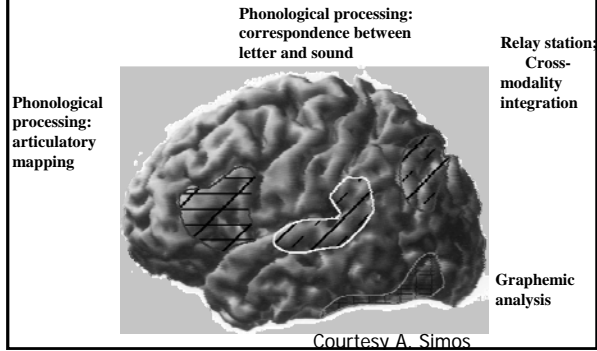
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### A Model for the Brain Circuit for Reading (Component Processes)



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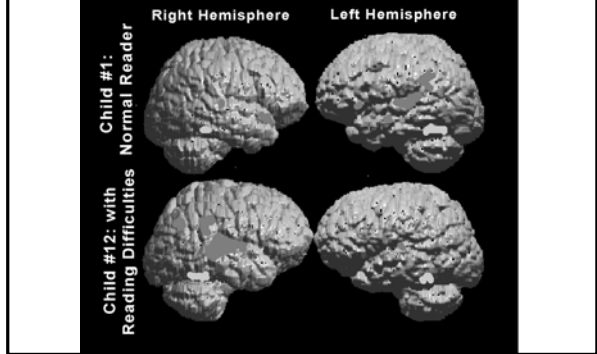
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### Brain Function in Dyslexia (Simos et al., 2001)



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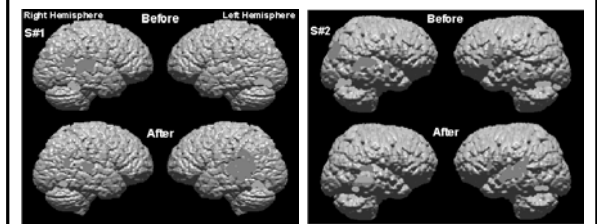
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### Neural Response to intervention; (Simos et al., 2002)



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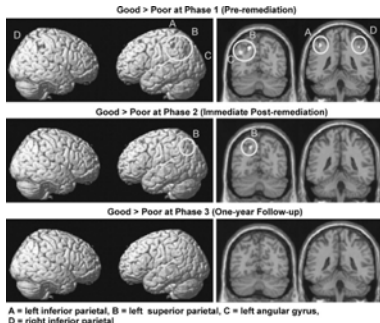
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Meyler et al.,  
Neuropsychologia, 2008




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### Genetic Factors

- Benton (1975): runs in families, esp. MZ twins; more males
- Reading, math, and writing are heritable traits; 11 sites, 4 candidate genes for reading/dyslexia
- In reading, heredity accounts for 50-80% of variance in outcomes
- No genes specific to poor development (e.g., no dyslexia genes)
- Genetic organizations (quantitative trait loci) make brains at risk; level of risk is modified by environment, but genetic correlation increases with age

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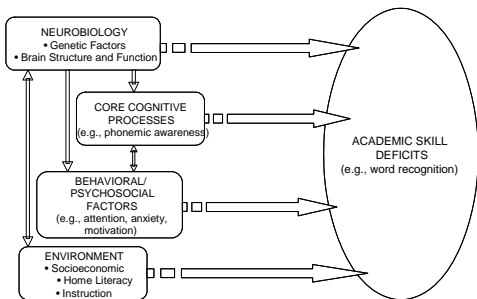
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### A Comprehensive Model of LD (Fletcher, Lyon et al., 2007)




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Environmental Factors

- Home environment and quality of language
- Socioeconomic factors: parental education, poverty
- Instruction

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Word Reading: Multiple Meta-Analyses

- Lipsey and Wilson (1993) .34 for educational interventions
- Swanson (1999) .57 for word reading in LD
- NRP: .98 K-2; .49 G2-6 for word reading in poor readers
- Similar effects in multiple studies of children identified with word reading problems
- Effects stronger if programs more comprehensive, begin earlier, last longer, in smaller groups with more intensity, and focus on reading; smaller for fluency and comprehension, esp. if remedial

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Mathes et al., 2005: Grade 1 Inadequate responders

**Enhanced Classroom: 15/92 = 16% (3.2% of school population)**

**Enhanced Classroom/Small Group Pullout: 7/163 = 4% (<1% of school population)**

(Woodcock Basic Reading < 30<sup>th</sup> percentile); fluency benchmarks add 5 students

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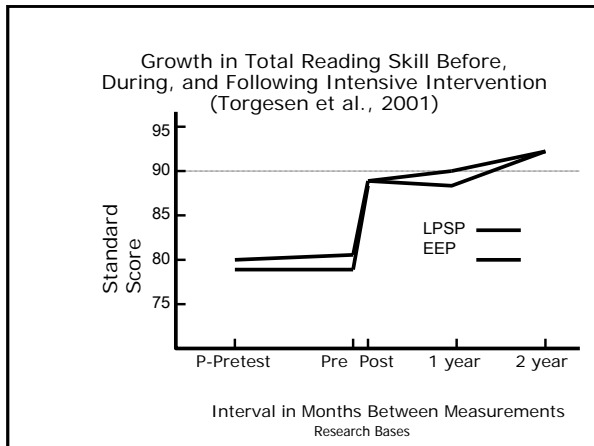
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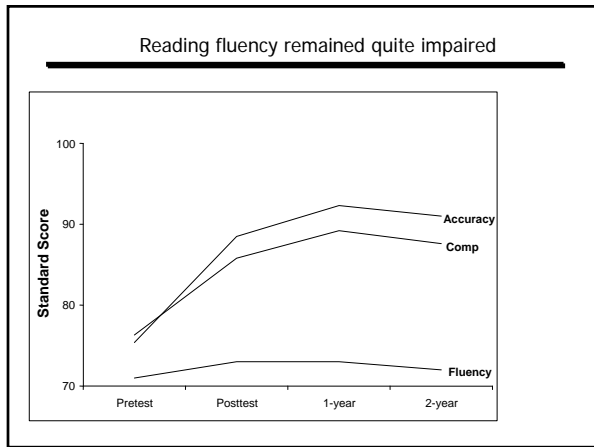
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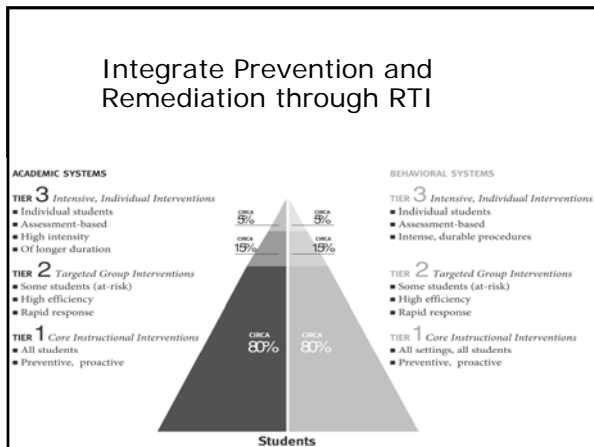
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### What's the Impact?

- Universal screening required in many states
- Highlights randomized trials and "scientifically" evaluated instruction
- Early intervention more common, but still a struggle
- Put the biology in dyslexia as an active field of research and not as a metaphor or hypothesis
- Promotes interdisciplinary, public health approaches; dyslexia is not just an education issue
- Research base best developed for dyslexia (most common); more to do in other reading domains and math and writing

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### IDEA 2004: RTI or Discrepancy?

- (2)(i) The child does not make sufficient progress to meet age or State-approved grade-level standards...when using a process based on the child's response to scientific, research-based intervention; or
- (ii) The child exhibits a pattern of strengths and weaknesses in performance, achievement, or both, relative to age, State-approved grade-level standards, or intellectual development...
- Children may not be identified for special education without evidence of adequate instruction in reading and math

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### Some Concluding Caveats

- Beware of accepting the null hypothesis as well as promissory notes: more research, but stick to what we know, not what we believe
- Minor signs not adequate for identification, but may be important for understanding brain function. LD is more than an academic skills disorder, but focus on nonresponders
- Low achievement is necessary but not sufficient, but must do research in the context of academic subtypes; build on what we know
- Structural studies must involve larger samples and need to link to functional studies
- Genetic studies need more diversity

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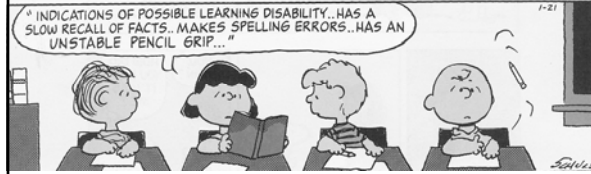
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## Is Charlie Brown LD?



How can we tell if we don't evaluate his achievement levels and put him in an intervention? Major signs, not correlates

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## Who is dyslexic/LD?

- The student who does not respond to quality instruction: hard to teach, not unable to learn
- Low achievement and inadequate instructional response, not IQ or cognitive processes
- Often preventable with early intervention
- Heritable, but neural systems are malleable
- Advances in science occur at the boundaries of disciplines (Wilson, 1998)

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## More Information?

- [www.nasdse.org](http://www.nasdse.org)
- [www.centeroninstruction.org](http://www.centeroninstruction.org)
- [www.rtinetwork.org](http://www.rtinetwork.org)
- [www.iris.peabody.vanderbilt.edu/](http://www.iris.peabody.vanderbilt.edu/)
- [www4.scoe.net/rti/programs.cfm](http://www4.scoe.net/rti/programs.cfm)

jackfletcher@uh.edu

[www.texasldcenter.org](http://www.texasldcenter.org)

Funded by NICHD P50 HD052117

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