Deciphering Dyslexia

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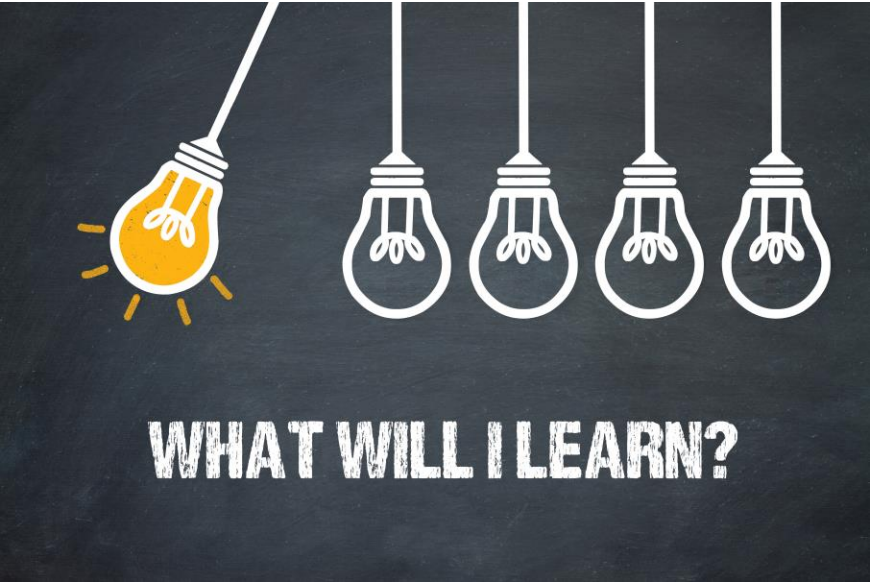


You will learn about:

1. Language Basis of Literacy
2. A Conceptual Model Of Dyslexia
3. Neurobiological Differences
4. Characteristics of Dyslexia
5. Secondary Consequences

Section 1

Language Basis of Literacy

LANGUAGE IS KEY

"Possessing language, humans have had a high-fidelity code for transmitting detailed information down the generations. Many, if not most, of the things we make use of in our everyday lives, rely on specialized knowledge or skills to produce. The information behind these was historically coded in verbal instructions, and with the advent of writing, it could be stored and become increasingly complex."

Pagel, M. (2017)

LANGUAGE BASICS

Figure developed based on the American Speech-Language-Hearing Association (ASHA) definition of language.

ORAL AND WRITTEN LANGUAGE

1 Oral Language came first

We have used spoken language to communicate for a long time, around 240,000 years.

Highly integrated brain networks have evolved to allow for oral language.

Reading is a newer human invention (2,600 BCE). It is the interaction of attention, language, vision, and knowledge.

2 Reading Must be Taught & Practiced

Children learn to understand and produce oral language from exposure.

Children must be directly taught how to read and write written language.

It takes practice to become automatic readers and writers.

Individual differences exist in how much instruction and practice is required to become proficient readers and writers.

3 Oral Language is ever present

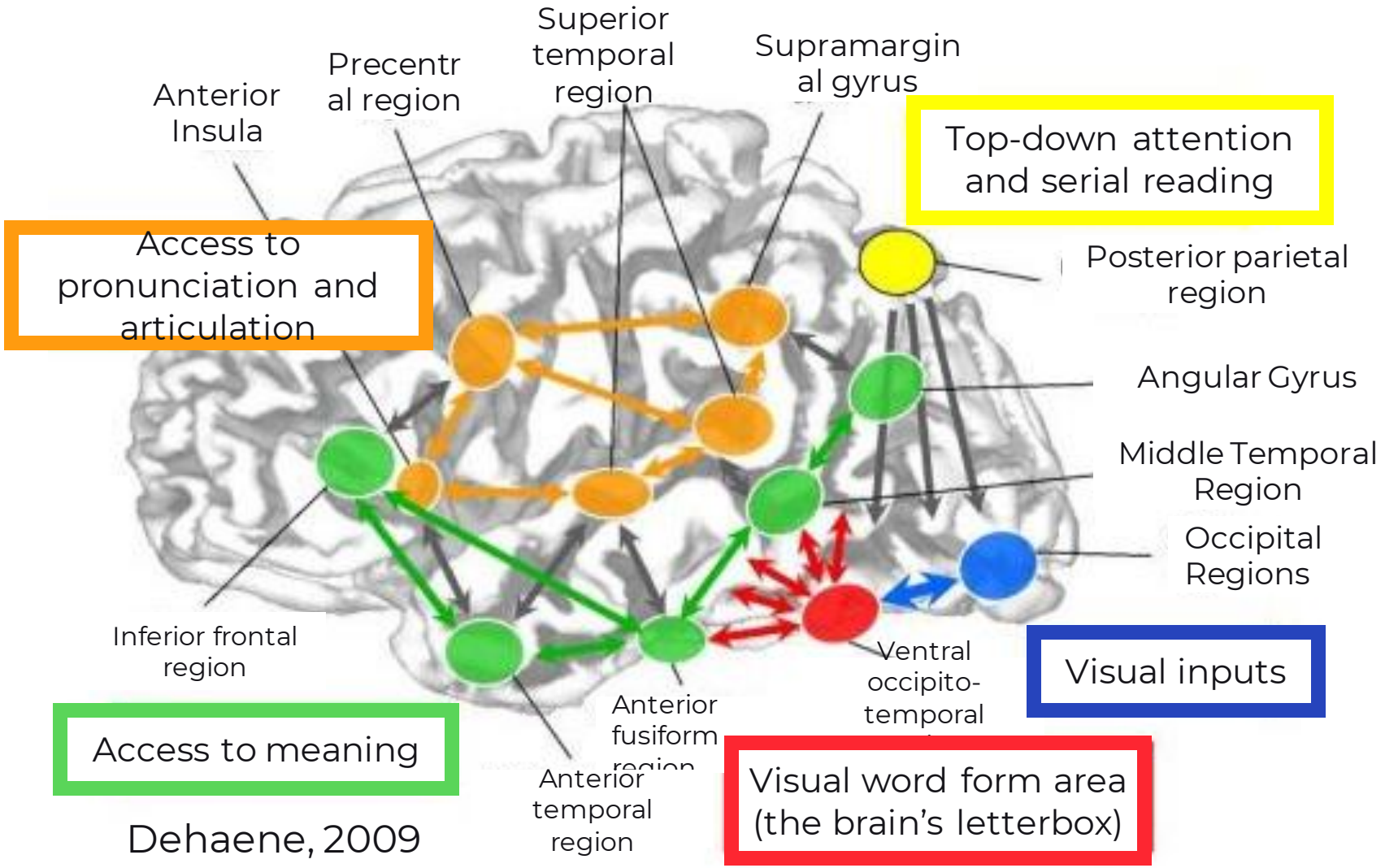
Oral language continues to develop and expand even after a child enters school, and this development interacts with reading development.

Engaging meaningfully and deeply with text fosters vocabulary, background knowledge, creativity, and innovation.

Dehaene, 2009; Wolf, 2007

“My firm conviction is that every teacher should have some notion of how reading operates in the child’s brain.”
-Dehaene

CORTICAL MODEL OF READING



Dehaene, 2009

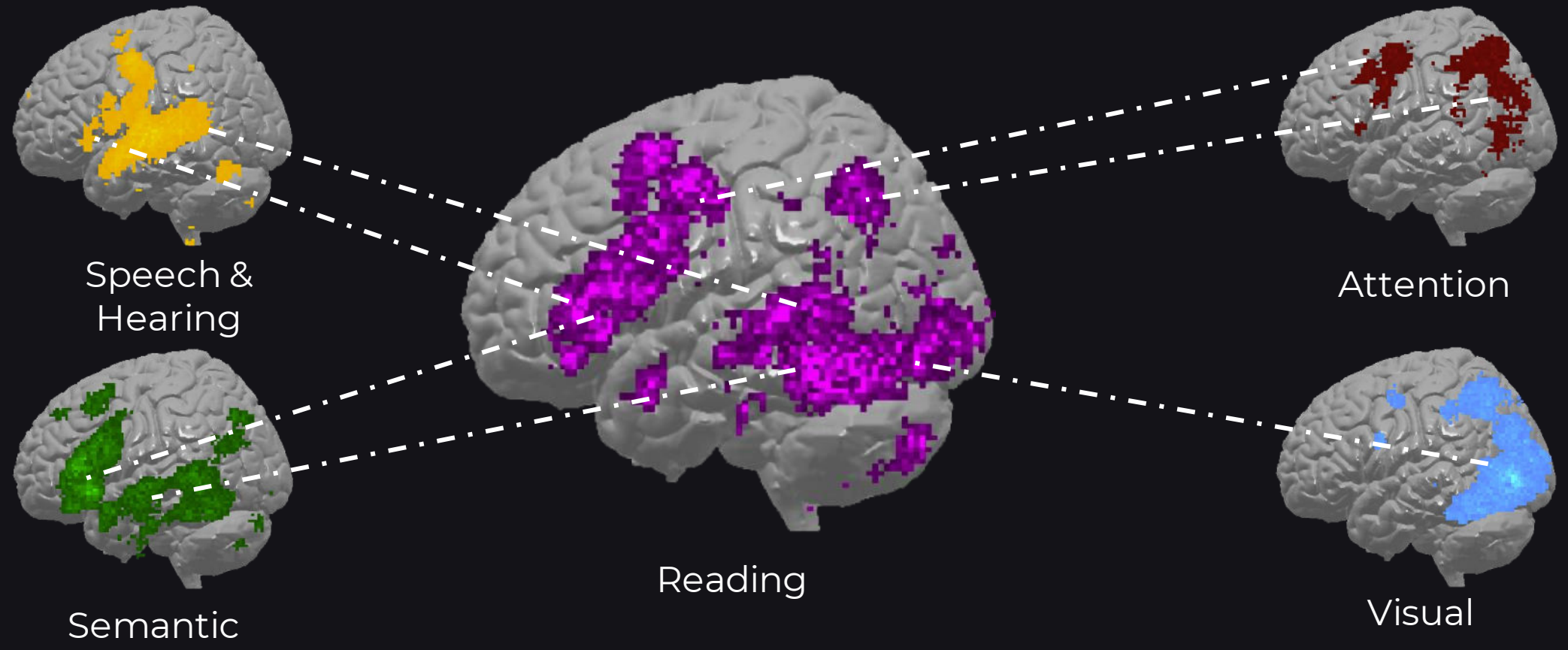
Brain Areas Involved When Reading

Reading is a compilation of many cortical brain regions

Aspects of Oral Language

Receptive Written Language

Supporting Processes



UNIVERSALITIES ACROSS ORTHOGRAPHIES?

Similar brain networks are engaged when reading

English

Spanish

Chinese

Hebrew

Print only

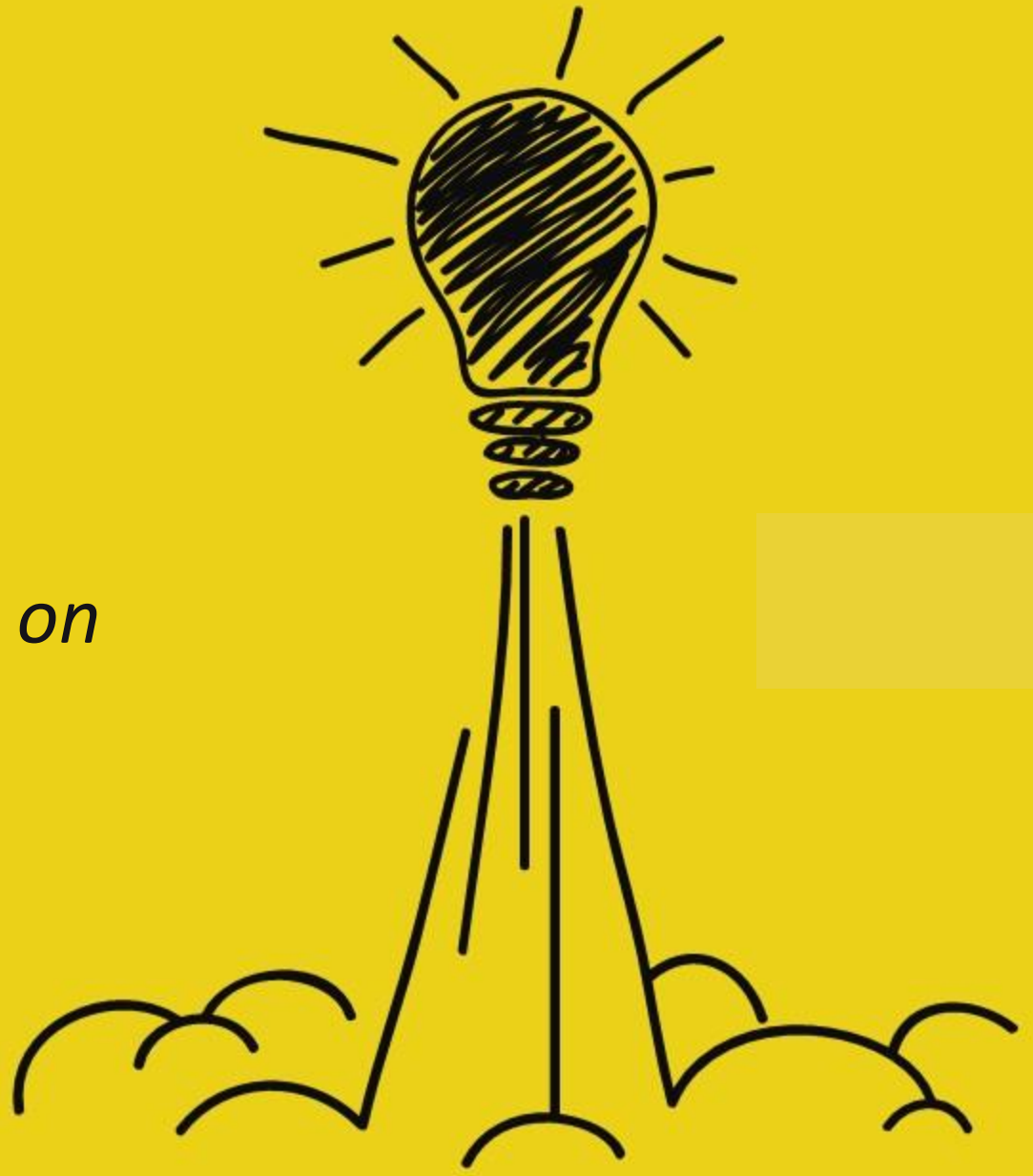
Speech only

Overlap

Adapted from Rueckl et al., 2015
Figure 1

Big Idea

Written language builds on oral language.



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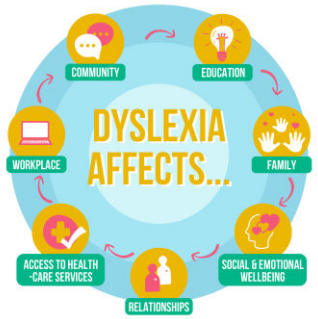
Section 2

Conceptual Model of Dyslexia



Abridged Contemporary Model of Dyslexia

Intrinsic Protective and Risk Factors

Behavioral Presentation

Inaccurate/Inefficient Word Reading, Inaccurate/Inefficient Decoding, Spelling Deficits, Persistently Slow Learning Rate

Proximal Causes

Phonological Processing Deficits, Sound-Symbol Correspondences Deficits, Lack of Automaticity in Accessing Phonology and Orthography

Distal Causes

Neuro-biological (genetics, brain structure, brain function, brain connectivity)

Environmental Factors

Graphic was developed based on the conceptual understanding of learning disabilities outlined in Fletcher et al., 2019. A similar and expanded understanding of dyslexia is described in Catts & Petscher, 2021.

Odegard et al., 2020

Expanded Contemporary Model of Dyslexia

ENVIRONMENTAL FACTORS

BEHAVIORAL PHENOTYPE

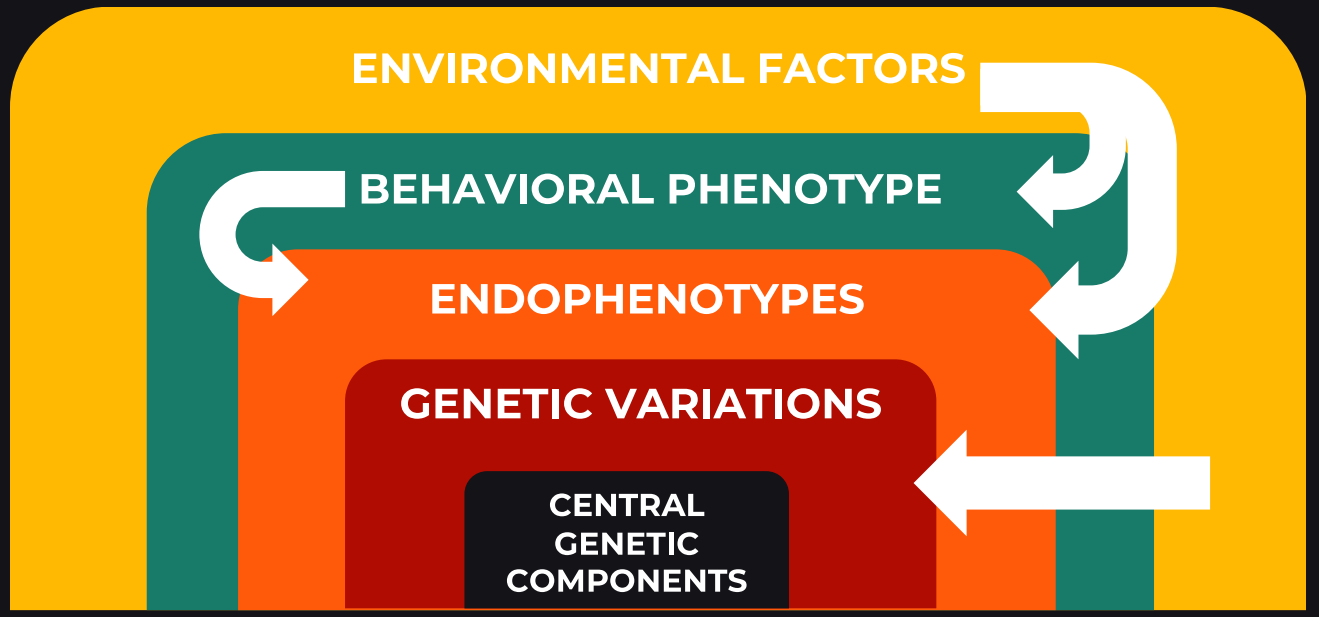
ENDOPHENOTYPES

GENETIC VARIATIONS

CENTRAL GENETIC COMPONENTS

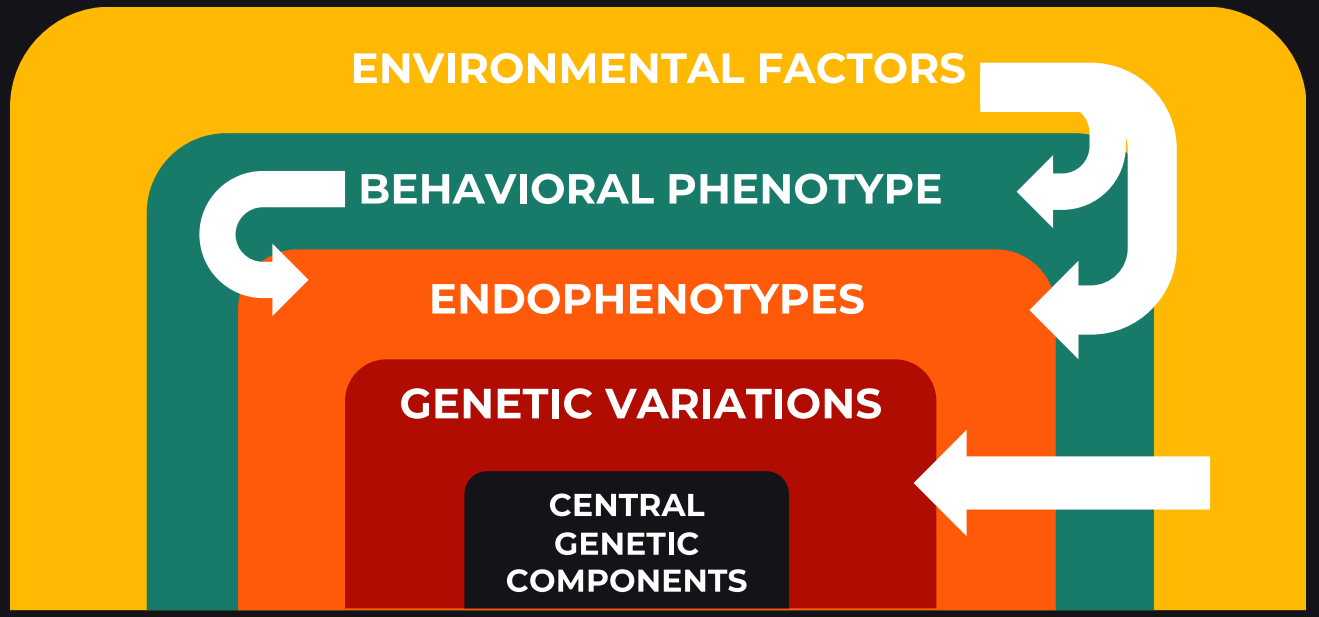
Central Genetic Components

The "Central Genetic Components" represent the foundational genetic factors that contribute to the broader aspects of development, neurobiology, domain-general aspects of cognition, and language (oral and written).



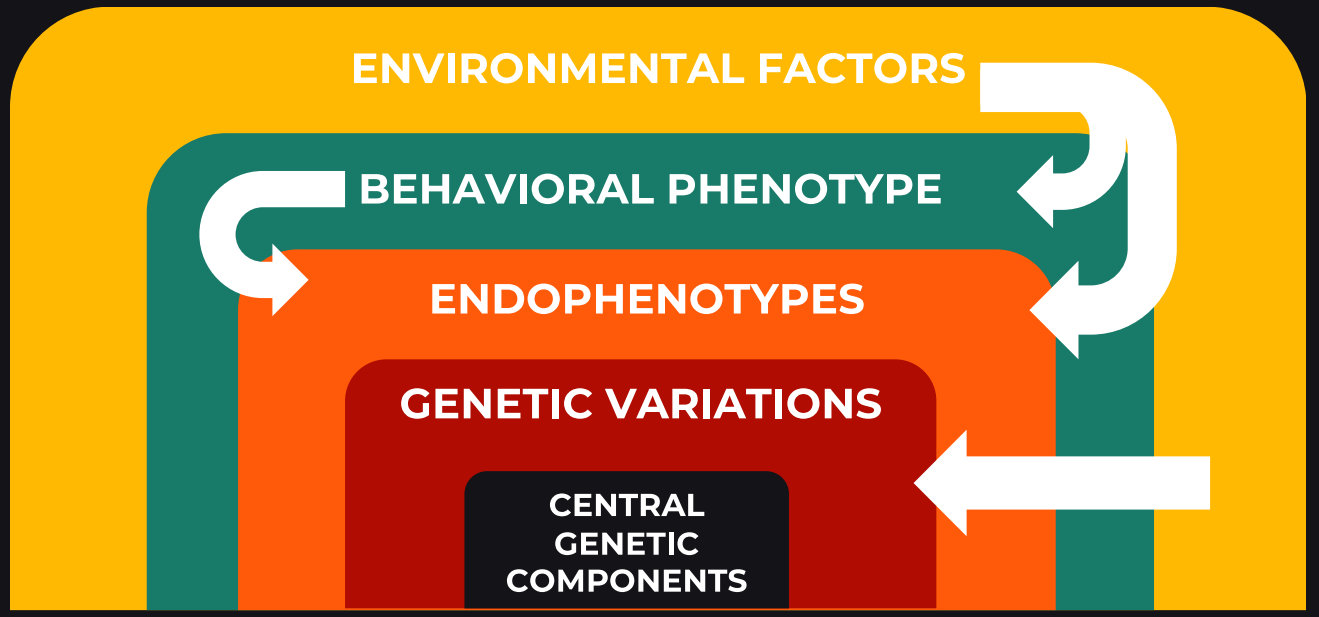
Genetic Variations

Genetic variations, occurring across multiple genes (i.e., polygenetic), play a crucial role in shaping the behavioral presentation of dyslexia. This level of specificity acknowledges the diversity in genetic influences, particularly those related to language processing—both oral and written.



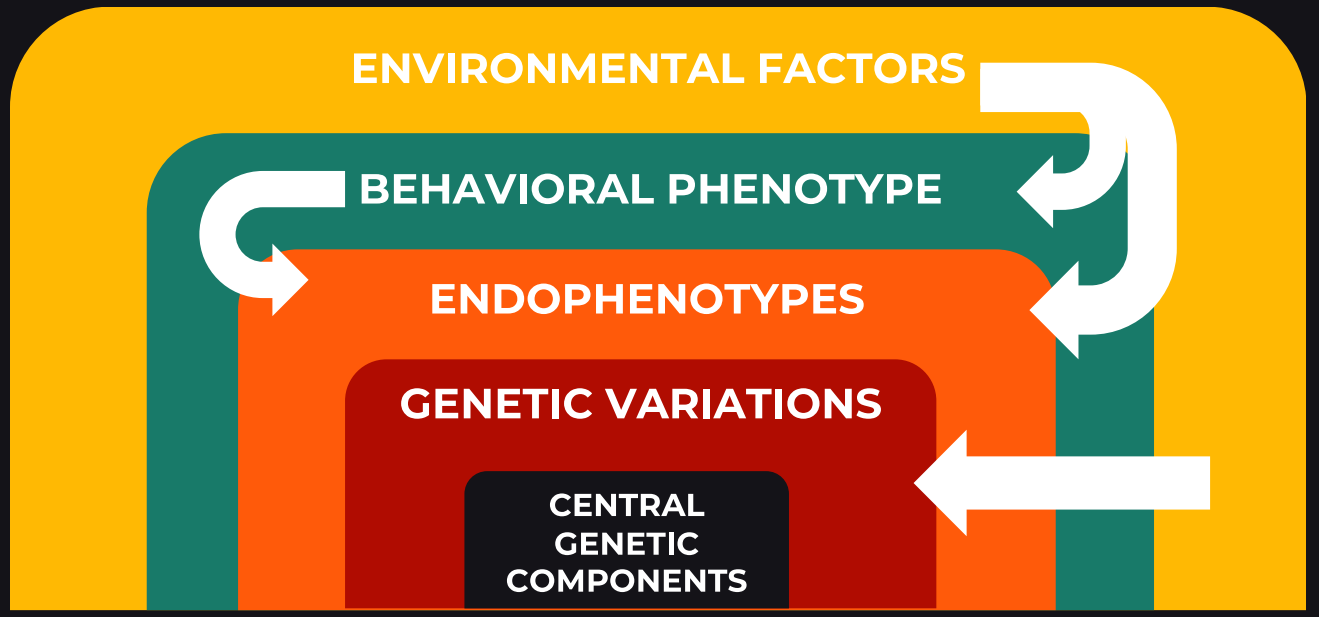
Endophenotypes

An endophenotype is a measurable and heritable trait that is thought to be an intermediate link in the causal chain between genes and complex multifactorial traits or conditions such as dyslexia.



Behavioral Phenotype

Behavioral phenotype refers to the observable and measurable behaviors associated with the condition. The complex behavioral phenotype of dyslexia results from the interaction between genetic expression into endophenotypes and environmental factors.



Expanded Contemporary Model of Dyslexia

ENVIRONMENTAL FACTORS

BEHAVIORAL PHENOTYPE

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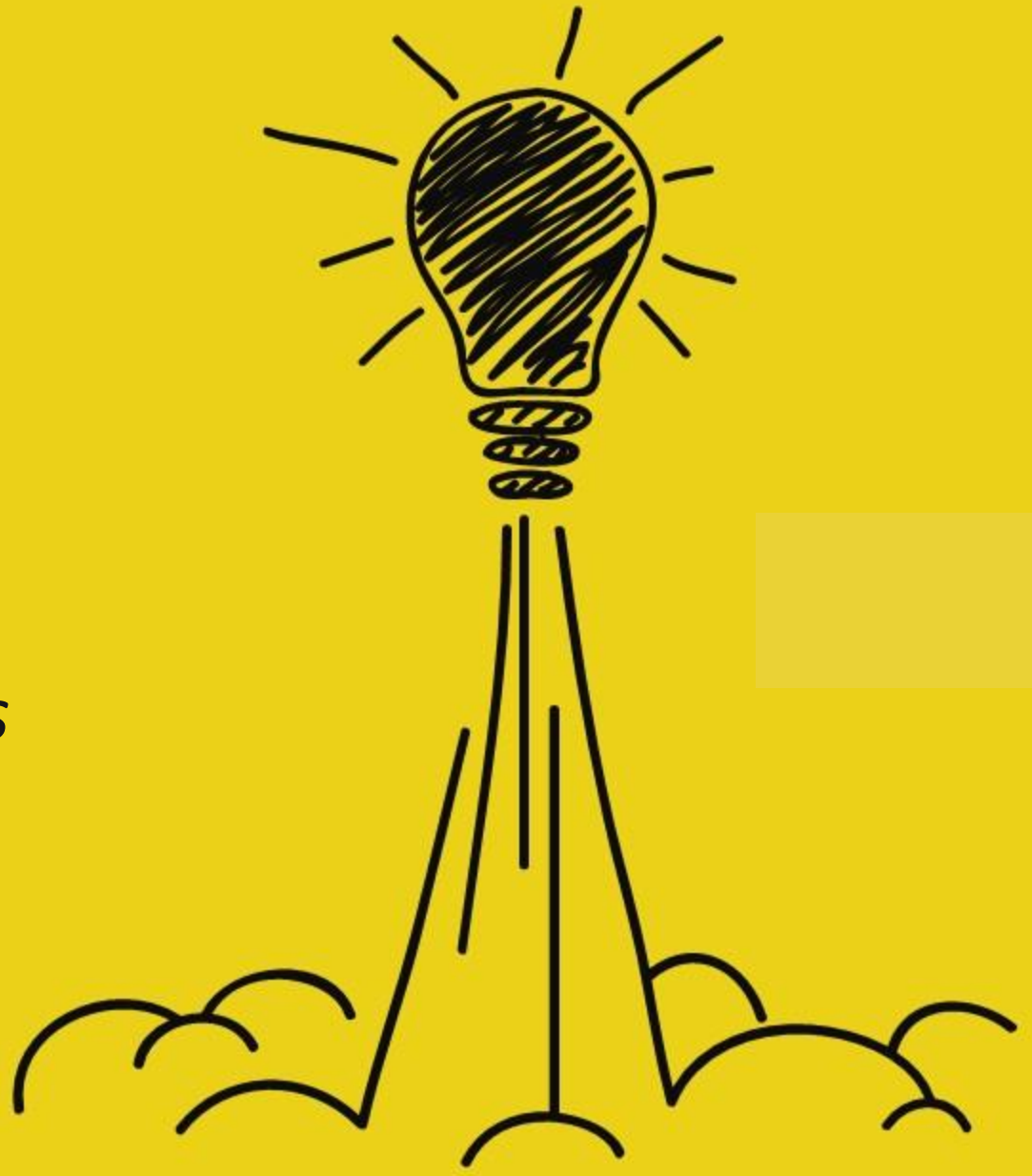
GENETIC VARIATIONS

CENTRAL GENETIC COMPONENTS

Big Idea

The link between oral language and dyslexia is encoded in our DNA.



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Section 3

Dyslexia
Brain Basis

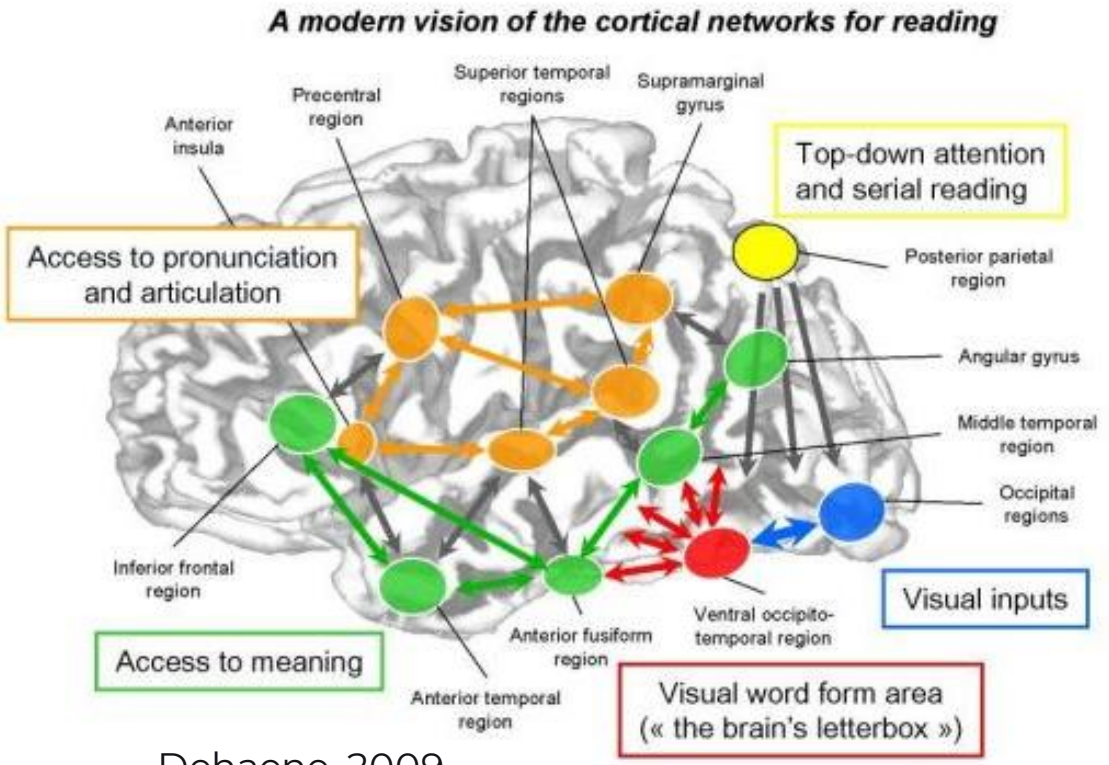
Dyslexia and Neurobiology

Differences are commonly observed in the brains of individuals with dyslexia when compared to their peers with typical reading development

1) Structural Brain Differences
2) Functional Brain Differences
3) Differences in Brain Connectivity
4) Differences in Brain Chemistry

Dyslexia is a brain-based type of learning disability that specifically impairs a person's ability to read.

Excerpt from the definition adopted by the National Institute of Child Health and Human Development (2014)



Dehaene, 2009

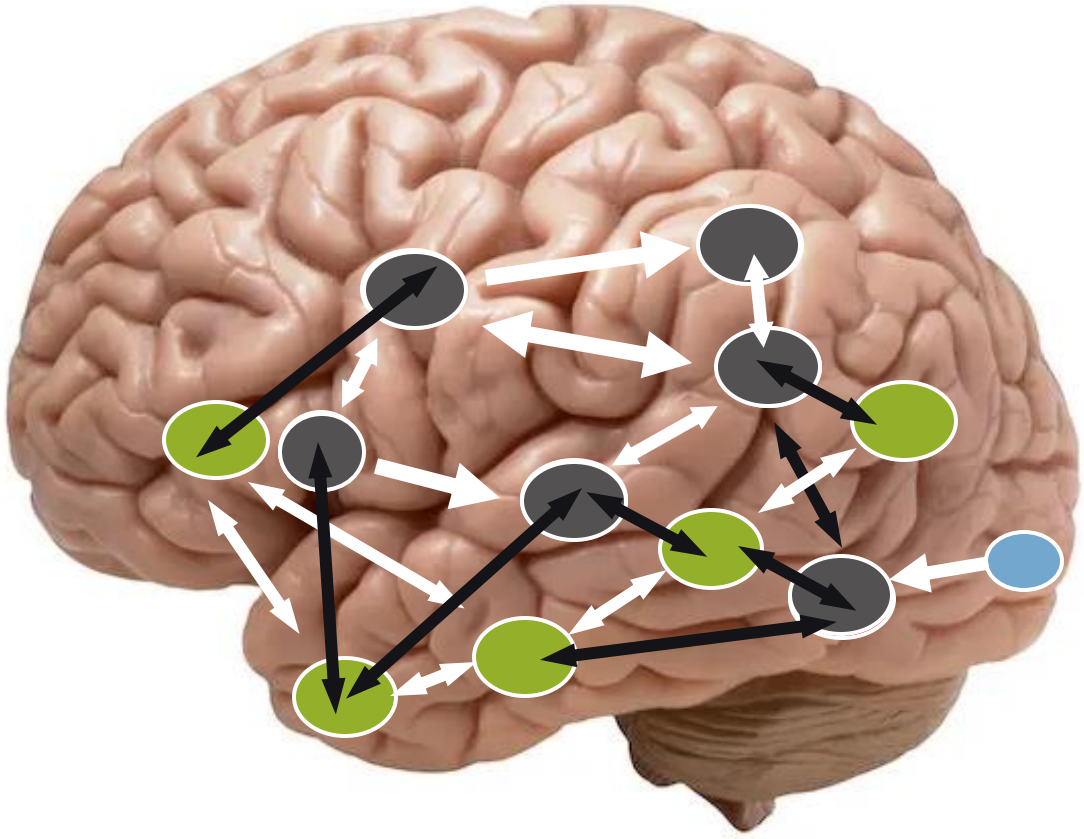
Brain Differences Associated with a Dyslexia

Differences occur in 3 main areas:

1. Areas in the back of the brain involved in mapping letters and sounds together
2. The brain's letterbox responsible for processing letters as visual units.
3. Areas in the front of the brain involved in the articulation of spoken language.

Richlan, F., et al., 2011; Pugh et al., 2010

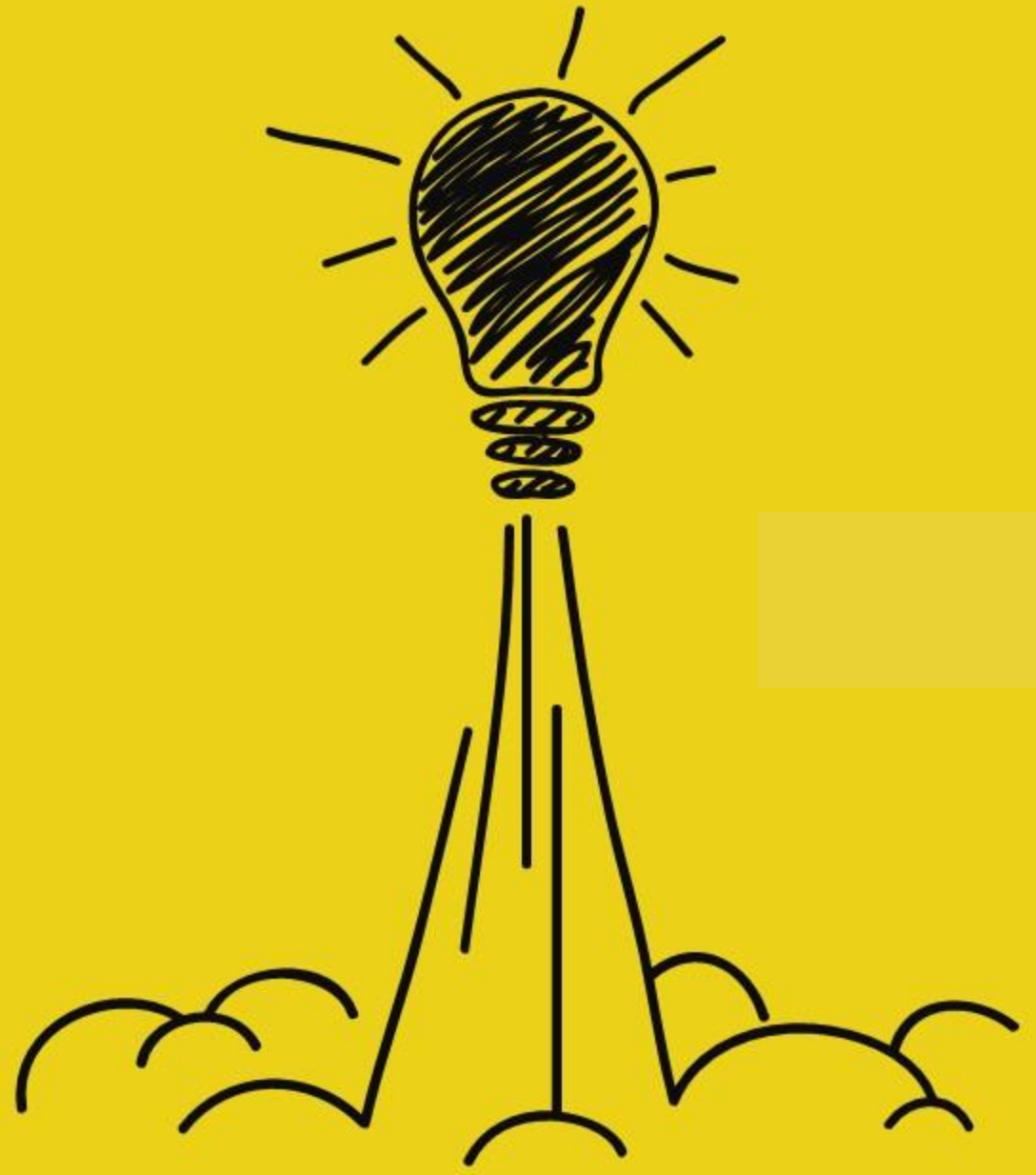
Brain differences are observed between children with dyslexia compared to their peers who do not struggle to read.



Left hemisphere

Big Idea

Exploring brain-based differences of dyslexia highlights the role of language processing.



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Section 4

Dyslexia
Characteristics

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.

International Dyslexia Association (2002)

Components of Skilled Reading

A Less Simple View

EXECUTIVE FUNCTIONING
ATTENTION / INHIBITION / WORKING MEMORY

READING COMPREHENSION

SYNTACTIC STRUCTURE

MORPHOLOGY

VOCABULARY

BACKGROUND KNOWLEDGE

READING FLUENCY

WORD RECOGNITION

DECODING/ ENCODING

LK

PA

SIGHT WORD

RAPID NAMING

AUTOMATIC

ACCURATE

Odegard, 2016

Primary Characteristics of dyslexia

READING COMPREHENSION

- SYNTACTIC STRUCTURE
- MORPHOLOGY
- VOCABULARY
- BACKGROUND KNOWLEDGE
- READING FLUENCY
- WORD RECOGNITION
- DECODING/ ENCODING
  - LK
  - PA
- SIGHT WORD
- RAPID NAMING
- AUTOMATIC
- ACCURATE

Odegard, 2016

Deficits Associated with dyslexia

READING COMPREHENSION

- SYNTACTIC STRUCTURE
- MORPHOLOGY
- VOCABULARY
- BACKGROUND KNOWLEDGE
- READING FLUENCY
- WORD RECOGNITION
- DECODING/ ENCODING
  - LK
  - PA
- SIGHT WORD
- RAPID NAMING
- AUTOMATIC
- ACCURATE

Odegard, 2016

Secondary Consequences

dyslexia

READING COMPREHENSION

- SYNTACTIC STRUCTURE
- MORPHOLOGY
- VOCABULARY
- BACKGROUND KNOWLEDGE
- READING FLUENCY
- WORD RECOGNITION
- DECODING/ ENCODING
  - LK
  - PA
- SIGHT WORD
- RAPID NAMING
- AUTOMATIC
- ACCURATE

Odegard, 2016

People often ask about the presentation of dyslexia in different languages.

Are there differences in presentation in the primary characteristics?

Summary of Key Pattern of Results (Carioti et al., 2021)

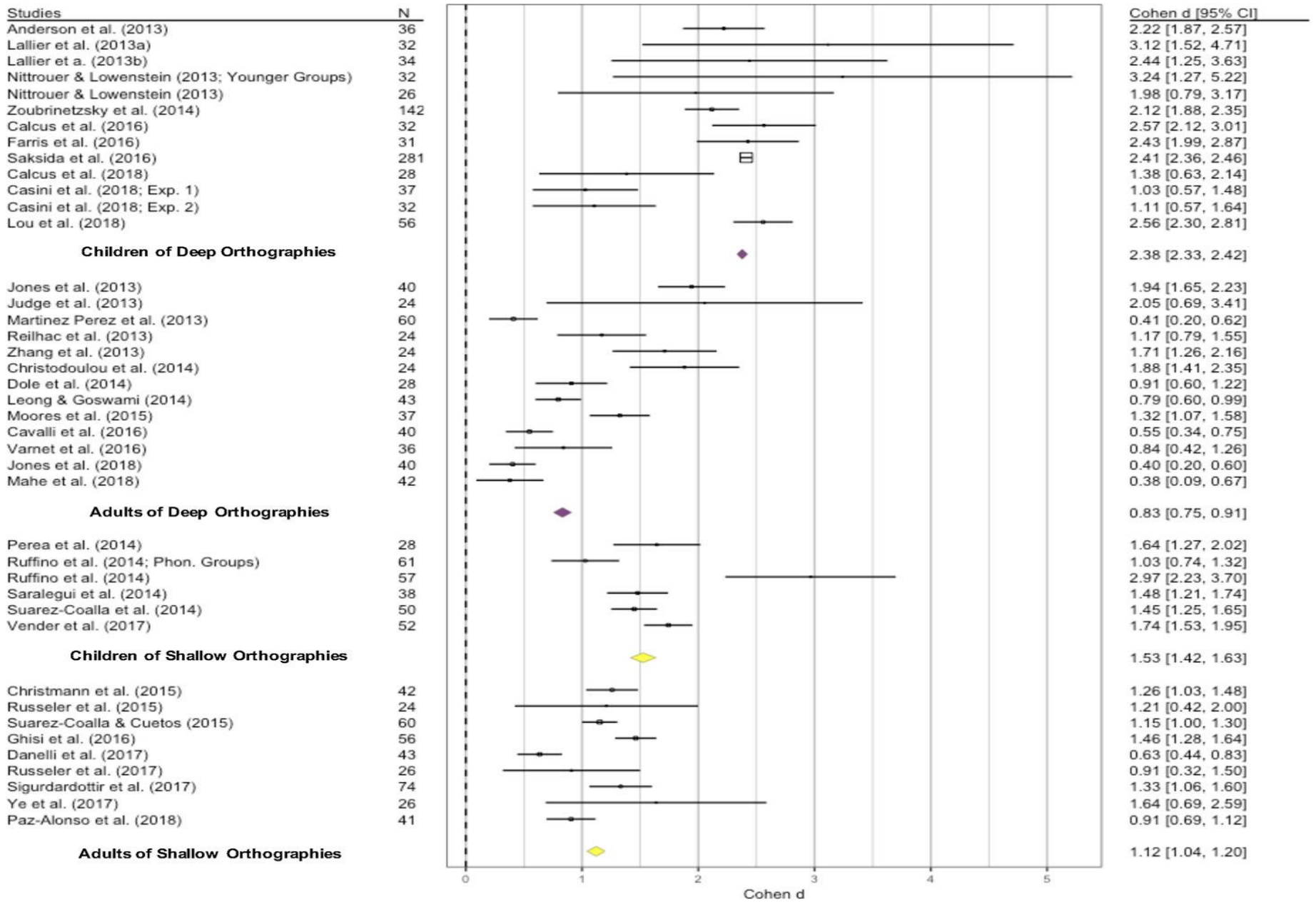
	Group	Ortho	Age	OrthoXAge
Word Reading				
Accuracy	**Yes**	**Yes**	**Yes**	**Yes**
Fluency (TU)				
Fluency (TL)				
Non-Lexical Decoding				
Accuracy				
Fluency (TU)				
Fluency (TL)				
Related Skills				
Phonological Manipulation				
Non-word Repetition				
Working Memory				
Non-verbal Reasoning				

TU – time-unlimited; TL – time-limited

People often ask about the presentation of dyslexia in different languages.

Are there differences in presentation in the primary characteristics?

Forest Plot of the random effect model on word reading accuracy



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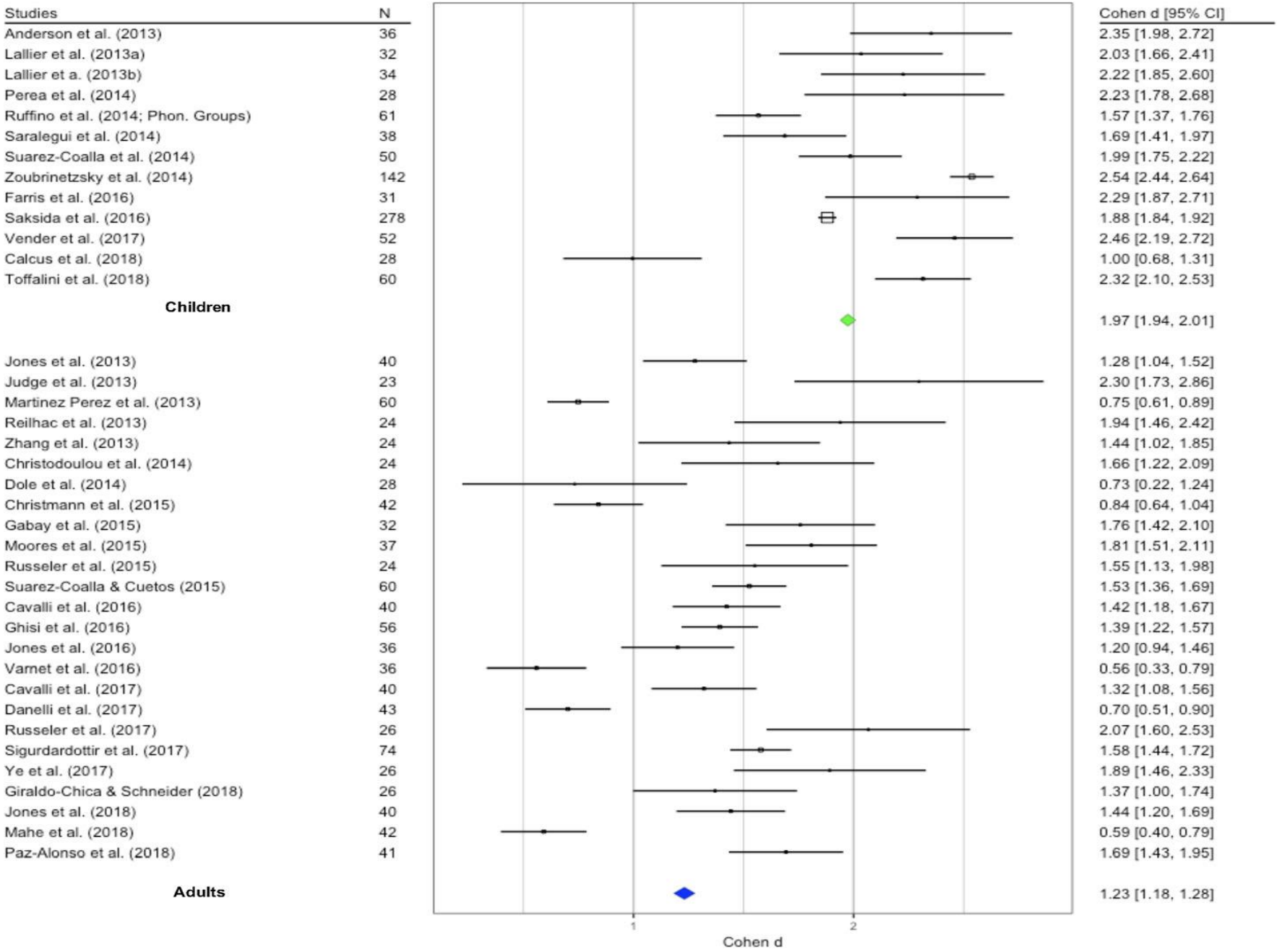
	Group	Ortho	Age	OrthoXAge
Word Reading				
Accuracy	**Yes**	**Yes**	**Yes**	**Yes**
Fluency (TU)	**Yes**	No	No	No
Fluency (TL)	**Yes**	No	No	No
Non-Lexical Decoding				
Accuracy	**Yes**	No	**Yes**	No
Fluency (TU)				
Fluency (TL)				
Related Skills				
Phonological Manipulation				
Non-word Repetition				
Working Memory				
Non-verbal Reasoning				

TU – time-unlimited; TL – time-limited

People often ask about the presentation of dyslexia in different languages.

Are there differences in presentation in the primary characteristics?

Forest Plot of the random effect model on non-lexical decoding accuracy



People often ask about the presentation of dyslexia in different languages.

Are there differences in presentation in the primary characteristics?

Are there differences in the associated skills?

Summary of Key Pattern of Results (Carioti et al., 2021)

	Group	Ortho	Age	OrthoXAge
Word Reading				
Accuracy	**Yes**	**Yes**	**Yes**	**Yes**
Fluency (TU)	**Yes**	No	No	No
Fluency (TL)	**Yes**	No	No	No
Non-Lexical Decoding				
Accuracy	**Yes**	No	**Yes**	No
Fluency (TU)	**Yes**	No	No	No
Fluency (TL)	**Yes**	No	No	No
Related Skills				
Phonological Manipulation	**Yes**	No	No	No
Non-word Repetition	**Yes**	No	No	No
Working Memory	**Yes**	No	No	No
Non-verbal Reasoning	No	No	No	No

TU – time-unlimited; TL – time-limited

Note. *Non-verbal reasoning did not moderate differences in word reading (accuracy, fluency-TU, fluency-TL).*

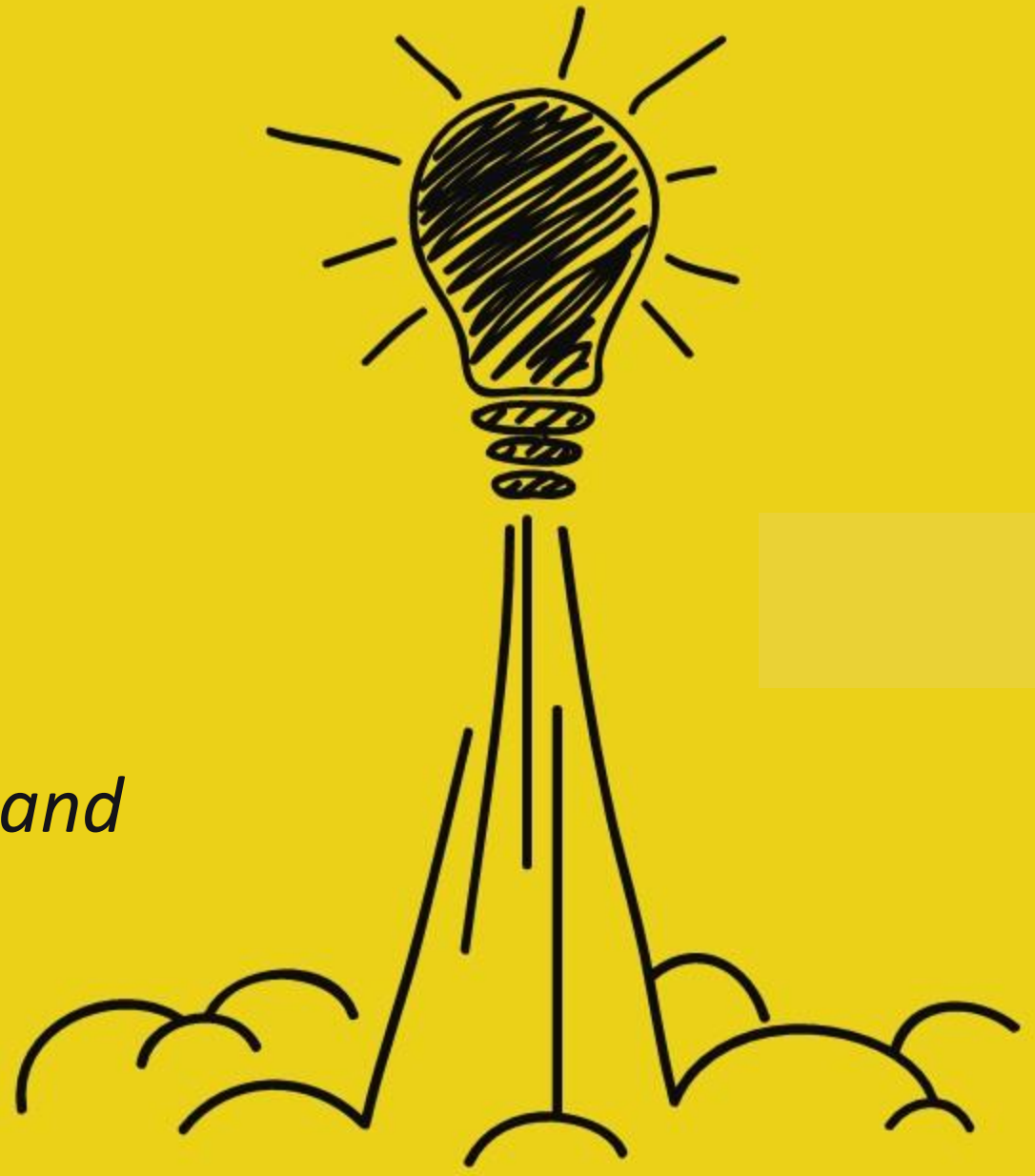
dyslexia

Dyslexia is a learning disability that involves significant difficulties in reading and spelling single words accurately and automatically. These difficulties are observed despite the provision of generally effective reading instruction and supplemental interventions. Word reading and spelling difficulties in dyslexia are often associated with difficulties in phonological processing, but dyslexia is not identified when reading difficulties are the result of second language learning, problems with vision or hearing, or intellectual disability.

Vaughn et al. (2024) ***Annals of Dyslexia***

Big Idea

We need a clear and concise definition of dyslexia that directly informs identification and intervention.



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Section 5

Dyslexia
Secondary Consequences

Mental Health as a Secondary Consequence

Catts et al. (2024) *Annals of Dyslexia*

There is a growing awareness of the socio-emotional impact of dyslexia (and literacy struggles) on the mental well being of an individual.

Many studies have documented high proportions of anxiety and depression among children with dyslexia.

(Francis et al., 2019 Vierira et al., 2024)

Meta-Analysis

Several meta-analyses have explored the relationship between dyslexia and a specific learning disability in reading and mental health outcomes.

Vieira et al. (2024) A random-effects model revealed a moderate overall effect size (Hedge's g = .54). Individuals with Reading disability experience more internalizing problems than their chronological-age (CA) controls.

Francis et al. (2019) Observed statistically significant differences between poor readers and typical readers on general measures of internalizing problems (d=0.41), anxiety (d=0.41) , and depression (d=0.23).

Donolato et al. (2022) – Children with LLDs showed higher internalizing (Hedges' g = 0.36) and externalizing problems (Hedges' g = 0.42) than controls did. The group standardized difference in internalizing problems was moderated by the primary disorder, with children with language disorders (Hedges' g = 0.494) showing more internalizing problems than those with reading disorders (.310).

Overall, prior research has explored internalizing issues more than externalizing issues. However, Donolato et al. (2022) found both internalizing and externalizing issues to be more prominent in children with a reading disability. These findings point to a relationship between dyslexia and an increased incidence of decreased psychological wellbeing.

Developmental Epidemiological Framework

Kellam & Rebok, 1992; Kellam et al., 1994

Psychological Well-Being

Refers to an individual's overall mental health and emotional state. It encompasses factors such as happiness, life satisfaction, positive affect, and the absence of psychological distress or mental health problems such as anxiety or depression.

DEPRESSION
ANXIETY

Social Adaption (*Adaptive, Maladaptive*)

Refers to an individual's ability to effectively function and thrive within their social environment. It encompasses a range of social skills, behaviors, and interactions that enable individuals to navigate social situations, form relationships, and participate in social roles and activities.

READING / SPELLING DEFICITS

Maladaptation at a particular developmental level reflects a failure to resolve the social task demands that are most salient for that period of development.

Development happens within a larger ecological system. Reading and spelling are defined by people with the ability to do so as being important to do within a societal context (e.g., parents, teachers, peers).

Developmental Epidemiological Framework

Kellam & Rebok, 1992; Kellam et al., 1994

ANTECEDENT → **DEPRESSION ANXIETY**

OUTCOME → **READING / SPELLING DEFICITS**

CONSEQUENCE → **SCHOOL ACHIEVEMENT**

ANTECEDENT → **READING / SPELLING DEFICITS**

OUTCOME → **SCHOOL ACHIEVEMENT**

CONSEQUENCE → **DEPRESSION ANXIETY**

Developmental Epidemiological Framework

Kellam & Rebok, 1992; Kellam et al., 1994

ANTECEDENT

READING / SPELLING DEFICITS

OUTCOME

SCHOOL ACHIEVEMENT

CONSEQUENCE

DEPRESSION ANXIETY

Failure to adequately respond early in life makes later social adaption and integration more difficult and can lead to internalizing symptoms or vulnerabilities.

Kellam et al. 1994

The nature of the relationship between mental health challenges and reading struggles

McArthur et al. (2022)

Millenium Cohort Study - UK

p < .001
p < .05
p > .05

Sample
N = 7870

Fit Indices
RMSEA **0.060** < .08
SRMR ***0.087*** > .08
CFI 0.703 < .9
AGFI 0.829 < .9

Age 5 (2006)
Age 7 (2008)
Age 11 (2012)

Cognition
Reading
Depression
Peer Prob
Anxiety
Ext. Beh
Other EH
Main Parent
Other Parent

The nature of the relationship between mental health challenges and reading struggles

Do mental health issues lead to reading struggles?

Do reading struggles lead to mental health issues?

McArthur et al. (2022)

Table 3

Summary of Key Pattern of Results from all 4 Longitudinal Datasets

Measure	MCS	ECLS:98	ECLS:10	ELVS	Total
From Early Emotional health (5) to Reading (7)	N=7870	N=8001	N=7160	N=768	
Peer Relationships	No	Yes	No	No	1/4
Depression/Internalizing	No	No	No	No	0/4
Externalizing	Yes	Yes	No	Yes	3/4
Attention			Yes		1/1
Anxiety	No			No	0/2
From Reading (7) to later emotional health (9/11)					
Peer Relationships	Yes	Yes	Yes	Yes	4/4
Depression/Internalizing	Yes	Yes	Yes	Yes	4/4
Externalizing	Yes	Yes	Yes	Yes	4/4
Attention			Yes		1/1
Anxiety	Yes			Yes	2/2
Bullying			Yes		1/1
Reading self-concept		Yes	Yes		2/2

Developmental Epidemiological Framework

Kellam & Rebok, 1992; Kellam et al., 1994

ANTECEDENT

READING / SPELLING DEFICITS

OUTCOME

SCHOOL ACHIEVEMENT

CONSEQUENCE

DEPRESSION ANXIETY

INSTRUCTION AND INTERVENTION

Prevention Based Approaches

Some researchers have attempted to use academic instruction and intervention to reduce mental health symptoms in young children.

Kellam et al., (1994) Provided a reading intervention to first grade students as part of a randomized controlled study. Overall observed students who responded well to the reading intervention did not develop as many depressive symptoms as did students who did not respond as well to the intervention.

Traficante et al. (2017). Provided a reading intervention to second-grade students as part of a controlled study. Overall, they observed that students who received the intervention from teachers experienced gains in general well-being and school well-being. The students who received a computerized decoding intervention or no intervention did not make similar gains.

Grills et al. (2023) Provided tier-2 intervention to second grade students as part of a randomized controlled study. Students who responded better to the tier-2 instruction experienced a greater decline in their internalizing symptoms. Evidence was found that students with greater internalizing symptoms at the beginning of the year did not respond as well to Tier 2 instruction. However, these data

Overall, research that monitors internalizing and externalizing mental health outcomes as a function of response to literacy instruction and intervention is very limited, but the initial results are promising.

Developmental Epidemiological Framework

Kellam & Rebok, 1992; Kellam et al., 1994

ANTECEDENT

READING / SPELLING DEFICITS

OUTCOME

SCHOOL ACHIEVEMENT

CONSEQUENCE

DEPRESSION ANXIETY

PEER REALTIONS

SOCIAL STIGMA

SELF CONCEPT

SELF ESTEEM

Developmental Epidemiological Framework

Kellam & Rebok, 1992; Kellam et al., 1994

ANTECEDENT

READING / SPELLING DEFICITS

OUTCOME

SCHOOL ACHIEVEMENT

CONSEQUENCE

DEPRESSION

PEER REALTIONS

SELF ESTEEM

PEER MENTORSHIP

Near Peer Mentoring

Research has explored the impact of near-peer mentoring on the psychological well-being of neurominorities, such as dyslexia and ADHD.

Haft et al., (2019) Conducted a trial of a near mentoring program (eye-to-eye) with elementary and middle school students (age 8-16 years). The study included typically developing control students (n=84), non-mentored students with LD/ADHD (n=51), and mentored students with LD/ADHD (n=99). Measures of self-esteem, interpersonal relations, depression, and anxiety were obtained in the fall and spring. Mentored students received 18 peer-mentorship sessions.

Change in Outcomes measures from fall to spring

	TD-Control	NM-LD/ADHD	Mentored-LD/AHDH
Self-esteem	No Change	Decreased	Increased
Interpersonal Relations	Decreased	Decreased	No Change
Depression	No Change	Increased	Decreased
Anxiety	No Change	No Change	No Change

In this initial study, near-peer mentorship showed promise in supporting the psychological well-being of students with LD, ADHD, or both.

Developmental Epidemiological Framework

Kellam & Rebok, 1992; Kellam et al., 1994

ANTECEDENT

READING / SPELLING DEFICITS

Intervening to prevent reading and spelling deficits should happen early in development.

INSTRUCTION AND INTERVENTION

OUTCOME

SCHOOL ACHIEVEMENT

It is never too late to intervene to remediate reading and spelling deficits

PEER REALTIONS

SELF ESTEEM

CONSEQUENCE

DEPRESSION

Fostering opportunities to allow individuals with dyslexia to support each other can positively impact their psychological well-being

PEER MENTORSHIP

Big Ideas

1) Educators can impact the psychological well-being of their students through quality instruction and intervention.

2) Students can support each other to raise their psychological well-being through peer mentorship.

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The "WHO" and "WHERE"

Instructors

Tier 1:
General Education Classroom Teacher

Tier 2:
General or Special Education Teacher, Reading Specialist, Interventionist

Tier 3:
Dyslexia Specialist, Interventionist, Special Education Teacher

The "WHAT"

Instructional content integrates the domains of language as they pertain to reading (word recognition and comprehension) and written expression (handwriting, spelling, and composition).

Word Recognition, Spelling, and Handwriting	Comprehension, Composition
Phoneme Grapheme	Vocabulary, Background, Knowledge
Morphemes	Sentence Structure, Grammar
Syllables & Stress Patterns	Text Structure
Orthographic Conventions	Critical Thinking

Integrated Language, Reading & Writing Instruction Supporting Automaticity, Fluency, and Reading Proficiency

Structured Literacy

The "HOW"

Essential principles of instruction guide how content is taught for written language (reading, written expression). These principles are beneficial for all students and necessary for struggling students.

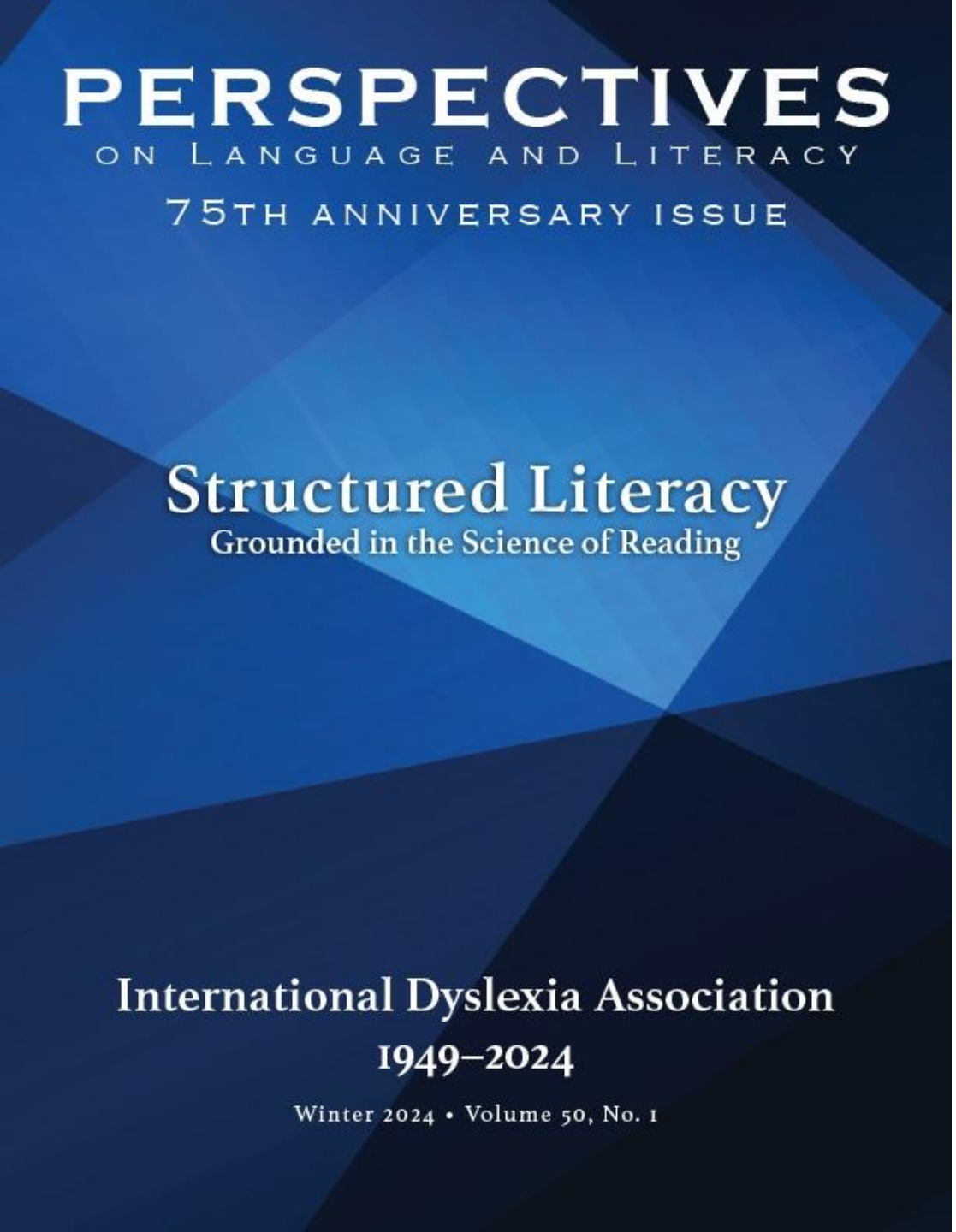
Direct & Systematic	Mastery Oriented with Practice for Automaticity
Explicit	Data Driven
Sequential	Targeted Prompt Feedback
Cumulative	Highly Interactive
Multimodal	Scaffolded

Planned, Purposeful Instructional Decisions for Tasks and Text

The Science of Reading

Scientific evidence from basic and applied research on oral and written language development, assessment, instruction, and intervention provides the foundation for Structured Literacy

Adapted from the 2023 Structured Literacy Info Map from the International Dyslexia Association



Learn more about Structured Literacy and how we can teach all learners to read and write in the latest issue of ***Perspectives on Language and Literacy***.

Access it now at the IDA Library

https://dyslexialibrary.org

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