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The Science of Reading At Your Fingertips: What You Need to Know

April 2022

Features of Effective Literacy Instruction

- Grounded in the Science of Reading
- Comprehensive
- Differentiated
- Empowers Students, Educators, and Families

The Science of Reading at Your Fingertips: What You Need to Know

Literacy in 2021

Learning to Read

Essential Elements

Beyond the School Building

Literacy in 2021

“Reading is a civil right.”

Phyllis C. Hunter

Striving readers can face a lifetime of challenges.

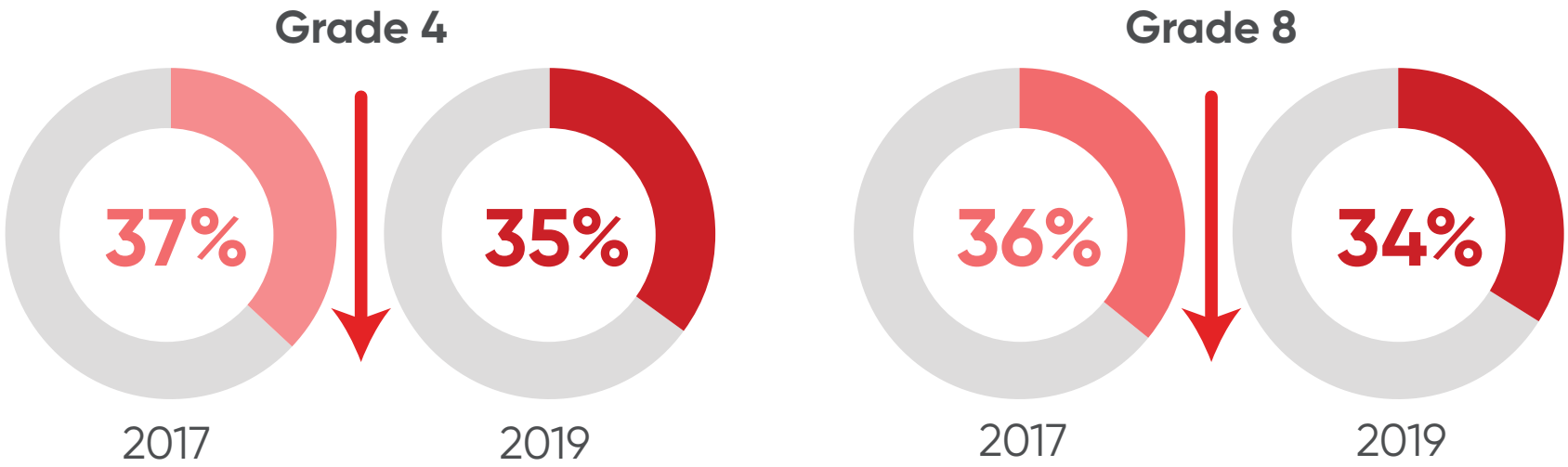
Not reading proficiently by **3rd grade** makes it harder to learn other subjects (The Annie E. Casey Foundation, 2010).

75% of non-proficient 3rd graders do not reach proficiency in future grades (Hernandez, 2012).

One in six children who are not reading proficiently in third grade do not graduate from high school on time, a rate **four times** greater than that for proficient readers (The Annie E. Casey Foundation, 2010).

Most students in America are not proficient readers.

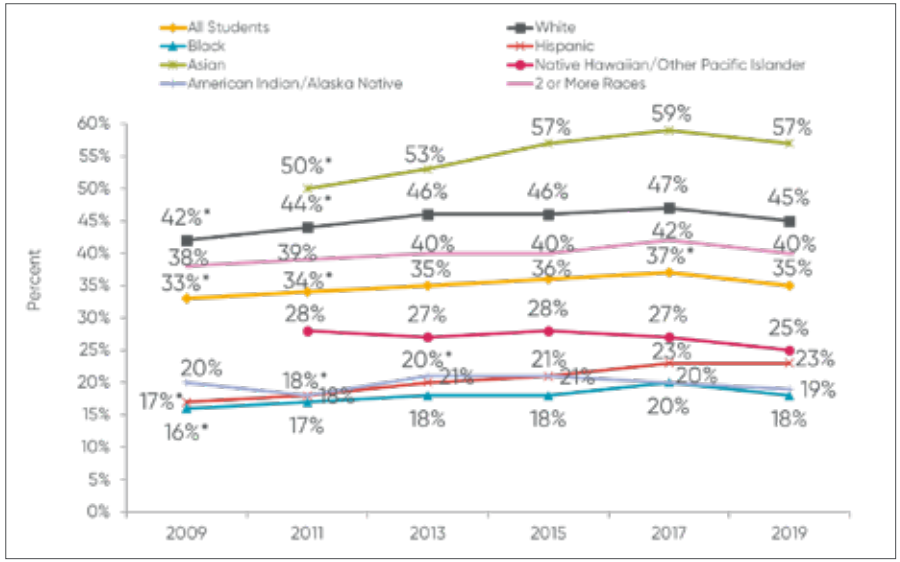
Two-thirds of U.S. students are not reading proficiently at 4th or 8th grade, and scores have decreased from 2017 to 2019 (U.S. Department of Education, 2019).



There is an opportunity gap when it comes to reading.

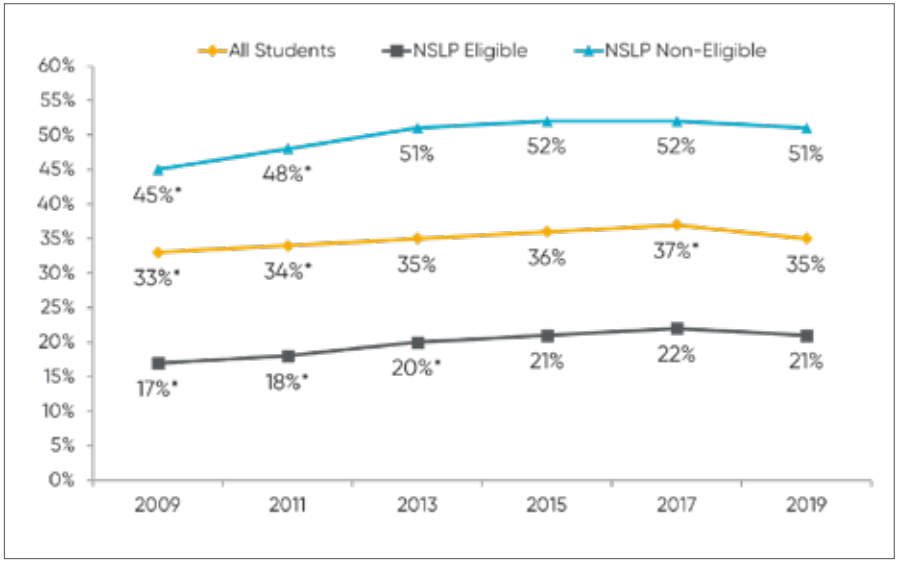
Inequity in learning opportunities and socio-economic contexts has led to disparities in reading outcomes (U.S. Department of Education, 2019).

Grade 4 NAEP Reading % Proficient or Higher, by Race and Ethnicity



*Significantly different ($p < .05$) from 2019.

Grade 4 NAEP Reading % Proficient or Higher, by Eligibility for School Lunch Program



*Significantly different ($p < .05$) from 2019.

So, what does it take to build a reading brain?

Learning to Read

Educators and families across the U.S. favor a *comprehensive literacy* approach to instruction, assessment, and professional development grounded in the *Science of Reading*.

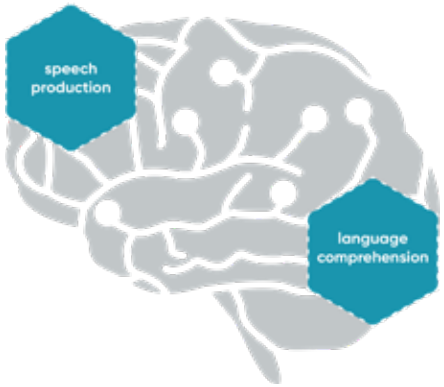
The Science of Reading

Is a body of evidence drawn from fields like cognitive psychology, educational psychology, neuroscience, and linguistics about how people learn to read.

Shows that reading and writing don't come naturally: building a reading brain requires explicit, systematic, and cumulative instruction in key literacy elements.

(Castles et al., 2018; Gough & Hillinger, 1980; NICHD, 2000; Seidenberg, 2017, Templeton, 2021)

While spoken language is innate, our brains don't come wired to read and write.



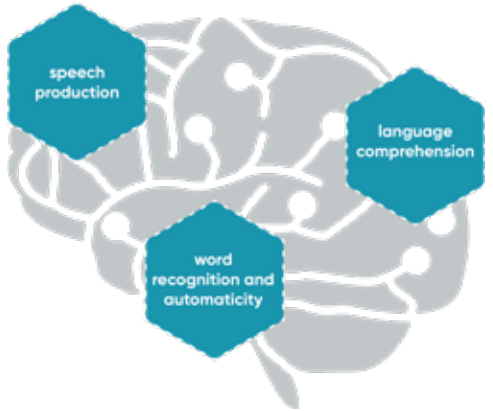
Spoken language is 70,000 years old, so our brains have had time to evolve structures to support speaking and listening. Barring developmental delays, children only need lots of input and informal practice to learn their first language (Harai, 2015).

200,000 years ago
Homo Sapiens evolve

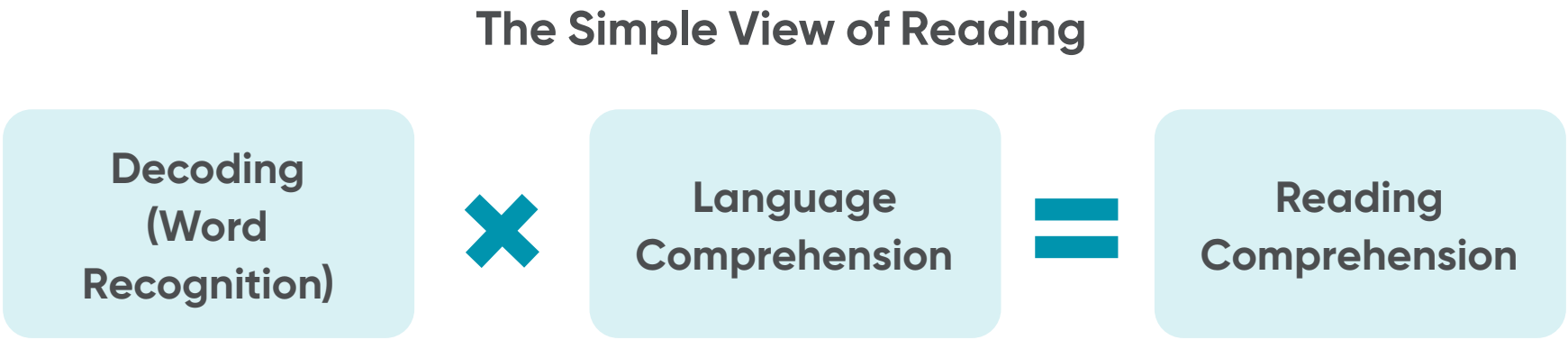
70,000 years ago
First human language

~ 5,000 years ago
First writing system

Written language is around 5,000 years old - too new for our brains to have evolved structures for reading and writing. A reading brain must create the Visual Word Form Area to recognize written words, and this requires explicit reading instruction (Dehaene, 2009).



At first glance, learning to read may appear simple.



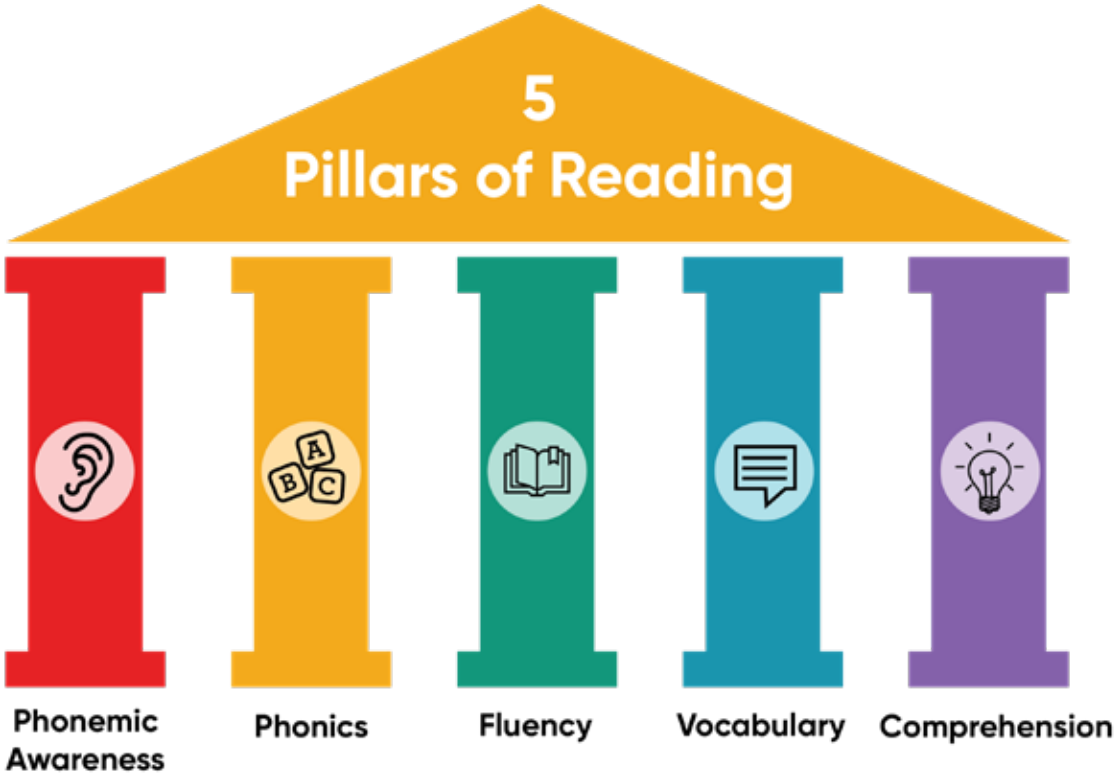
(Gough & Tunmer, 1986)

Reading is a complex multi-faceted skill, acquired over years of instruction and practice.

Essential Elements

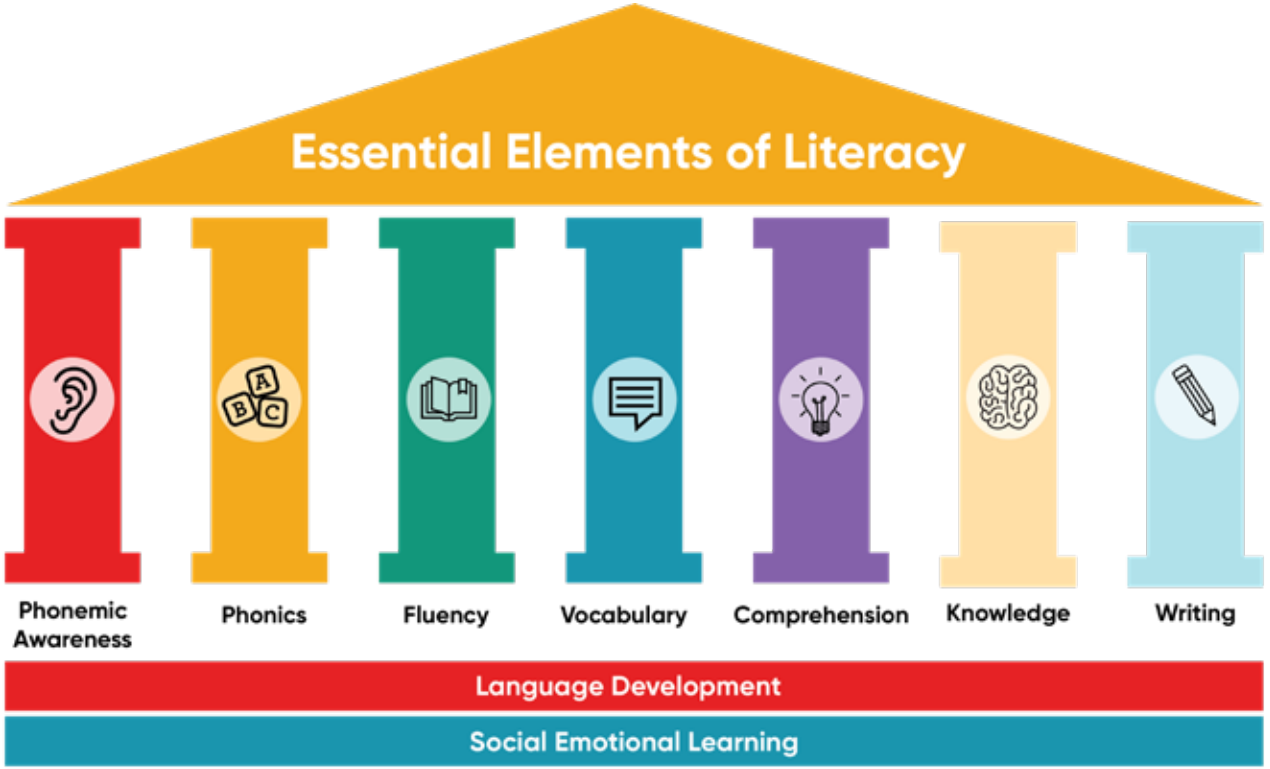
Building a reading brain requires effective instruction and practice.

The groundbreaking report by the National Reading Panel in 2000 was instrumental in establishing the 5 pillars of reading, which were determined **essential** for effective instruction (NICHD, 2000).



The Science of Reading continues to evolve and expand our understanding.

Over the last 20 years, numerous other factors have been identified as essential to literacy, including background knowledge, writing, language development, and the integration of social and emotional competencies (HMH, 2020a; HMH, 2020b).



It all starts with sounds.

"I see a rainbow.
It's so pretty."

Written language is discrete; letters and words are clearly separated.

But language is a continuous waveform spoken without clear boundaries.

The first task in building a reading brain is distinguishing speech sounds, or phonemes, so they can be mapped to letters.

Phonemic awareness follows a developmental progression.

From continuous speech sounds
īsēərānbōĭtssōprĭtē
↓
To sentences
īsēərānbō. ĭtssōprĭtē.
↓
To words
ī sē ə rānbō. ĭts sō prĭtē.
↓
To rhyming and alliteration
rānbō rhymes with ĕlbō (elbow) and starts with the same sound as rŭn (run)
↓
To syllables
rān/bō
↓
To parts of syllables
r-ān/b-ō
↓
To phonemes
r-ā-n-b-ō

But, phonemic awareness can be hard for brains that don't already know how to read.

Spelling knowledge interferes with our ability to segment sounds.

Try it: how many phonemes are in the word “exit”?

Hearing the phonemes in words isn't easy, but it is essential.

"Exit" contains **5** phonemes.

The correspondence between letters and sounds is NOT 1 to 1.

letters	e	x		i	t
phonemes	ĕ	g	z	ə	t

If you didn't answer correctly, you're not alone.
Many adults do not identify the accurate number of phonemes on their first try.

Phonemic awareness prepares the brain to link letters with sounds.

This letter-sound connection is what allows us to read words.

It's how we differentiate between similar-looking words like ***dip*** and ***bid*** and how we decode unfamiliar words like ***sesquipedalian***.

But the brain's visual system doesn't naturally recognize letter shapes.

Reading requires us to quickly make small but critical distinctions between letters, many of which are mirror-images like "b" and "d".

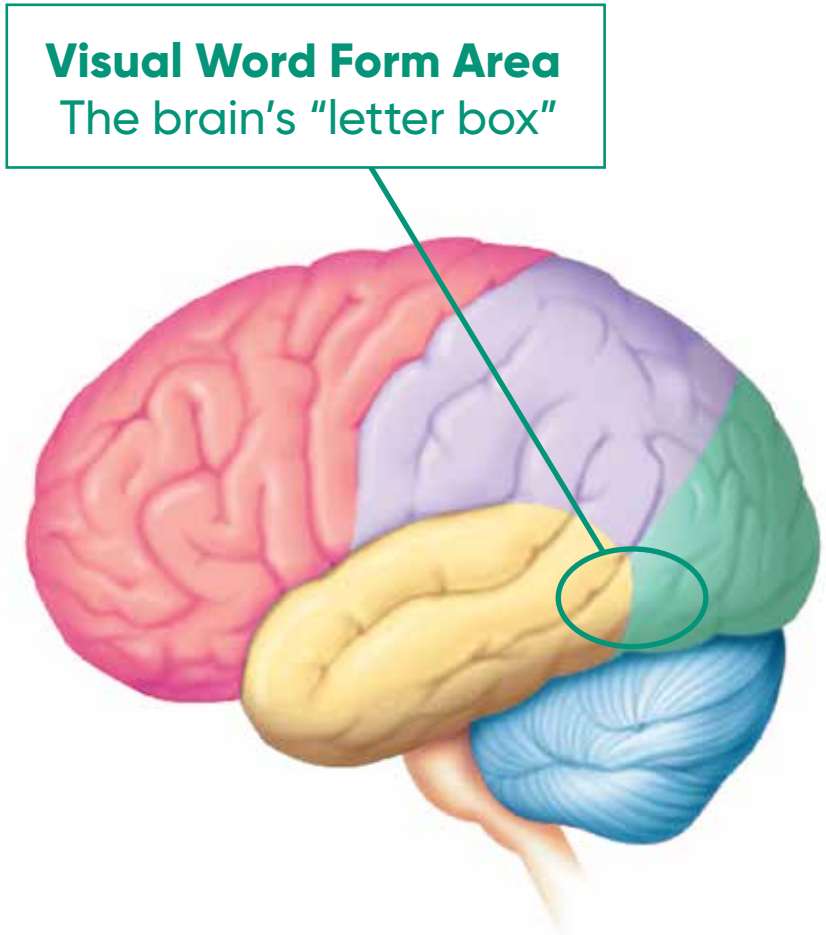
These distinctions are not as important when looking at a picture, since both images are still a lion.

b
p

d
q

Fortunately, brains can change with instruction.

Our brains naturally specialize in recognizing things that have always been important to humans, like faces. Through schooling, the brain is able to repurpose some of the visual area that recognizes faces, places, and objects to recognize letters and words, creating the Visual Word Form Area (Dehaene et al., 2009).



Systematic phonics instruction activates the Visual Word Form Area (Dehaene, 2009).

Categories of phonics knowledge	
Letters	c-a-t, s-l-i-p
Letter combinations	c-oa-t, th-r-ee
Word families/Sound spellings	d-ay, st-ay, pl-ay
Syllables	cre-ate, pi-a-no
Morphemes	in-excus-able, im-poss-ible
Position-based spelling	catch vs. lunch

And fluency instruction strengthens it.

Imagine you're learning to read a new script where numbers are used instead of letters.

a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1

Use the code above to read the sentence below:

21 15 6 22 13 24 2 | 18 8 | 7 19 22 | 25 9 18 23 20 22 | 25 22 7 4 22 22 13 | 23 22 24 12

23 18 13 20 | 26 13 23 | 24 12 14 11 9 22 19 22 13 8 18 12 13.

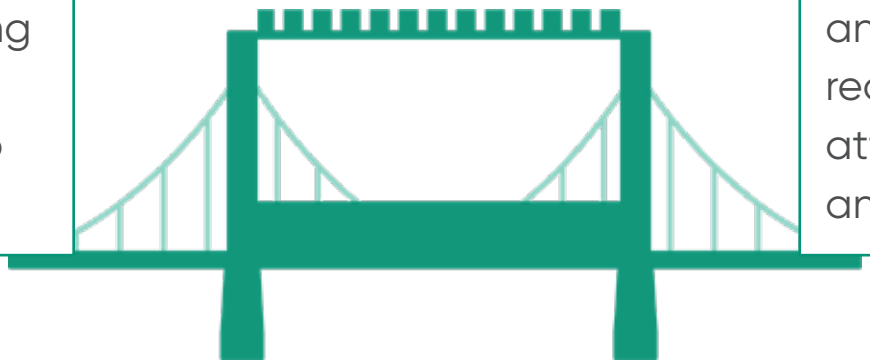
Fluency is the bridge between decoding and comprehension (Pikulski & Chard, 2005)**.**

If decoding the numerical sentence on the previous page was painstakingly slow, you know what it feels like to be a beginning reader.

The brain can only pay attention to one thing at a time; if it's so focused on decoding word-by-word, it's hard to keep track of what the text means.

Accuracy and automaticity reduce the cognitive load of decoding.

Fluency practice with repetition and feedback encourages instantaneous mapping of letters to sounds, causing most words to become “sight words”.



Prosody draws attention to meaning and supports comprehension.

Reading like we speak, with appropriate phrasing, intonation, and expression requires the brain to attend to language and meaning.

Vocabulary is fundamental to understanding text.

Quick quiz:

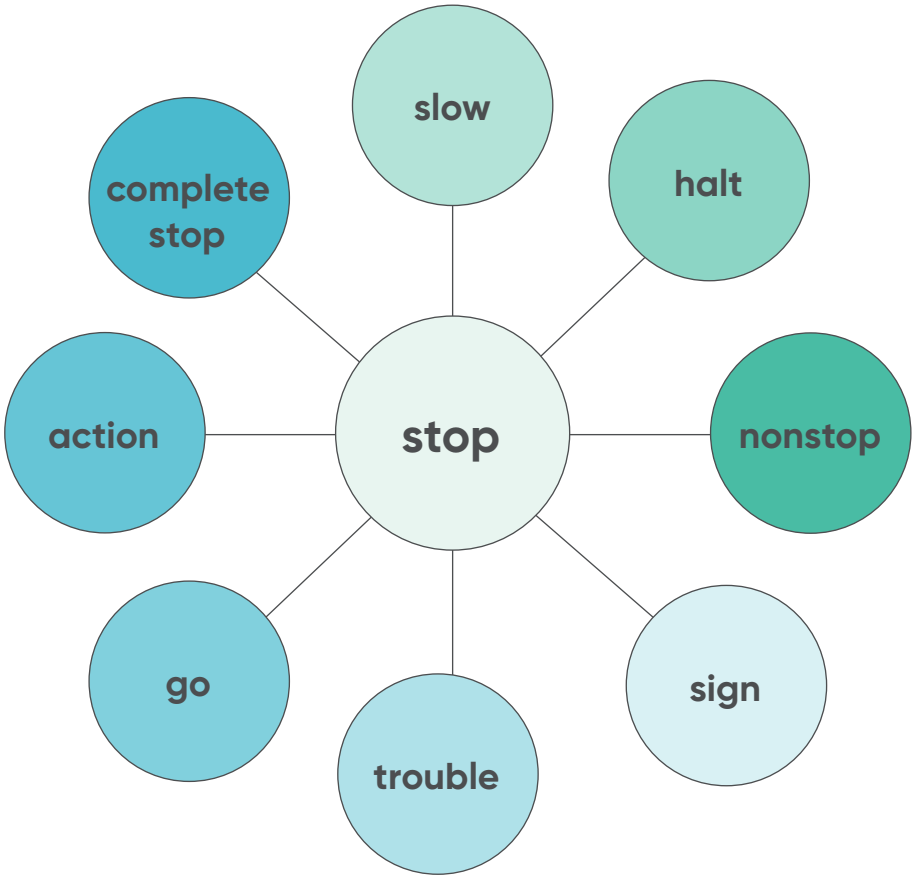
Vocabulary knowledge in the brain is most like a _____.

1. dictionary
2. spreadsheet
3. network

Vocabulary knowledge is a network that is constantly growing and changing.

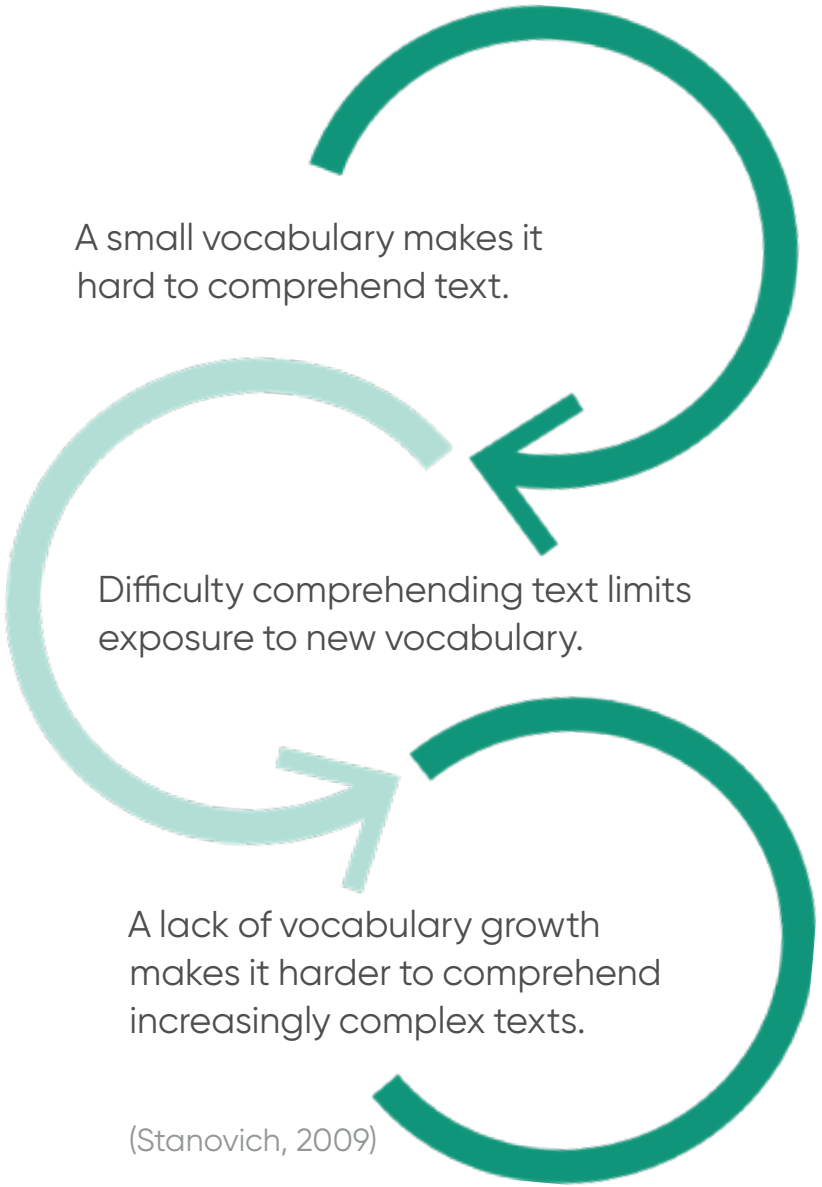
This network connects word meanings, usage, and relationships with other words.

It takes many exposures to words in various contexts to build a rich network.



A small vocabulary limits comprehension.

A combination of direct instruction – meanings, relationships, usage, morphology – and exposure to words in text and speech can grow a reading brain's vocabulary network.

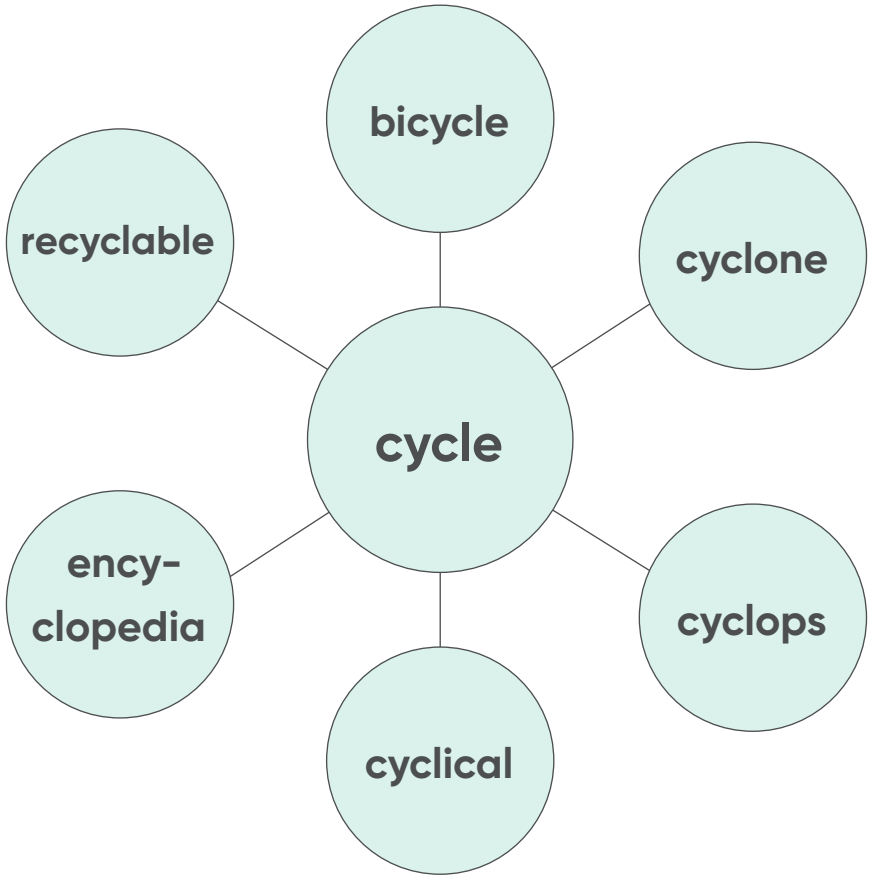


(Stanovich, 2009)

Morphological awareness in particular accelerates vocabulary learning.

Morphemes - prefixes, suffixes, and roots - provide clues to meaning and grammar.

Morphological analysis is an efficient strategy for the brain to learn a large number of new words in text based on a smaller set of morphemes.



To comprehend, the brain extracts meaning at two levels (Kintsch, 2012; Willingham, 2017).

Text-base level: a mental model of the text's language.

Situation model level: an overall interpretation of the text, integrated with the reader's knowledge.

Knowledge is critical for both levels of comprehension.

We study M-theory compactification on $\mathbb{T}^7/\mathbb{Z}_2^3$ in the presence of a seven-flux, metric fluxes, and KK monopoles. The effective four-dimensional supergravity has seven chiral multiplets whose couplings are specified by the G_2-structure of the internal manifold. We supplement the corresponding superpotential by a KKLT type nonperturbative exponential contribution for all, or for some of the seven moduli, and find a discrete set of supersymmetric Minkowski minima. We also study type IIA and type IIB string theory compactified on $\mathbb{T}^6/\mathbb{Z}_2^2$. In type IIA, we use a six-flux, geometric fluxes, and nonperturbative exponents. In type IIB theory, we use F and H fluxes, and nongeometric Q and P fluxes, corresponding to consistently gauged supergravity with certain embedding tensor components, *without nonperturbative exponents*. Also in these situations, we produce discrete Minkowski minima. Finally, to construct dS vacua starting from these Minkowski progenitors, we follow the procedure of mass production of dS vacua.

(Cribiori, Kallosh, Linde, & Roupec, 2020, p. 046018-1)

Adult reading brains might not notice the importance of knowledge until they read a text they can't understand – like this one on string theory.

“Knowledge is like Velcro – it sticks to other related knowledge” (Wexler, in Barnum, 2019).

For a young reading brain, there is lots of knowledge yet to be learned.

Wide reading and a broad curriculum can provide the foundational knowledge needed to extract meaning from a range of texts (Wexler, 2019).

Good writers make good readers.

Reading and writing are the receptive and productive sides of the same coin, and they reinforce one another (Graham & Hebert, 2010).

Students' reading abilities are improved by:

Writing about the texts they have read

Explicit instruction in spelling and composition

Increasing length and frequency of writing

Speaking and listening skills are the foundation that reading and writing knowledge is built on.

Area of Language	Phonology *sound system*	Semantics *word meaning*	Morphology *word parts*	Syntax *sentence structure*	Pragmatics *social context*
Speaking & Listening	articulate & differentiate spoken words	higher frequency, concrete words	common prefixes & suffixes	simple, redundant, informal grammar	interaction with familiar social norms
Reading & Writing	map written letters to sounds	lower frequency, abstract words	Greek & Latin roots, prefixes, & suffixes	complex, dense, formal grammar	no interaction & social norms vary

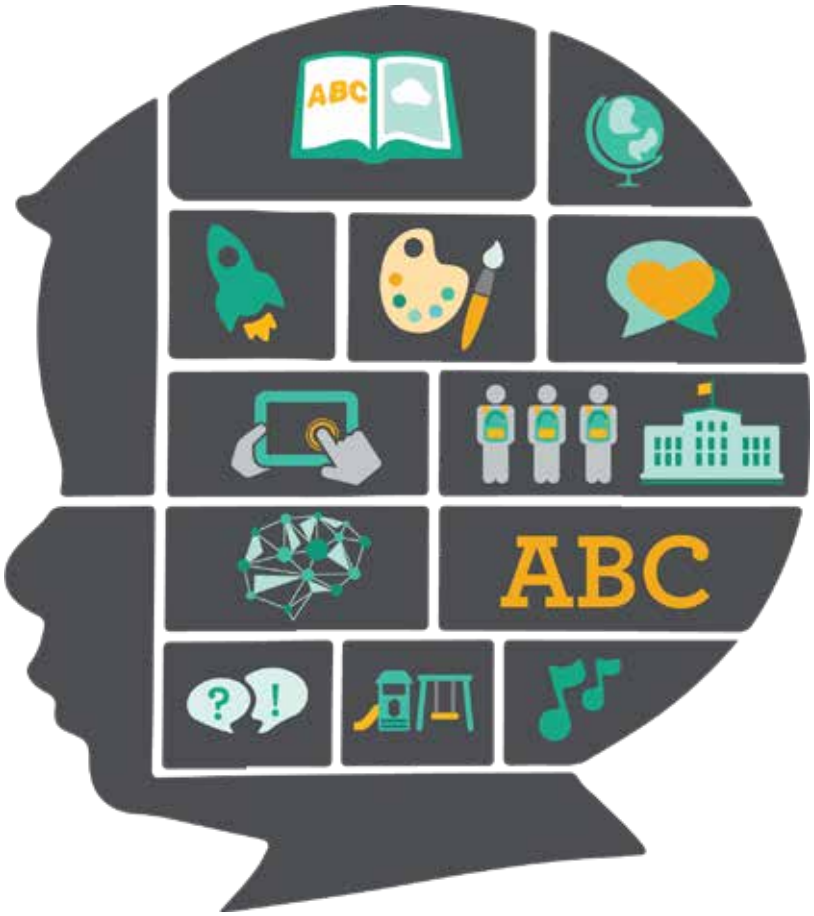
Reading is not just cognitive, but also social and emotional.

Learning to read is a challenging and effortful process that requires the capacity to persevere. Comprehending text requires empathy and the ability to take the perspective of others.

When educators and families come together to support students socially and emotionally, reading outcomes improve (Duckworth et al., 2007; Durlak et al., 2011; Dweck, 2006; Hughes & Kwok, 2007; Wolf, 2018).

While we know how to build a reading brain, each brain is unique.

The greatest gains happen within a student-centric model in which teachers responsively target high-quality instruction to the skills students are ready to learn, based on frequent, formative assessment.



Beyond the School Building

Good instruction is good instruction.

The research-based principles of the science of reading apply, but **remote instruction** requires some adaptations to implement them:

Provide synchronous instruction when introducing new material or providing additional support to particular students.

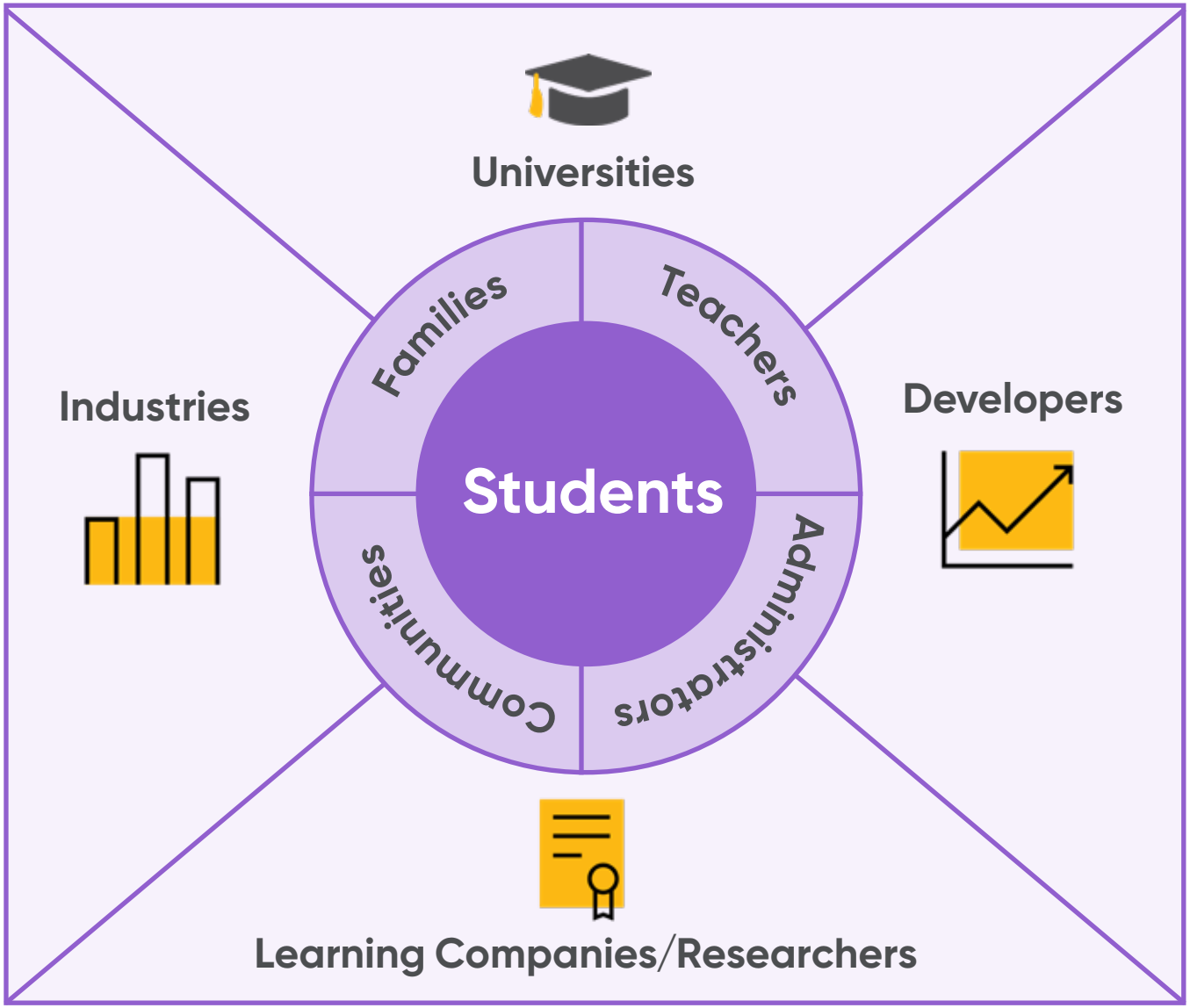
Use asynchronous applications for independent skill practice, especially those that give feedback and track progress.

Provide access to e-books for independent reading and teach students to use features for scaffolding and accessibility.

Engage families by providing how-to videos and encouraging read-alouds with caregivers or virtually.

So what does it take?

It will take ALL of US!



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