Amplify.

Science of Reading

A Primer | Part Two

IN THE UNITED STATES, we aim to be a society in which everyone can read and understand text at a college-entry level or above.

We consider schools that are not on track to achieve this goal to be failing their students.

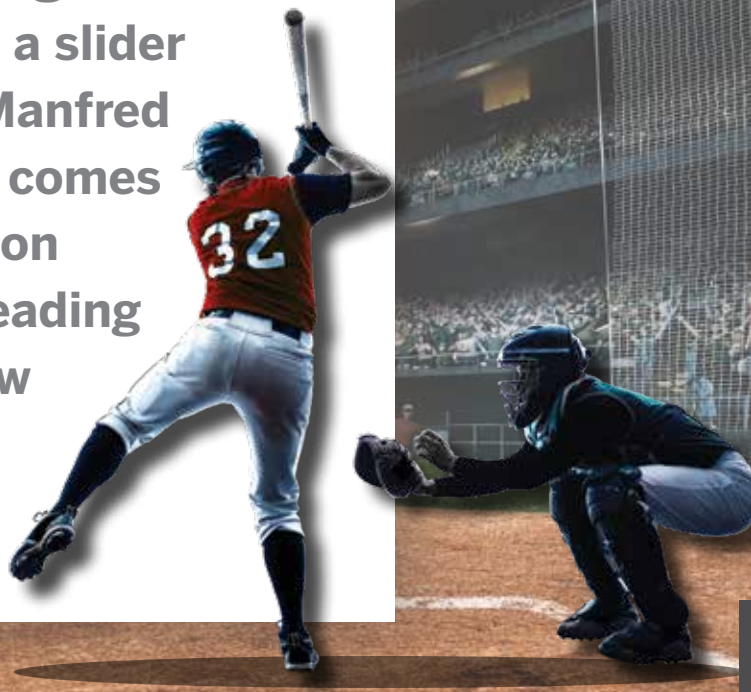
What does it take to succeed?

Norway, Wisconsin is a small, well-kept town a few miles west of Lake Michigan. There, in 1988, two young researchers and 64 students took part in an experiment that has changed forever how we think about reading and comprehension.

The researchers, Donna Recht and Lauren Leslie, created an 18 by 20-inch replica of a baseball field furnished with four-inch wooden figures.

One by one, the students were handed the same story covering half an inning of a made-up baseball game and asked to reenact it.

“Churniak swings and hits a slow bouncing ball toward the shortstop. Haley comes in, fields it, and throws to first, but too late. Churniak is on first with a single, Johnson stayed on third. The next batter is Whitcomb, the Cougars’ left-fielder. The ball is returned to Claresen. He gets the sign and winds up, and throws a slider that Whitcomb hits between Manfred and Roberts for a hit. Dulaney comes in and picks up the ball. Johnson has scored, and Churniak is heading for third. Here comes the throw and Churniak is out. Churniak argues but to no avail.”



Who did best at correctly reconstructing the story?

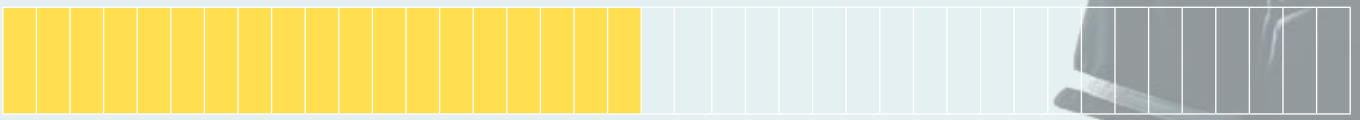
1. Strong readers
2. Kids with good knowledge of baseball
3. It made no difference.

Stop and make your prediction before reading further.

To their surprise, Recht and Leslie found that reading ability had little impact on how well kids understood the story.[1]

But knowledge of baseball did. In fact, students who were weak readers did as well as strong readers if they had knowledge of baseball.

Good readers who didn't know baseball: 19/40



Poor readers who knew baseball : 27/40

[1] Recht & Leslie (1988)

If those same kids—or kids you teach—were taking a state test or the SAT or any other standard test of comprehension, and the passage just happened to be about baseball, they would outperform everyone else.

But, on topics they knew little about, they would fare much worse.

“Prior knowledge creates a scaffolding for information in memory.”

– Donna Recht

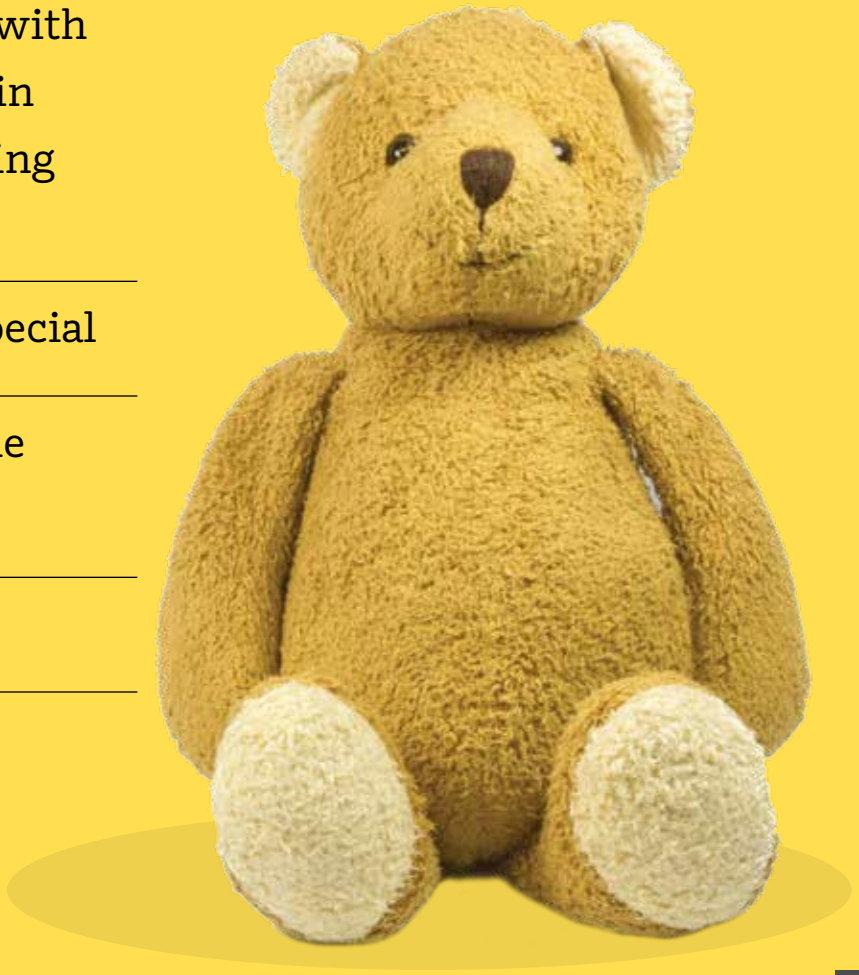
Of course, high-stakes tests don't contain passages on baseball precisely because that would be unfair to kids who don't follow the sport.

But they do contain passages on the founding documents of the United States, on animal ecology, and on space.

The graphic lists 89 passage topics in the top 10 content categories.
The other 11 passages covered poetry, the arts, various areas of science and a single passage on sports.

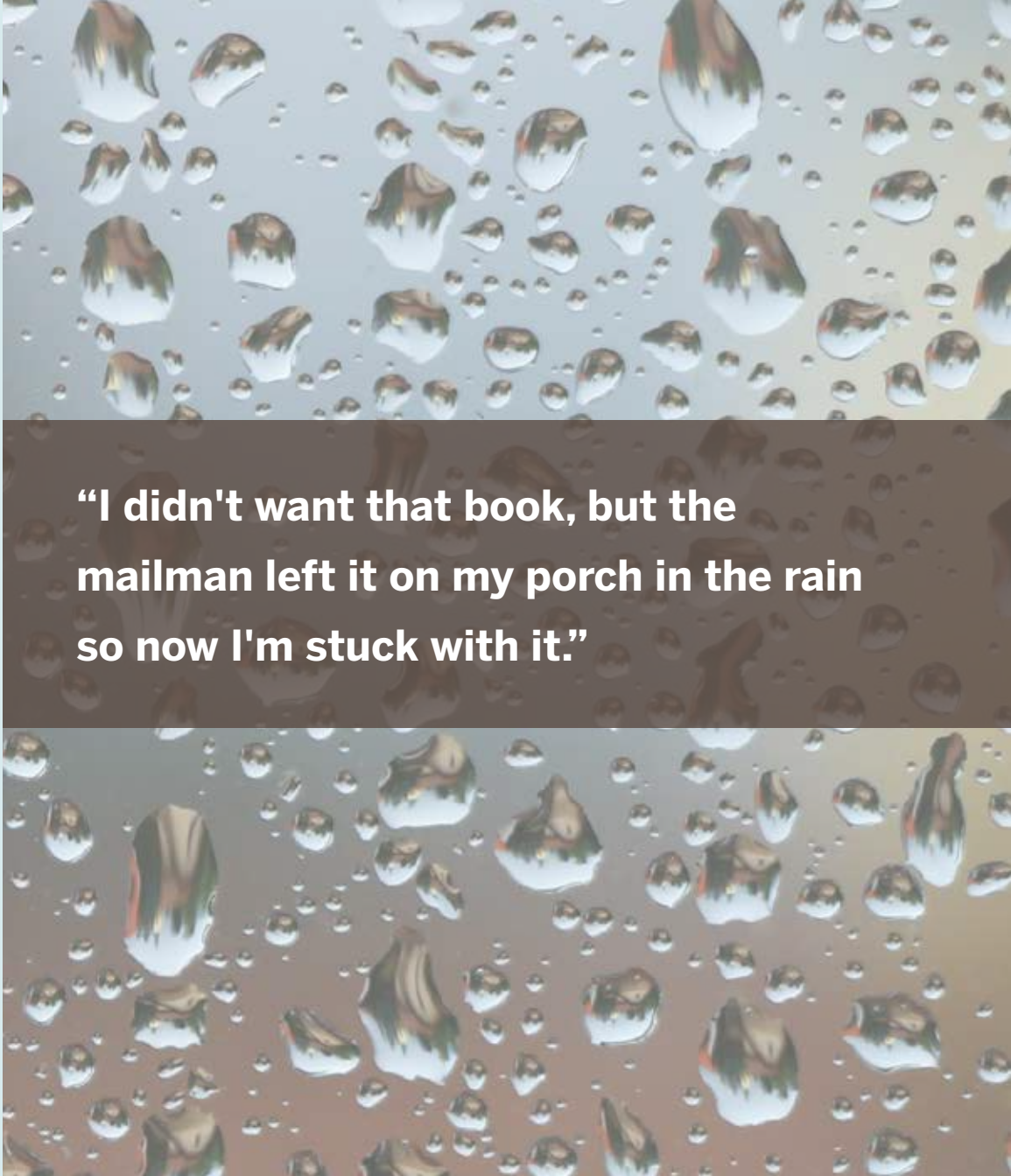
Contrast the rich (and fascinating) topics on the left—from a survey of 100 actual state test passages—with the banal subject matter found in a recent review[2] of typical reading basals:

- What makes grandmothers special
- What could happen if everyone brought their pets to school
- What teddy bears look like



[2] Walsh (2003)

Why does prior knowledge matter so much? Dan Willingham, a psychologist at the University of Virginia likes to give these two examples:



You can likely use your knowledge of book return policies to bridge the gap in the first. But prior knowledge may not bridge that gap in the second.

1. Wet books are ruined. You can't return ruined products.
2. Brain scans use magnets. Metal makes images fuzzy. Makeup contains trace amounts of metal.

Writers (and speakers) leave out things they assume their readers know. But that stumps readers who don't. It is sometimes argued that knowledge is just facts that can be Googled. But try googling *sacrifice*.[3]

sac·ri·fice /sakrə fis/

noun: sacrifice; plural noun: sacrifices

1. an act of slaughtering an animal or person or surrendering a possession as an offering to God or to a divine or supernatural figure.
   "they offer sacrifices to the spirits"
   synonyms: ritual slaughter, offering, oblation, immolation
   - an animal, person, or object offered in a sacrifice.
     synonyms: (votive) offering, burnt offering, gift, oblation
     "the calf was a sacrifice"
   - an act of giving up something valued for the sake of something else regarded as more important or worthy.
     "we must all be prepared to make sacrifices"
     synonyms: surrender, giving up, abandonment, renunciation, forfeiture, relinquishment,
     "joining a federation may result in the sacrifice of sovereignty"

CHRISTIAN CHURCH Christ's offering of himself in the Crucifixion.

CHESS a move intended to allow the opponent to win a pawn or piece, for strategic or tactical reasons.

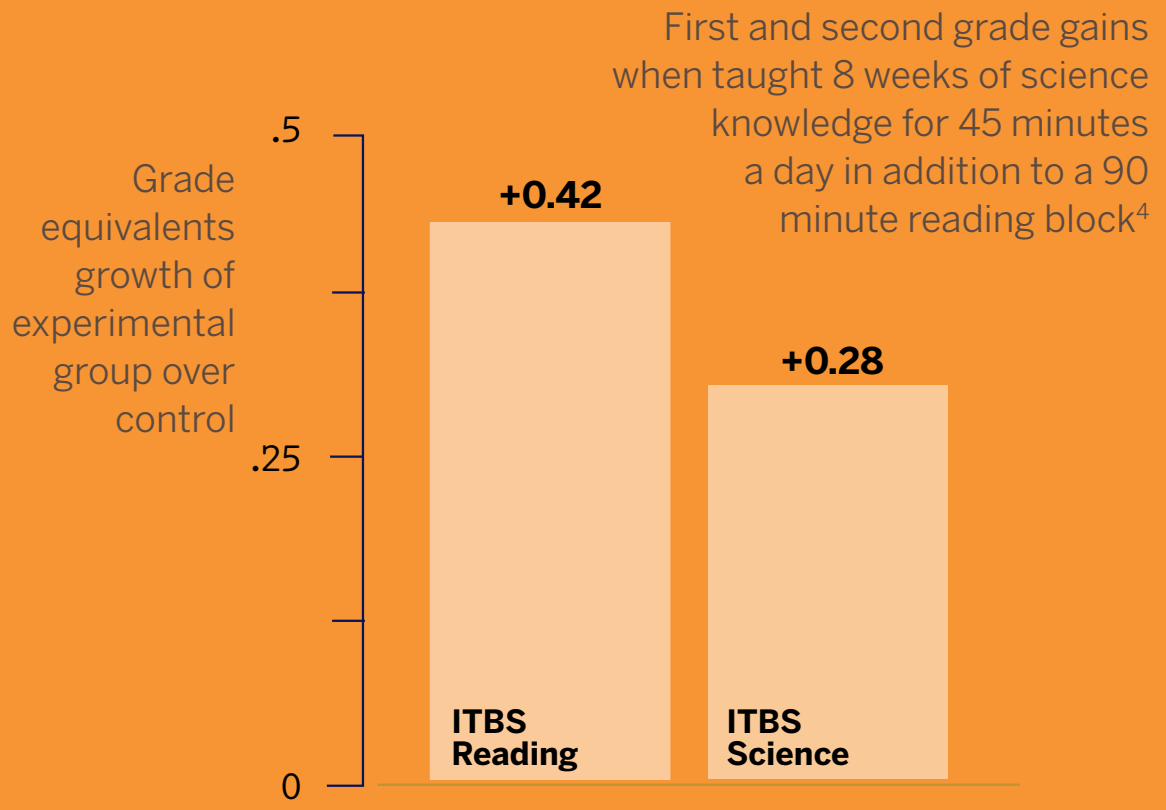
BASEBALL a bunted ball that puts the batter out but allows a base runner or runners to advance.

noun: sacrifice bunt; plural noun: sacrifice bunts

Most knowledge for comprehension needs to be in your head, available immediately.

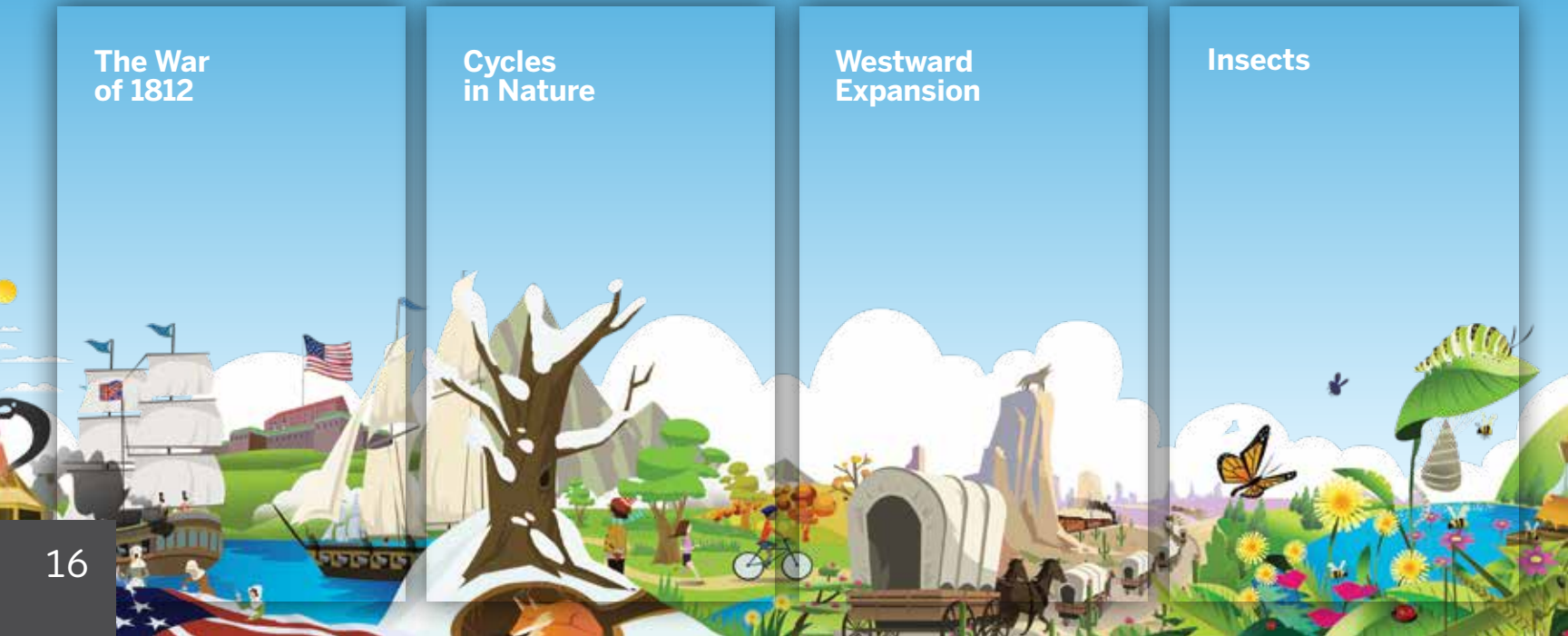
[3] Example is from Hirsch (2007)

That's why teaching knowledge explicitly improves reading comprehension. As Willingham has said: 'Reading tests are knowledge tests in disguise.'

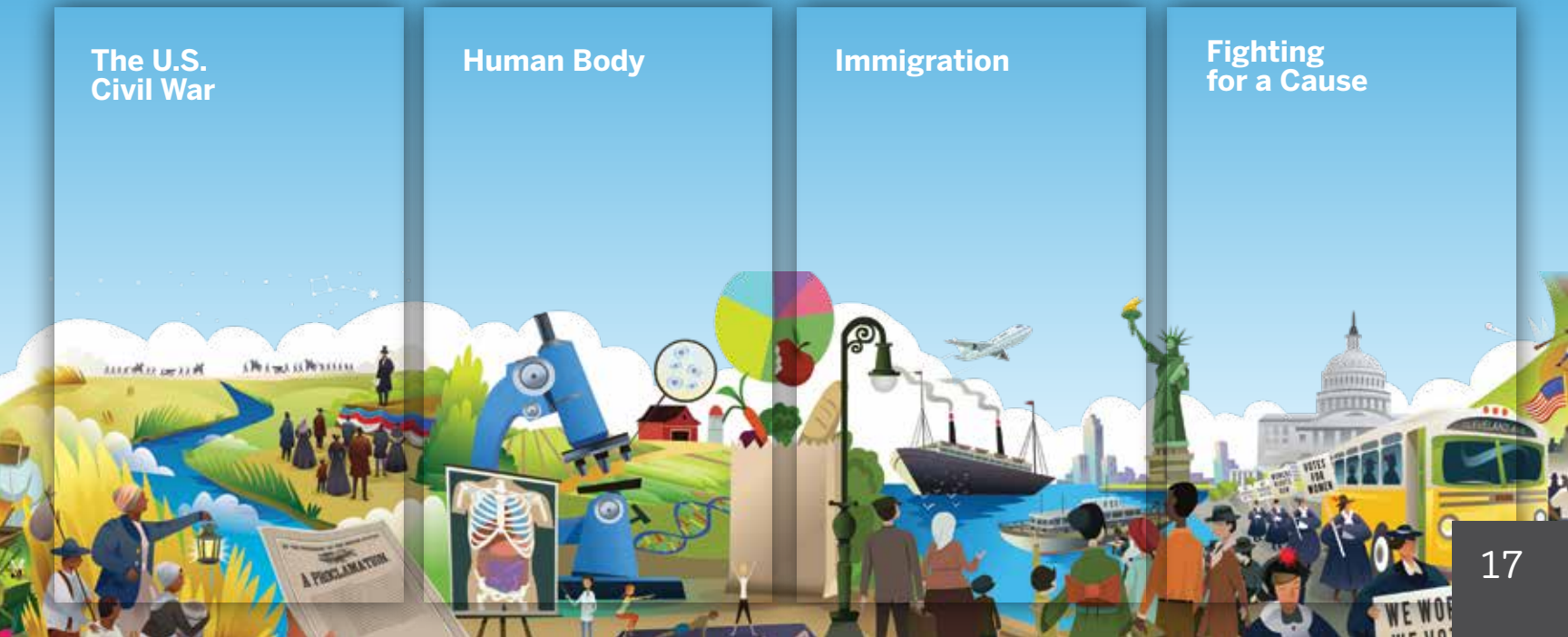


[4]Vitale & Romance (2011)

Plus, things of value are worth knowing by heart. Like the origins of worlds, the endless parade of peoples



and cultures, the great and evil deeds of history, and the vast panoramic photograph that is nature.



So we know content knowledge is critical. Are widely taught strategies like ‘finding the main idea’ equally critical?

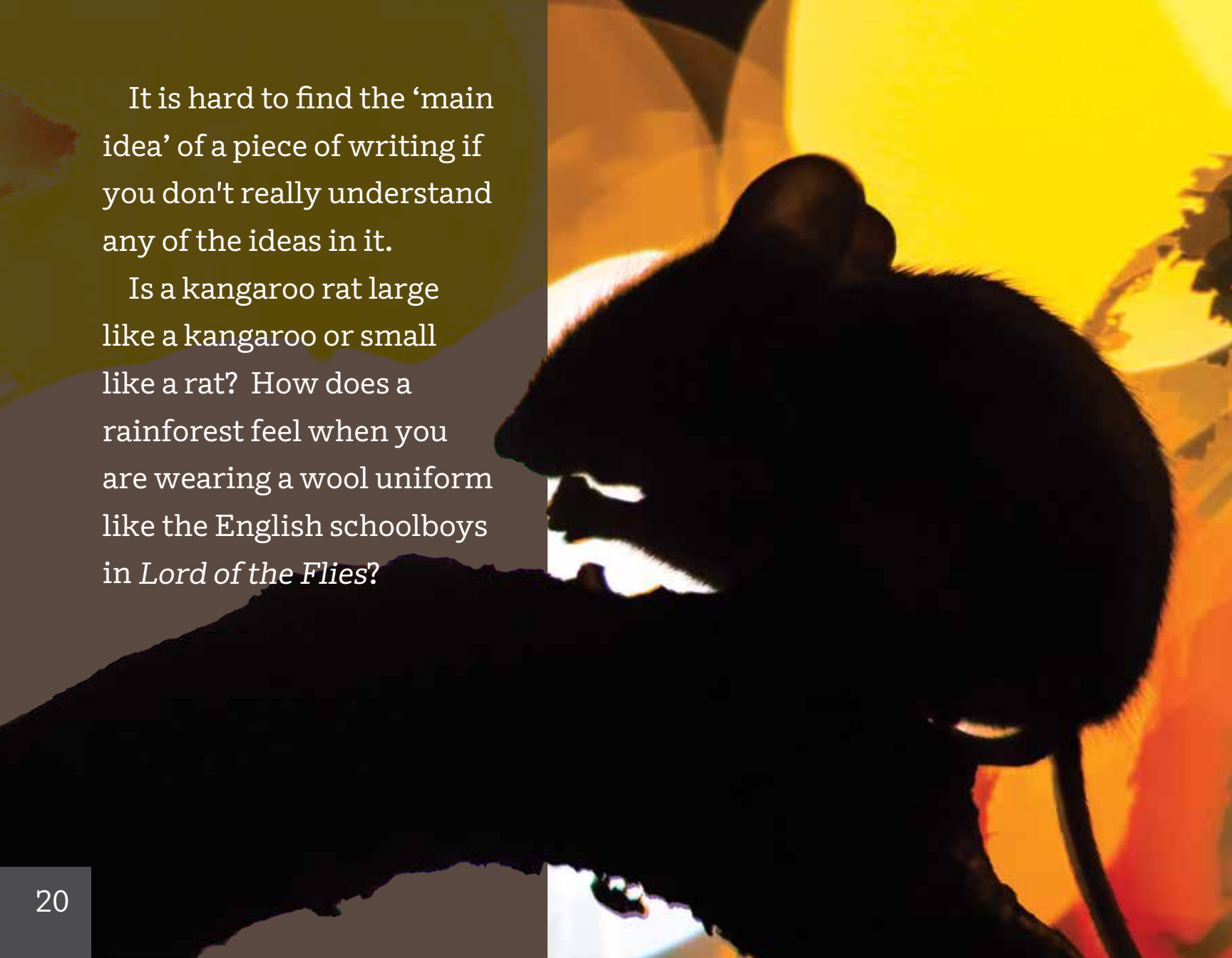
A large body of research proves their value.

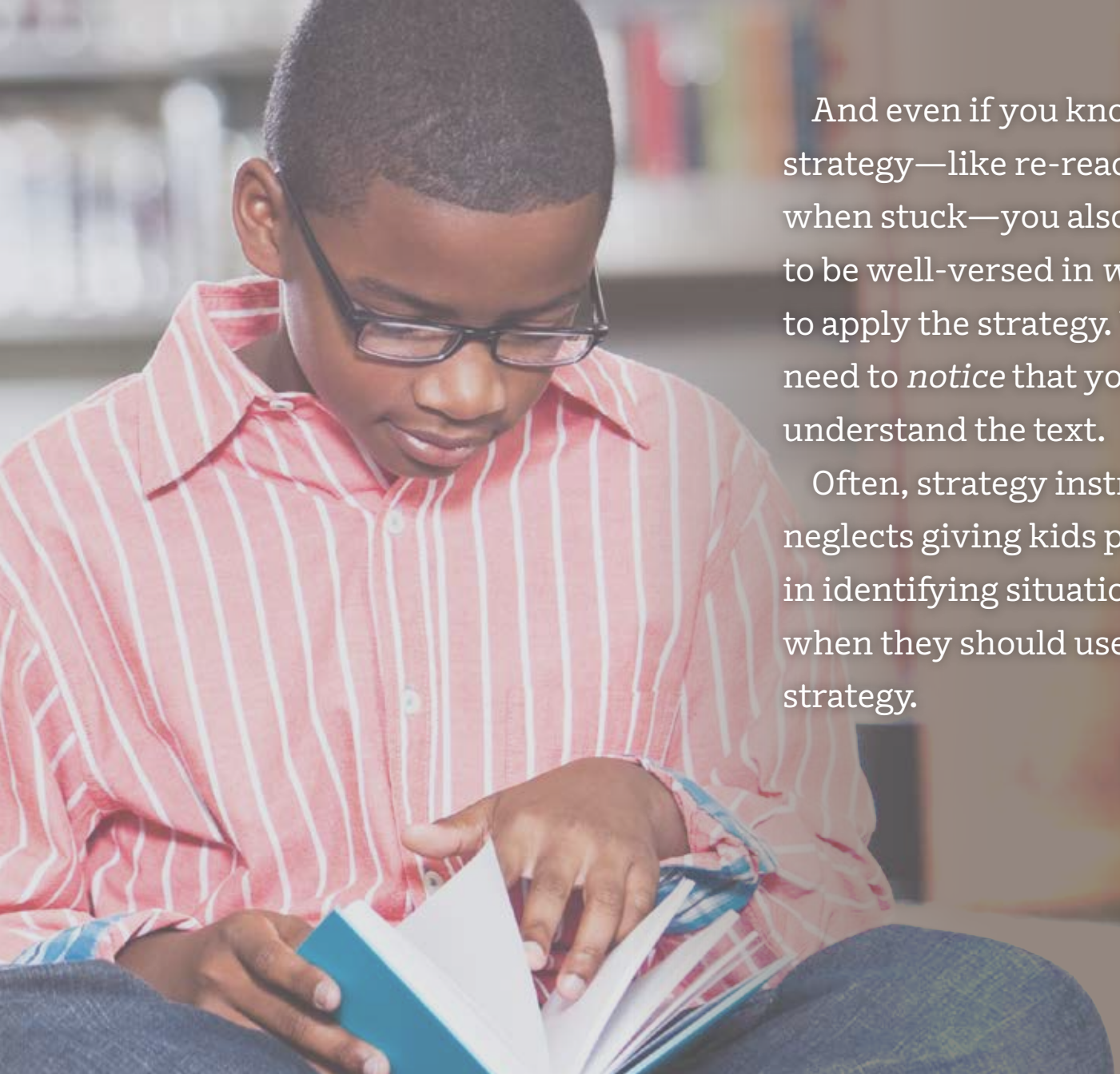
And many strategies make intuitive sense: stopping and re-reading when comprehension breaks down, for instance, is plainly helpful for many children.

But teaching the main idea strategy over and over is less helpful.

It is hard to find the ‘main idea’ of a piece of writing if you don't really understand any of the ideas in it.

Is a kangaroo rat large like a kangaroo or small like a rat? How does a rainforest feel when you are wearing a wool uniform like the English schoolboys in *Lord of the Flies*?





And even if you know a strategy—like re-reading when stuck—you also need to be well-versed in *when* to apply the strategy. You need to *notice* that you didn't understand the text.

Often, strategy instruction neglects giving kids practice in identifying situations when they should use the strategy.

Before going further, give yourself the experience of a struggling ninth grader.

Read the passage below and identify the main idea.

The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point. Frequently the messages have meaning; that is they refer to or are correlated according to some system with certain physical or conceptual entities. These semantic aspects of communication are irrelevant to the engineering problem. The significant aspect is that the actual message is one selected from a set of possible messages. The system must be designed to operate for each possible selection, not just the one which will actually be chosen since this is unknown at the time of design.

Most people find the task extremely difficult. (The paper, by the way, is one of the most famous research papers ever published—in which Claude Shannon invents modern information theory. [5])

Is the problem that you need more practice in identifying main ideas?

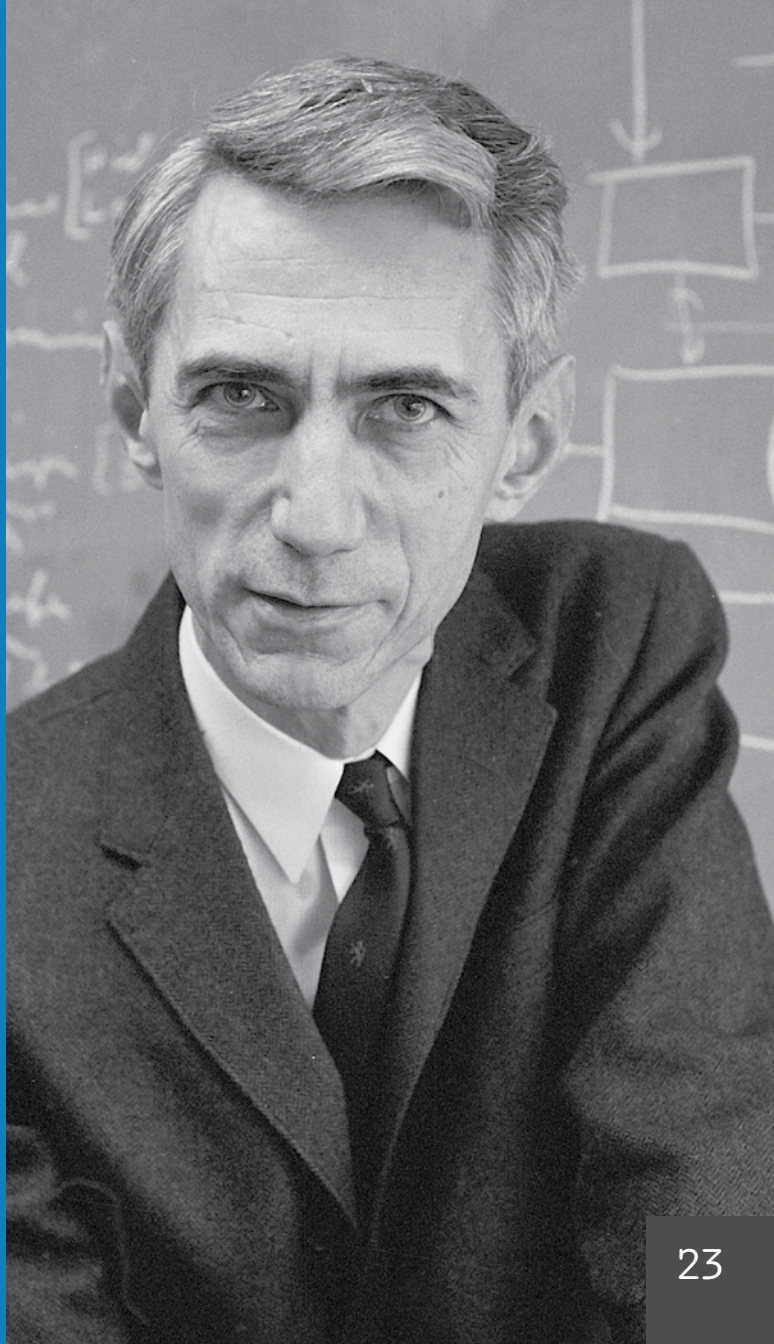
Surely not.

Is the problem that the text's complexity is too high for you?

Unlikely: it has a lexile of 1080L, which is ninth or tenth grade level.

The problem is that you lack prior knowledge.

[5] Shannon (1948)



Until the 1930s in the US, the role of the elementary school teacher was to be a guide to the world. Building knowledge was explicit and systematic.

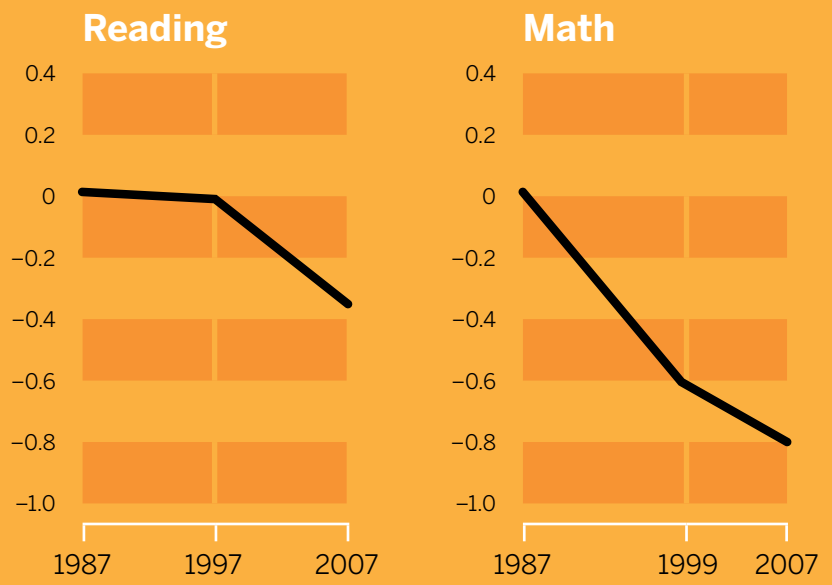
But then something changed. The idea gained currency that thinking skills and strategies are what children need to learn.

The same 'great skills shift' can be traced in the U.K., Sweden, Germany, and, most recently, France.[6]

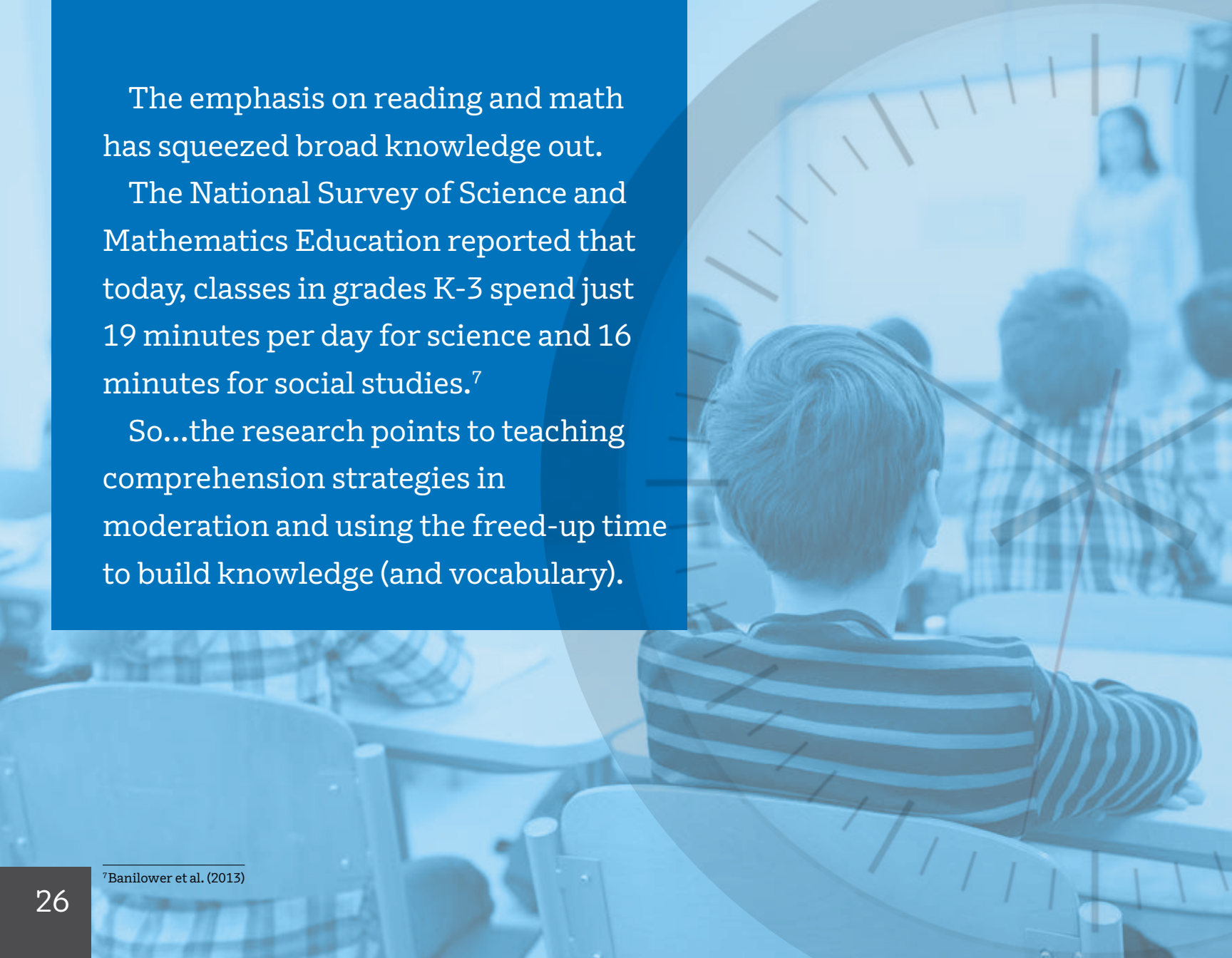
Some have linked the decline in scores—on the SAT in the U.S. and the DEPP national exam in France—to this shift.

Decline in achievement in curriculum scores for fifth graders in France

Average in 1987=0



[6] Rocher (2008)



The emphasis on reading and math has squeezed broad knowledge out.

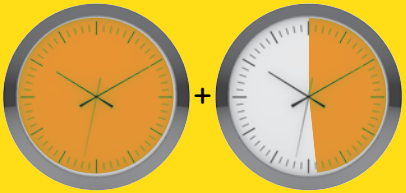
The National Survey of Science and Mathematics Education reported that today, classes in grades K-3 spend just 19 minutes per day for science and 16 minutes for social studies.[7]

So...the research points to teaching comprehension strategies in moderation and using the freed-up time to build knowledge (and vocabulary).

[7] Banilower et al. (2013)

Average number of minutes per day spent teaching each subject in self-contained classes, by grade

Reading/Language Arts



K–3	4–6
89	83

Mathematics

K–3	4–6
54	61

Science

K–3	4–6
19	24

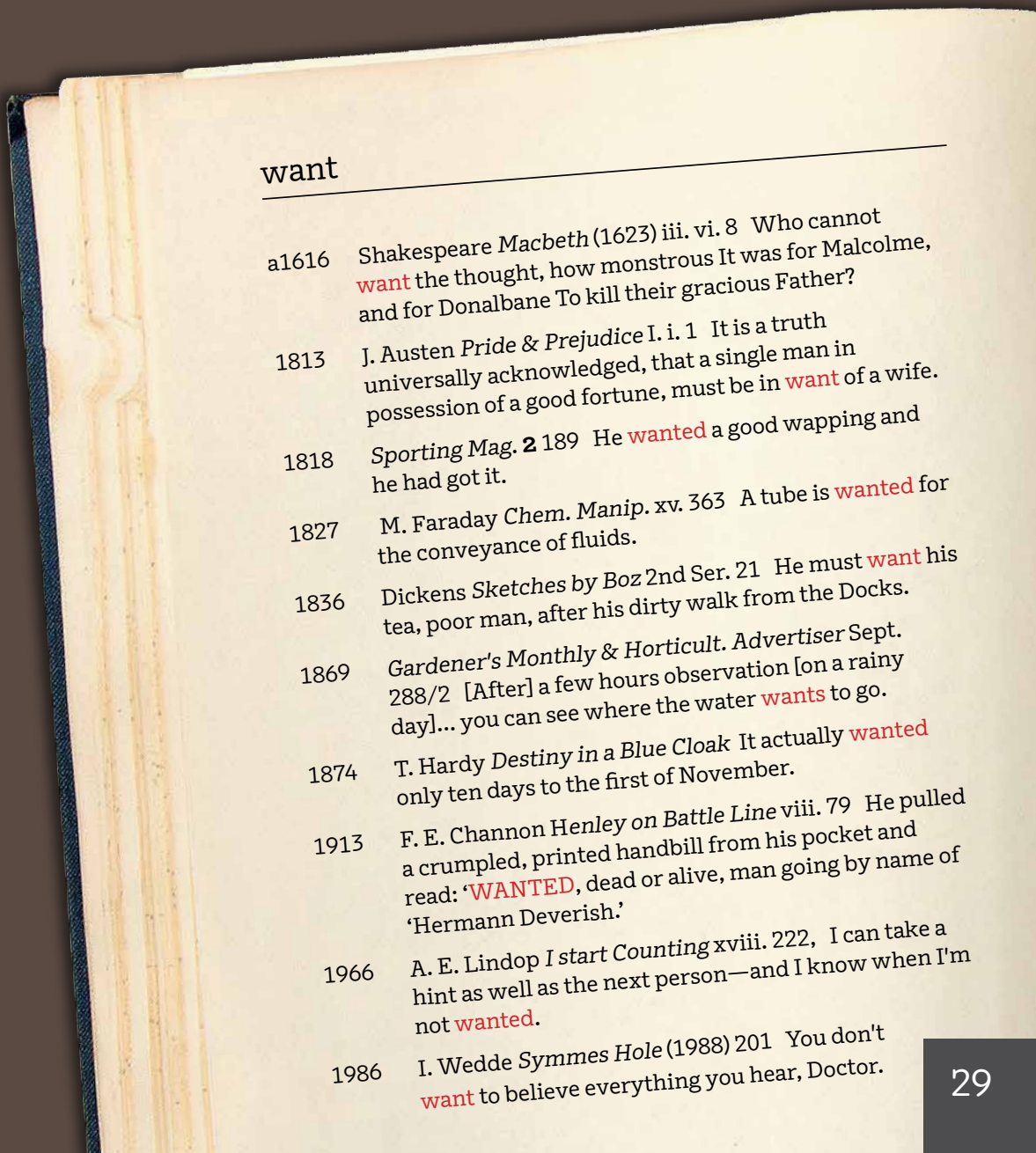
Social Studies

K–3	4–6
16	21

LONG BEFORE he invented Orkish and Elvish, John Ronald Reuel Tolkien—JRR to his fans—worked as an assistant on a far grander project: the taming of every word in the language for the *Oxford English Dictionary*. It took 70 years to define all 300,000 words.

JRR and friends

Tolkien was assigned *walnut*, *walrus*, *want* and other *wa-* words. But he didn't sit in a room in Oxford, England and write definitions. Instead, he looked at hundreds of actual uses of each word 'in the wild'. Then he synthesized.



want

a1616 Shakespeare *Macbeth* (1623) iii. vi. 8 Who cannot want the thought, how monstrous It was for Malcolme, and for Donalbane To kill their gracious Father?

1813 J. Austen *Pride & Prejudice* I. i. 1 It is a truth universally acknowledged, that a single man in possession of a good fortune, must be in want of a wife.

1818 *Sporting Mag.* **2** 189 He wanted a good wapping and he had got it.

1827 M. Faraday *Chem. Manip.* xv. 363 A tube is wanted for the conveyance of fluids.

1836 Dickens *Sketches by Boz* 2nd Ser. 21 He must want his tea, poor man, after his dirty walk from the Docks.

1869 *Gardener's Monthly & Horticult. Advertiser* Sept. 288/2 [After] a few hours observation [on a rainy day]... you can see where the water wants to go.

1874 T. Hardy *Destiny in a Blue Cloak* It actually wanted only ten days to the first of November.

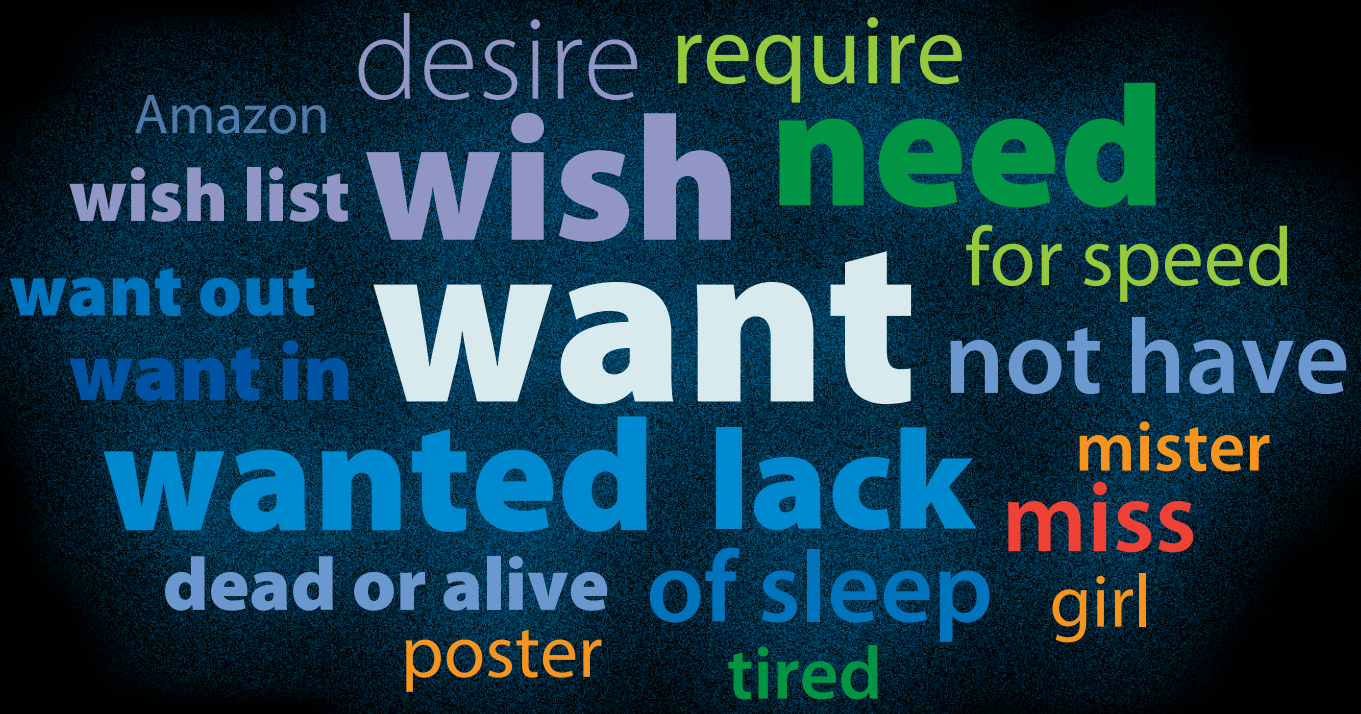
1913 F. E. Channon *Henley on Battle Line* viii. 79 He pulled a crumpled, printed handbill from his pocket and read: 'WANTED, dead or alive, man going by name of 'Hermann Deverish.'

1966 A. E. Lindop *I start Counting* xviii. 222, I can take a hint as well as the next person—and I know when I'm not wanted.

1986 I. Wedde *Symmes Hole* (1988) 201 You don't want to believe everything you hear, Doctor.

That is, in fact, how dictionaries are created. They are not just lists of definitions; they are webs of words.

And the same is true of words in your brain. You don't have a list of definitions. In fact, you may never have thought much about the different senses of *want* such as lack, need, or desire. You just know.



Often, definitions are illusions anyway—they are circular because words are defined in terms of other words. (Though the circularity is not usually as glaring as this famous example.)

hill:-

1: a usually rounded natural elevation of land **lower than a mountain**.

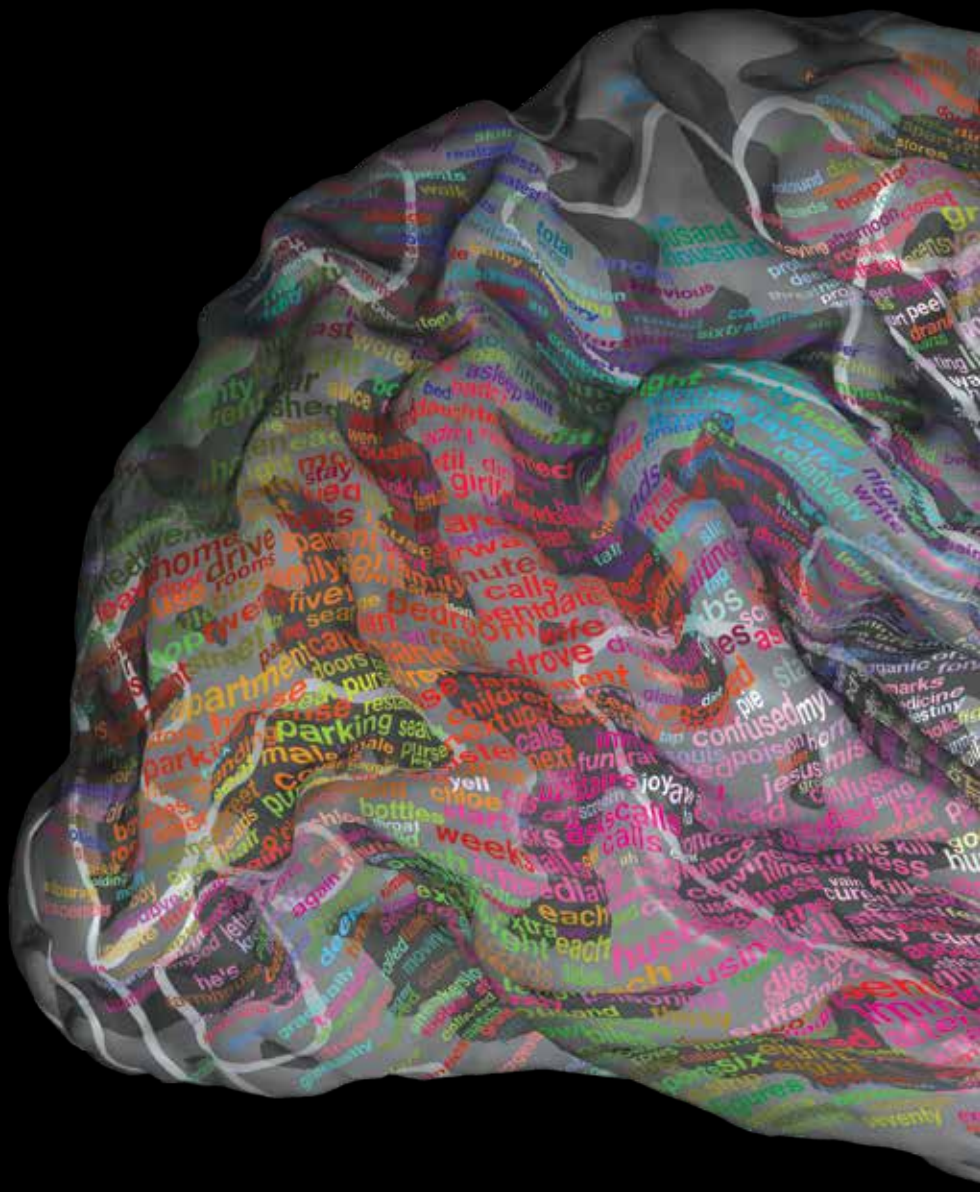
mountain:-

1a: a landmass that projects conspicuously above its surroundings and is **higher than a hill**.

— from The 2007 Merriam-Webster dictionary

How do you ‘just know’? Each time you hear or see a word, it leaves a trace in your brain, expanding or strengthening your web of word senses.

Researchers recently found a way to map words across the entire cortex of a typical brain.[8]



[8] Huth et al. (2016)

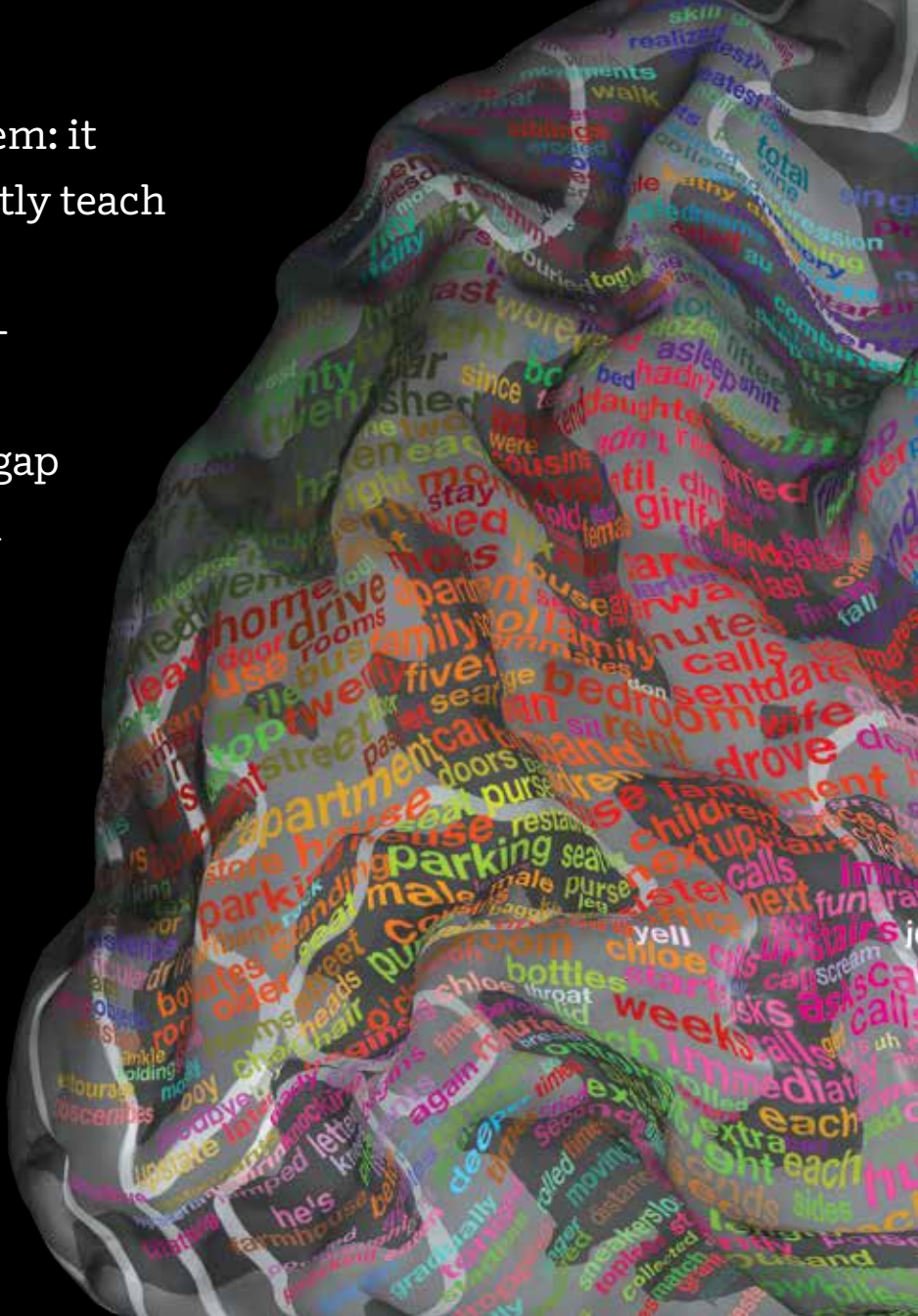
You can't see them all on this image, of course, but you know around 50,000 words. Between the ages of 2 and 18, you learned 10 new words every day.

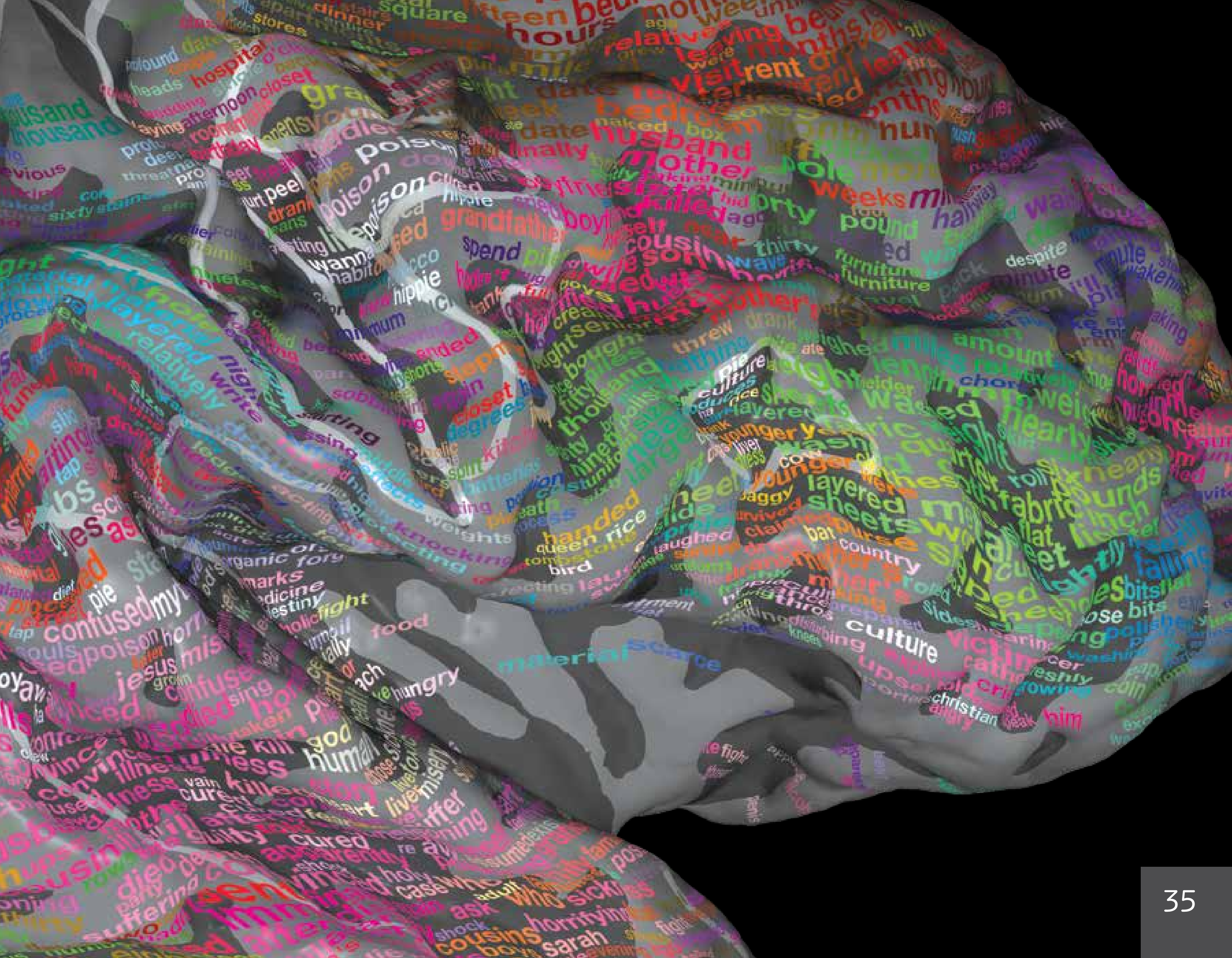
Yet you probably learned only a few of those words from their definition. You learned almost all them from context.

Educators face the same problem: it would take far too long to explicitly teach all the words needed to close the gap between a low- and high-vocabulary student.

On the first day of school, that gap may already be several thousand words.

And it's not just the number of words a child recognizes that drives reading comprehension. Making good connections and inferences depends on the richness of the word network he or she has built.




square
hours
relatives
rent
visit
hospital
afternoon
husband
mother
sister
killed
cousin
grandfather
spend
weeks
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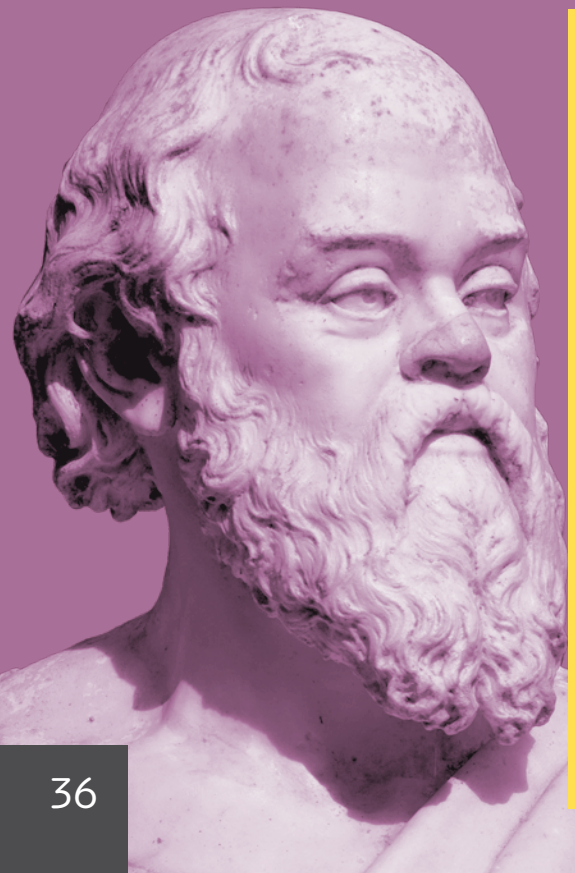
thirty
furniture
despite
minute
hallway
hippie
poison
relatively
layered
night
write
closet
degrees
amount
younger
sheets
layered
baggy
claimed
handed
rice
queen
bird
country
culture
confused
jesus
hungry
food
god
human
cured
shock
cousins
sarah
christian
him

Richness can't be learned solely from speech. Imagine Socrates and Einstein walk into a bar. If they talk about their weekend (not physics or philosophy), what level of vocabulary do they use?

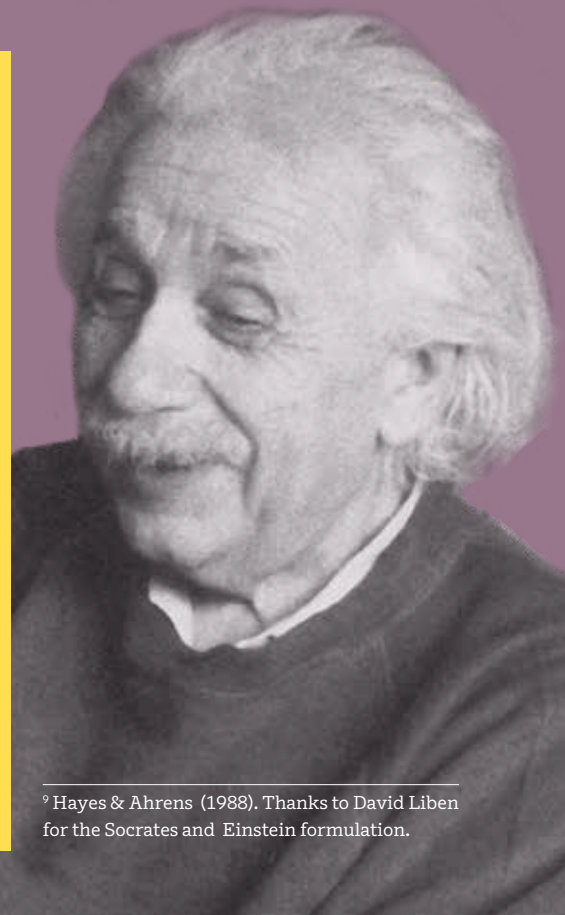
Typically around 20 unusual words—such as *dismayed* or *zeal*—per 1,000. Newspapers and books contain more than twice as many.[9]



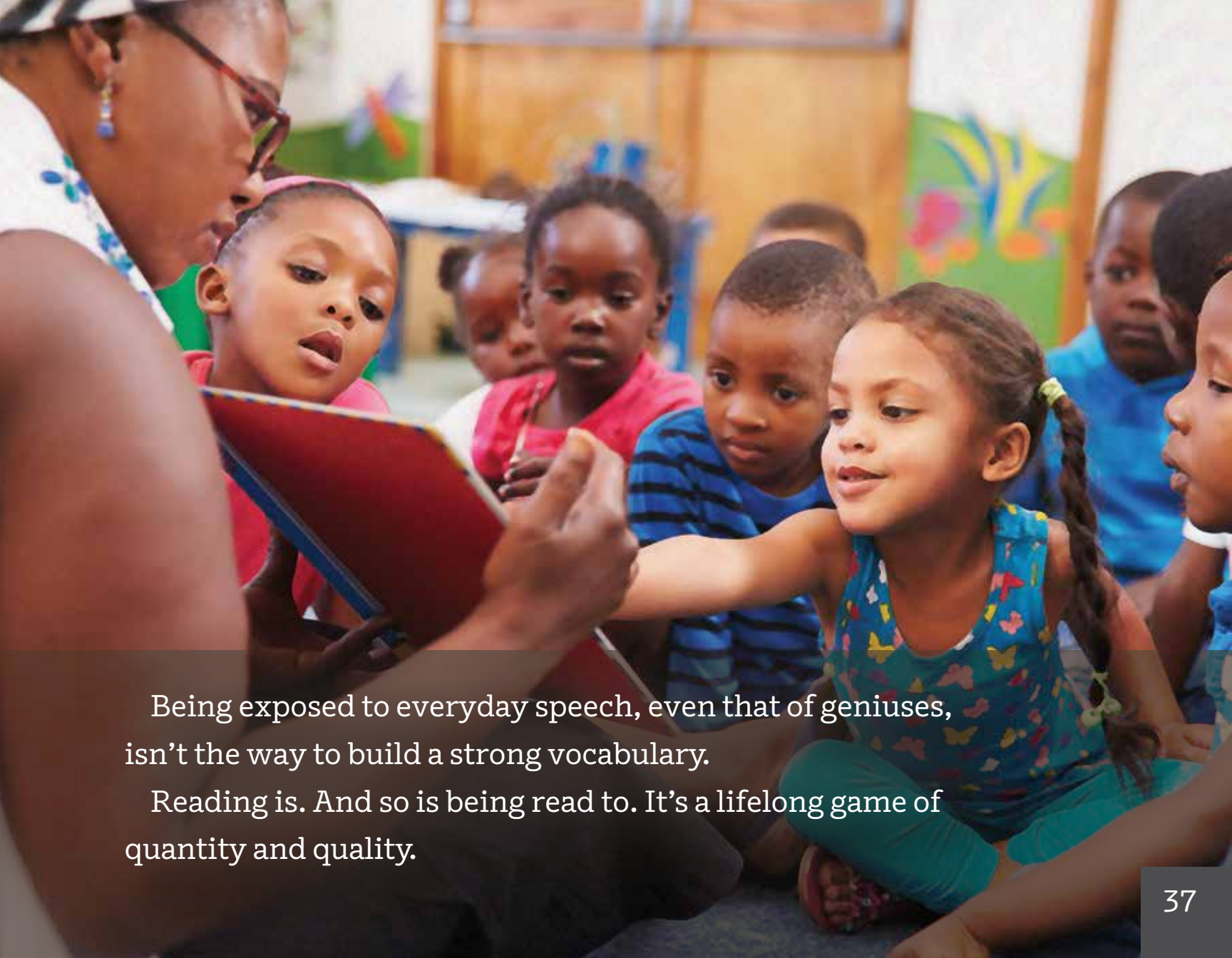
rare words

(per thousand)

Newspapers	**68.3**
Popular magazines	**65.7**
Comic books	**53.5**
Adult books	**52.7**
Children's books	**30.9**
Prime-time adult TV	**22.7**
Prime-time children's TV	**20.2**
College graduate speech	**17.3**



[9] Hayes & Ahrens (1988). Thanks to David Liben for the Socrates and Einstein formulation.

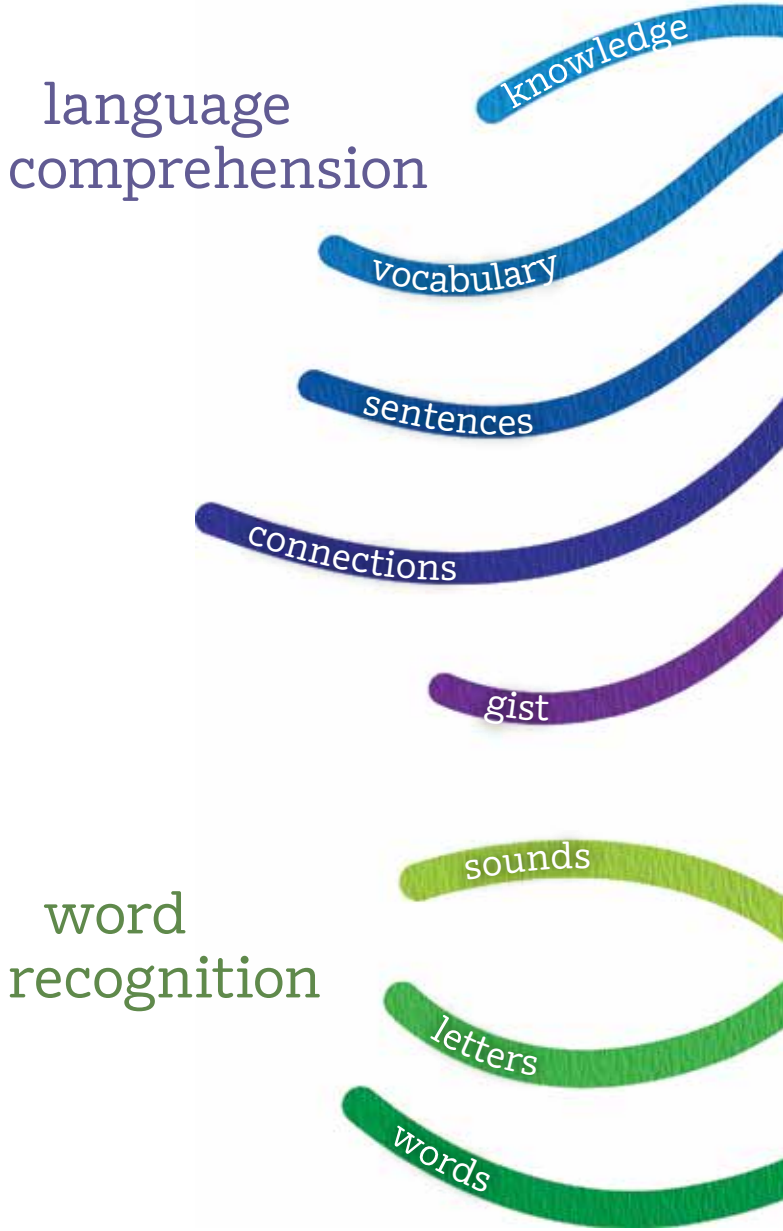


Being exposed to everyday speech, even that of geniuses, isn't the way to build a strong vocabulary.

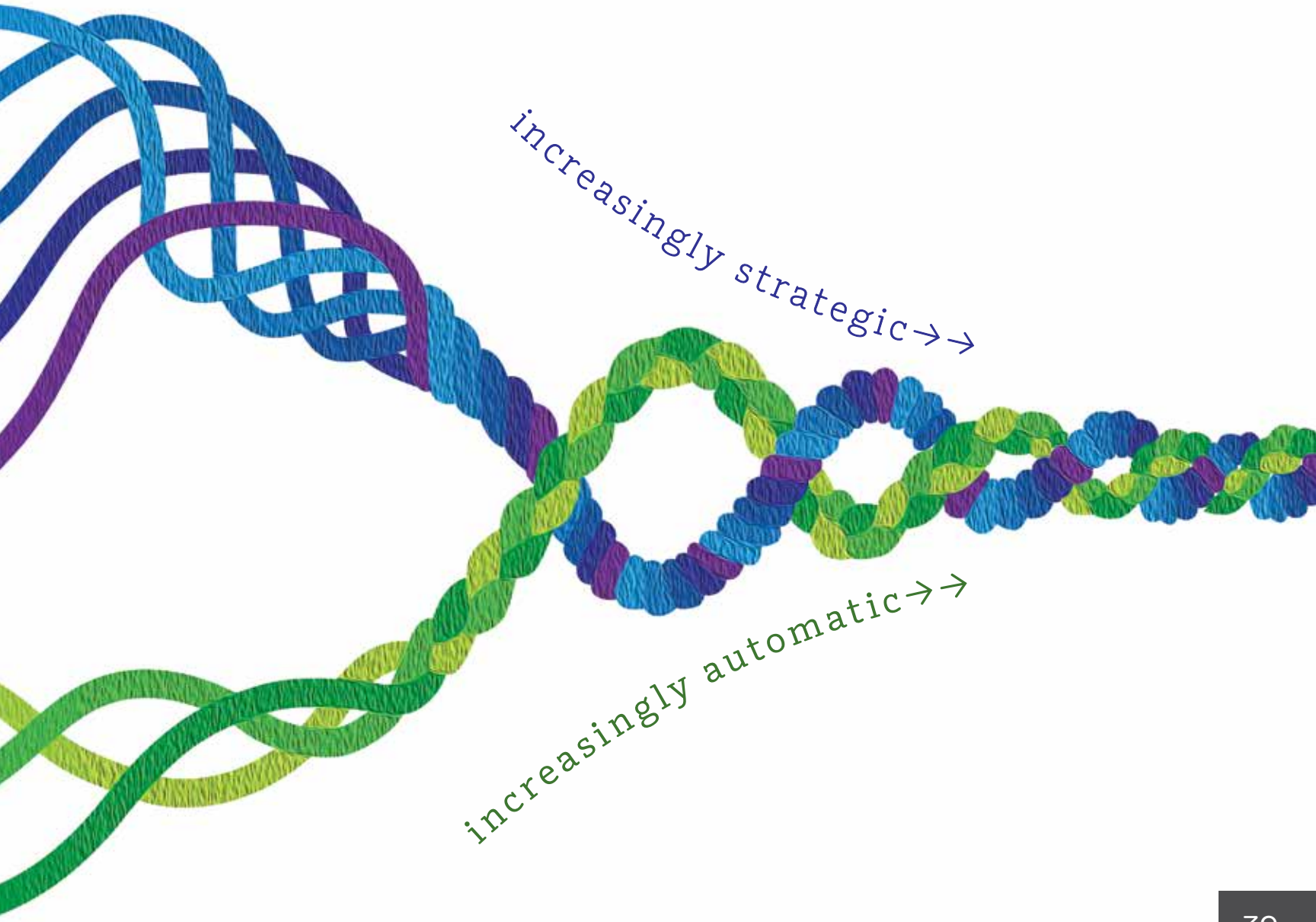
Reading is. And so is being read to. It's a lifelong game of quantity and quality.

WE'VE COVERED almost every part of the braid we started with in Part One*. But what about comprehension: sentences, connections across sentences, and gist?

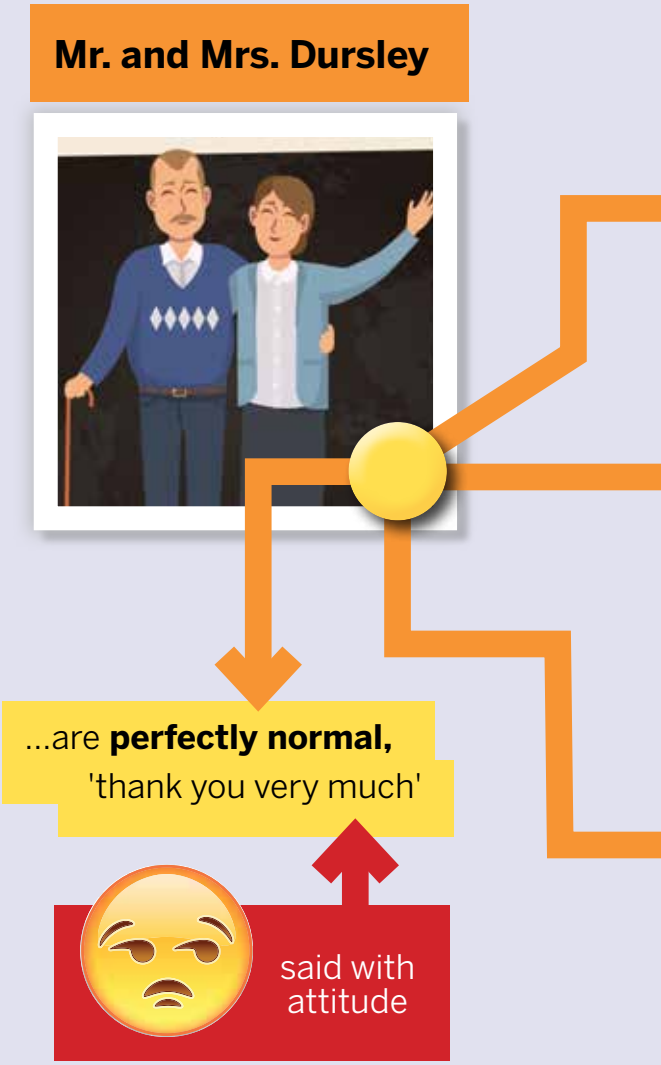
Some readers with good word recognition, vocabulary, and knowledge are still weak comprehenders. Why?



* If you don't have Part One of this Primer, you can download it from www.amplify.com/cfer/learning-to-read
Braid illustration based on Scarborough et al. (2001)


increasingly strategic→→
increasingly automatic→→

"Mr. and Mrs. Dursley, of number four, Privet Drive, were proud to say that they were perfectly normal, thank you very much. They were the last people you'd expect to be involved in anything strange or mysterious, because they just didn't hold with such nonsense." [10]



[10] Rowling (1997)

...live at number 4 Privet Drive

...are not involved in **anything strange or mysterious**

because

...believe that anything strange or mysterious is **nonsense**

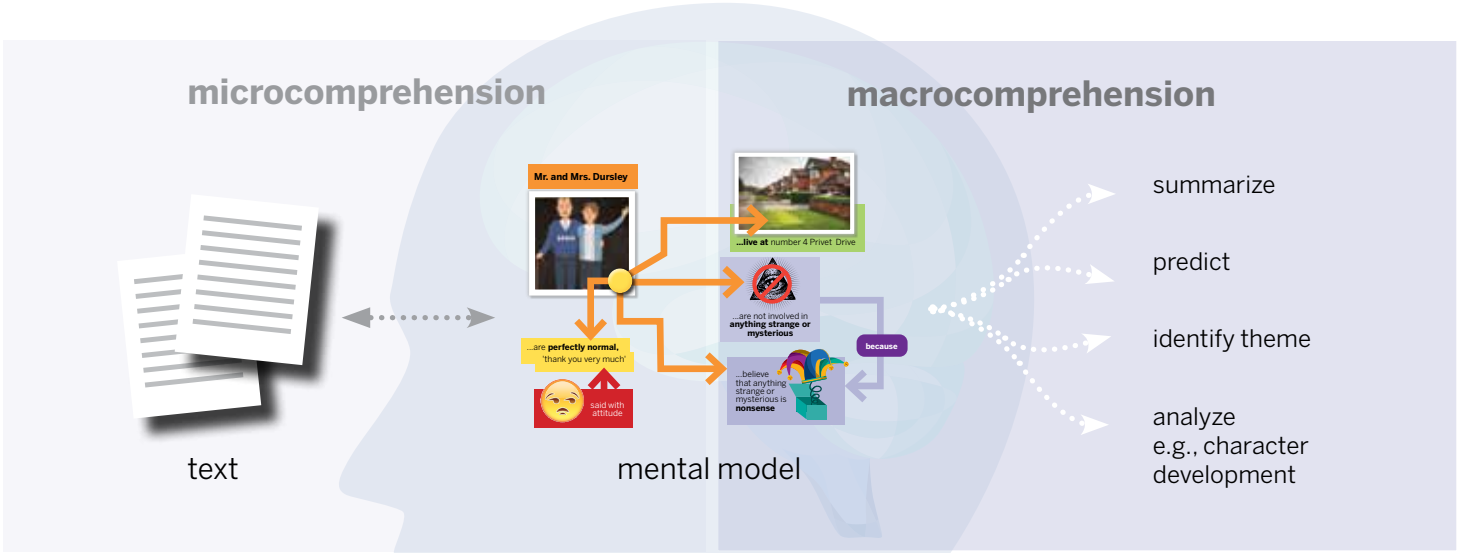
Read the passage on the left, then set aside this book and try to recall as much as of it as you can.

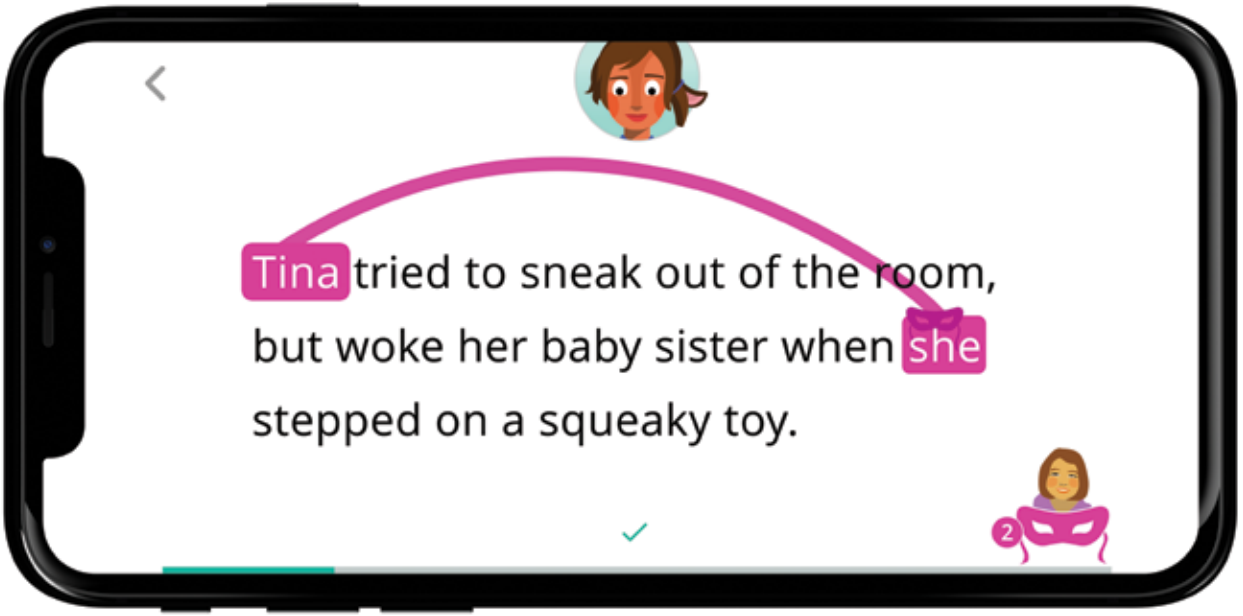
Most likely, you didn't recall the precise wording. But you had the ideas: the Durselys live on Privet Drive, they don't get involved with weird goings-on, etc.

Researchers use the term *mental model* to describe the structure you created in your mind to perform this feat.

Think of the process of building a mental model as a sort of micro-comprehension. Weak comprehenders build poor models. Whichever macro-comprehension question you ask them, they answer poorly.

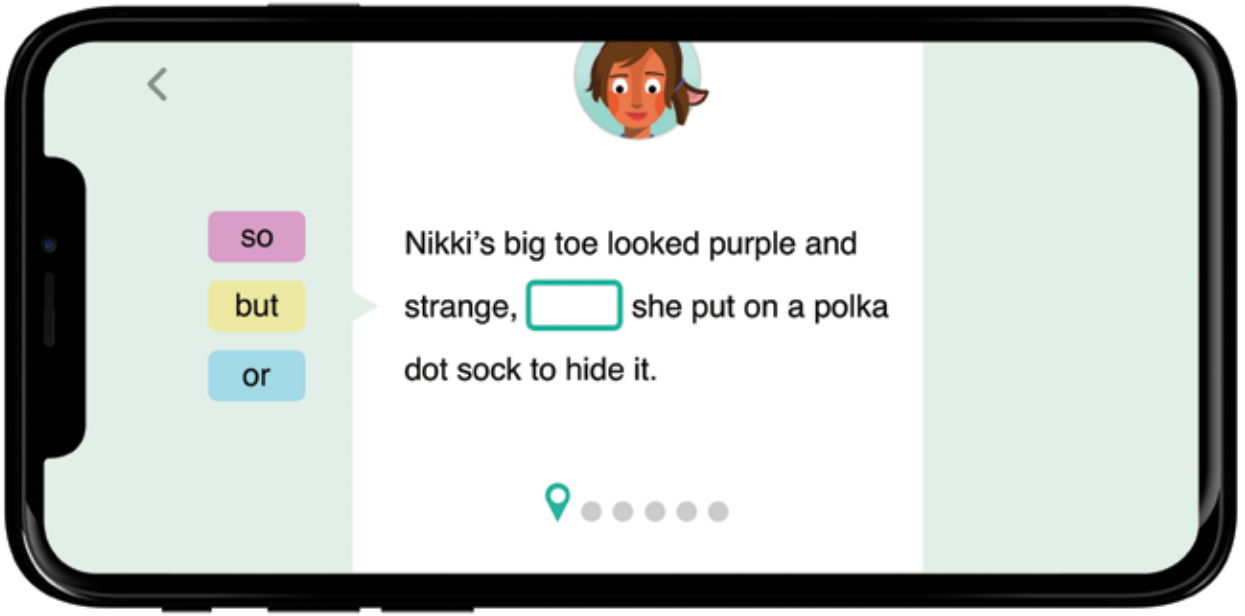
But they don't need more practice at the macro level—prediction or mapping character development. They need better mental models. Researchers have uncovered four critical skills.





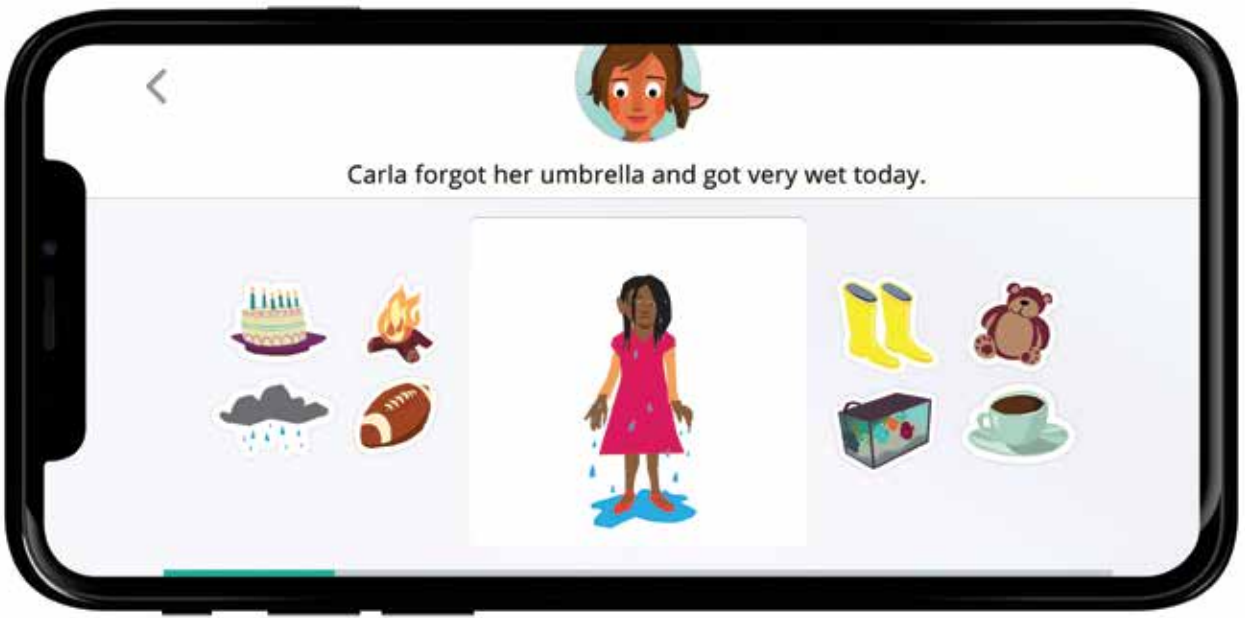
1. Writers avoid repeating things like characters' names. Instead they (the writers, not the characters) assume you can figure out who they mean when they use *they*.

   The technical term for this is anaphora (an-AFF-or-a). Some early readers don't reliably figure out who the pronoun is referring to, especially in ambiguous text.

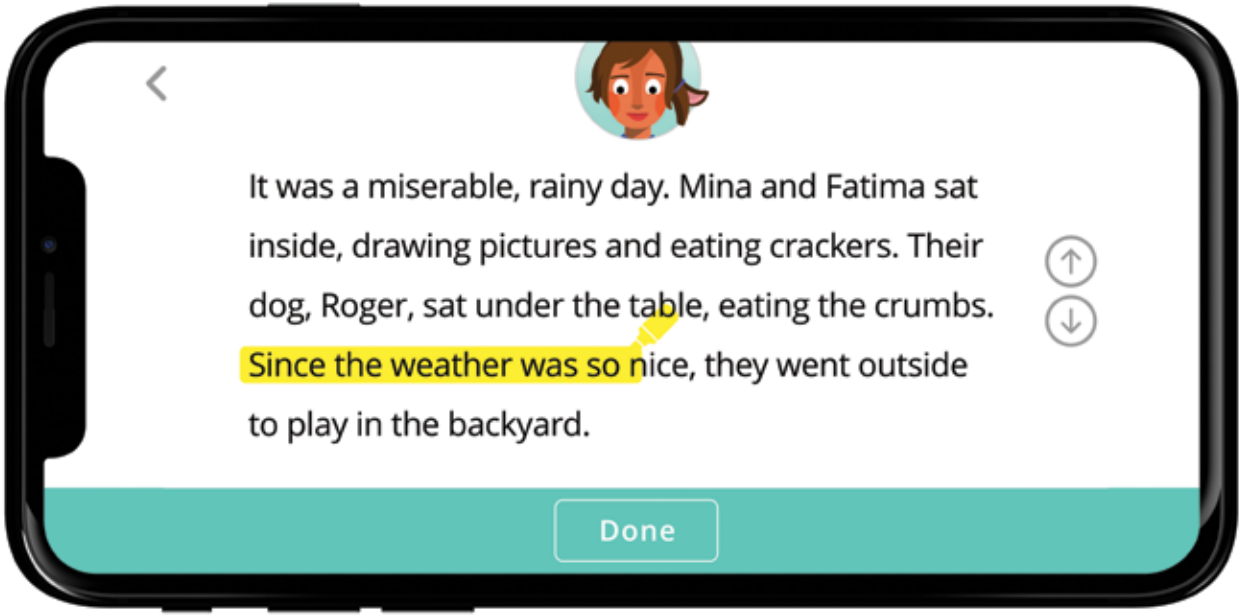


2. Writers use markers to signal ways that the text fits together—connectives like so, though, or whenever, structure cues ('meanwhile, back at the ranch'), and directions ('there are three reasons why...').

   Inexperienced readers may not know *but*, *though*, *yet*, and *however* signal that something opposite follows.



3. Writers make assumptions about what can be left unstated. For instance, when they read 'Carla forgot her umbrella and got very wet today,' good readers will use their prior knowledge to conclude that it rained. Weaker readers who fail to make these *gap-filling inferences* wind up with gaps in their mental model.



4. It may seem obvious to good readers that, when something doesn't make sense, you stop, re-read, and try to figure it out. But weaker readers just keep going—it's not that they fail to figure it out; it's that they fail to notice in the first place. They need explicit instruction in *monitoring comprehension* as they read.

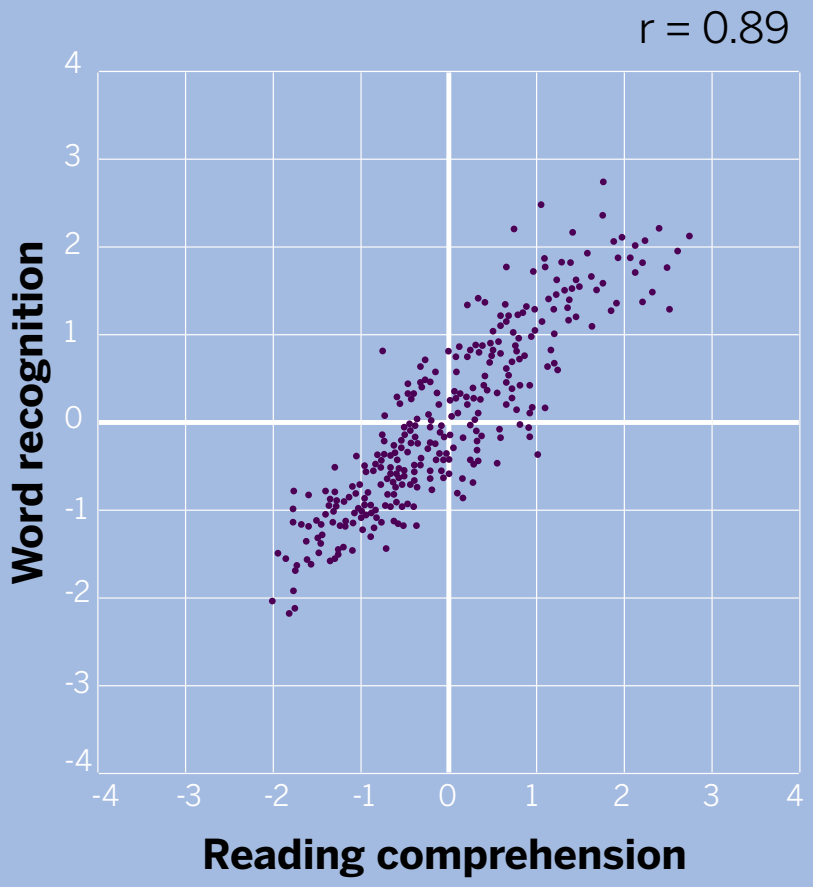
Teachers can model these skills by thinking aloud while reading complex text.

For good readers, the skills have become automatic: fast and effortless, like shifting gears is for an experienced driver who, when first learning to drive, could not shift gears and hold a conversation at the same time.

THINK OF reading as a suitcase that requires two keys to open it. The first key is word-level decoding skill that becomes automatic, fluent. The second key is language, vocabulary, domain-specific knowledge, and the microcomprehension skills to build a good mental model.

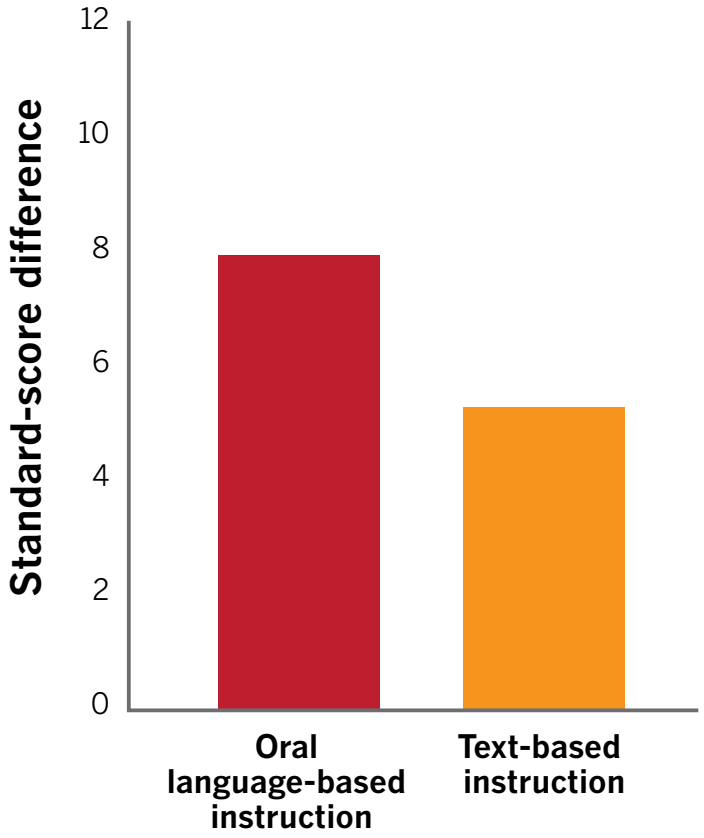
The evidence for each key is overwhelming.

For instance, researchers at the Haskins Lab at Yale found an extraordinarily high correlation between how well a 7- to 9-year-old child can recognize words and how well he or she comprehends text.[11]



[11] Shankweiler et al. (1999)

And when researchers ran a bake-off between spoken language-based comprehension instruction and text-based comprehension instruction, language won, even when measured 11 months later on a test of text comprehension.[12]



[12] Clarke et al. (2010)

When schools focus heavily on one key or the other, the suitcase doesn't open—reading comprehension is delayed.

But you can be confident that when you work diligently with both keys, good readers will emerge.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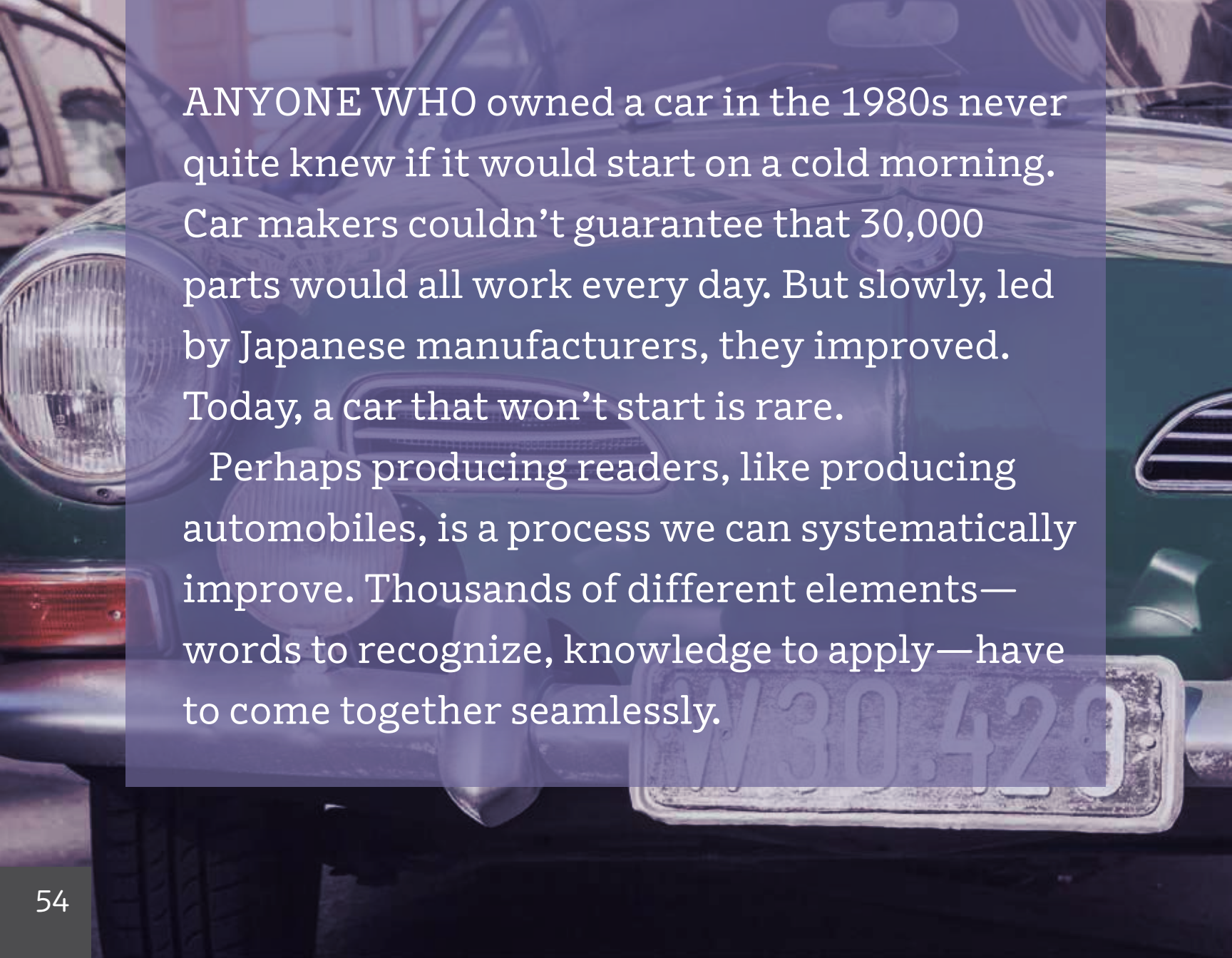
As in many kinds of learning, a flywheel begins to turn that slowly gathers its own momentum. The more words you can decode, the more new words—and their meanings—you can learn.

Similarly, the more knowledge you have on a topic, the more you can soak up on the same topic—and on related topics.



ANYONE WHO owned a car in the 1980s never quite knew if it would start on a cold morning. Car makers couldn't guarantee that 30,000 parts would all work every day. But slowly, led by Japanese manufacturers, they improved. Today, a car that won't start is rare.

Perhaps producing readers, like producing automobiles, is a process we can systematically improve. Thousands of different elements—words to recognize, knowledge to apply—have to come together seamlessly.

In the two parts of this primer, it has been our goal to point the way, to convey the dramatic advances in our understanding of what early readers have to master.

The greater task of applying that knowledge awaits us.

Our children are so excited about what they are learning. They love being in school, and they can't wait until it's time to talk about the Mayas, the Aztecs, the solar system, or any other topic. When a unit ends, they don't want to stop learning. I have to remind them that they will return to the topic at another grade level. But they say, 'Tell us now, tell us now Miss Pacheco, we want to know now!'

Rachel Pacheco, Hawthorne Academy, San Antonio

Some suggestions for further reading

Jane Oakhill and Kate Cain are the reigning champions of inference and its connection to comprehension. Their book with Carsten Elbro, *Understanding and Teaching Reading Comprehension: A handbook*, is an excellent source on what this Primer calls microcomprehension, as are Kelly Cartwright's high practical *Word Callers* and Heidi Anne Mesmer's *Teaching Skills for Complex Text*.

The Reading Mind: A Cognitive Approach to Understanding How the Mind Reads is a new, engaging explanation of the psychology of reading from University of Virginia professor Dan Willingham. In prose aimed at teachers, it starts with a single E. L. Doctorow sentence and unpacks what the mind does in order to understand it. For a more thorough alternative, try Mark Seidenberg's *Language at the Speed of Sight: How We Read, Why So Many Can't, and What Can Be Done About It*—though note that the book, like its title, is not short.

E. D. Hirsch's readable and convincing *Why Knowledge Matters: Rescuing Our Children from Failed Educational Theories* lays out the argument for bringing content back into elementary classrooms. And on vocabulary there is no substitute for *Bringing Words to Life* by Isabel Beck and Margaret McKeown.

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