

# Does the Complexity of Unified English Braille Interfere with Self-Teaching?

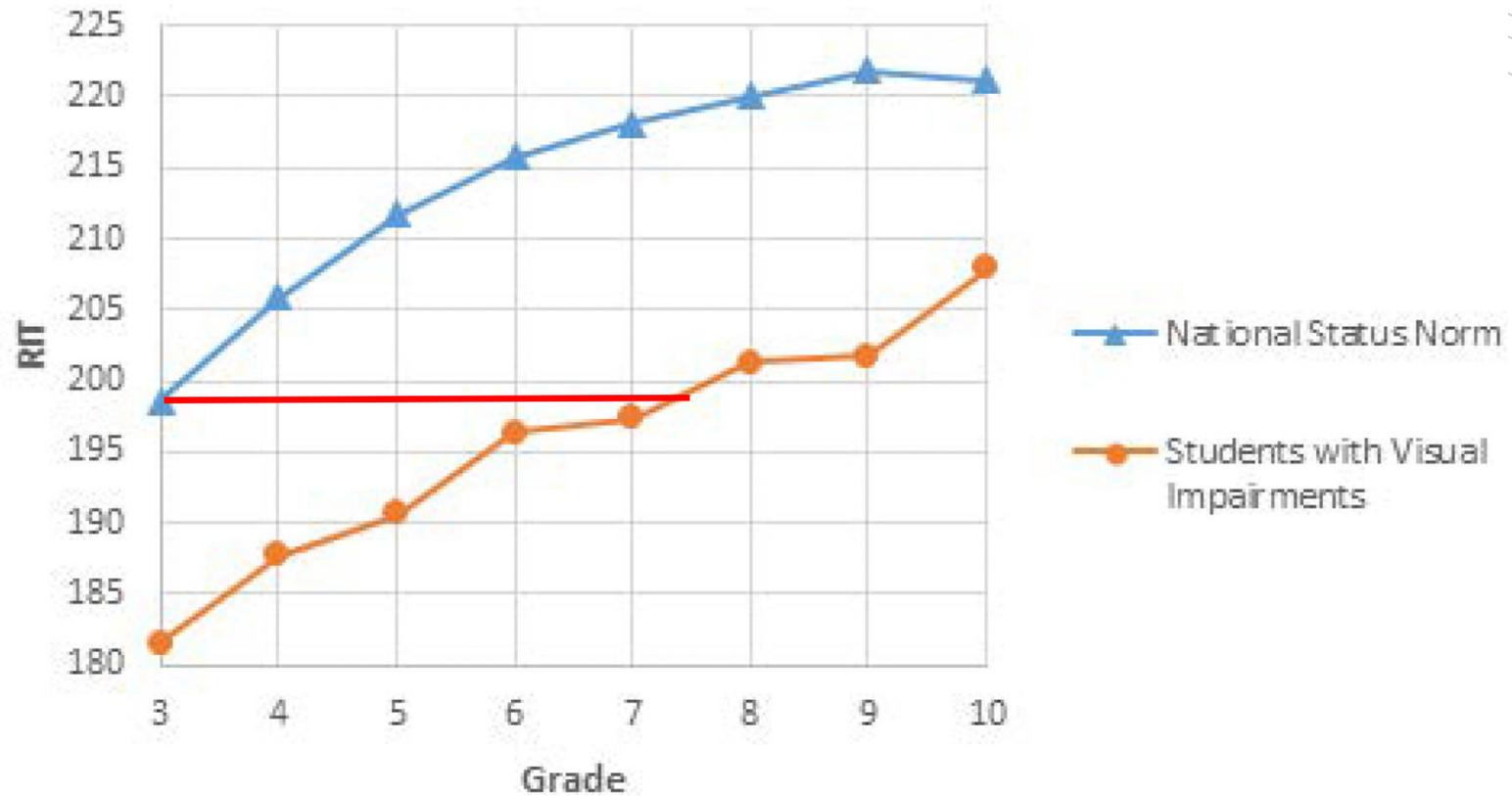
Association for Written Language and Literacy

Pisa, Italy

October 29, 2025

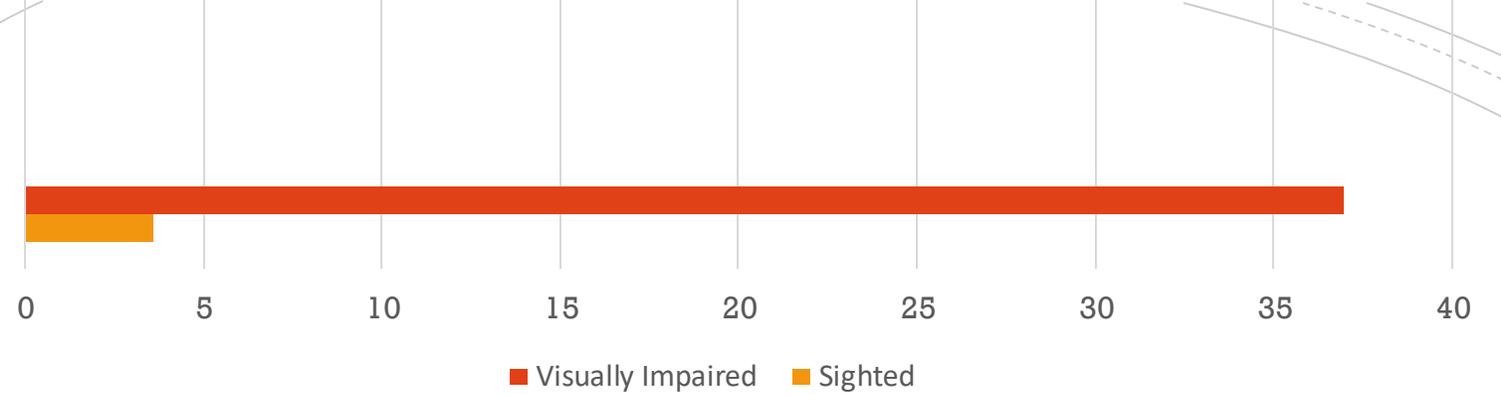
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Most blind children have reading delays.



- US students who are blind or have visual impairments do not read at the level of a third-grader (age 8-9) with typical sight until, on average, halfway through the seventh grade (age 12-13; Boroson et al., 2017)

Rates of learning disability among blind children are high.



- 37% of students with visual impairments in the US have a learning disability (compared with 3.6% of all students; Cameto & Nagle, 2007)
- Dyslexia represents 80% of cases of learning disability (Shaywitz, 1998)
- Dyslexia may actually be *underdiagnosed* in students with visual impairments, including students who read braille (Harris et al., 2024)

*dyslexia* - a learning disability characterized by difficulty with word-level reading (decoding)

Blind braille readers can have dyslexia.

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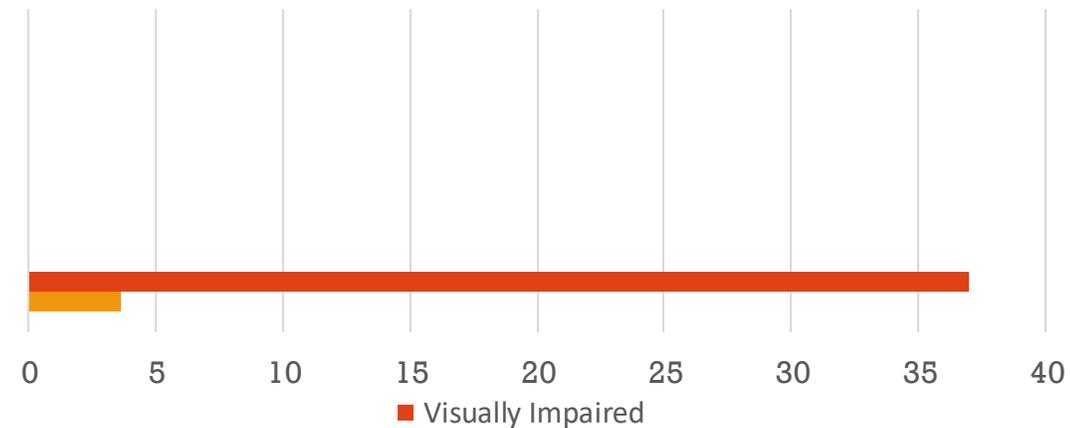
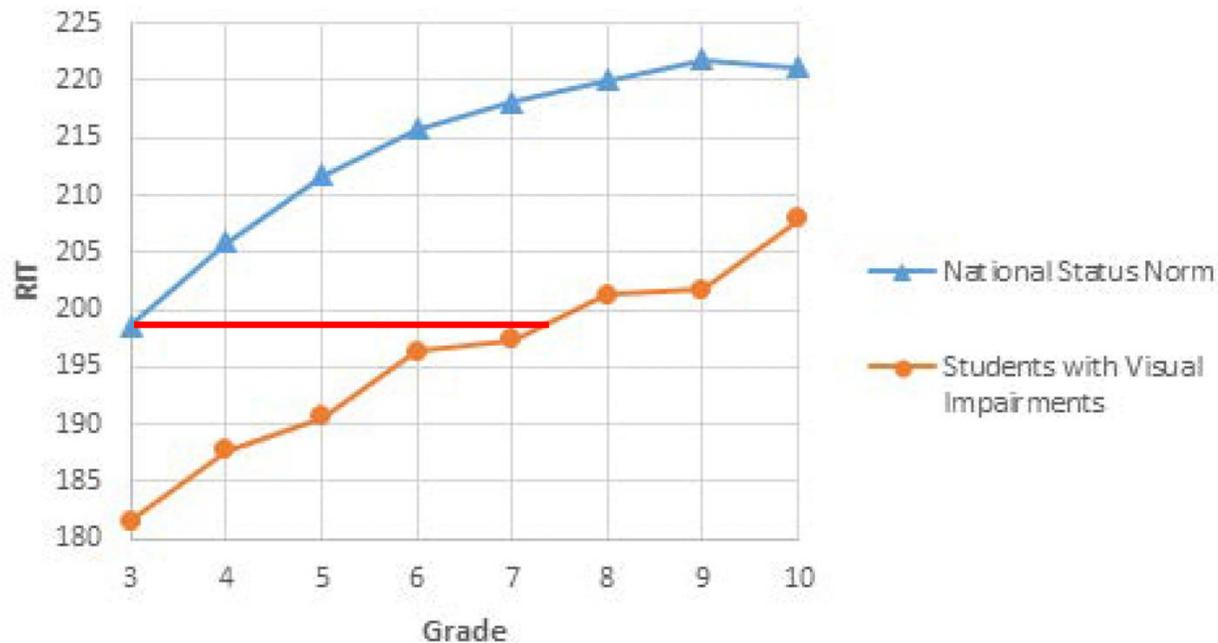
**Braille Dyslexia: Does it Exist?**

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**Could Specific Braille Reading Difficulties Result from Developmental Dyslexia?**

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**Braille Reading by Children: Is there a Phonological Explanation for their Difficulties?**



- US students who are blind or have visual impairments do not read at the level of a third-grader (age 8-9) with typical sight until, on average, halfway through the seventh grade (age 12-13; Boroson et al., 2017)

- 37% of students with visual impairments in the US have a learning disability (compared with 3.6% of all students; Cameto & Nagle, 2007)

What's going on?



Why do blind children struggle with reading?



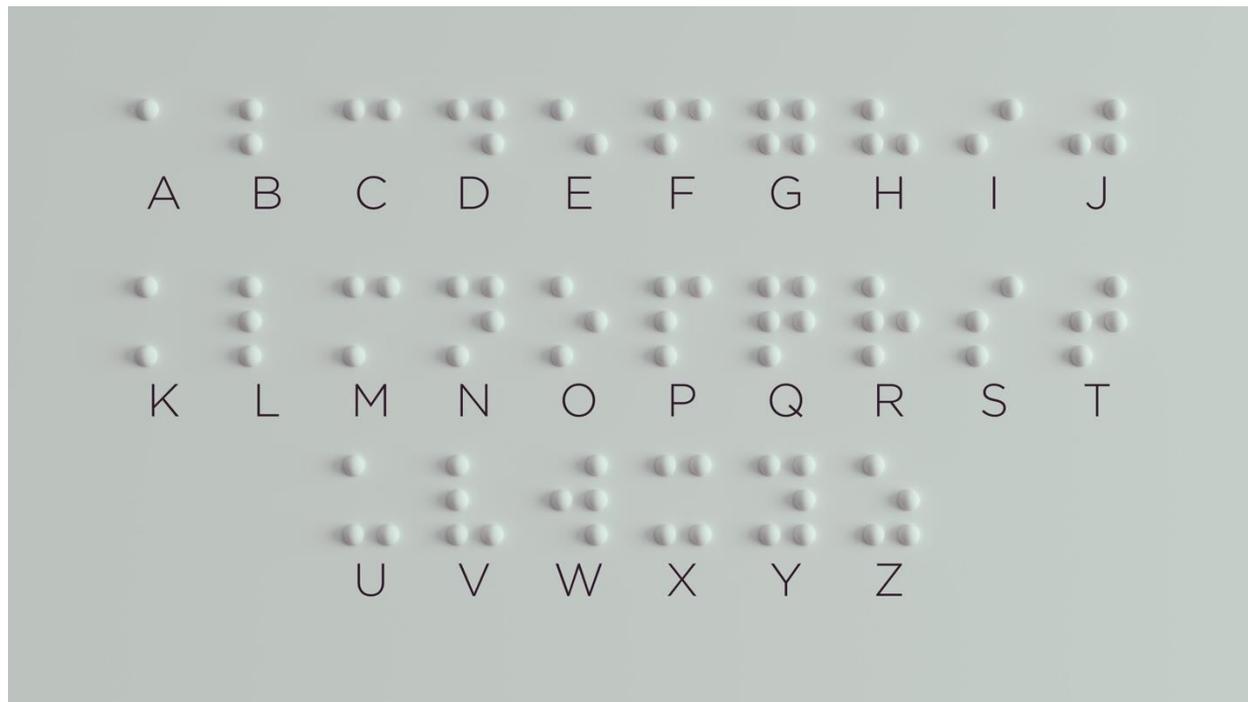
- Preterm birth?
- Environmental print exposure?
- Teacher knowledge?
  - *Probably not* (Gul et al., 2022)
- Complexity of the English braille code?



## Phonological decoding skill in braille readers: implications for dyslexia

Lindsay N. Harris · Luis E. Lopez · Ailing Li · Alecia M. Santuzzi

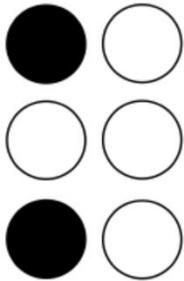
- The cognitive deficits that underpin dyslexia can impair reading to a greater or lesser degree depending on the transparency of the orthography (Landerl et al., 2019; Moll et al., 2014; Ziegler et al., 2010, 2019)
- Could the complexity of the English braille code interfere with reading acquisition?



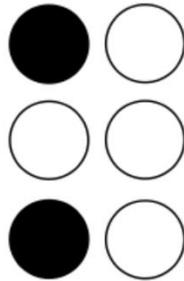
The braille cell.

Braille is complex.

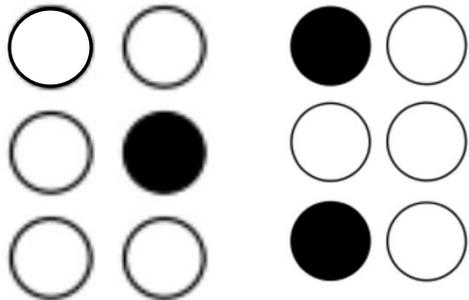
- Unified English Braille includes two modes of orthography: *uncontracted* and *contracted*



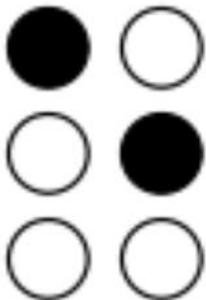
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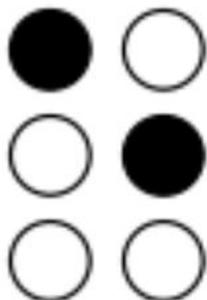
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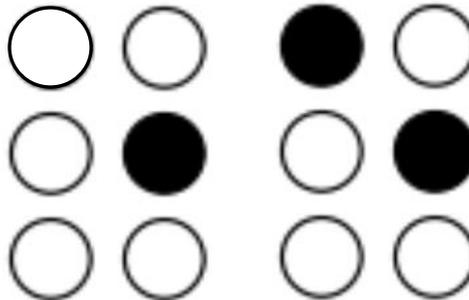
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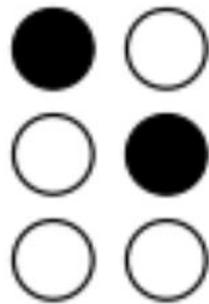
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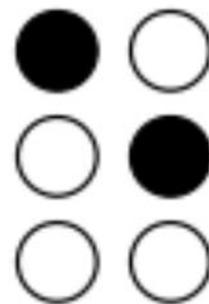
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Braille is complex.

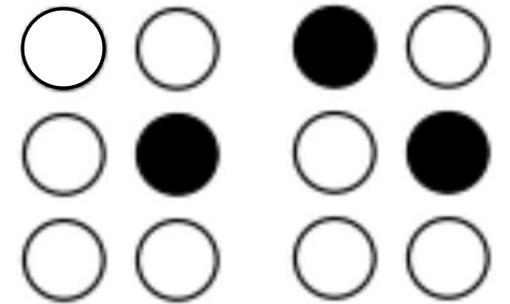
- Unified English Braille includes two modes of orthography: *uncontracted* and *contracted*
- There are contractions for some common words (e.g., *the*) and not others (e.g., *on*)
- There are contractions for some common affixes (e.g., *tion*) and not others (e.g., *ly*)



*e*



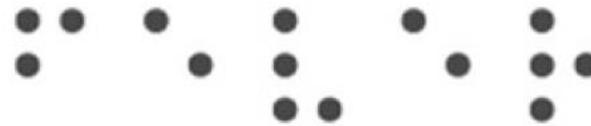
*every*



*ever*

Braille is  
complex.

- Braille contractions do not necessarily correspond to clear morphological boundaries



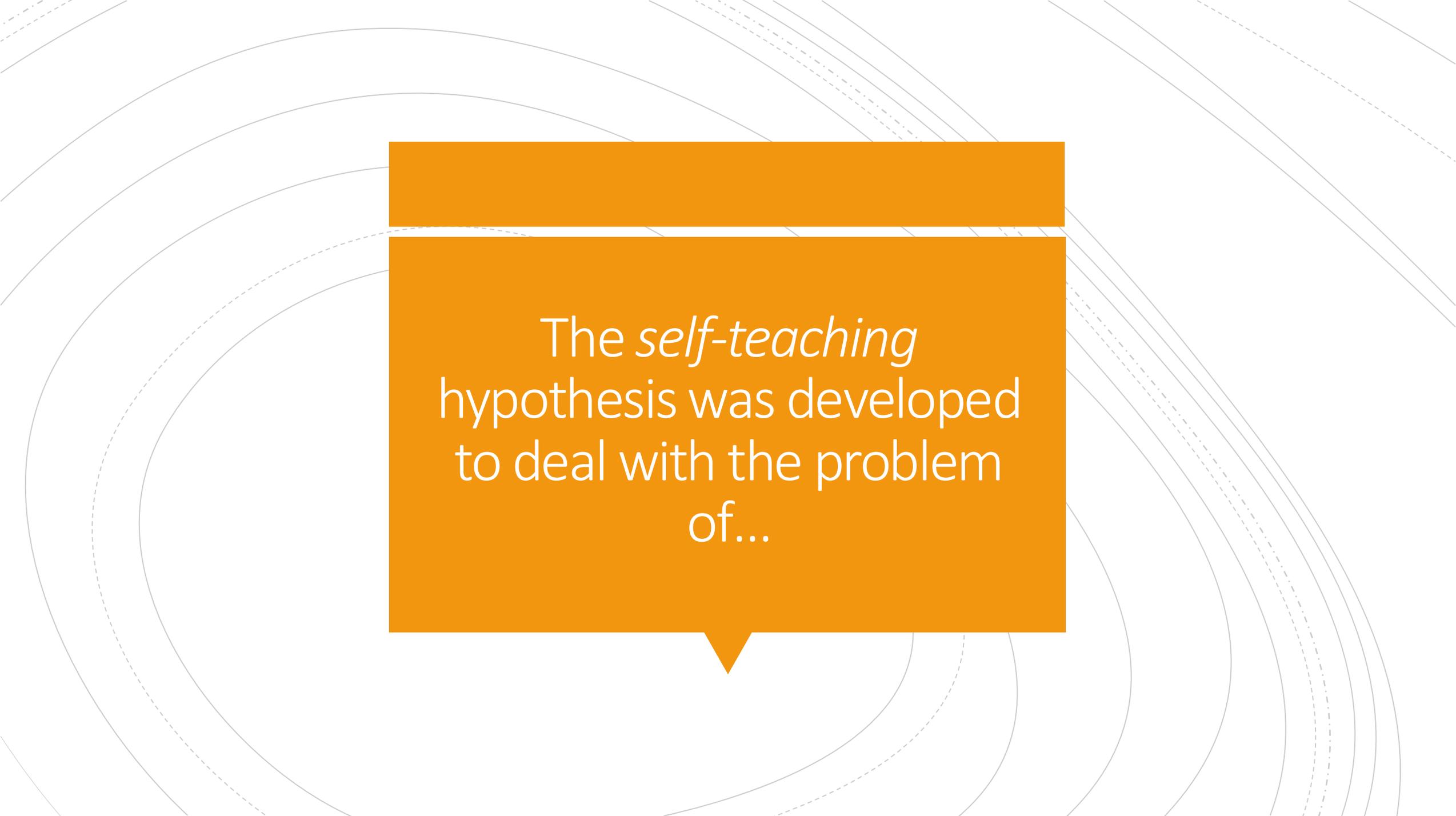
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fEVER

ALPHABET AND NUMBERS	PUNCTUATION	SIGNS OF OPERATION AND COMPARISON	ALPHABETIC WORDSIGNS	STRONG GROUPSIGNS	INITIAL-LETTER CONTRACTIONS	FINAL-LETTER GROUPSIGNS	SHORTFORM WORDS
1 2 3 4 5 6 7 8 9 0 a b c d e f g h i j k l m n o p q r s t u v x y z w	comma , period . apostrophe ' . colon : dash - long dash — exclamation mark ! hyphen - question mark ? semicolon ; ellipsis ... forward slash / backward slash \ opening outer quotation mark " " " " closing outer quotation mark " " " " opening inner quotation mark " " " " closing inner quotation mark " " " " grouping punctuation ( ) [ ] { }	plus + minus - multiplication x multiplication dot · division ÷ greater than > less than < equals = cent ¢ dollar \$ euro € British Pound £ feet ' " inches "	b but c can d do e every f from g go h have j just k knowledge l like m more n not p people q quite r rather s so t that u us v very w will x it y you z as	ch sh th wh ou st gh ed er ow ar ing ea bb cc ff gg be con dis en in be enough were his in was	day ever father here know lord mother name one part question right some time under work young there character through where ought upon word these those whose cannot had many spirit world their	ound ance sion less ount ence ong ful tion ness ment ity could deceive deceiving declare declaring either first friend good great ation com by ally to oc o'clock	ab about abv above ac according acr across af after afn afternoon afw afterward ag again agg against alm almost alr already al also alth although alt altogether alw always bec because bef before beh behind bel below ben beneath bes beside bet between bey beyond bli blind bri braille chn children concv conceive concvg conceiving cd could dcv deceive dcvg deceiving ddl declare dclg declaring ei either fst first fr friend gd good grt great hgrf herself hm him hmf himself imm immediate xs its xf itself lr letter ll little mch much mg must myf myself nec necessary nei neither onef oneself ourvs ourselves pd paid pgrcv perceive pgrcvg perceiving pgrh perhaps qk quick rcv receive rcvg receiving rjc rejoice rjcg rejoicing sd said shd should sch such thmvs themselves thyf thyself td today tgr together tm tomorrow tn tonight wd would yr your yrf yourself yrs yourselves
<b>INDICATORS</b> Numeric Capital letter word passage capital terminator Grade 1 symbol word passage Grade 1 terminator Typeform italic symbol italic word italic passage italic terminator bold symbol bold word bold passage bold terminator underline symbol underline word underline passage underline terminator script symbol script word script passage script terminator	<b>CURRENCY AND MEASUREMENT</b> cent ¢ dollar \$ euro € British Pound £ feet ' " inches "	<b>SPECIAL SYMBOLS</b> percent % degree ° angle ∠ hashtag # ampersand & copyright © trademark ™ superscript indicator subscript indicator bullet • @ sign @ asterisk * dot locator for mention	<b>STRONG CONTRACTIONS (Part and Whole Word)</b> and for of the with	<b>LOWER GROUPSIGNS</b> ea bb cc ff gg	<b>STRONG WORDSIGNS</b> child shall this which out still	<b>LOWER WORDSIGNS</b> be enough were his in was	<b>Retired Contractions (not used in UEB)</b> ble dd into ation com by ally to oc o'clock

- Additional codes use the same cells to represent mathematical symbols, musical notation, and IPA

The background features several concentric, overlapping curved lines in shades of light gray and white, some solid and some dashed, creating a sense of depth and movement. In the center, there is a large orange callout box with a white border and a small white triangle pointing downwards from its bottom center. Inside this box, the text is written in white.

The *self-teaching*  
hypothesis was developed  
to deal with the problem  
of...



The *phonological decoding self-teaching loop*.



- Effortfully decoding a letter string for the first time creates a connection between the *phonological* wordform and the *orthographic* wordform (Share, 2011)
- This connection facilitates recognition of the string next time it is encountered, creating a learning loop (Ziegler, Perry, & Zorzi, 2014)

*The phonological  
decoding self-  
teaching loop.*

- Perry, Zorzi, & Ziegler (2019) created a connectionist model incorporating the loop
- The model was given the abilities of 234 real non-dyslexic and 388 real dyslexic children
  - Orthographic processing efficiency
  - Phoneme activation efficiency
  - Spoken vocabulary size
- Predicted real-life learning outcomes more accurately than alternative models

The *phonological decoding self-teaching loop*.



- Underlying cognitive deficits can interfere with the phonological decoding self-teaching loop
- The atypical reading trajectory commonly termed *developmental dyslexia* can result

	English	Italian
Spelling	l a u g h	r i d e r e
Decoding result	<i>l o w g</i>	<i>r i d e r e</i>
IPA	/læf/	/ridere/
Rates of Dyslexia	5-10% ( <i>Catts et al., 2024</i> )	3.5% ( <i>Barbiero et al., 2019</i> )

“Laugh”ing in the U.S. and Italy



## Implications for braille-reading children.



- Increasing orthographic depth *decreases* opportunities for successfully decoding novel letter strings (Ziegler, Perry, & Zorzi, 2014)
- Lowered chances a given word will enter the reading lexicon via the loop
- Increased chances for dyslexia symptoms to emerge

## Our plan.

- We assessed phonological decoding skill in **non-dyslexic, adult, proficient** braille readers to investigate the possibility that braille's complexity is the source of higher rates of dyslexia identification in blind readers.

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Our plan.

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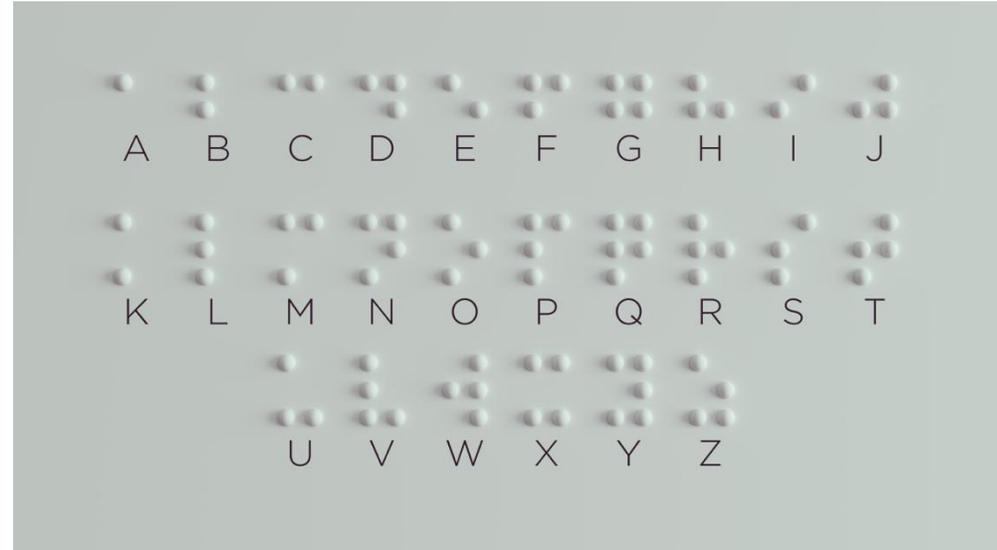
skwees

- Studying **non-dyslexic** individuals allows us to home in on decoding difficulties in the absence of underlying cognitive and linguistic deficits
- Studying **adults** ensures that all participants have achieved full reading and decoding proficiency.
- A **pseudohomophone** task replicates self-teaching



- If *skilled* adult braille readers are worse at phonological recoding than print readers, it could be evidence that braille interferes with the self-teaching loop

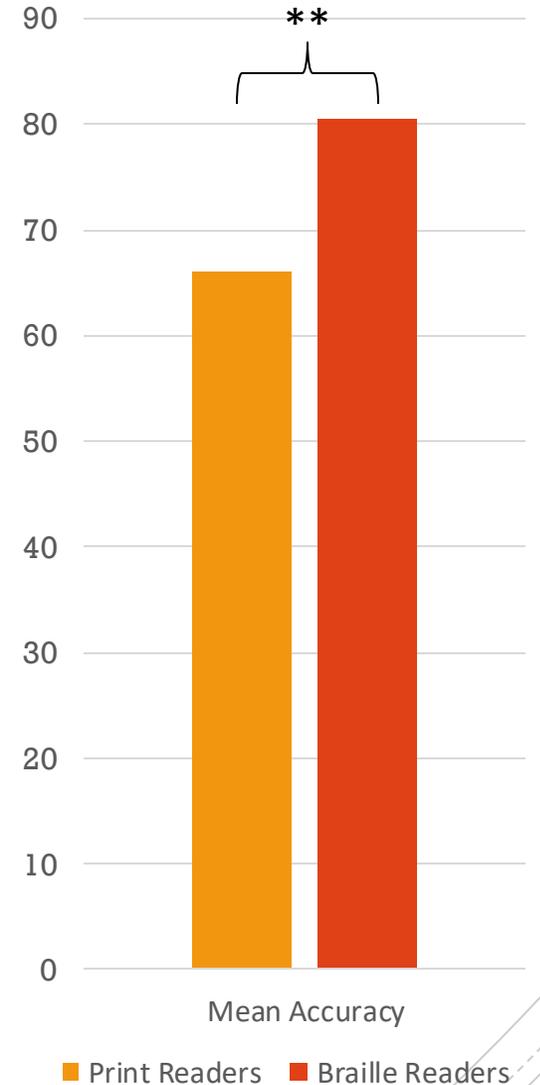
# The method.



- Participants
  - Braille readers:  $n = 29$
  - Print readers:  $n = 22$
- Materials
  - Subset of items from the Real Word Test (Nelson, 2010)
  - Computer screen for print readers and cards for braille readers
- Procedure
  - Silently read letter strings and indicate if pronounced like a real word
  - Half would sound like words (*kake*) and half would not (*threp*)

# The analysis.

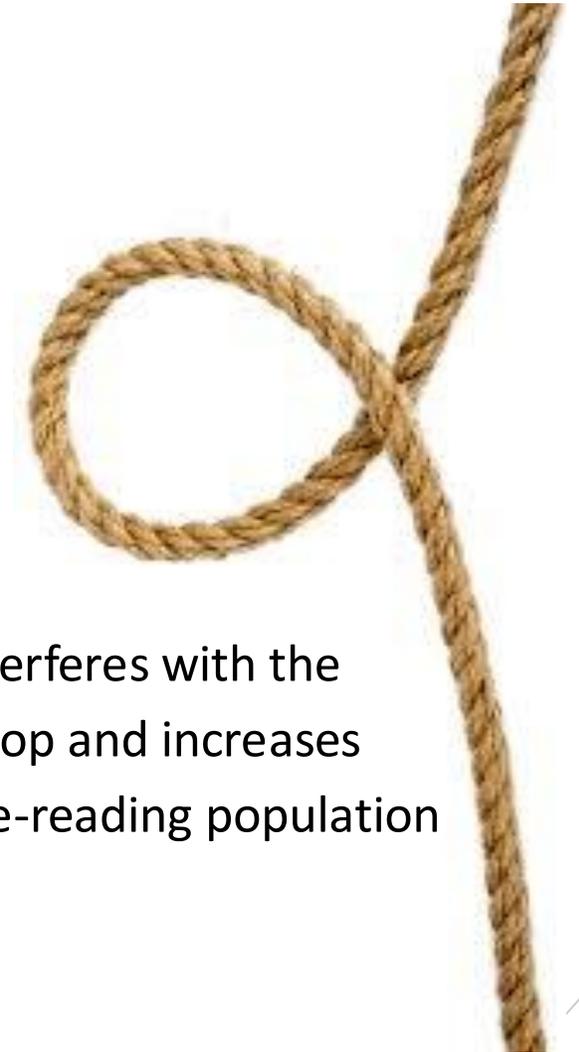
- Mean accuracy
  - Braille readers: 80.60%
  - Print readers: 66.12
- Regression analysis
  - Braille readers outperformed print readers,  $F(1, 49) = 10.28, p = .002$



Let's discuss.

- Hypothesis\* *not* supported

\*The complexity of the braille code interferes with the phonological decoding self-teaching loop and increases rates of dyslexia diagnosis in the braille-reading population



Why might  
braille *facilitate*  
decoding?

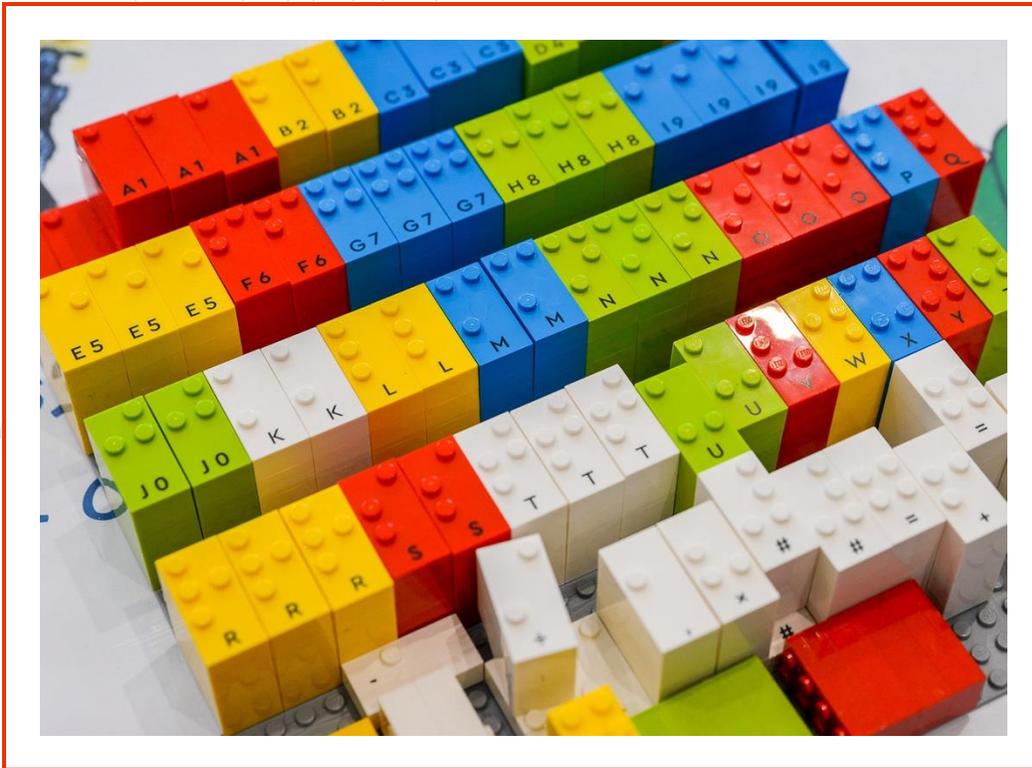


- Sequential reading may impose more careful phonological analysis of letter strings
- Braille readers may have an enhanced *set for variability*

Is braille a *deeper* orthography than print?

- Braille is more complex than print, but maybe not more inconsistent
- Braille contractions don't always make sense or preserve morphemes, but they do correspond with perfect reliability to printed letter strings

# The takeaways.



- Once the additional complexities of braille are mastered by braille readers, they may be able to *rely on the learning loop* to the same extent as readers of printed English
- Other factors likely responsible for differential dyslexia rates between print and braille readers
- More research is needed!



Why do blind children struggle with reading?



- Preterm birth?
- Environmental print exposure?
- Teacher knowledge?
  - *Probably not* (Gul et al., 2022)
- Complexity of the English braille code?
  - *Probably not* (Harris et al., 2023)
- Semantic knowledge deficits?
  - *Research ongoing*

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Questions?



Thank you!