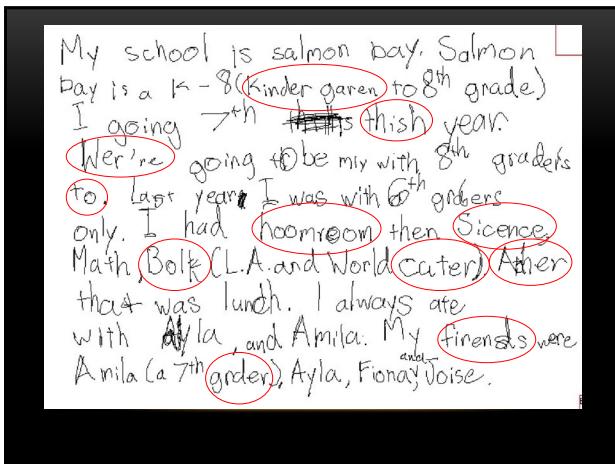


Spelling Errors and Writing Fluency for Students with Dyslexia

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Students with Dyslexia

- Dyslexia is characterized by specific difficulties in learning to read and spell (Nation, 2011)
 - Reading and spelling problems often stem from difficulties with phonological processing
 - Many experience impaired coding of phonological information in memory, and translating phonological information into orthographic codes (Berninger et al., 2008)

Students with Dyslexia and Writing

- Students with dyslexia/reading difficulties:
 - often fail to complete timed writing tasks (Gregg, Coleman, Davis, & Chalk, 2007)
 - produce less text overall when writing (Gregg et al., 2007)
 - compose less fluently when handwriting or keyboarding than peers (Beers et al., 2017)
 - compose texts rated lower in quality than their peers (Sumner, Connell, & Barnett, 2013; Graham et al., 2021)
 - make more spelling errors than typically developing peers (Sumner et al., 2013; Graham et al., 2014)

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How spelling difficulties can influence writing

There can be a “double disadvantage” for writers with dyslexia (Connell & Dockrell, 2016)

- 1) Spelling difficulties can impair writing by increasing cognitive effort and the number of pauses during writing (Berninger et al., 2008; Sumner, Connell, & Barnett, 2013)
- 2) Decreases in lexical diversity can result as writers choose more easily spelled replacement words (Sumner, Connell, & Barnett, 2014)

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Research Questions

Might spelling difficulties lead to a “third” disadvantage for students with dyslexia?

- What happens during and after students make spelling errors?
- Do students with dyslexia review their own spelling errors?
- If so, how much time do students with dyslexia spend reviewing their misspelled words?

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Hypotheses

- 1) Students with dyslexia will review spelling errors longer than correctly spelled words
 - Average fixation durations (including regressions) upon spelling errors vs. correctly spelled words

- 2) Students with dyslexia will review their spelling errors longer than their typically developing peers
 - Average fixation durations (including regressions) upon spelling errors

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Participants

Recruited and screened for dysgraphia, dyslexia, or oral and written language learning disabilities along with typical students

- Focus upon students with dyslexia and typically developing students (part of larger study)
- N=23 students, ages 10-14
- 13 students with dyslexia, 10 typically-developing

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Procedures

Writing task (autobiographical narrative)

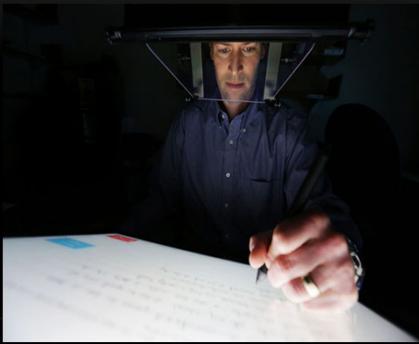
- Up to 10 minutes for the task
- Topic: "Tell the story of your life at school"

Equipment: Writing upon 21" Wacom digital tablet

- Eye and Pen software to collect handwriting and eye movement data (Alamargot, Chesnet, Dansac, & Ros, 2006)
- Eyelink 1000 for eye tracking

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In the bright and cheery lab. . .



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Coding eye movements

Only writing sessions with high-quality eye movement data were selected (accurate fixation data for the entire writing session)

Student texts were printed and then coded for spelling errors by three researchers

Areas of Interest were created around misspelled words to determine fixation durations and gaze durations upon them

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Measures

- Percentage of spelling errors per text (to control for differences in text length)
- Average fixation durations upon misspelled words and correctly spelled words
- Percentage of total writing time accounted for by fixations upon misspelled words

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Analysis/Results

ANOVAs comparing across diagnostic groups, with planned T-tests to compare fixation durations within groups

Percentage of spelling errors in texts:

typically developing dyslexia

3% 11% $p = .006$ $\eta^2 = .31$

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Results: Fixations upon errors

Students with dyslexia, but not typically developing students, had longer average fixation durations upon spelling errors than upon correctly spelled words

correct	incorrect	
1418 ms	1976 ms	$p < .001$

Typically developing students:

correct	incorrect	
1177 ms	1175 ms	<i>ns</i>

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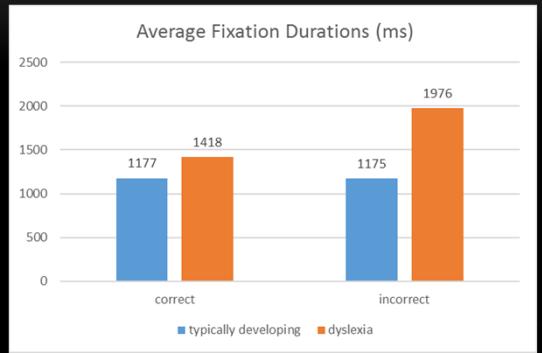
Results: Fixations upon errors

Students with dyslexia had longer average fixation durations upon spelling errors than their typically developing peers

dyslexia	typically developing	
1976 ms	1175 ms	$p < .005$

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Average Fixation Durations Upon Word Types



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Results: Time reviewing errors

Students with dyslexia viewed spelling errors for a higher percentage of their total writing time than their peers

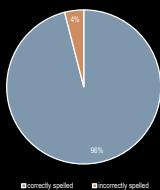
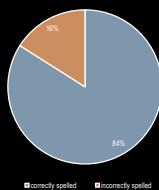
typically developing	dyslexia
4 %	16 %

$p < .001$

$\eta^2 = .58$

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Percent of Total Writing Time Viewing Misspelled Words



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Reviewing Errors: During writing or reviewing the text?

Are average fixations longer while writing misspelled words than when reviewing them after writing?

While writing	Review after writing
2635 ms	871 ms

T-tests for average fixations upon errors: $t = 5.22, p < .001$

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During writing or reviewing the text?

Percent of overall writing time viewing misspelled words:

While writing	While reviewing
13%	3%

$t = 11.65, p < .001$

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Discussion/Implications

- Students with dyslexia do appear to struggle most while composing misspelled words, as suggested by longer average fixations and a higher percentage of time viewing them.
- Most of the reviewing time occurs as they compose the misspelled words.
- There were no significant differences between fixations upon incorrect/correct words for typically developing students.

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Discussion/Implications

For students with dyslexia, spelling difficulties may lead to a “triple disadvantage” when writing:

1. Increased cognitive effort in initial attempts to spell words
2. Decreased lexical diversity as students choose words they believe they can spell
3. Decreased writing fluency as students take more time to compose and review incorrectly spelled words

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Discussion/Implications

- Students with dyslexia could be encouraged to compose more fluently, with less regard for correct spelling. The “cost” of spelling difficulties upon fluency is high for these students.
- Writing interventions for students with dyslexia should include spelling instruction targeting phonological, orthographical, and morphological components

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Next steps

- Analyze the misspelled words
Phonological, orthographic, and morphological complexity
- Compare across writing modes (handwriting vs. keyboarding)

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Appendix A: Screening measures

- Verbal Comprehension Index (*WISC IV*)
- Reading single words (*TOWRE*, *WJ-III*, *Sight Word Efficiency*)
- Reading pseudowords (*TOWRE*, *WJ-III Word Attack*)
- Silent word reading (*TOSWRF*)
- Reading comprehension (*WJ-III Passage Comprehension*)
- Alphabet letter writing/DASH copy task
- Spelling (TOC, TOC Homophone Choice, WIAT-III Spelling)

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Appendix A: Screening procedures

To qualify for a dyslexia diagnosis, the evidence-based criteria used were below -2/3 SD (90 standard score or 8 scaled score) on two or more spelling and word reading measures and parent reported current and past history of persisting word reading/decoding and spelling/encoding problems (see Berninger et al., 2015).

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	Typically Developing		Dyslexia	
	M	SD	M	SD
Verbal Comprehension	112.50	11.81	115.90	12.87
Copy Sentence Best	11.30	2.06	8.30	3.44
Copy Sentence Fastest	10.80	2.25	6.15	3.08
TOC Letter Choice	11.09	1.70	6.95	2.35
TOC Word Choice	12.43	3.05	9.21	2.72
WIAT3 Spelling	108.60	9.98	83.50	14.40
TOSWF	102.07	9.57	90.55	9.86
WJ3 Word ID	108.40	10.56	95.90	8.86
WJ3 Word Attack	106.53	10.51	93.50	7.71
TOWRE Sight Words	109.07	12.88	93.50	11.99
TOWRE Phonemic Reading	107.47	16.00	84.30	10.55
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Additional Characteristics				
Age (months)	149.2		143.6	
Grade	6.4		6.2	