

Relationship Between Students' Stages of Orthographic Knowledge and Reading Efficiency

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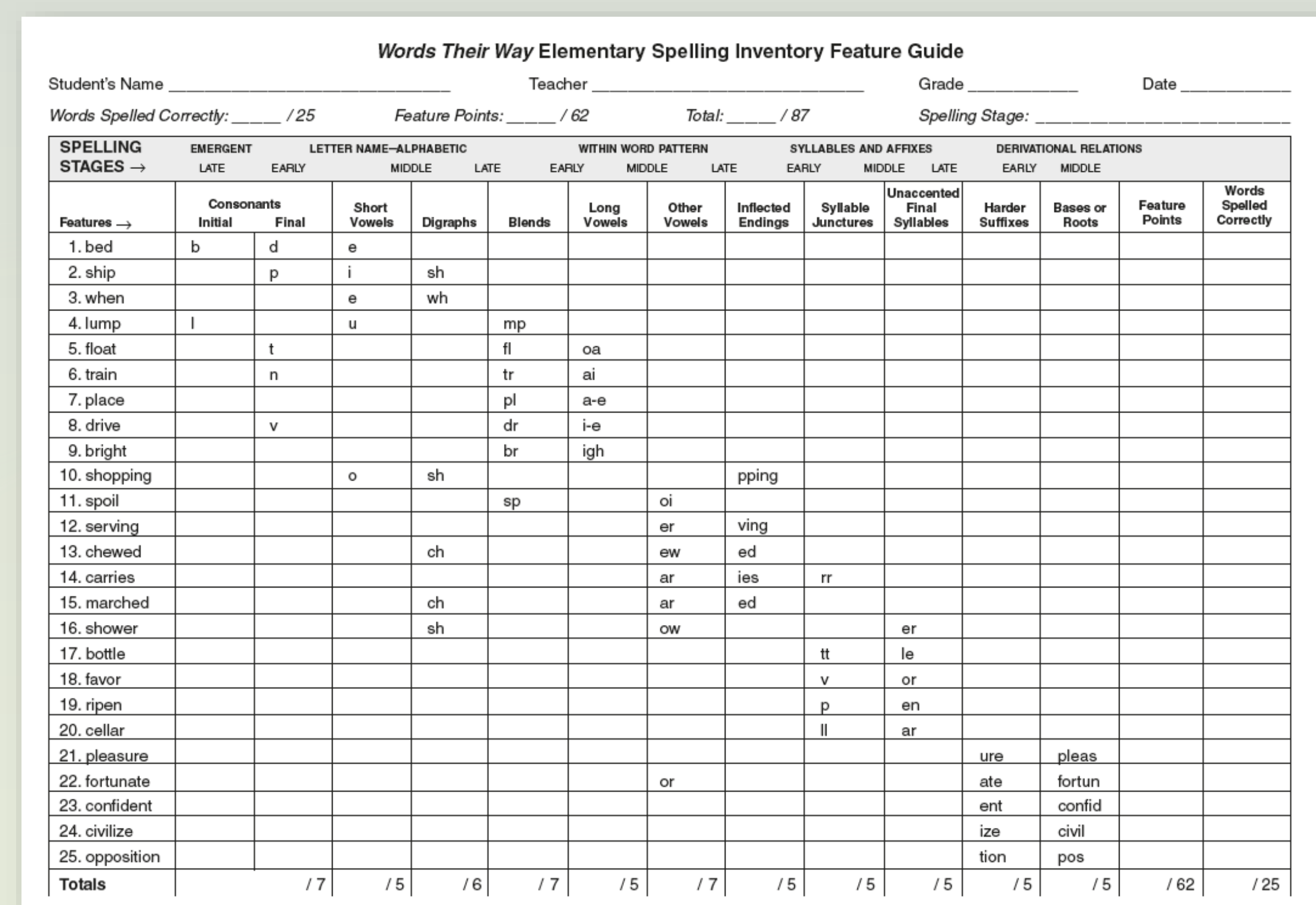
Background

Developmental spelling inventories are commonly used to assess students' orthographic knowledge (i.e., knowledge of how written words work). Specifically, these inventories identify the orthographic features (e.g., consonants, vowels, inflected endings, syllable junctures, affixes, and Greek and Latin elements) students use when spelling a list of 25–35 intentionally selected words. Students' use of these orthographic features is an indicator of their stage of spelling development. Previous research has identified five distinct stages of spelling development as well as a reciprocal relationship between orthographic knowledge and reading/literacy development (see Bear, Invernizzi, Templeton, and Johnston, 2016; Templeton & Bear, in press; and Templeton & Gehsmann, 2014 for reviews and instructional implications). The current research evaluated the relationship between students' orthographic knowledge and four measures of reading efficiency collected using an eye movement recording system: reading rate, fixations, regressions, and fixation duration.

Method

Orthographic Knowledge

Orthographic knowledge was assessed in 273 fourth and fifth grade students (~ages 10 and 11) using a recently validated online version of the Elementary Spelling Inventory described in *Words Their Way* (Bear et. al, 2016; Gehsmann, Spichtig, & Tousley, 2017; Figures 1 & 2). This measure enables the classification of students into five distinct stages of spelling and literacy development (i.e. emergent, letter name alphabetic, within word pattern, syllables and affixes, derivational relations).



The table lists 25 words and their orthographic features across five spelling stages. The features include components (initial, final), letter name-alphabetic (late, early), within word pattern (whole, late), syllables and affixes (syllable, juncture), and derivational relations (suffix, base or roots, feature points, words spelled correctly).

Figure 1. *Words Their Way* Elementary Spelling Inventory Feature Guide (Bear, D., Invernizzi, M., Templeton, D., & Johnston, F., 2016).

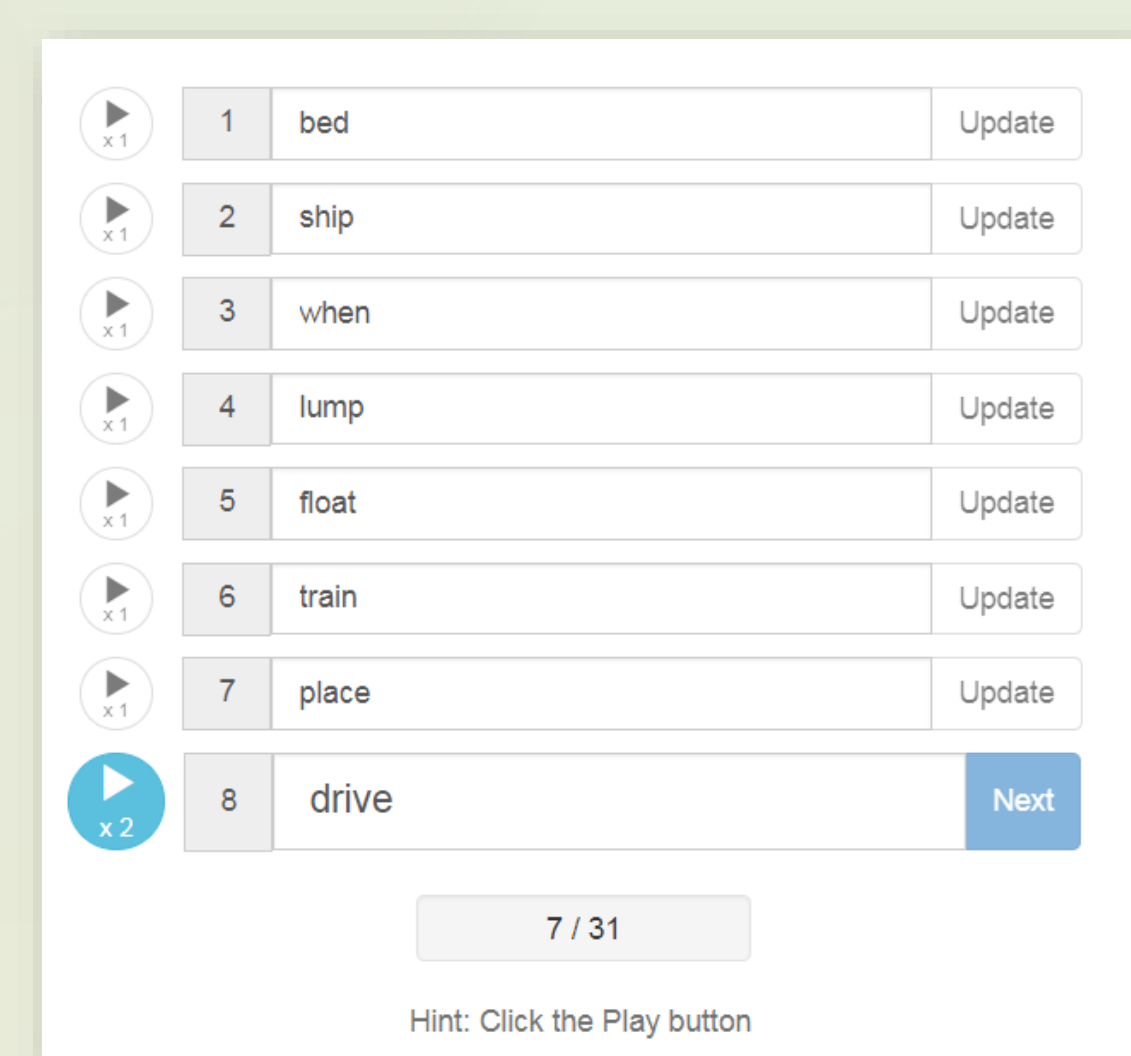


Figure 2. Screenshot from the online version of the Elementary Spelling Inventory (Gehsmann, Spichtig, & Tousley, 2017).

Eye Movement Recording

Eye movement recordings were obtained using a low-cost, portable eye movement recording system that uses goggles fitted with infrared emitters and sensors to measure corneal reflections at a sampling rate 60 Hz (Visagraph, Taylor, 2009). Students wore the goggles while reading standardized grade 4 passages from a normed test booklet (Figure 3). Each passage comprised 12 lines of text containing about 120 words. Data from the first and last line were discarded to minimize anomalies while starting and ending a passage. Analyses were based on data from the middle 10 lines, which contained 100 words. Each test passage was followed by a brief comprehension check involving 10 true/false questions.



Figure 3. Student reading text from a normed test booklet while eye movements were recorded using the Visagraph.

Results

All eye movement measures differed significantly across the stages of spelling/literacy development, with the later stages being associated with faster reading rates, fewer fixations and regressions per word, and shorter fixation durations ($p < .001$). See Table 1.

The reading efficiency measures of students in each spelling/literacy stage were also compared to US national normative values (Spichtig et al., 2016). Here it was found that the reading efficiency of students in spelling/literacy stages 2, 3, and 4 aligned fairly well with normative values for grades 2, 4, and 6 respectively. The reading efficiency of students in spelling/literacy stage 5 compared favorably to high school students (Figure 4).

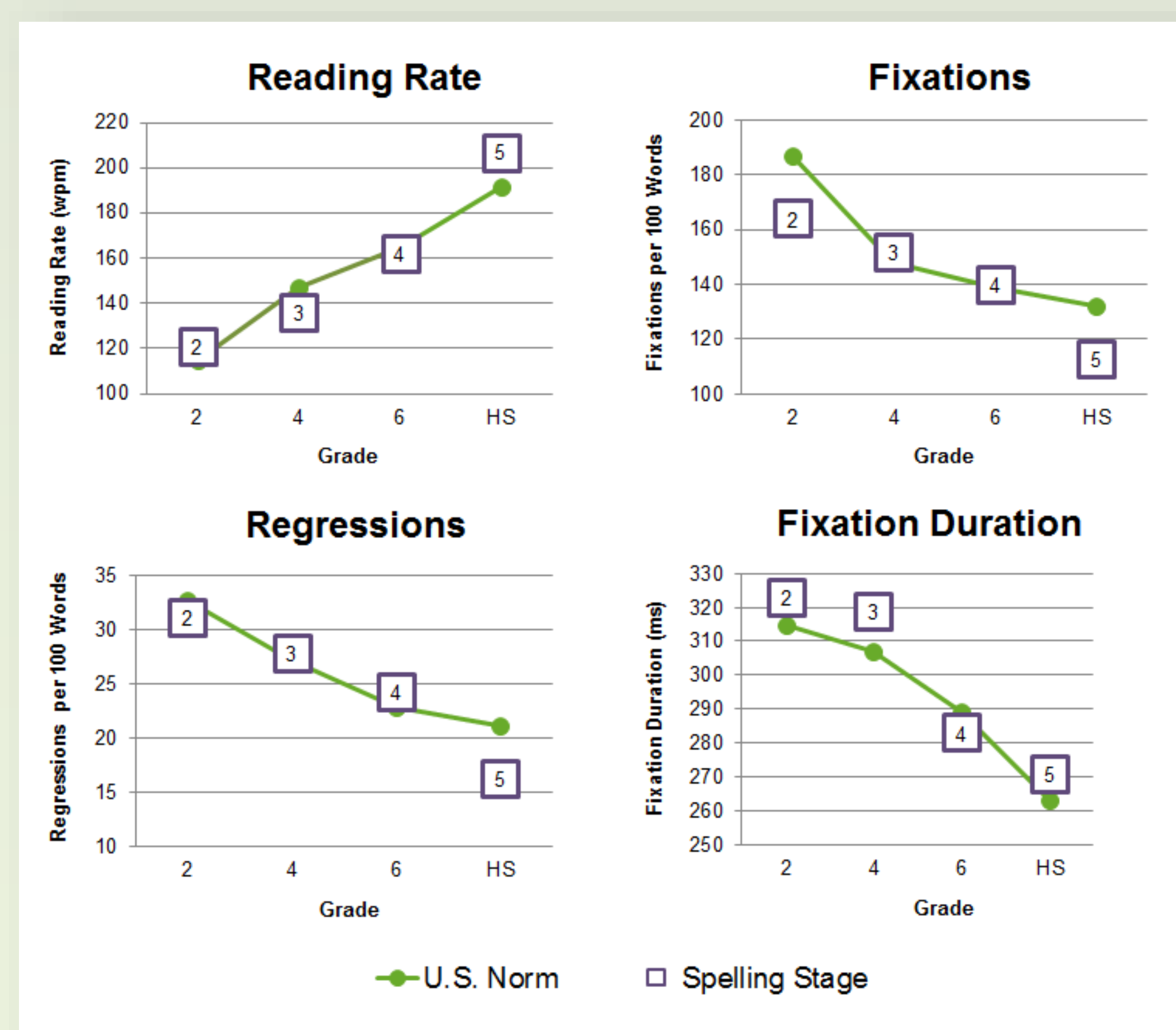


Figure 4. Comparison of reading efficiency measures at each spelling/literacy stage in relation to U.S. grade level norms.

Table 1. Reading efficiency measures in grade 4 and 5 students at each spelling/literacy stage.

| | Spelling/Literacy Stage | | | |
|----------------------------------|-------------------------|------|------|------|
| | 2 | 3 | 4 | 5 |
| <i>n</i> | 17 | 50 | 157 | 49 |
| Reading Rate (wpm) | | | | |
| Mean | 121 | 136 | 162 | 207 |
| SD | 33.9 | 43.1 | 47.4 | 51.6 |
| Fixations per 100 Words | | | | |
| Mean | 164 | 152 | 140 | 113 |
| SD | 32.1 | 33.2 | 29.5 | 22.2 |
| Regressions per 100 Words | | | | |
| Mean | 31.1 | 27.8 | 24.2 | 16.2 |
| SD | 11.3 | 12.9 | 12.3 | 8.0 |
| Fixation Durations (ms) | | | | |
| Mean | 323 | 319 | 283 | 271 |
| SD | 58.5 | 64.1 | 37.9 | 33.2 |

Notes: Only short range regressions (up to about 15 characters) are included. Fixation durations include saccade time.

Conclusions

These results demonstrate a strong relationship between orthographic knowledge and reading efficiency as measured by comprehension-based silent reading rate and eye movement behavior during reading.

While the reciprocal relationship between orthographic knowledge and reading development is well established, this is the first known demonstration of the relationship between orthographic knowledge, comprehension-based reading rate, and oculomotor efficiency across multiple stages of spelling/literacy development.

References

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