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Relationships of French and English Morphophonemic Orthographies to Word Reading, Spelling, and Reading Comprehension during Early and Middle Childhood

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Abstract

Two longitudinal studies of word reading, spelling, and reading comprehension identified commonalities and differences in morphophonemic orthographies—French (Study 1, $n=1313$) or English (Study 2, $n=114$) in early childhood (grade 2) and middle childhood (grade 5). For French and English, statistically significant concurrent relationships among these literacy skills occurred in grades 2 and 5, and longitudinal relationships for each skill with itself from grade 2 to 5; but concurrent relationships were more sizable and longitudinal relationships more variable for English than French especially for word reading to reading comprehension. Results show that, for both morphophonemic orthographies, assessment and instructional practices should be tailored to early or middle childhood, and early childhood reading comprehension may not be related to middle childhood spelling. Also discussed are findings applying only to English, for which word origin is primarily Anglo-Saxon in early childhood, but increasingly French in middle childhood.

Morphophonemic Orthographies

In morphophonemic orthographies more than the alphabetic principle is required for decoding, which is transforming written words into spoken words (Joshi & Aaron, 2006). Morphemes also play a role (Nagy, Anderson, Schommer, Scott, & Stallmann, 1989; Nagy, Berninger, & Abbott, 2006; Nagy, Diakidoy, & Anderson, 1993; Nagy & Scott, 1990; Nunes & Bryant, 2006, 2009; Pacton, Fayol, & Perruchet, 2005; Venezky, 1970, 1995, 1999). Moreover, word spelling, that is, encoding spoken words into written words, is not a simple matter of decoding in reverse (Joshi, Treiman, Carreker, & Moats, 2008–2009). Not only the alphabetic principle but also abstractions of orthographic and morphological regularities (Pacton, Perruchet, Fayol, & Cleeremans, 2001; Pacton et al., 2005), phonotactic regularities

(Treiman, Kessler, Knewasser, Trincoff, & Bowman, 2000), and phonotactic and orthotactic regularities (Apel, Wolter, & Masterson, 2006) contribute to decoding and encoding. Such regularities may include identity, position, and sequencing of sounds, letters, and/or morphemes (Kessler & Treiman, 1997; Manis & Morrison, 1982). Onset-rimes (Treiman, 1985), prosody of stress patterns in multisyllabic words (Beattie & Manis, 2011), and word frequency (Lété, Peereboom, & Fayol, 2008) also contribute.

Cross-Language Perspectives on Morphophonemic Orthographies

Transparency versus opaqueness

Many assumptions about the transparency of a specific orthography are based only on the one-to-one correspondences for pronouncing a written word (letter/s to sound conversion) while decoding during oral reading, especially in the early grades when reading instruction emphasizes oral reading. However, complexity does not mean the process is not transparent given the evidence that many of the regularities are extracted in implicit memory outside conscious awareness (e.g., Pacton et al., 2001, 2005). Moreover, in morphophonemic orthographies, neither oral decoding nor written spelling is totally opaque—rather there are degrees of transparency or predictability. Instead of invariant one-to-one correspondence while decoding during oral reading, there are definable, predictable alternations, that is, a small set of possibilities (Venezky, 1970, 1995, 1999). Furthermore, the predictability is often very transparent when morphology, orthography, AND phonology are taken into account (Nunes & Bryant, 2006, 2009).

However, morphophonemic orthographies like French and English may also differ in some ways. To begin with, French is highly predictable in the oral word reading direction, but less predictable in the spelling direction. English is also less predictable in the spelling direction (more alternations from sound to spelling) than reading direction (fewer alternations from spelling to sound) (see Venezky, 1995), but also less predictable in the oral word reading direction than is French. Often the alphabetic principle is conceptualized as correspondences between single alphabet letters and phonemes and taught accordingly. However, in English most of the predictability is related to a *two-letter grapheme rather than a one letter grapheme* corresponding to a phoneme (e.g., *ng*) or to a *multi-letter unit that corresponds with a rime unit* of a spoken syllable (e.g., *igh* in right). In addition, because timing of syllable production is highly variable in English, syllable types (e.g., open or closed) in English signal the nature of a vowel sound more reliably than syllable boundaries, which may vary with timing and stress of syllable production (e.g. *bas/ket* versus *bask/et*), do. In contrast, in French, the syllable boundaries are more clear cut and do not depend on variability of timing (Fayol, Zorman, & Lété, 2009). Moreover, morphophonemic orthographies may also differ in how the phonology and orthography are integrated with the morphology in base words. For example, in English, morphemes modify base words via prefixes (semantic markers), inflectional suffixes (number, tense, comparison markers), and derivational suffixes (marks part of speech and grammar, but the first vowel in the words *sane* and *sanity* is spelled the same despite being pronounced differently because the base word is the same).

How morphotactic, orthotactic, and phonotactic regularities (identity, position, sequencing) play a role in integrating morphology, orthography, and phonology in word reading and spelling may vary across morphophonemic orthographies. Repeated exposure to orthographic regularities in words one reads can contribute to development of memory for word-specific spellings in French, see Pacton, Borchardt, Treiman, Lété, and Fayol (2014). However, in an orthography like French, which is highly predictable in the reading direction but not spelling direction, abstraction of these orthographic regularities may emerge later in development than in English in which developing readers rely on such regularities beginning in early reading because the spelling-to-sound correspondences are less predictable in English (Lété & Fayol, 2013).

French-English word connection

English words typically used in reading and spelling programs in the early grades are high frequency one- and two- syllable words of Anglo-Saxon origin, but beginning in fourth grade increasingly words in academic text books are of French/Latin (Romance) origin (Balmuth, 2009; Henry, 2010). By fifth grade learning to read and spell English depends to a large degree on learning to spell English words of French origin that are three to five syllables in length and have different stress patterns or prosody than words of Anglo Saxon origin common in early reading material and oral conversation. Thus, the within-grade correlations for word reading and spelling may be more comparable between French and English in the fifth than the second grade. Also, liaison in spoken French that phonologically links sequential words may contribute in important ways to French literacy acquisition, which are not available to children learning to read and spell sequential words in syntax in English.

Theoretical Framework and Developmental Changes in Literacy Acquisition

Second graders were studied who are still in early childhood and have had a year of formal literacy instruction. Fifth graders were studied who are in middle childhood and have transitioned beyond primarily oral reading to primarily silent reading. Literacy acquisition in any orthography may not be as simple as learning to decode during early childhood and reading to learn during middle childhood (Chall, 1996), that is, comprehend across varied reading materials. Both word-level reading and spelling and sentence- and text- level reading comprehension may be involved both in early and middle childhood; and word decoding (reading) and word encoding (spelling) may not be inverses of each other in either early or middle childhood (e.g., Abbott, Berninger, & Fayol, 2010). Rather, according to the *levels of language theoretical framework* guiding these analyses, reading comprehension and decoding may contribute in separable and interactive ways both in early childhood and middle childhood.

By comparing the concurrent and longitudinal development of three literacy skills—word reading, word spelling, and text reading comprehension at two times in literacy development (early childhood and middle childhood) in two morphophonemic orthographies—French and English—it may be possible to identify how literacy development may be the same or different for learning to read and write morphophonemic orthographies. This approach of

combining both longitudinal and correlational data analyses to the same sample has been useful in prior research on literacy development (Abbott, Berninger, & Fayol, 2010; Berninger & Abbott, 2010). Results based on both longitudinal and correlational analyses across languages might inform school psychology assessment of literacy skills in students learning to read and write in French or English.

Research Questions

The first research question is whether word reading, word spelling, and text reading comprehension show the same patterns of concurrent correlations with each other during early childhood and during middle childhood for French (Study 1) and for English (Study 2). The second research question is whether word reading, word spelling, and reading comprehension show the same patterns of longitudinal correlations from early childhood to middle childhood in French (Study 1) and in English (Study 2). The third research question is whether, compared to unconstrained models, controlling for multivariate constraints results in the same concurrent and longitudinal correlations between the French language and the English language (Study 1 and Study 2 samples are compared).

Study 1

Background

A public health perspective was introduced in 1997 in Grenoble, France by the third author, who headed a multidisciplinary team that included public health and literacy experts and collected the data. This large scale effort involved 102 schools with at least one classroom in each school in the Grenoble, France school system to determine the best predictors of 5th grade performance in reading and spelling from reading and spelling achievement in 2nd grade. The only published study based on this data set compared four groups of French fifth graders who were good spellers and good readers, poor spellers and poor readers, good readers and poor spellers, or poor spellers and good readers and found that the double dissociations in the last two groups occurred in a small number of children who read accurately and fast but were poor spellers or were accurate but slow readers and adequate spellers (Fayol et al., 2009). Thus, individual differences in fifth grade outcomes were documented, but heretofore, the second grade data and their relationships to the fifth grade data have not been analyzed.

Method

Participants—French language participants were randomly selected from 2,179 classrooms with 37,000 students. The second grade data were collected in 1999 and the fifth grade data were collected in 2002. Data for the 1,313 children given each of the three measures described next in both second and fifth grade were used in the current study.

Measures—The three individually administered measures were researcher-designed by a team that included literacy experts. The first task was to pronounce real words on a list without context clues from other words in a passage. Both completely predictable (regular) and partially predictable (irregular) words, based on the alphabetic principle, were included

in this researcher-designed task that also took into account word frequency in the language. The words (40 more frequent words—20 completely predictable and 20 partially predictable, and 40 less frequent words—20 completely predictable and 20 partially predictable) used are now available for free at the website Cognisciences.com under the title BALE. The second task was to spell in writing the comparable dictated words that were both completely and partially predictable so that the word reading and spelling tasks could be compared. The third task was to read grade-appropriate text for grades 2 and 5 and then answer questions about the text orally to assess reading comprehension. See Table 1 for Means (M 's) and standard deviations (SD 's) for these experimenter-designed tasks.

Results

Concurrent correlations—Table 2 shows the within-grade correlations at both grade 2 and grade 5 between each of the three measures two at a time for the French language sample. All correlations within grade 2 and within grade 5 are statistically significant at $p < .01$ or $p < .001$. However, the correlations between the two word-level variables (word reading and spelling) and reading comprehension at grade 2 are markedly lower than the correlations between word reading and reading comprehension at grade 5 or between word reading and word spelling at both grade levels. The correlation between word spelling and reading comprehension at grade 5 was lower than between word reading and reading comprehension at grade 5.

Longitudinal paths from grade 2 to grade 5—Multiple group structural equation modeling was used to model the variance/covariance matrices for word reading, spelling, and reading comprehension in second and fifth grade. After examining the within grade correlations, a multiple group autoregressive model was fit using maximum likelihood estimation and EQS, version 6 (Bentler & Wu, 1998–2006). In this model, the 2nd grade measures (word reading, spelling, reading comprehension) covary (e.g., $WR \leftarrow \rightarrow Sp$), each 5th grade measure is autoregressed on its 2nd grade measure (e.g., $WR \rightarrow WR$), and each 2nd grade measure is a predictor of each 5th grade measure (e.g., $WR \rightarrow Sp$). Table 3 shows the standardized path estimates and z -values for the multiple group *unconstrained* autoregressive plus lag 3 structural model. All longitudinal paths were statistically significant except reading comprehension in grade 2 and spelling in grade 5.

Discussion

Both the concurrent and longitudinal correlations were consistent with the levels-of-language theoretical framework (Abbott et al., 2010). The word-level measures were more highly correlated with each other than were the word level reading or spelling measures with the text level reading comprehension measures. The three literacy measures were concurrently correlated with each other. With only one exception, the three literacy measures were longitudinally correlated with each other. Yet they were not perfectly correlated, consistently with their being separable but interacting skills (Berninger & Abbott, 2010) within and across levels of language.

Study 2

Background

In the United States federal initiatives (e.g., National Reading Panel, National Institute of Child Health and Human Development, 2000; National Research Council Committee on Prevention of Reading Difficulties in Young Children, 1998) led to application of a three-tier public health model to literacy: Tier 1 (universal screening and early intervention), Tier 2 (supplementary instruction), and Tier 3 (special education). Although Tier 1 early intervention may be necessary, it may not be sufficient to deal with literacy problems that may persist into or emerge in middle childhood (see Sabatini, 2009). However, writing (e.g., spelling) was largely ignored in the three-tier models, which were largely focused on reading. To broaden what literacy acquisition entails, one five-year longitudinal study of grades 1 to 5 and 3 to 7 studied concurrent and longitudinal trajectories of reading and writing at multiple levels, ranging from subword to word to syntax/text levels; word-spelling significantly predicted reading as well as writing skills in the following school year (Abbott et al., 2010). However, the concurrent and longitudinal analyses in the current study were not previously conducted.

Method

Participants—The children were recruited by sending flyers to all kindergarten parents in a large urban school district who contacted the university research team if interested in enrolling their typically developing child in first grade. Consent procedures approved by the institutional review board were used to enroll the participating children who attended one of 51 elementary schools in this large district serving diverse SES and racial groups. Altogether 114 children (62 girls, 52 boys) completed the annual assessment in both grade 2 and grade 5.

Measures—Individually administered normed measures of word reading, spelling, and reading comprehension comparable to the literacy skills assessed in Study 1 were analyzed: the Word Reading, Spelling, and Reading Comprehension subtests of the *Wechsler Individual Achievement Test, Second Edition, WIAT 2* (Psychological Corporation, 2001). Children were asked to read orally real words on a list without context clues provided by a written passage, spell in writing dictated words pronounced in isolation and then in sentence context and then again in isolation, and answer questions about texts they read. As in Study 1, the English word reading and spelling tasks in Study 2 included completely and partially predictable words based on the alphabetic principle. See Table 1 for Means (*M*) and standard deviations (*SDs*) for the normed measures.

Data Analyses

As in Study 1, multiple group structural equation modeling was used to model the variance/covariance matrices for word reading, spelling, and reading comprehension in 2nd and 5th grade. After examining the within grade correlations, a multiple group autoregressive model was fit using maximum likelihood estimation and EQS, version 6 (Bentler & Wu, 1998–2006). In this model, the 2nd grade measures (word reading, spelling, reading comprehension) covary (e.g., **WR** ← → **Sp**), each 5th grade measure is autoregressed on its

2nd grade measure (e.g., **WR**→**WR**), and each 2nd grade measure is a predictor of each 5th grade measure (e.g., **WR**→**Sp**).

Results

Concurrent correlations—Table 2 shows the within-grade correlations at grade 2 and grade 5 between each of the three literacy skills at each grade level. All correlations within grade 2 and within grade 5 are statistically significant, one at $p < .01$ and five at $p < .001$. Magnitudes of zero-order correlations within grade level are larger for the English language sample in Study 2 than for the French language sample in Study 1.

Longitudinal paths from grade 2 to grade 5—Table 3 shows the standardized path estimates and z -values for the multiple group *unconstrained* autoregressive plus lag 3 structural model. Although the same skill was significantly correlated across grade 2 and grade 5, only two longitudinal paths were statistically significant across grades 2 and 5 in the English language sample: word reading in grade 2 to word spelling in grade 5 and reading comprehension in grade 2 to word reading in grade 5.

Discussion

Although the zero-order correlations within grade level were higher for the English language sample than the French language sample both in early childhood and middle childhood, fewer longitudinal paths were statistically significant from grade 2 to grade 5 in the unconstrained univariate structural model in the English language sample. This finding suggests that the three literacy skills may be more interrelated within early childhood or middle childhood but more variable from early childhood to middle childhood in the English language than the French language. One possible explanation for the contrast between French and English in the significant longitudinal paths is that the nature of the morphophonemic orthography changes from early childhood to middle childhood in English from words primarily of Anglo-Saxon origin to words of increasing French/Latinate origin (see Henry, 1993, 2010). One of the challenges for learning to read and spell English words is learning how the interrelationships among morphology, phonology, and orthography change during this transition, which is necessary for successful academic achievement in grade 4 and beyond; and those interrelationships differ for words of Anglo-Saxon origin and words of French/Latinate origin (Henry, 1993, 2010).

Comparison of Study 1 and Study 2

Two additional modeling approaches were applied to compare the French and English language samples across the two studies. To test for equivalency across samples, the second model was fit with all the structural paths between grade 2 and grade 5 constrained to be equal in the two cohorts. As compared to the unconstrained models already reported for Studies 1 and 2, the constrained model had a significantly worse fit, $\chi^2(9) = 216.66$, $p < .001$. Then, in the third model, each constraint was released using the Lagrangian multiplier to assess the improvement in fit. Initially, the significantly different paths were identified when a cumulative χ^2 criterion was used to determine the order of considering successive

constraints to release. Finally, analyses were performed to determine if each equality constraint was significant when considered univariately.

Table 4 shows the paths significantly different in the two samples when a cumulative multivariate χ^2 criterion was used to determine the order of considering successive constraints to release. Table 4 also shows the improvement in fit that occurred when a specific equality constraint was released so that the unstandardized path was allowed to be different in the US and French samples. The paths with the significant multivariate improvement to fit are shown from most multivariate improvement to less improvement. The multivariate improvement assesses whether freeing the constrained path improves the fit of the model given the prior released equality constraints. Even with a more conservative approach in which the largest path is first examined and taken into account for analyzing each path in succession, some longitudinal paths are significantly different between France and the US. Although all three auto-regressive paths for the same skills had been statistically significant in the unconstrained approach (see Table 3), this more conservative constrained approach showed that the sizes of the paths were significantly larger in the English sample. In addition, one cross-skill longitudinal path was significantly larger in the French sample (WR→RC) and one cross-skill longitudinal path was significantly larger in the US sample (RC→WR).

In contrast, Table 5 shows results when each equality constraint is considered univariately. That is, it shows the univariate improvement in fit assuming that each path was freed univariately, that is, the univariate improvement in fit. Tables 4 and 5 about here.

Discussion

Collectively, the different approaches to modeling documented that the French and English language samples showed both commonalities and differences in the longitudinal paths from grade 2 to grade 5 for each of the same three skills and each of six possible cross-skill comparisons for word reading, reading comprehension, and spelling. The specific findings depended, however, on whether an unconstrained model (Study 1 or Study 2) or constrained models were used (Comparison of Study 1 and Study 2).

Overall Discussion

Limitations

Because data were used from completed studies there were a number of unavoidable limitations including differences in sample sizes. The French language data were unnormed and based on experimenter-designed measures, but the English language data were normed based on national standardization samples. However, the constrained models attempted to control for such differences in sample size as well as differences in measurement.

Finally, the longitudinal research design does not permit teasing apart the causal reasons for the observed differences observed across two morphophonemic orthographies for which there may be alternative explanations. On the one hand, linguistic contrasts in these two morphophonemic orthographies may explain the differences. On the other hand, instructional differences between the two countries may have contributed, to some degree, to

observed developmental differences. For example, in France the grade 2 reading program focuses mainly on decoding, whereas the grade 5 reading program focuses mainly on reading comprehension, not decoding, but not necessarily explicit strategies for reading comprehension. Beginning in grade 2 considerable spelling instruction is provided in France involving phonology, morphology, and lexical orthography and by grade 5, lexical grammar spellings and morphology because number and gender inflections and verbal tenses are very complicated in French spelling. In contrast, for English, instruction in decoding written words during oral reading and reading comprehension tend to be emphasized in the early grades. Reading instruction aimed at silent reading word recognition may not be provided in grade 5. Spelling may not be taught systematically at either grade level.

Contributions and Implications for Assessment and Instruction

Nevertheless, despite these limitations, commonalities were observed across the two morphophonemic orthographies (see Tables 2 and 3) as well as differences. Specific findings depended on whether approaches to data analyses were unconstrained or constrained for univariate or multivariate influences. One implication of the current findings is that while early assessment and intervention are necessary, they are probably not sufficient (see Berninger, 2015, chapters 5 and 6 and companion websites for a review of the research literature on need for ongoing assessment and intervention in the middle and upper grades). Literacy development is changing across early childhood and middle childhood and should continue to be monitored and instruction individually tailored to individual differences in development of specific literacy skills. Implications of language-specific findings and language-common findings for French and English morphophonemic orthographies for educational assessment and instruction are now considered.

Longitudinal change between word reading to reading comprehension in

French—The increase from grade 2 to grade 5 in the concurrent correlation between word reading and reading comprehension for French can be explained by Lété et al.'s (2008) finding that French children move from decoding in grades 1 and 2 using intra-lexical units to processing whole words as a function of their frequencies in grades 3 to 5. Automaticity of word recognition in these grades depends on completely specified lexical representation with strong links among the orthographic, phonological, and semantic representations of a word (Perfetti, 2007). This increased lexical precision in older students (Lété & Fayol, 2013) may enhance reading comprehension in the older children. Thus, not only decoding (alphabetic principle) but also lexical level word-specific spelling should be assessed and taught at the fifth grade level for French.

Reading comprehension to spelling in both French and English—In neither morphophonemic orthography was text level reading comprehension in grade 2 related longitudinally to word spelling in grade 5 (see Table 3). This finding may be related to the dual influence of different levels of language (text to word) and language system involved (reading and writing). In contrast, reading comprehension in grade 2 was related longitudinally to word reading in grade 5 in both French and English (see Table 3) when two levels of language within the same language system (reading) are involved. There are of course potential alternative explanations other than levels of language in explaining the

findings which could be investigated in future research, perhaps related to opportunities to engage in integrated reading-writing activities. However, it cannot be assumed that assessing and teaching reading alone during early childhood will necessarily be sufficient for preventing spelling problems in French or English.

Word reading or word spelling to reading comprehension in English—For English, the cross-skill longitudinal paths in the unconstrained models are weak to moderate, with the weakest paths being those from the grade 2 word level measures (Word Reading and Spelling) to grade 5 Reading Comprehension – neither of which are significant. As shown in Tables 4 and 5, the greatest difference between the English and French results for cross-grade paths is for the path from grade 2 Word Reading to grade 5 Reading Comprehension, which is one of the weakest cross-skill paths in English, and one of the strongest cross-skill paths in French. Yet for English, grade 2 word recognition is the strongest predictor of grade 2 reading comprehension.

There are two possible alternative explanations for this conundrum. The first is the change between grade 2 in which the words students encounter in text are primarily Anglo-Saxon (English-Germanic) in origin and most of them are short one or two syllable words, but after grade 4, are increasingly of French and Latinate origin, which are longer, three to five syllable words, and morphologically complex, with different letter-sound correspondences than words of English-German origin (Henry, 1993, 2010). Phonics generalizations learned in primary grades do not work for many of the words of French and Latinate origins that students encounter in the academic texts of the upper grades for English. Moreover the strategies for integrating phonology, orthography, and morphology that are relevant to both reading and spelling these words of French and Latinate origin are seldom explicitly taught because many teachers have not been taught how to teach such strategies for words of different word origins for reading and spelling English (Berninger & Joshi, in press).

It follows that reading and spelling assessment and instruction at each grade level should be tailored to word origin in English. See Berninger and Abbott (2003) and associated Reproducibles for instructional resources for teaching (a) the alternations of English in both the reading and spelling direction, (b) the most frequent rimes (Anglo Saxon words best learned as multi-letter rime units), and (c) the morphology of English for words of Anglo-Saxon, French/Latin, and Greek word origin and its interrelationships with phonology and orthography. Also see Bear, Ivernezz, Templeton, and Johnston (2000), Dixon and Englemann (2001), Fry (1996), and Henry (2010) for related word-level instructional resources.

Implications for Future Research

Morphophonemic orthographies—commonalities and differences—Claims about transparency versus opaqueness need to go beyond application of the alphabetic principle in the oral reading direction in early reading instruction to consideration of all the aspects of phonology, orthography, and morphology that may contribute to learning to read and write at different times in literacy acquisition especially following the transition to silent

reading in middle childhood. The longitudinal path from word reading to other literacy skills was not always significant in either French or English.

Designing future studies comparing morphophonemic orthographies—The current study used existing longitudinal studies but future ones could be designed for comparability in ascertainment, sample size, literacy skills assessed, and nature of the measurement tools used. Additional oral and written language skills could be included beyond only word reading and spelling and reading comprehension, for example, handwriting and written composition and listening comprehension and oral expression. Reading and writing relationships should also be examined in French-English bilinguals. Cross-language literacy development should be investigated beyond early and middle childhood and extended to adolescence and even young adulthood. Not only European morphophonemic orthographies but also non-European morphophonemic orthographies should be investigated and compared with each other.

Conclusions

School psychologists have important contributions to make in assessment of reading and writing skills in morphophonemic orthographies such as French and English and working with Interdisciplinary Teams to design grade-appropriate reading and writing instruction using multiple assessment tools and approaches (Berninger, 2015). In the process they can educate other members of the team about the predictability of morphophonemic orthographies if morphological, phonological, and orthographic processes are taken into account at both the subword and word levels and their application to sentence level reading and writing as well.

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References

- Abbott R, Berninger V, Fayol M. Longitudinal relationships of levels of language in writing and between writing and reading in grades 1 to 7. *Journal of Educational Psychology*. 2010; 102:281–298.
- Apel K, Wolter JA, Masterson JJ. Effects of phonotactic and orthotactic probabilities during fast-mapping on five year-olds' learning to spell. *Developmental Neuropsychology*. 2006; 1:21–42.
- Balmuth, M. The root of phonics. A historical introduction. Paul H. Brookes; Baltimore, MD: 2009.
- Bear, D.; Ivernezz, M.; Templeton, S.; Johnston, F. Words their way: Word study for phonics, vocabulary, and spelling instruction. 2. Upper Saddle River, NJ: Merrill; 2000.
- Beattie RL, Manis FR. The relationship between prosodic perception, phonological awareness and vocabulary in emergent literacy. *Journal of Research in Reading*. 2011; doi: 10.1111/j.1467-0917.2011.01507.x
- Bentler, PM.; Wu, E. EQS Program manual. Los Angeles, CA: Multivariate Software; 1998–2006.

- Berninger, VW. Interdisciplinary frameworks for schools: Best professional practices for serving the needs of all students. Washington, DC: American Psychological Association; 2015. <http://dx.doi.org/10.1037/14437-002> Companion Websites with Readings and Resources and Advisory Panel
- Berninger V, Abbott RD. Listening comprehension, oral expression, reading comprehension and written expression: Related yet unique language systems in grades 1, 3, 5, and 7. *Journal of Educational Psychology*. 2010; 102:635–651. [PubMed: 21461140]
- Berninger, V.; Abbott, S. PAL Research-supported reading and writing lessons. Instructional Manual and Reproducibles. San Antonio, TX: Pearson; 2003.
- Berninger, V.; Joshi, M. New directions in preservice and inservice professional development for teaching students with and without specific learning disabilities in middle childhood and early adolescence. In: Schiff, R.; Joshi, M., editors. *Handbook of Interventions in Learning Disabilities*, in the 'Literacy Studies' series. Springer; in press
- Chall, J. Learning to read: The great debate. 3. Fort Worth, TX: Harcourt Brace; 1996. First published in 1967 and in 1983 by McGraw-Hill
- Dixon, R.; Englemann, S. Spelling through morphographs. DeSoto, TX: SRA/McGraw-Hill; 2001.
- Fayol M, Zorman M, L B. Associations and dissociations in reading and spelling: Unexpectedly poor and good spellers. Teaching and learning writing. The British Psychological Society Monograph Series II. 2009; 6:63–75.
- Fry, E. Spelling book. Level 1–6. Words most needed plus phonics. Westminster, CA: Teacher Created Materials, Inc; 1996. www.teachercreated.com
- Henry M. Morphological structure: Latin and Greek roots and affixes as upper grade code strategies. *Reading and Writing: An Interdisciplinary Journal*. 1993; 5(2):227–241.
- Henry, M. Unlocking literacy. Effective decoding and spelling instruction. 2. Baltimore: Paul H. Brookes Publishing; 2010.
- Joshi, R.; Aaron, PG., editors. *Handbook of orthography and literacy*. Mahwah, NJ: Laurence Erlbaum; 2006.
- Joshi RM, Treiman R, Carreker S, Moats L. How words cast their spell. *American Educator*. 2008–2009 Winter;34:6–16. 42–43.
- Kessler B, Treiman R. Syllable structure and the distribution of phonemes in English syllables. *Journal of Memory and Language*. 1997; 37:295–311.
- L B, Fayol M. Substituted and transposed-letter effects in a masked priming paradigm with French developing readers and dyslexics. *Journal of Experimental Child Psychology*. 2013; 114:47–62. [PubMed: 23046691]
- L B, Peereman R, Fayol M. Phoneme-to-grapheme consistency and word-frequency effects on spelling among first- to fifth-grade French children: A regression-based study. *Journal of Memory and Language*. 2008; 58:952–977.
- Manis F, Morrison F. Processing of identity and position information in normal and disabled readers. *Journal of Experimental and Child Psychology*. 1982; 33:74–86.
- Nagy WE, Anderson R, Schommer M, Scott J, Stallman A. Morphological families in the internal lexicon. *Reading Research Quarterly*. 1989; 24:262–282.
- Nagy W, Berninger V, Abbott R. Contributions of morphology beyond phonology to literacy outcomes of upper elementary and middle school students. *Journal of Educational Psychology*. 2006; 98:134–147.
- Nagy W, Diakidoy I, Anderson R. The acquisition of morphology: Learning the contribution of suffixes to the meaning of derivatives. *Journal of Reading Behavior*. 1993; 25:155–170.
- Nagy WE, Scott J. Word schemas: Expectations about the form and meaning of new words. *Cognition and Instruction*. 1990; 7:105–127.
- National Reading Panel, National Institute of Child Health and Human Development (NRO). Report of the National Reading Panel: Teaching children to read. Bethesda, MD: National Institute of Child Health and Human Development; 2000.
- National Research Council Committee on Prevention of Reading Difficulties in Young Children (NRC). Preventing reading difficulties in young children. Washington, DC: National Academy Press; 1998.

- Nunes, T.; Bryant, P. Improving literacy by teaching morphemes. New York, NY: Routledge; 2006.
- Nunes, T.; Bryant, P. Children's reading and spelling. Beyond the first steps. Oxford UK: Wiley-Blackwell; 2009.
- Pacton S, Borchardt G, Treiman R, L B, Fayol M. Learning to spell from reading: General knowledge about spelling patterns influences memory for specific words. *The Quarterly journal of Experimental Psychology*. 2014; 67(6):1019–1036. DOI: 10.1080/17470218.2013.846392 [PubMed: 24224481]
- Pacton S, Fayol M, Perruchet P. Children's implicit learning of graphotactic and morphological regularities. *Child Development*. 2005; 76:324–339. [PubMed: 15784085]
- Pacton S, Perruchet P, Fayol M, Cleeremans A. Implicit learning in real world context: The case of orthographic regularities. *Journal of Experimental Psychology: General*. 2001; 130:401–426. [PubMed: 11561917]
- Perfetti CA. Reading ability: Lexical quality to comprehension. *Scientific Studies of Reading*. 2007; 11:357–383.
- Psychological Corporation. Wechsler Individual Achievement Test. 2. San Antonio, TX: Author; 2001.
- Sabatini, J. From health/medical analogies to struggling middle school readers: Issues in applying research to practice. In: Rosenfield, S.; Berninger, V., editors. *Implementing evidence-based academic interventions in school settings*. New York: Oxford University Press; 2009. p. 285-316.
- Treiman R. Onsets and rimes as units of spoken syllables: Evidence from children. *Journal of Experimental Child Psychology*. 1985; 39:161–181. [PubMed: 3989458]
- Treiman, R.; Kessler, B.; Knewasser, S.; Trincoff, R.; Bowman, M. English speakers' sensitivity to phonotactic patterns. In: Broe, M.; Pierrehumbert, J., editors. *Papers in laboratory phonology V: Acquisition and the lexicon*. Cambridge: Cambridge University Press; 2000. p. 269-282.
- Venezky, R. *The structure of English orthography*. The Hague: Mouton; 1970.
- Venezky, R. From orthography to phonology to reading. In: Berninger, V., editor. *The varieties of orthographic knowledge II: Their relation to phonology, reading, and writing*. Dordrecht, The Netherlands: Kluwer Academic Press; 1995. p. 23-46.
- Venezky, RL. *The American way of spelling: The structure of origins of American English orthography*. New York: Guilford Press; 1999.

Biographies

Robert Abbott received his PhD in psychometrics in 1970. He is currently Professor of Educational Statistics and Measurement at the University of Washington. His research interests include the analysis of longitudinal data and structural equation modeling.

Michel L. Fayol received his PhD in psychology and education science in 1976. He is currently emeritus Professor of cognitive and developmental psychology at the University of Clermont-Ferrand Auvergne Blaise Pascal. He is studying the acquisition and use of written language, and also the acquisition of numeracy and the corresponding difficulties.

Michel Zorman was a physician in charge of public health service in the Grenoble (France) school area. He considered that detecting and fighting against illiteracy was a part of public health missions. As a consequence he developed a series of investigations and pedagogical actions devoted to improve language acquisition (the PARLER program) and the learning of reading.

Sverine Casalis is Professor of cognitive psychology at the University of Lille. Her research interest includes learning to read and more specifically morphological processing, in typical

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William E. Nagy received his PhD in linguistics from the University of California, San Diego in 1974. He spent 18 years at the Center for the Study of Reading at the University of Illinois, Urbana-Champaign, and since 1996 has been a professor of education at Seattle Pacific University, where he teaches graduate courses in reading and research methods. His interests include vocabulary acquisition and instruction, the role of vocabulary knowledge in first- and second-language reading, and the contributions of metalinguistic awareness to learning to read.

Virginia Berninger is a licensed clinical psychologist and experimental psychologist who has been on the faculty at Harvard Medical School, Tufts New England Medical School, and the University of Washington. Her research on typical language and math learners and those with specific learning disabilities has been interdisciplinary, drawing on cognitive science, neuroscience, linguistics, and developmental science, with emphasis on translating research into educational practice for school psychologists and other educational practitioners.

Table 1

Mean Performance of French Sample (raw scores) and US Sample (standard scores) in Grades 2 and 5 on Word Reading, Word Spelling, and Reading Comprehension Measures

	2 nd grade		5 th grade	
	M	SD	M	SD
<i>French sample</i> (n=1313)				
Word Reading	29.95	4.74	73.15	5.72
Spelling	20.47	5.13	28.09	3.02
Reading Comprehension	6.76	1.58	27.57	6.64
<i>US sample</i> (N=114)				
Word Reading	112.12	14.94	112.19	12.23
Spelling	107.94	13.12	107.41	14.53
Reading Comprehension	109.04	13.15	115.54	8.82

Table 2

Within Grade 2 and Within Grade 5 Concurrent Correlations between the Measures for Univariate, Unconstrained Model

Within Grade	French Sample		US Sample	
	2	5	2	5
WR ← → Sp	0.63***	0.61***	0.79***	0.81***
WR ← → RC	0.37**	0.63***	0.83***	0.65***
Sp ← → RC	0.32**	0.49**	0.59**	0.59***

WR: Word Reading; Sp: Word Spelling; RC: Reading Comprehension

*
 $p < .05$;

**
 $p < .01$;

 $p < .001$

Table 3

Autoregressive Plus Lag 3 Structural Model for Longitudinal Standardized Paths from Grades 2 to 5 for Same Skill or between Skills for Univariate, Unconstrained Model

	French Sample		US Sample	
	Path	Z	Path	Z
<u>Same Skill</u>				
WR→WR	0.46	17.7 ***	0.54	4.0 ***
Sp→ Sp	0.44	16.2 ***	0.48	5.2 ***
RC→ RC	0.23	9.5 ***	0.62	4.9 ***
<u>Cross-Skill</u>				
WR→ Sp	0.24	8.7 ***	0.30	2.2 *
WR→ RC	0.34	11.4 ***	0.06	0.3
Sp→ WR	0.24	9.3 ***	0.10	1.1
Sp→RC	0.15	5.2 ***	0.01	0.1
RC→WR	0.14	6.6 ***	0.22	2.2 *
RC→ Sp	0.04	1.8	0.07	0.7

WR: Word Reading; Sp:Word Spelling; RC: Reading Comprehension

*
 $p < .05$;

**
 $p < .01$;

 $p < .001$ for null hypothesis parameter=0.

Table 4

Longitudinal Paths that Are Significantly Different in the France and US Cohorts Based on the Multivariate Cumulative Improvement in Fit from Releasing the Equality Constraints

Grade2→Grade5	χ^2 multivariate cumulative improvement in fit
WR→RC	101.82 ***
WR→WR	34.84 ***
Sp→Sp	26.14 ***
RC→RC	11.36 ***
RC→WR	5.06 *

WR: Word Reading; Sp: Word Spelling; RC: Reading Comprehension

*
 $p < .05$;

**
 $p < .01$;

 $p < .001$

Table 5

Univariate Improvements in Fit from Releasing Each Equality Constraint in the Multiple Group SEM

Grade2→Grade5	χ^2 univariate improvement in fit
WR→RC	101.82 ***
RC→RC	86.33 ***
Sp→RC	66.95 ***
WR→WR	34.84 ***
RC→WR	32.88 *
Sp→WR	28.72 *
Sp→Sp	26.14 *
WR→Sp	22.58 *
RC→Sp	12.57 *

WR: Word Reading; Sp: Word Spelling; RC: Reading Comprehension

*
p<.05;**
p<.01;***
p<.001