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Invented Spelling in Kindergarten as a Predictor of Reading and Spelling in Grade 1: A New Pathway to Literacy, or Just the Same Road, Less Known?

Gene Ouellette
Mount Allison University

Monique Sénéchal
Carleton University

In this study we evaluated whether the sophistication of children's invented spellings in kindergarten was predictive of subsequent reading and spelling in Grade 1, while also considering the influence of well-known precursors. Children in their first year of schooling (mean age = 66 months; $N = 171$) were assessed on measures of oral vocabulary, alphabetic knowledge, phonological awareness, word reading and invented spelling; approximately 1 year later they were assessed on multiple measures of reading and spelling. Path modeling was pursued to evaluate a hypothesized unique, causal role of invented spelling in subsequent literacy outcomes. Results supported a model in which invented spelling contributed directly to concurrent reading along with alphabetic knowledge and phonological awareness. Longitudinally, invented spelling influenced subsequent reading, along with alphabetic knowledge while mediating the connection between phonological awareness and early reading. Invented spelling also influenced subsequent conventional spelling along with phonological awareness, while mediating the influence of alphabetic knowledge. Invented spelling thus adds explanatory variance to literacy outcomes not entirely captured by well-studied code and language-related skills.

Keywords: literacy, reading, spelling, invented spelling, precursors, path models

Before children attain a conventional level of spelling and reading ability, they use what they know about the phonology and orthography of their language to create novel forms of spellings. These invented spellings are a manifestation of children's ability to represent in print what they hear in speech. As such, children's early attempts at spelling provide a window into their developing awareness of the alphabetic principle—an analytic stance that relies on an awareness of phonemes and alphabetic knowledge (Gentry & Gillet, 1993; Ouellette & Sénéchal, 2008a; Read, 1971). Practice and experience with invented spelling has also been shown to further boost phonological awareness (Martins & Silva, 2006; Ouellette & Sénéchal, 2008b; Ouellette, Sénéchal, & Haley, 2013; Sénéchal, Ouellette, Pagan, & Lever, 2012). Rather than being seen as a mere proxy for phonological awareness (McBride-Chang & Ho, 2005), however, we contend that the analytical process of invented spelling invokes other cognitive skills pertinent to literacy acquisition and potentially improves the quality of phonological and orthographic representations. Given that there is now a building consensus that these mental representations underlie successful literacy acquisition (e.g., Perfetti, 2007; Plaut, 2005), there may be reason to hypothesize a causal relation between invented spelling sophistication at the onset of schooling and subsequent reading and spelling skills. In the present study, we evaluated directly this possibility by modeling relations between invented spelling sophistication early in kindergarten and reading and spelling in Grade 1; importantly, this is done while also considering the roles of known influential predictors, within code-related and oral language domains.

Invented Spelling

Invented spelling typically refers to children's spontaneous or self-directed attempts to represent words in print (Read, 1971). Developmental descriptions of invented spelling reflect the progression of phonological acuity, letter knowledge, and their systematic yet not always conventional associations (Bear & Templeton, 1998; Gentry & Gillet, 1993). In the initial phases of invented spelling, young children know that writing conveys a message encoded in print symbols, but their early attempts at print only mimic conventional writing without the realization that these symbols have any meaningful sound connections. It is only with alphabetic knowledge and some phonological awareness that children begin to capture, albeit partially, the sounds of words in print. As described in detail by Gentry and Gillet (1993), children typically begin by representing the first heard sound in a word, for example, writing *D* for DOG; other random letters may be added. Children then learn to represent final sounds, and gradually medial sounds. The next phase is phonetic spelling, and simply put, children attempt to spell all of what they hear, although not necessarily in conventional ways. Here, children can make use of

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Gene Ouellette, Department of Psychology, Mount Allison University; Monique Sénéchal, Department of Psychology, Carleton University.

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Correspondence concerning this article should be addressed to Gene Ouellette, Department of Psychology, Mount Allison University, 49A York Street, Sackville, New Brunswick, Canada E4L 1C7. E-mail: gouellette@mta.ca

letter names or letter sounds to spell. At the boundary between phonetic and conventional spelling, children may still spell phonetically, but with reading and spelling instruction, they can learn that conventional writing is based on more than just sounds; spelling has other orthographic (and morphological) requirements that compose word identity (e.g., learning BOAT, not BOTE; learning inflections such as ING). Upon reaching conventional spelling, children are no longer creating their own spellings; they are able to balance phonological demands with orthographic, morphological, and semantic aspects of word identity.

Invented Spelling and Phonological Awareness

Phonological awareness refers to the ability to detect and to manipulate the elemental sounds in speech (Ehri et al., 2001). Half a century of research has made the initial correlational, and the later predictive, links between phonological awareness and successful reading one of the most robust findings in early developmental psychology (Ball & Blachman, 1991; Ehri et al., 2001; National Early Literacy Panel [NELP], 2008).

The effect of phonological awareness on early literacy development is augmented when combined with knowledge of the correspondences between alphabet letter names and sounds (Ehri et al., 2001; NELP, 2008). While the vast majority of training studies have focused on reading outcomes, there is also evidence that phonological awareness is highly predictive of early spelling accuracy (e.g., Ouellette & Sénéchal, 2008a; Tangel & Blachman, 1995). Furthermore, more recent work into the connection between invented spelling and phonological awareness has shown a bidirectional relation; not only does invented spelling sophistication depend upon phonological awareness, but phonological awareness is augmented through practice with invented spelling. Increases in phonological awareness have been reported for children receiving practice and feedback focused on invented spelling, in Portuguese (Martins, Salvador, Albuquerque, & Silva, 2014; Martins & Silva, 2006) and English (Ouellette & Sénéchal, 2008b; Ouellette, Sénéchal, & Haley, 2013; Sénéchal, Ouellette, Pagan, & Lever, 2012). Hecht and Close (2002) also reported robust reciprocal relations between phonological awareness and invented spelling for children undergoing an intensive phonological awareness intervention, wherein phonological awareness predicted invented spelling sophistication and then subsequently, invented spelling predicted unique variance in both analytical (i.e., separate sounds in words) and synthetic (i.e., blend sounds to form words) phonological awareness skills.

This close association has led some researchers to propose that invented spelling is a proxy for phonological awareness (Mann, 1993; McBride-Chang & Ho, 2005). This conceptualization may lead researchers to omit invented spelling when exploring individual differences in literacy or modeling predictors of reading acquisition, opting to just evaluate phonological awareness directly with norm-referenced assessment measures. Indeed, invented spelling is typically absent in such descriptive studies (e.g., Caravolas et al., 2012; Lonigan, Burgess, & Anthony, 2000). It is therefore unknown if the contribution of invented spelling to subsequent reading and spelling is beyond the sizable effects of other variables known to influence reading and spelling achievement, most notably, phonological awareness and letter knowledge. Alternatively, if invented spelling results from an analytic stance that practices the alphabetic principle, then invented spelling may mediate the relation between alphabetic knowledge, phonological awareness, and literacy outcomes. The present study tested these possibilities.

Not the Whole Story?

Research to date has established an important role of phonological awareness in early reading and spelling acquisition, and one that is facilitated when connected with alphabetic knowledge. However, while these skill areas appear necessary, they do not fully explain successful literacy acquisition (Bus & van IJzendoorn, 1999). As noted by Share, Jorm, Maclean, and Matthews (1984), less than half of the variance within reading ability is typically accounted for by phonological awareness and letter–sound knowledge in 5-year-olds. Furthermore, in a recent meta-analysis of 299 peer-reviewed journal articles, the average Pearson correlation coefficient between decoding and both phonological awareness and knowledge of letter names and sounds (measured in kindergarten or earlier) were 0.40 and 0.50, respectively (NELP, 2008). Taken together, these findings indicate that there are other factors at work in the acquisition of literacy.

Whether invented spelling plays a direct role in literacy acquisition has been examined to a limited extent. Early investigations by Ehri and Wilce (1987) found that children who were taught to spell phonetically simplified words (e.g., MEAT spelled as *MET*) performed better on posttest measures of reading and spelling of similar words than did control group children who practiced letter–sound associations. From this, it was ascertained that invented-style spelling makes a unique contribution to early reading acquisition. In a naturalistic study, Clarke (1988) showed that first-grade classrooms that encouraged children to use invented spelling resulted in significantly higher scores in reading than traditional spelling classrooms, while subsequent work by Richgels (1995) found interesting differences in reading ability between strong and weak invented spellers. However, these studies do not specifically isolate the impact of invented spelling on subsequent literacy beyond known code-related and oral language precursors.

Ouellette, Sénéchal, and colleagues published a series of training studies that partly address this concern. Ouellette and Sénéchal (2008b) first extended this work to assess specifically the causal role of invented spelling in early reading acquisition. A sample of 69 kindergarten children (mean age = 5.7 years), matched for invented spelling sophistication, letter–sound knowledge, and phonological awareness, were separated into three different intervention groups: an invented spelling training group (experimental), a phonological awareness training group (comparison), and a group that was asked to draw picture for the target words (control). Children in all groups were trained in alphabet knowledge for the letters used in the study. The intervention lasted 4 weeks, and pre- and posttest measures of invented spelling, letter–sound knowledge, phonological awareness, and a learn-to-read task were administered. Findings confirmed the main hypothesis of the study: Children trained in invented spelling performed better, at posttest, on a learn-to-read task, and an invented-spelling task than did the children in the two other groups. Equally important is that the invented-spelling group performed at the same level on phonological awareness as the children trained on phonological awareness. Hence, invented spelling, as an early literacy task, seems to facil-

itate learning to read, and this facilitation was not attributable solely to gains in letter knowledge or phoneme awareness. Similar findings have been reported for children at risk of reading difficulties due to low phonological awareness (Sénéchal et al., 2012), as well as for a more diverse, unselected sample more representative of a typical kindergarten classroom (Ouellette et al., 2013). Ouellette and colleagues argued that invented spelling increased children's understanding of the alphabetic principle beyond that afforded by letter knowledge or phonological awareness, although it should be noted that in each of these training studies, the sample size was modest and effect sizes were small.

Still, if this interpretation is correct, then invented spelling should be a unique contributor to reading development. To examine this question, we turn to a limited number of correlational studies. First, studies conducted in kindergarten confirm that alphabet knowledge and phoneme awareness explain unique variance in kindergarten children's invented spelling (Kim, Al Otaiba, Puranik, Folsom, & Gruelich, 2014; Ouellette & Sénéchal, 2008a). Second, invented spelling in kindergarten has been investigated along with subsequent literacy skills in only a few studies. Lin et al. (2010) found kindergarten invented spelling to predict unique variance in subsequent reading in pinyin (the phonological coding of words in Chinese) and Caravolas, Hulme, and Snowling (2001) included invented spelling in modeling literacy acquisition in English kindergarten. Caravolas et al. conducted path analyses showing that phonological awareness and letter–sound knowledge were the strongest precursors to invented spelling development early in kindergarten, and that in turn, invented spelling early in the kindergarten year predicted invented spelling and reading later in that school year. This finding suggests that some aspect of invented spelling uniquely impacts reading and spelling beyond phonological awareness and letter–sound knowledge. However, paths from Time 1 (early in kindergarten) to subsequent grades were not directly modeled; rather reading and spelling in Grade 1 were modeled as largely predicted by earlier measures of the same construct. It should also be noted that the only aspect of phonological awareness assessed was phoneme identity, which may not be entirely sensitive to the range of emerging phonological abilities in children as young as kindergarten age (Ouellette & Haley, 2013). Furthermore, the invented spelling test did not involve spoken models from the tester in a dictation, necessary for the auditory analysis that underlies invented spelling, and the scoring methodology used scored each grapheme from 0 to 4 based only on phonological (and not orthographic) appropriateness. As such, the full contribution of invented spelling in kindergarten to reading and spelling in Grade 1 remains unspecified.

Present Study

Phonological awareness and letter–sound knowledge are essential skills for early literacy acquisition. Empirical studies have focused on effective means of combining phonological awareness and letter–sound knowledge in training programs to much success. Important to note, however, is that these code-related skills do not fully account for early literacy acquisition. Furthermore, invented spelling has been shown to hold bidirectional relations with phonological awareness, and there is a limited body of research that is suggestive of a causative role of invented spelling in early literacy, beyond its association with phonological awareness (and alphabet knowledge). Thus, the current study explores the role of invented spelling in early literacy by modeling paths of influence from kindergarten into Grade 1.

The lexical quality hypothesis (Perfetti, 2007; Perfetti & Hart, 2002) and connectionist models of reading (Plaut, 2005; Plaut, McClelland, Seidenberg, & Patterson, 1996) suggests that successful reading relies on the integration of phonological, orthographic, and semantic representations. Awareness of phonology and knowledge of its links to orthography are central to invented spelling, so it may well be that the process of invented spelling stimulates and promotes the integration of these internal representations (Ouellette & Sénéchal, 2008b). In support of this view, Graham and Hebert (2011) included in their meta-analysis on writing and reading comprehension across grades four studies that confirmed that spelling instruction in Grade 1 or 2 transfers to improved word reading as compared to alternative training. By extension, it is proposed here that invented spelling may play a causal role in early reading acquisition beyond the influence of known predictors. Additionally, given the reported connection between early invented spelling and subsequent spelling sophistication (Caravolas et al., 2001; see also Bégin, Saint-Laurent, & Giasson, 2005; Sirois, Boisclair, & Giasson, 2008) it was hypothesized that invented spelling sophistication in kindergarten should predict conventional spelling in Grade 1, even after considering the known precursors that are phonological awareness, alphabetic knowledge, and oral vocabulary (Kim et al., 2014; Ouellette & Beers, 2010). To date, a modeling study focused on these two hypotheses is lacking.

Method

Participants

Participants originally included a sample of 218 kindergarten children enrolled in public school in two districts in eastern Canada. These children had participated in two previous studies (Ouellette & Sénéchal, 2008b; Ouellette et al., 2013). Only children with no known speech-language or learning disability were eligible to participate, and of these, 173 children were tested both in early kindergarten and 1 year later in Grade 1. Two participants were excluded from this sample because they were clear multivariate outliers with z scores greater than 4 on multiple measures. The final sample size thus included 171 participants (81 male, 90 female; mean age = 65.7 months, SD = 4.18). All children were English speaking. Information regarding parental education level was solicited and the distribution was as follows: 3% with less than high school; 20% with a high school degree; 36% with a college/trade program; 29% with an undergraduate degree; and 12% with postgraduate studies.

In all, children came from 17 classes across seven schools, reducing the risk of biases due to teacher and class factors. These schools were located in two school districts, with three schools from a school district with a more back-to-basic kindergarten curriculum and with four schools in a more balanced oral language and early literacy kindergarten curriculum. Given this difference in kindergarten literacy curriculum, school district is controlled in all analyses.

Measures in Kindergarten

Oral vocabulary. Children's oral vocabulary knowledge was assessed using the Peabody Picture Vocabulary Test—Revised (Dunn & Dunn, 2007; $\alpha = .97$). This test required participants to indicate which picture, out of four presented pictures on a panel, best represented the word spoken by the experimenter. There are 228 panels in the test, increasing in difficulty and grouped into sets of 12, which correspond to normative standards of difficulty based on age. Testing was stopped after the child made eight errors within a single set of 12 items, as per test instructions. Reliability is reported to be excellent at this age ($\alpha = .97$).

Phonological awareness. Three subtests of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999) were used to measure phonological awareness: the Sound-Matching subtest, the Elision subtest, and the Blending Words subtest. The Sound-Matching subtest was administered in order to assess children's awareness of phonemes in word-initial and word-final positions. Children were shown four pictures on each trial and were asked to indicate which picture either starts the same or ends the same as the first picture. The experimenter names each picture upon presentation. There was a total of 20 items; 10 of which were first sound matching and 10 were final sound matching. Testing was stopped when the child missed four of seven items, and was scored by allotting 1 point for each correct answer. The Elision subtest was administered in order to assess children's ability to delete a syllable or a phoneme from a spoken word. In this test, the child repeated a word item after the experimenter, then was asked to repeat the item again but omitting certain sounds. For example, the child may have been asked to say "tan" without the /t/. There were 20 items in total; testing was stopped after the child made three consecutive errors, with 1 point allotted to each correct answer. The Blending Words subtest was administered in order to test the child's ability to blend individually presented phonemes together to form words. The participant listened to a recording of a female voice saying words phoneme by phoneme, with brief pauses between phonemes. The child was then required to then say what the complete intended word was, based on the presented phonemes. Testing was stopped when the child made three consecutive errors within a series of 20 test items. One point was awarded for each correct answer.

In line with the recommended scoring procedures of the CTOPP, scores on these subtests were combined to create a phonological awareness composite. The reported reliability of these subtests and composite are very good at this age ($\alpha = .88–.93$).

Alphabet knowledge. Children were shown 27 letter items that included each letter of the English alphabet excluding *X* and *Q* (because of their lack of a singular phonemic association) and adding the digraphs *CH*, *SH*, and *TH*. These letter items were presented one at a time and were in upper- and lowercase in a fixed random order on separate cue cards in 72-point font. Children were asked to name the letter and to vocalize the sound that each letter item made, and were allotted 1 point for each correct letter name (or for naming both letters of the digraphs) and 1 point for each correct letter sound vocalization. Very strong interitem reliability has been reported for this task ($\alpha = .91$).

Invented spelling. Children's level of invented spelling sophistication was evaluated using a nonstandardized measure borrowed from the work of Ouellette and Sénéchal (2008a, 2008b). The measure included 10 words, chosen to present a range of articulatory characteristics known to influence invented spelling. These words included a variety of characteristics such as voiced stop consonants, back vowels, and a diphthong. The selected words also represented other potentially influential lexical characteristics, including mono- and multisyllabic words, and open and closed syllables. This word set is in the Appendix.

Each of the 10 words was dictated to the child at the normal rate of pronunciation twice, and again for a third time with each phoneme pronounced in an elongated fashion, but maintaining coarticulation. A corresponding picture was presented with each word in order to control for memory effects. Children were encouraged to attempt a spelling of the words as best as they could, without consideration of how an adult might spell them.

In order to measure the sophistication of the invented spellings produced, the scoring system described by Ouellette and Sénéchal (2008a, 2008b), as adapted from the work of Tangel and Blachman (1995), was implemented. This scoring system reflects the extent of phonemic and orthographic representation on a 7-point scale, wherein a score of 0 denotes a random series of characters, a score of 1 indicates the presence of a letter marking of a salient phoneme in the word (e.g., lady as *A*), a score of 2 if the initial sound is represented (e.g., lady as *L*), a score of 3 if more than one properly sequenced phonetic marking is present (e.g., lady as *LA*), a score of 4 for spellings that have all phonemes of the word represented either through phonetic or conventional spellings (e.g., lady as *LAD*), a score of 5 for representing all consonants with conventional spelling but only representing vowels phonetically (e.g., lady as *LADE*), and a score of 6 for complete conventional spelling (e.g., lady as *LADY*). Multisyllabic words and those with consonant clusters had slightly different criteria for scoring but followed the same developmental rationale of initial and salient consonant sounds being represented correctly before vowels are mastered; a detailed breakdown of the scoring guidelines for each word can be found in the work of Ouellette and Sénéchal (2008b). Two raters scored all spelling attempts. In the rare instances when there was a discrepancy in their scoring ($r = .97$), both scorers discussed each item until a consensus was reached.

Reading. Children's reading ability was measured by asking children to read a list of 10 words, including 5 high-frequency decodable words and 5 high-frequency irregular sight words taken from lists provided by Fry, Kress, and Fountoukidis (2000) and Fountas and Pinnell (1996). All 10 words were between two and four letters in length, and are presented in the Appendix. Words were presented one at a time in a fixed random order on separate index cards in 48-point font. Reliability was very good ($\alpha = .87$). Children were also administered the Word Attack subtest from the Woodcock Reading Mastery Tests—Revised (WRMT-R; Woodcock, 1998; $\alpha = .94$). This test required participants to correctly read a series of presented nonwords, including two practice items and 45 test items. Words were presented in increasing difficulty. The test was stopped when the six highest numbered items on a test page were failed. Performance on these two reading measures was converted to *z* scores and averaged to make a Time 1 reading score.

Measures in Grade 1

Reading. In order to measure word reading ability, a list of 15 words was presented to participants in a fixed-random order one at a time on separate cue cards in 48-point font. Five of these words were high-frequency irregularly spelled sight words (from Fry et al., 2000, and from Fountas & Pinnell, 1996), and 10 were high-frequency decodable consonant-vowel-consonant (CVC) words. Children were asked to say what they thought the word was for sight words, and were encouraged to sound out and blend the decodable CVC words. The list of words may be found in the Appendix; reliability was strong ($\alpha = .88$). As in kindergarten, the WRMT-R Word Attack subtest (Woodcock, 1998; $\alpha = .94$) was administered. Performance on both measures was standardized and the z scores were averaged to create a Time 2 reading composite.

Conventional spelling. Spelling ability was appraised using a nonstandardized spell-to-dictation measure taken from Weekes, Castles, and Davis (2006, Experiment 3). The measure included 12 words that differed in letter–sound consistency: six of the words were classified by Weekes et al. as phonological-orthographic inconsistent (i.e., variability in the possible spelling of the phonology such as /i/ being spelled *EA* or *EE*) and the other six words were phonological-orthographic consistent (i.e., no variability in plausible spellings, such as *ING* and *ISH*). This word set thus taps both phonological and orthographic knowledge. Children first heard each word in isolation, then in context of a sentence, and then repeated. No time limit was imposed and feedback was not given. Spelling accuracy was scored by allotting 1 point for every correctly spelled word. The list of words may be found in the Appendix; reliability was very good ($\alpha = .83$).

Procedure

Children were assessed for letter–sound knowledge, phonological awareness, receptive vocabulary, reading, and invented spelling in early kindergarten. Children were assessed for a second time midway through first grade on the outcome measures of reading and conventional spelling. All testing took place individually in a quiet room at the child's school, with each session lasting between 40 and 60 min. Testing was completed by one of four testers, two of whom were former teachers, and Gene Ouellette, a former speech language pathologist, trained all. Task presentation occurred in a fixed order that varied the types of elicited responses (e.g., alternating oral and written responses) to keep the child's interest throughout the testing period.

Results

The present study tested the concurrent and longitudinal relations between kindergarten code-related and oral language skills and reading and spelling, seeking in particular to elucidate the predictive validity of invented spelling in kindergarten to subsequent reading and spelling. To test predictive paths that imply causality in the most straightforward manner, path analyses were conducted with observed variables and the two reading composites using the AMOS modeling program within SPSS (Arbuckle, 2006).

Descriptive Statistics

Descriptive statistics (raw scores and composites) for all measures are presented in Table 1. With reference to test norms for the standardized measures, performance on phonological awareness, vocabulary, and word attack was within age-expected values. Alphabet knowledge was solid, with children, on average, naming 24 letters and sounding out 19, and none scoring 0 on these measures. Given the variation typically seen in kindergarten, it is not surprising that there was a fair range of reading and spelling performance, with word list reading scores ranging from 0 to 8 and invented spelling sophistication from 3 to 54. For kindergarten word reading, 25% of participants scored 0, reflecting the inclusion of nonreaders at this point in development. Noteworthy is that no child scored 0 on spelling, which validates the sensitivity of the developmental scoring. Moreover, no child spelled all words conventionally, again showing the appropriateness of the measure for kindergarten children. Consider that no child produced conventional spellings on four words (i.e., ape, train, pretty, elephant); only 4% of children, on average, produced conventional spellings on four other words (i.e., day, book, sick, lady); and that 52% of children, on average, produced conventional spelling for two words (i.e., no, lap), words for which sophisticated invented spelling could lead to correct spelling. Finally, the Grade 1 literacy scores reflect the growth expected in the first year of formal instruction in school.

Table 2 presents the correlation matrix of the variables to be used in the path modeling. As was expected, there are strong-to-moderate relations among alphabet knowledge, phonological awareness, invented spelling, and reading and spelling. Correlations with vocabulary are more modest yet statistically significant.

Path Models Predicting Grade 1 Reading and Spelling

Path modeling was pursued to evaluate the hypothesized causal, unique role of invented spelling in early literacy: One set of

Table 1
Descriptive Statistics (N = 171)

Variable	Mean	*SD*	Range (min.–max.)
Phonological awareness	17.20	7.77	4–40
Sound matching (max. 20)	7.30	4.25	1–19
Elision (max. 20)	3.92	2.25	1–11
Blending (max. 20)	5.97	3.16	1–15
Alphabet knowledge	43.28	9.68	11–54
Letter names (max. 27)	24.11	4.08	8–27
Letter sounds (max. 27)	19.16	6.55	1–27
Receptive vocabulary[a]	108.59	3.17	86–132
Kindergarten invented spelling (max. 60)	29.29	13.48	3–54
Kindergarten reading[b]	.00	.88	−.78–3.50
Word list (max. 10)	2.10	2.09	0–8
Word attack (max. 45)	1.38	2.70	0–15
Grade 1 reading	.00[a]	.95	−1.65–2.35
Word list (max. 15)	9.39	3.96	1–15
Word attack (max. 45)	10.40	7.80	0–39
Grade 1 accurate spelling (max. 12)	2.75	2.77	1–11

Note. Min. = minimum; max. = maximum score for unstandardized measures.
[a] Standardized score. [b] Composite score, average of z scores.

Table 2
Correlations Among Child Variables in Kindergarten and Grade 1

Variable	PA-K	ABC-K	Voc-K	ISpell-K	Read-K	Read-Gr1
ABC-K	.66	—				
Voc-K	.33	.24	—			
ISpell-K	.74	.69	.32	—		
Read-K	.64	.55	.15	.64	—	
Read-Gr1	.53	.45	.18	.48	.37	—
Spell-Gr1	.47	.34	.16	.46	.32	.75

Note. PA = phonological awareness; K = kindergarten; ABC = alphabet knowledge; Voc = receptive vocabulary; ISpell = invented spelling in kindergarten; Read = word reading; Gr1 = Grade 1; Spell = conventional spelling in Grade 1.
$r > .31$, $p < .001$; $r > .23$, $p < .01$; $r > .14$, $p < .05$.

models was built and tested predicting Grade 1 reading and another set for Grade 1 spelling. This approach is both transparent and intuitive, presenting easily testable, clear models of the relations between measured variables. Given the established role of phonological awareness, alphabet knowledge, and oral vocabulary in explaining literacy acquisition, these variables were modeled as exogenous, with causal paths to spelling and reading measures. To evaluate the current hypothesis that kindergarten invented spelling is a unique predictor of reading and spelling in Grade 1, invented spelling as well as kindergarten reading were treated both as endogenous (being predicted from the above variables) and exogenous in predicting longitudinally literacy in Grade 1 (i.e., the final outcome or endogenous variables of interest).

As a first step to testing data-driven and stringent hypothesis-driven models, an initial model was established in which all possible paths between exogenous and endogenous variables were included; this created a saturated, or just-identified, model. A saturated model will always provide the best fit to the data because it represents the complete covariance matrix. Hence, alternative models were tested against this saturated model to determine whether the alternative model under consideration provided as reasonable a fit to the data. To do so, the chi-square difference test was used; note that a significant result would indicate that an alternative model is inferior to the saturated model. In other words, with this approach a nonsignificant result shows that the alternative model provides as good a fit to the data as does the best-fitting saturated model. Importantly, this approach also shows that the alternative model is more parsimonious (i.e., it has fewer paths) than the saturated model and, as such, is preferred. Model fit indices were calculated using maximum likelihood estimation because it is robust to variations in normality. Values that reflect a good fit are as follows: values greater than .95 and .90 on the comparative fit index (CFI) and the goodness-of-fit index (GFI), respectively; and values below .085 on the root-mean-square error of approximation (RMSEA; Hu & Bentler, 1999).

Two alternative models were then tested. First, a data-driven model was established by deleting all nonsignificant paths from the saturated model, leaving only the statistically significant relations depicted. Second, a stringent-hypothesis-driven model was tested in which invented spelling and reading in kindergarten were the only variables directly predicting Grade 1 literacy (i.e., the contribution of other kindergarten precursor skills to Grade 1 literacy were only manifested through their influence on concurrent invented spelling and reading).

Figure 1 shows the data-driven path model for Grade 1 reading, obtained by pruning nonsignificant paths from the saturated model. Standardized path weights are shown which represent the direct effects, along with the amount of variance accounted for in the endogenous variables (52% for kindergarten reading; 63% for kindergarten invented spelling, and 52% for Grade 1 reading). In

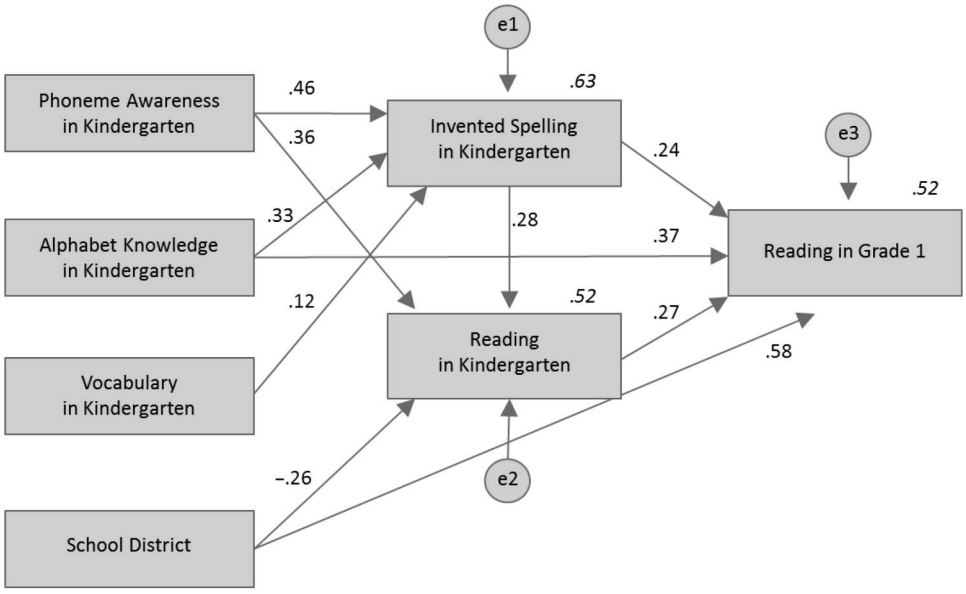

Figure 1. Data-driven path analysis for Grade 1 reading with all significant path coefficients included. Standardized path coefficients, representing the direct effects, are shown. R^2 values for Invented Spelling, Reading in Kindergarten, and Reading in Grade 1 are in italics.

the interest of clarity, correlations among exogenous variables are not shown; these are available in Table 2, whereas coefficients for total and indirect paths are in Table 3. The model as depicted reflects the influence of phonological awareness, alphabet knowledge, and oral vocabulary on concurrent invented spelling and reading in kindergarten, as well as the concurrent influence of invented spelling on reading. Alphabet knowledge continues to contribute to Grade 1 reading (as does the school district), and both kindergarten reading and invented spelling exert additional unique influence on Grade 1 reading, while the influence of phonological awareness and oral vocabulary are mediated by invented spelling. This model confirms the hypothesis that invented spelling uniquely contributes to subsequent reading beyond the influence of known precursor skills. All model indices indicate an acceptable fit to the data (CFI = .99; GFI = .98; RMSEA = .05) and it was not significantly different from the saturated model, $\chi^2(5, N = 171) = 7.01$, $p = .22$, but it was more parsimonious.

The second alternative model provided a more stringent test of our hypothesis because only the hypothesized paths from kindergarten invented spelling and reading were modeled to Grade 1 reading (i.e., the longitudinal paths from alphabet knowledge and school district were deleted). This model, however, did not meet acceptable criteria for fit indices (CFI = .850; GFI = .89; RMSEA = .26) and was significantly different from the saturated model, $\chi^2(7, N = 171) = 89.78$, $p < .001$, and thus is not shown in Figure 1.

Figure 2 shows the data-driven path model for Grade 1 spelling. As in the model focused on Grade 1 reading, this model too presents standardized path weights along with the amount of variance accounted for in the endogenous variables, and correlations among exogenous variables are not shown (see Table 2); direct and indirect effects are presented in Table 3. The depicted model includes only statistically significant paths (nonsignificant paths have been pruned) and again shows the influence of phonological awareness, alphabet knowledge, and oral vocabulary on concurrent invented spelling and reading in kindergarten. Grade 1 spelling is directly influenced only by earlier phonological awareness and prior invented spelling sophistication (and school district); the influence of alphabetic knowledge and oral vocabulary are mediated by invented spelling. This confirms the hypothesis that invented spelling uniquely contributes to subsequent spelling beyond the influence of known precursors. All model indices indicate an excellent model fit: CFI = 1.00; GFI = .99; RMSEA = .04; $\chi^2(6, N = 171) = 8.46$, $p = .21$. A further reduced, hypotheses-driven model was created by deleting the pathways from school district and phonological awareness to Grade 1 spelling (i.e., the only direct predictor of Grade 1 spelling permitted was earlier invented spelling). This model was found to have relatively poorer fit for the data: CFI = .95; GFI = .95; RMSEA = .14; $\chi^2(8, N = 171) = 34.27$, $p < .001$.

Table 3
Standardized Indirect and Total Effects From Data-Driven Models on Grade 1 Literacy Outcomes

Outcome	PA.K	ABC.K	Voc.K	District	ISpell.K	Read.K
Grade 1 reading						
Indirect effect	.24	.11	.04	−.07	.08	.00
Total effect	.24	.48	.04	.51	.32	.27
Grade 1 spelling						
Indirect effect	.16	.12	.04	.00	.00	.00
Total effect	.44	.12	.04	.30	.35	.00

Note. PA = phonome awareness; K = kindergarten; ABC = alphabet knowledge; Voc = vocabulary; District = school district; ISpell = invented spelling; Read = word reading. Standardized path coefficients are shown, which represent the direct effects.

Supplemental Analyses

Because the highest score in the invented spelling measure represented conventional spelling, one could argue that it was conventional spelling rather than invented spelling that accounted for the findings obtained. At some level, this seemed unlikely given that only two words (lap, no) were spelled conventionally correctly by more than 25% of participants, four words were never spelled conventionally correct, and the other four words were only spelled correctly by 1.8%–14.6% of participants (see the Appendix). Nonetheless, it was best to verify this possibility. We did so in two steps. First, we recalculated total kindergarten invented spelling, using only the four words that were never spelled conventionally correct and reran all models; the overall pattern of results and amount of variance explained changed little from the models presented in Figures 1 and 2. To be clear, the only substantive change was that the path from vocabulary to invented spelling was no longer significant ($\beta = .01$, $p = .90$), while fit indices remained strong for predicting Grade 1 reading (CFI = .99; GFI = .98; RMSEA = .05), $\chi^2(5, N = 171) = 9.45$, $p = .12$, and Grade 1 spelling (CFI = .99; GFI = .98; RMSEA = .05), $\chi^2(6, N = 171) = 9.02$, $p = .17$. Second, invented spelling performance was rescored to reflect conventional spelling only (i.e., spellings scored 0 for incorrect, 1 for correct), and the path analyses rerun. In all models, this changed the pattern of significant paths dramatically. In predicting Grade 1 reading, the hypothesized causative pathway from kindergarten spelling to subsequent reading dropped out of the model altogether ($\beta = .06$, $p = .35$), fit indices were less favorable (CFI = .96; GFI = .95; RMSEA = .15) and the model became significantly different from the saturated model, $\chi^2(5, N = 171) = 24.37$, $p < .001$. When the final variable of interest was Grade 1 spelling, conventional spelling in kindergarten did predict Grade 1 spelling as may be expected ($\beta = .34$, $p < .001$), yet the kindergarten measure no longer played any mediating role and the model became significantly different from the saturated one (CFI = .98; GFI = .97; RMSEA = .12), $\chi^2(6, N = 171) = 18.48$, $p < .01$; paths were necessary from all other kindergarten measures to Grade 1 spelling for the model to have adequate fit. Taken together, these supplemental analyses showed that conventional spelling, unlike invented spelling, did not mediate the relation between known predictors in kindergarten and literacy outcomes in Grade 1, nor directly predict reading.

Discussion

In the present research, we proposed that the analytical stance that young children adopt when they attempt to capture with letters the sounds in spoken words might be a key building block to reading and spelling. There are two reasons for this. First, the analytic stance afforded by invented spelling gives children insight into the alphabetic principle. Second, invented spelling might be

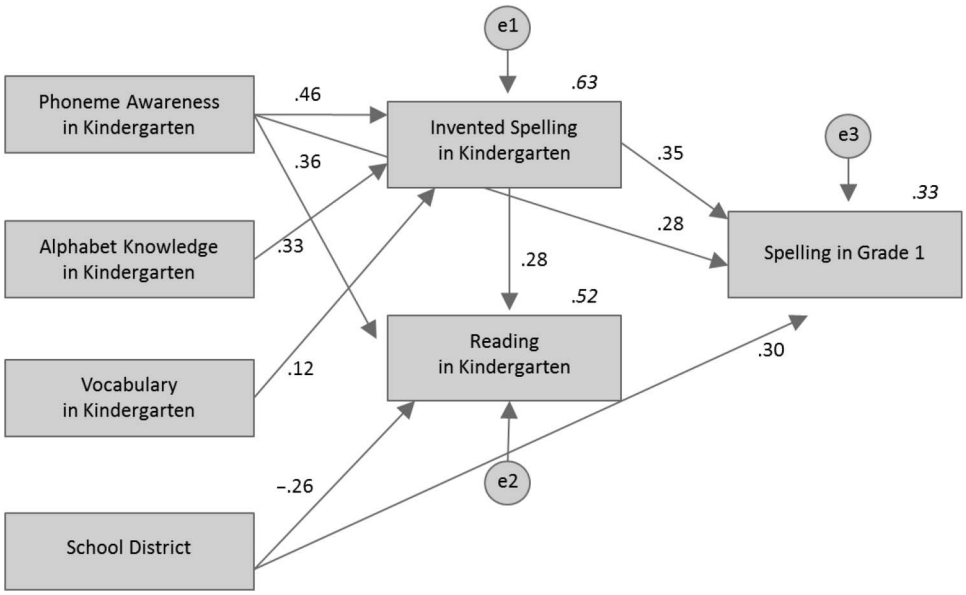

Figure 2. Data-driven path analysis for Grade 1 spelling with all significant path coefficients included. Standardized path coefficients, representing the direct effects, are shown. R^2 values for Invented Spelling, Reading in Kindergarten, and Reading in Grade 1 are in italics.

particularly beneficial in establishing links in memory between phonological and orthographic representations. If this is the case, then invented spelling should be a unique predictor of growth in early reading skills, over and above children's alphabet knowledge and phonological awareness. The longitudinal findings reported here provided support for this view.

The path models tested were such that alphabet knowledge and phonological awareness predicted the more advanced skills that are invented spelling and beginning reading, and these, in turn, predicted reading in Grade 1. The results of data-driven modeling showed that this view was accurate, but only up to a point. For reading, the most parsimonious acceptable model included an additional link: That is, alphabet knowledge was also directly linked to Grade 1 reading. As for phonological awareness, it had indirect links to Grade 1 reading via invented spelling and beginning reading. Importantly, the obtained findings are in accord with the view that invented spelling is not merely a proxy measure of phonological awareness (cf. Mann, 1993; McBride-Chang & Ho, 2005). The present findings extend to Grade 1 those of Caravolas et al. (2001), where phonological awareness and letter–sound knowledge were the strongest precursors to invented spelling early in kindergarten, and that in turn, invented spelling early in the school year predicted literacy outcomes later in that school year. The present findings also suggest that longitudinal studies testing the predictive role of early skills to eventual reading skills should include measures of invented spelling (cf. Caravolas et al., 2012; Lonigan et al., 2000).

The path models for conventional spelling in Grade 1 also provided support for the proposed contribution of invented spelling, but again only up to a point. This model confirmed a direct path from kindergarten invented spelling to Grade 1 conventional spelling. This is an important finding because it shows that invented spelling attempts do not set children on a path where they will not learn to spell correctly. Here, however, the most parsimonious acceptable model included additional links: That is, phoneme awareness was also directly linked to spelling in addition to its indirect path via invented spelling. At some level, this direct link from phonological awareness might not be surprising if performance on phonological awareness as well as spelling relies on the quality of phonological representations as shown longitudinally in Thomas and Sénéchal (2004). That is, phonological awareness and spelling require that children encode accurately the speech stream, and it is this encoding that depends on the quality of phonological representations. The quality of representations will also facilitate the identification and manipulation of individual speech sounds, again a skill necessary during spelling acquisition. Adding to the distinction between encoding speech sounds in spelling versus recoding letters into speech sounds in reading is the finding that beginning reading did not have a significant path to Grade 1 spelling. These speculative interpretations for Grade 1 spelling, however, should be treated with caution given the generally low children's performance; they certainly provide testable hypotheses for future research.

Comparing the models for reading and spelling, it is also noteworthy that there was a statistically significant direct path leading from early invented spelling to early reading (and not in the other direction; see Figures 1 and 2). This finding provides some insight into how invented spelling helps young children break the alphabetic code (e.g., Ehri & Wilce, 1987). This finding is also consistent with the results of intervention studies showing that kindergarten children for whom invented spelling was scaffolded learned to read more words in a paired-associate task than did children for whom it was phonological awareness that was scaffolded (Ouellette & Sénéchal, 2008b; Martins & Silva, 2006; Ouellette et al., 2013).

In the present research, we also included a measure of receptive vocabulary, and it had a statistically significant link to invented spelling, but not to beginning reading (see Figures 1 and 2). As previously noted, there is some evidence showing that vocabulary might play a role in word reading at least in the later grades (Ouellette & Beers, 2010; Ouellette & Shaw, 2015). Children with a larger vocabulary might have more clearly specified phonological representations that, in turn, might ease the cognitive load when children are trying to translate phonemes into graphemes in spelling, and graphemes into phonemes in decoding text. For children just starting down the path to literacy, vocabulary may also exert its influence on reading indirectly, via its association with phonological awareness (Ouellette & Haley, 2013).

Preliminary analyses had revealed that school district was related to child performance. As shown in Figures 1 and 2, school district had significant paths to beginning reading in kindergarten as well as to Grade 1 literacy measures. Although entirely speculative, it appears that the more back-to-basic curriculum—where there were defined word reading and spelling outcomes for kindergarten—was associated with advanced performance within that same year; interestingly, the more oral language rich curriculum of the other school district was associated with higher literacy scores by the time the children were retested in Grade 1.

It is important to note that in both path models presented here, there remained unaccounted variance in the outcome variables of reading and spelling. This is meaningful in light of findings that show that, in addition to the variables tested here, orthographic awareness (Deacon & Kirby, 2004; Nagy, Berninger, & Abbott, 2006), morphological processing (Caravolas, Kessler, Hulme, & Snowling, 2005; Schiff & Raveh, 2007), and phonological memory (Brunswick, Martin, & Rippon, 2012) have significant associations with reading and spelling abilities. The present results are an initial step in clarifying the relative contributions of alphabet knowledge, phonological awareness, oral vocabulary, and invented spelling in explaining literacy early in school. Further research is warranted to include other areas in the explanatory models.

Morphology in particular is an area that warrants further study in relation to invented spelling. In the present study we did not include a measure of morphology primarily because our focus was on past claims of invented spelling being a proxy for phonological awareness and alphabetic knowledge. Furthermore, studies that have found meaningful contributions of morphological awareness to literacy outcomes have tended to have participants beyond the kindergarten years (e.g., Fejzo, 2016) where morphology may have a more direct influence on expanding reading and spelling proficiency. Still, Ouellette and Sénéchal (2008a) did report a moderate correlation between morphological awareness and invented spelling in kindergarten. It is therefore important to consider whether the inclusion of morphological awareness would have changed the pattern of obtained associations. Examining the results of Ouellette and Sénéchal might be useful to address this possibility. They showed that despite statistically significant zero-order correlations, morphological awareness was not a unique predictor of invented spelling in stringent regression models. In contrast, phoneme awareness and letter knowledge did account for unique variance. As such, we can speculate that adding morphological awareness in the path models might add predictive power, but it should not mediate the obtained longitudinal associations between invented spelling and subsequent literacy. Nonetheless, the relations between morphology, invented spelling, and subsequent literacy remain largely unexplored for future studies to elucidate.

Further research is also needed to delineate the developmental trajectories between invented spelling and reading and writing beyond the kindergarten years. In particular, it would be of interest to explore whether invented spelling continues to account for unique variance in literacy outcomes as students progress through the elementary grades. Furthermore, it is of interest to explore if invented spelling would prove useful as a teaching methodology for older students, including those struggling with literacy. Finally, our assessment battery contained experimental tasks to evaluate spelling that were comprised of limited word sets. While care was taken to vary the orthographic and phonological complexity of these words, additional research is required to explore effects of lexical properties (consistency, regularity, etc.) on the invented spelling and reading/conventional spelling relations revealed in the present study.

Conclusion

The present findings, when taken together with prior correlational and training studies involving invented spelling, have important implications for understanding both literacy acquisition and efficacious instruction. Foremost, as alluded to earlier, fears that allowing children to "invent" their own spelling may prevent them from learning conventionally correct spellings can be alleviated. Indeed, the training data reviewed earlier suggest the exact opposite: Allowing children to engage in the analytical process of invented spelling, followed by appropriate feedback, has been found to facilitate learning to read and spell, not hamper the process. Ouellette et al. (2013) suggested the use of invented spelling as a means of teaching literacy has been largely overlooked in recent years; invented spelling provides an opportunity for developmentally appropriate instruction that would fall naturally within a child's zone of proximal developmental (Vygotsky, 1962). The present results add direct longitudinal evidence that invented spelling has direct relations over both subsequent reading and spelling skills, and mediates the contribution of both alphabetic knowledge and phonological awareness in early literacy learning.

This longitudinal causal role of invented spelling in literacy acquisition reported here is also in accord with recent research that has demonstrated spelling practice transfers to reading improvement in general; recent meta-analyses have shown that spelling instruction benefits word reading across the school years (Graham & Hebert, 2011), and also specifically in the elementary years (Graham & Santangelo, 2014). In the latter meta-analysis, Graham and Santangelo reported that of 16 studies examining spelling and reading in elementary school (kindergarten to Grade 6), all but one study yielded a positive effect of spelling teaching on word reading. The present results add to this picture by showing that invented spelling in particular plays an influential role in emerging reading and spelling skills from kindergarten to Grade 1.

In conclusion, the contribution of the present study lies in the longitudinal modeling of reading and spelling; path models across the first year of schooling clearly depict an important and unique role of invented spelling in explaining both reading and spelling in Grade 1. Importantly, this causal pathway was found even with

other known predictors in the model. As argued by Ouellette and Sénéchal (2008b), invented spelling is a highly analytical and engaging process and this may in part account for its facilitative effect on subsequent literacy growth. Furthermore, invented spelling actively integrates phonological and orthographic representations, potentially leading to higher-quality lexical representations as per the lexical quality hypotheses (Ouellette et al., 2013; Perfetti, 2007). Finally, invented spelling is by default developmentally appropriate and falls naturally within a child's zone of proximal development (Vygotsky, 1962); children are not being asked to memorize or reproduce a spelling that may beyond their current level of development but rather they are creating a spelling that reflects, and potentially increases, their current knowledge.

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(*Appendix follows*)

Appendix

Word Lists

Invented Spelling Assessment Word List

The Invented Spelling Word List presented here includes mean spelling scores, standard deviations, and number of participants spelling correctly conventionally.

no (4.12, 2.18, 91)

lap (3.46, 1.97, 51)

day (3.02, 1.97, 25)

boot (2.71, 1.84, 16)

sick (3.04, 1.70, 8)

lady (2.63, 1.53, 3)

train (2.30, 1.36, 0)

elephant (2.53, 1.23, 0)

pretty (2.69, 1.36, 0)

ape (2.85, 1.77, 0)

Conventional Spelling Assessment Word List

Phonologic–orthographic consistent: craft, fish, spring, ring, rust, wing

Phonologic–orthographic inconsistent: boat, cheek, coat, deal, heap, rail

Word Reading Lists

Kindergarten: are, to, here, come, no, lady, lap, day, ape, have

Grade 1: kindergarten words plus these five words: lip, so, ate, bay, bony

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