The Role of Invented Spelling on Learning to Read in Low-Phoneme awareness Kindergartners: A Randomized-Control-Trial Study

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Sénéchal, M., Ouellette, G., Pagan, S., & Lever, R. (2012). The Role of Invented Spelling on Learning to Read in Low-Phoneme-Awareness Kindergartners: A Randomized-Control-Trial Study. *Reading and Writing: An Interdisciplinary Journal*, *25*, 917-934. doi: 10.1007/s11145-011-9310-2

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Abstract

The goal of the present intervention research was to test whether guided invented spelling would facilitate entry into reading for at-risk kindergarten children. The 56 participating children had poor phoneme awareness, and as such, were at risk of having difficulty acquiring reading skills. Children were randomly assigned to one of three training conditions: invented spelling, phoneme segmentation, or storybook reading. All children participated in 16 small group sessions over eight weeks. In addition, children in the three training conditions received letter-knowledge training and worked on the same 40 stimulus words that were created from an array of 14 letters. The findings were clear: on pretest, there were no differences between the three conditions on measures of early literacy and vocabulary, but, after training, invented spelling children learned to read more words than did the other children. As expected, the phoneme-segmentation and invented-spelling children were better on phoneme awareness than were the storybook-reading children. Most interesting, however, both the invented spelling and the phoneme-segmentation children performed similarly on phoneme awareness suggesting that the differential effect on learning to read was not due to phoneme awareness per se. As such, the findings support the view that invented spelling is an exploratory process that involves the integration of phoneme and orthographic representations. With guidance and developmentally appropriate feedback, invented spelling provides a milieu for children to explore the relation between oral language and written symbols that can facilitate their entry in reading.

Keywords: intervention, invented spelling, kindergarten, reading

The Role of Invented Spelling on Learning to Read in Low-Phoneme awareness Kindergartners: A Randomized-Control-Trial Study

Young children often experiment with writing before being able to read (Read, 1971). These early attempts at written language, labeled invented spelling to reflect their non-conventional nature, offer a glimpse into the child's developing knowledge of how spoken language is represented in print. Descriptive studies have illustrated how children refine their invented spellings over time, moving from scribbles to a gradual representation of the phonological structure of words (Ehri, 1989; Ferreiro & Teberosky, 1982; Gentry & Gillet, 1993; Henderson, 1981; Treiman, 1993). In the present research, we examined the role that invented spelling can play in learning to read.

The exploratory nature of invented spelling allows children to analyze the correspondences between sounds and letters. The analytic stance afforded by invented spelling might, in fact, facilitate and strengthen the connections between orthographic and phonological representations (Ouellette & Sénéchal, 2008a). Because the integration of such representations is at the center of most reading acquisition theory, be it Ehri's (2005) phase theory, Share's (1995) self-teaching theory, or Perfetti and Hart's (2002) lexical quality hypothesis, it follows that invented spelling may be a facilitative precursor in learning to read. Indeed, longitudinal correlation studies provide some support for this relation by showing a robust predictive relation between the sophistication of children's invented (or phonological) spelling in kindergarten and reading outcomes in grade school (e.g., Caravolas, Hulme, & Snowling, 2001; McBride-Chang, 1998; Morris & Perney, 1984; Shatil, Share, & Levin, 2000). In the present research, we tested the role of invented spelling directly by implementing a training program to facilitate kindergarten children's progression in invented spelling, and, then, evaluated children on a learn-

to-read task. In particular, we were interested in whether systematic training in invented spelling would prove beneficial for kindergarten children at risk of reading difficulties.

Intervention Research on The Role of Invented Spelling to Reading

Initial support for the hypothesis that invented spelling facilitates reading acquisition came from training studies demonstrating that children whose spelling was more sophisticated phonologically learned to read words more easily (Ehri & Wilce, 1987; Richgels, 1995). Relatively few intervention studies, however, have incorporated the following dimensions in their research design: 1) encouraged invented spelling within a teaching paradigm; 2) provided individually tailored feedback based on spontaneous spelling attempts; and 3) included a measure of word reading and phoneme awareness on posttest. A search of the empirical literature yielded three training studies that included these criteria to varying degrees. First, Clarke (1988) found that grade 1 children whose classroom teachers promoted invented spelling showed greater improvements in both decoding and irregular word recognition compared to conventional spelling classrooms. Second, Rieben, Ntamakiliro, Gonthier, and Fayol (2005) found that kindergarten children who received feedback on their invented spelling scored significantly higher than both the control condition and other experimental conditions for reading practiced words. It seems, however, that this finding was limited to words practiced during the training program as no group differences were reported for new unpracticed words. The lack of group differences might have been due to the fact that the intervention was delivered infrequently at a rate of only three times per month.

The third and most comprehensive training study was conducted by Ouellette and Sénéchal (2008a). Ouellette and Sénéchal tested whether promoting invented spelling facilitated word reading with English-speaking kindergarten students who were non-readers. An intensive

four-week intervention was conducted with three homogenous groups of kindergarten children who were typically-developing and matched across conditions on phoneme awareness, letter knowledge, and invented spelling. Children in the invented spelling condition were provided with individualized feedback on their spelling attempts in the form of an alternate invented spelling that was slightly more complex than the one produced. This feedback respected the developmental progression depicted in descriptive naturalistic studies of young children's spelling attempts (e.g., marking the initial phoneme only as in *r* for *rough*; initial and final phoneme as in *rf* for *rough*; appearance of vowels as in *ruf* for *rough*, etc.). The invented spelling teaching methods used in this study were inspired by the work of Martins and Silva (2006) on the link between invented spelling and phoneme awareness. The two alternative treatment groups either received phoneme awareness training or exposure to the target words via drawing activities. All three conditions received training in alphabetic knowledge.

The findings from Ouellette and Sénéchal (2008a) were clear: The invented spelling children, on posttest, learned to read more novel words than did the children in the two control conditions. The invented spelling children were also able to read more of the words used during training than were the other children. Thus, promoting growth in invented spelling in the early phases of literacy acquisition eased children's entry into reading. Importantly, the children in the invented spelling and the phoneme awareness conditions made similar gains in phoneme awareness and children in both these conditions made greater gains than children in the drawing condition. The similarity in phoneme awareness gains across the invented spelling and phoneme awareness conditions is important theoretically because it showed that the facilitative effect of invented spelling could not be explained by the increase in phoneme awareness alone. If gains in phoneme awareness were the key explanatory factor, then children in the phoneme awareness

training condition should have shown a similar effect on reading.

Although Ouellette and Sénéchal's (2008a) findings are important in establishing a causal link between invented spelling and early reading, their participants were a homogenous sample of kindergarteners with age appropriate early language and literacy development. Given that regular kindergarten classrooms often include children who come to school with less developed early literacy skills, and that the stability of early emerging individual differences has been well documented, it is important to test whether an invented spelling intervention would benefit children who are at-risk for reading difficulties. One important risk factor is low phoneme awareness. For instance, Caravolas, Volín, and Hulme (2005) reported structural equation models in which phoneme awareness was the most powerful predictor of reading success. Furthermore, poor phoneme awareness has been repeatedly linked to subsequent reading failure (e.g., Juel, 1988; Vellutino, Fletcher, Snowling, & Scanlon, 2004). The beneficial effects of invented spelling training, however, have yet to be examined with a sample of kindergarten children considered at risk due to poor phoneme awareness. We tested this possibility directly in the present research.

The Present Research

An eight-week intervention study was conducted with children at-risk of reading difficulties. Children were pre-tested on a number of relevant language and literacy measures and randomly assigned to one of three instructional conditions. Invented spelling was the main intervention condition and feedback was offered to these children in the form of showing a slightly more complex invented spelling as was done by Martins and Silva (2006) and Ouellette and Sénéchal (2008a). Phoneme awareness training was the necessary comparison condition to demonstrate that any invented spelling advantage was not entirely due to developing phoneme

awareness, and provided a more stringent comparison than would a no-treatment condition. The study also included a control condition in which children participated in dialogic storybook readings. Following the intervention phase, children were immediately tested on early literacy including phoneme awareness and invented spelling. Importantly, a learn-to-read task was administered to test the hypothesis that invented spelling would facilitate learning to read words more so than phoneme awareness training.

The nature of the phoneme awareness training was determined on a theoretical basis. If one is to claim that the facilitative effect of invented spelling is due to the integration of phonological and orthographic representations, then it is crucial to show that the effect is not entirely due to increases in phoneme awareness alone (Ouellette & Sénéchal, 2008a). Accordingly, such a demonstration requires a phoneme awareness training condition that excludes the use of letters. In order to better understand the need for such a condition, it is necessary to consider the intervention research on phoneme awareness. In their meta-analytic review, Ehri, Nunes, Willows, Schuster, Yaghoub-Zadeh, and Shanahan (2001) reported that the reading effect sizes for phoneme awareness interventions that included a letter component were statistically significantly greater than those for studies that did not (also see, Bus & van IJzendoorn, 1999). However, a closer examination of the research with kindergarteners and preschoolers revealed a more complex picture than anticipated. First, there were only 11 studies with English-speaking children that included a letter component. Second, the letter component in these studies was some form of spelling. Specifically, six requested that children segment words (or nonwords) with letter tiles, two encouraged children to spell words, and the remaining three showed children the spelling of words. Third, nine of these studies included a no-treatment control group only and none of these assessed phoneme awareness on posttest. Fourth, the only

study that included training with and without letters as well as posttest phoneme awareness measure, reported no statistically significant difference in phoneme segmentation between children receiving segmentation training with letters and those receiving segmentation training without letters (Hohn & Ehri, 1983). Therefore, it cannot be concluded from this research that the obtained reading benefits were due to an increase in phoneme awareness. We contend that it is important for the elaboration of accurate theoretical models of reading acquisition to revisit the issue of the role of spelling with a stronger research design that includes (a) a phoneme awareness comparison group that does not include printed letters in the awareness tasks; and (b) phoneme awareness posttests in addition to reading posttests. The present research included these features.

Method

Participants

A sample of 60 kindergarten children was selected from an initial sample of 100 children from a large Canadian city. Children were recruited from six schools identified by a local school board as located in low-income neighborhoods and for which literacy scores were generally lower than other schools. The children selected could not decode any items on a standardized word attack test and had poor phoneme awareness, scoring, on average, at the 36th percentile on a standardized sound-matching test, the easiest phoneme awareness measure used in the present study. Specifically, 68% of the selected sample had scores lower than the 37th percentile, 14% at the 50th, while 19% were at the 63rd percentile.

There was some indication that the selected sample was not all from low socio-economic status homes, however. Of the 32 parents who reported on their education, 3% completed less than high school; 31% high school; 28% college; and 38% had attended university. Parents also

reported on family income. Of the 30 parents who responded, 33% reported a family income up to $20,000; 20% between $20,001 and $40,000; 13% between $40,001 and $60,000; 17% between $60,001 and $80,000; and 17% reported earning more than $80,000.

Boys and girls were assigned separately but randomly to one of three intervention conditions with the constraint that children from the same classroom be assigned to each group, thus counterbalancing classroom/teacher with training condition. Another constraint was attached to the random assignment, that is, that no group differences be found on receptive vocabulary because the selected low-phoneme awareness children varied greatly on this measure, and, therefore, possible group differences on vocabulary could confound the results. If group differences on vocabulary were found, then, random assignment was repeated. As a result of this constraint and given the sample size, three iterations were necessary before no differences were found. Once the interventions had started, two experimenter errors occurred that resulted in one child being omitted from the intervention and one child being trained in the wrong condition. As a result, there were 19 (11 boys) children in the invented spelling condition, 19 children (12 boys) in the phoneme awareness condition, and 21 (11 boys) children in the storybook reading condition. This final sample of 59 children had a mean age of 5 years, 3 months (*SD* = 3 months) at the beginning of the study.

Procedure

The study was conducted in three phases. First, children were pre-tested early in their kindergarten year. Second, the children participated in the eight-week intervention. Third, children were immediately post-tested after the end of the intervention. All testing was conducted individually and took two sessions for each testing time. To eliminate possible bias, testers were blind to condition assignment.

Description of the Intervention Conditions

Children participated in small groups for 16 teaching sessions over an eight-week period. The interventions started in the second half of the kindergarten year and consisted of two 20-minute sessions a week. Interventions were delivered to groups of three to six children, dependent upon the logistics of the number of participants per class and school (intervention conditions were counterbalanced across classrooms/teachers). The instructors were trained by the second author and were counterbalanced across conditions (i.e., each assistant taught an equal number of each intervention condition). All groups received letter-sound instruction at the beginning of each session. Children were taught a rhythmic chant for each letter shown on a card, with clapping and knee slapping, which included both the name and sound of the letter. This activity occurred at the start of each group session, with five letter sounds practiced each session and recycled in the same order throughout the duration of the training program. They practiced a total of 14 letter-sound associations this way, in addition to their regular alphabet instruction received in their classrooms. To ensure that children had received some instruction on the letters used in the stimuli, all training words were composed from this set of 14 letters, as were all regular words in the spelling and reading assessments. The letters and training words are in the appendix.

Invented spelling condition. Children in this condition were taught to increase the sophistication of their naturally occurring invented spellings following the procedure outlined in Ouellette and Sénéchal (2008a). The training words were presented, one at a time, in both picture form and orally by the instructor. Each word was spoken out loud by the instructor at a normal speech rate, and then repeated in a stretched manner with exaggerated articulation (but with no pausing between the phonemes). The word was said a third time at a normal speech rate, and the

children were asked to repeat the word out loud in unison. Finally, the word was said a fourth time and the children were instructed to print the word in a provided notebook. Children were repeatedly encouraged to do their best and were told that their spellings did not have to be the same as an adult might write or even be the same as the spellings produced by the other children in their group.

After each spelling attempt, the instructor quickly offered individually tailored feedback to each child in which their invented spelling was contrasted with an instructor-generated invented spelling representative of a minimal increase in sophistication. This feedback was provided in the context of praising the child's invented spelling and then showing another way to write the word; the corrected form typically contained one additional correct letter as per the developmental progression outlined by Gentry and Gillet (1993). From the fifth session onward, feedback also included the removal of any unnecessary letters from the child's spelling and the child was told how many sounds were in the word. Following the individualized feedback, the procedure was repeated using the same word. Within each session, five words were spelled (twice each); these words were repeated for two consecutive sessions. In all, 40 words were practiced over the intervention and are listed in the appendix. These words were all composed from the limited letter set taught to all participants, and include a variety of vowel and syllable patterns.

Phoneme awareness condition. This group was taught to analyze words into phoneme segments. Children in this condition were first taught to match pictures based on shared initial and final sounds, using the first 10 of the 40 training words, in the same order and at the same frequency as in the invented spelling condition (i.e., five words per session, each repeated twice and used for two consecutive sessions). Each child was given a sheet with the training item

pictured on the left with three other pictured items presented in the same row. All training items were named by the instructor in the same fashion as for the invented spelling condition: one time at a normal speech rate, one time with stretched speech, and two more times at a normal rate with the children repeating the word out loud in unison once. Thus, the frequency and manner of exposure to the training stimuli was carefully controlled across conditions. For each word, the children were asked to circle the picture that started or ended with the same sound as the training item. The instructor provided individually tailored corrective feedback, modelling the correct answer as necessary. Each trial was then repeated.

For the final 30 words (i.e., from the fifth session on), the children were taught a phoneme segmenting task based on Elkonin's (1973) original say-it and move-it activity as described by Ouellette and Sénéchal (2008a). In this task, children stamped a marker, once for each phoneme in a word, into squares below a picture of that word. Again, the instructor said each word four times as before, and the procedure was modelled as necessary. For each word, the children were asked to repeat the word out loud in unison and to make the appropriate number of stamps as they did so. Individually tailored feedback was given and the trial repeated. Once more, the same words were used in the same order and at the same frequency as with the other condition.

Storybook reading condition. Children in this group participated in shared reading sessions. The sessions aimed at promoting vocabulary and story knowledge using dialogic reading techniques (Lever & Sénéchal, 2011). At the beginning of each session, children received their alphabet training and exposure to target words. The same words were used as in the other groups, in the same order and with the same frequency of exposure. The experimenter showed a picture of a target item, labelled each picture four times (one of which was with

stretched speech), and children were required to repeat the word out loud in unison once. Two children assigned to this control condition did not participate in dialogic reading at the request of the school principal, but drew a picture of each target word.

Measures (and Testing Time)

Alphabetic knowledge (pretest and posttest). Children were presented with index cards containing each letter or digraphs in upper and lower case in 72-point font. All letters except X and Q were included as well as three digraphs (ch, sh, th) for a maximum score of 27. Cards were presented in a fixed random order and the children were asked to give the sound the letter(s) made. The inter-item reliability for this measure was excellent (α = .95).

Phoneme awareness (pretest and posttest). Phoneme awareness was assessed with three subtests of the Comprehensive Test of Phonological Processing (CTOPP; Wagner, Torgesen, & Rashotte, 1999). In the Sound Matching subtest, children were shown four pictures that were named by the experimenter on each trial, and asked to indicate which picture either started or ended with the same sound as the first. In the Elision subtest, children listened to a spoken word, and were required to say what was left from it once a sound spoken by the experimenter was deleted (for example, say farm without saying /f/). In the Blending Words subtest, children listened to an audio-recorded presentation of words spoken in individual phonemes and were asked to say the word formed by the individual sounds. Each subtest consists of 20 items and testing was stopped following three consecutive errors. The test manual reported inter-item reliability of these subtests are excellent at this age level (α = .88 - .93). Five children were just under the 60 month requisite for the tests, but were nonetheless administered the tests given the cut-off age for the school board in the present study (i.e., the children were all receiving the same educational experience at school). Children's standardized scores on the three subtests were

averaged to yield a single measure of phoneme awareness.

Invented spelling (pretest and posttest). Children were encouraged to try their best to spell five words (sick, elephant, pretty, train, boot) chosen to represent a variety of articulatory and syllabic features and not encountered in the intervention conditions. For each item spoken by the experimenter, a picture of the item was also shown to avoid confounds with memory. Spelling sophistication was assessed using a spelling scoring system adapted from Tangel and Blachman (1992) by Ouellette and Sénéchal (2008b). Each item was scored on a 7-point scale (0 - 6) where a larger number reflected greater phonological sophistication and the highest score indicated conventional spelling.

Word reading task (pretest and posttest). In this task, children were asked to read words. Words were presented one at a time in a fixed-random order, on separate index cards in 48-point font. This experimental measure was judged to be a more sensitive measure of kindergarten word reading because of the greater number of easier words included as compared to a standardized test like the Woodcock Reading Mastery Tests-Revised (WRMT-R; Woodcock, 1998). In the present task, five high-frequency words (are, to, here, come, have) were used to assess word reading on pretest and to these, three additional words (lip, bay, so) were added on posttest. One point was given for every item read correctly. The inter-item reliability for this task was very good at $\alpha = .86$.

Decoding (pretest). Children's ability to read non-words was assessed using the Word Attack subtest from the Woodcock Reading Mastery Tests-Revised (WRMT-R; Woodcock, 1998). The test included two practice items and 45 test items and testing was stopped when the six highest-numbered test items were failed. One point was given for every item read correctly. The test manual reported inter-item reliability was excellent at $\alpha = .94$.

Oral vocabulary (pretest only). Children's receptive vocabulary was assessed with the Peabody Picture Vocabulary Test – Third Edition (PPVT-III; Dunn & Dunn, 1997) in which children were required to point to the picture, out of four choices that matches a word spoken by the examiner. There were 228 items in all, with test specified ceiling rules followed for discontinuation of testing. The test manual reported excellent inter-item reliability for this test at $\alpha = .97$.

Analytic intelligence (pretest only). Children's analytic intelligence was measured with the Animal Pegs subtest of the Weschler Preschool and Primary Scale of Intelligence – Revised (WPPSI; Weschler, 1989). In this timed task, the child was shown pictures of four animals, each one associated with a peg of a particular color. The child was required to insert a peg of the correct color beneath each of a series of pictures of the four animals, using the first four as a guide. Standardized scores for age were used. The test manual reported that because this is a speeded test, internal reliability was estimated to be .66 from test-retest stability over seven weeks (Weschler, 1989).

Learn-to-read task (posttest only). To test the central hypothesis that invented spelling would facilitate learning to read, children were taught to read ten words. The words selected were constrained to include a selection of the 14 letters on which children were trained. Five started with B (bed, bee, bend, bone, baby) and five with P (pin, pie, pond, peel, pony) to ensure that the children had to attend to all letters in the words. Children were told that they were going to learn to read some words and that the words contained the letters that they had practiced in their groups. Each word was shown to the child and sounded out and blended by the instructor as she ran her finger under the word. A sentence was then read that provided a meaningful context for the word. The child was then asked to say the word while running their finger under

it. This was repeated for all ten words. A reading trial was then completed in which each word was shown individually and the child was asked to read it; a correct reading was given a score of 1, an incorrect reading a score of 0. If incorrect, the answer was given and the child was asked to repeat it while again running their finger under the word. Trials were repeated with the word order varied randomly, until all ten words were read correctly or to a maximum of five trials. The dependent variable was the averaged number of items read correctly across the five reading trials.

Results

Preliminary analyses revealed three outliers. One child had extremely low scores on the nonverbal IQ test (3rd percentile), the lowest standard score on the PPVT-III (72), and similar low scores on phoneme awareness (5th percentile) as well as consistently the lowest scores across literacy tasks; the data for that child were consequently omitted from the analyses. Two other children performed extremely well on the learn-to-read task such that their performance on the initial trial was either at ceiling or two standard deviations above the sample mean. Given that no other children performed similarly, their data were also omitted from the final analyses.

Children's Performance Before the Intervention

The descriptive statistics for alphabetic knowledge, phoneme awareness, early invented spelling, word reading, and oral vocabulary are presented in Table 1. The early literacy performance for this sample of low-phoneme awareness children was low, especially for alphabetic knowledge, phoneme awareness, and invented spelling. Moreover, floor performance on word reading and decoding confirmed that these kindergarten children were nonreaders. Statistical analyses failed to reveal any significant differences across conditions on any measure (*p*s range from .48 to .90, with a median of .75). Therefore, children in the three conditions were

comparable before the intervention.

Insert Table 1 about here

Children's Performance After the Intervention

The descriptive statistics for the posttest measures are presented in Table 2. Comparing Table 1 and 2 shows remarkable increases across the two test points. The key question was whether these differences could be explained by the different treatments over and above the early literacy stimulation that all children were receiving in their kindergarten classrooms. The results for reading and spelling were analysed with two planned orthogonal contrasts testing (1) that performance in the invented spelling condition was superior to the other two conditions and (2) that performance in the phonological awareness condition was superior to that in the storybook reading condition. For phoneme awareness, however, different planned orthogonal contrasts were computed because we expected that both invented spelling and phoneme awareness training would enhance phoneme awareness similarly and more so than storybook reading. Finally, we did not expect any group difference on letter knowledge given that all children received letter-knowledge training. In the analyses for measures that were pretested, the specific pretest measure was used as a covariate. In addition, preliminary correlational analyses revealed that children's age was related to outcomes, and, consequently, it was also included as a covariate (unless otherwise specified). One-tailed tests are reported because effects in the opposite direction as that expected would be equivalent to null results.

Insert Table 2 about here

Learning-to-read task. The main hypothesis of the research was that children who explored the written code through invented spelling would find it easier to learn to read than children receiving alternative treatments. As expected, children in the invented spelling condition

learned to read more words than the children in the two other conditions (Cohen's d = .50; Contrast = .98, 95% CIs = .03 to 1.93, p = .02). As reported in Table 2, there was no such advantage for children in the phoneme awareness condition as their mean performance was slightly inferior to that of children in the storybook condition.

Invented spelling. Two assessments were made to verify that children in the invented spelling condition learned about spelling phonologically. First, we assessed whether providing individualized feedback to the children had the desired effect of improving the phonological sophistication of their spelling. This is important because pretest performance was quite low and because Ball and Blachman (1991) showed that phoneme awareness training alone can improve invented spelling. Recall that the invented spelling children would attempt to spell a word, then were given feedback, and spelled the same word again. This procedure allowed us to compare children's first and second attempts at each word to test for the expected increase in spelling score. The examination of children's productions of the 40 intervention words before (M = 2.83 out of 6) and after (M = 3.98) feedback revealed that children were incorporating an additional component in their next attempt, $t(18) = -11.28$, $p < 0.01$. Hence, children's invented spellings were improving.

The second test of the success of the invented spelling training was to assess that children who were trained in invented spelling showed superior spelling sophistication when spelling novel words. As expected, children trained in invented spelling were able to spell novel words in a more phonologically complex manner than did the other children (Cohen's d = .58; Contrast = 2.69, 95% CIs = .45 to 4.93, $p < .02$). Although children trained in phoneme awareness appeared to perform better than children in the storybook condition, the difference did not reach statistical significance (Cohen's d = .38; Contrast = 2.11, 95% CIs = -.46 to 4.69, p = .06).

Phoneme awareness. Based on previous findings, we expected that children in the invented spelling and the phoneme awareness conditions would show superior phoneme awareness than the children in the storybook condition. Indeed, children trained in invented spelling and in phoneme awareness had better phoneme awareness scores than did the children in the storybook condition (Cohen's d = .45; Contrast = .65, 95% CIs = .12 to 1.42, p = .05). Based on the claim that phoneme awareness per se is not the central mechanism producing a word-learning advantage, we did not predict that the children in the invented spelling condition would show superior performance to that of the children in the phoneme awareness condition. In fact, the posttest performance of children in the phoneme awareness condition was slightly higher than that of children in the invented spelling condition, although this difference did not reach statistical significance (Contrast = -.63, 95% CIs = -1.53 to .28, p = .09). In these analyses, age was not included as a covariate because standardized scores were used.

Reading task. A word-reading task was administered to assess whether the children receiving invented spelling training would have built strong enough literacy skills that would allow them to read more novel words compared to the other children. This, however, was not the case as there was no statistically reliable difference between the invented-spelling children and the remaining children (Contrast = .47, 95% CIs = -.14 to 1.09, p = .07).

Letter knowledge. At the beginning of each session, children in the three conditions received instruction in letter knowledge. However, only children in the invented spelling condition used letters during training. Hence, it is possible that children in the invented spelling condition would learn more about letters than the other children. Even though there seemed to be posttest differences across conditions, no significant effect was found. Specifically, there was no statistically reliable difference between the invented-spelling children and the remaining children

(Contrast = 2.10, 95% CIs = -.55 to 4.74, p = .06).

Discussion

The findings of the present intervention study add to the growing literature that highlights the relevance of invented spelling in early literacy acquisition. Importantly, the obtained findings show that invented spelling can be beneficial to kindergarten children at risk of reading difficulties because of poor phoneme awareness. As predicted, the children trained in invented spelling outperformed on a learn-to-read task children who had received phoneme awareness training or an alternative intervention. Moreover, invented spelling instruction was found to increase the sophistication of children's spelling attempts. Especially noteworthy was the finding that the invented spelling children had posttest phoneme awareness levels equivalent to those observed for the children who received direct phoneme awareness training. Each of these findings is discussed.

Invented spelling practice with feedback resulted in superior group performance in learning to read simple words relative to the groups trained directly on phoneme awareness or receiving an alternative treatment. In accord with Frith (1985), invented spelling provides valuable insight into the alphabetic code that underlies written language. In analyzing the acoustic signal and mapping what is heard into printed letters, children actively integrate phonological and orthographic representations and knowledge. With practice and feedback, children’s internal representations become refined and inter-connected across the visual and auditory domains. It is this analytic stance as well as the refinement and integration of representations that helps in learning to read. This theoretical interpretation of the mechanisms by which invented spelling facilitates reading acquisition is consistent with cognitive theories that link reading success to the integration of phoneme and orthographic (and possibly semantic)

representations (Ehri, 2005; Perfetti & Hart, 2002; Share, 1995).

The learn-to-read advantage for children in the invented spelling condition did not generalize to reading novel words. That is, there were no differences across groups when children were asked to read eight high-frequency words —a finding comparable to those reported by Ouellette and Sénéchal (2008a) and Rieben et al. (2005). Hence, invented spelling training seems to promote precursor skills and knowledge that facilitate the acquisition of reading as evidenced on the learning-to-read task, but it does not automatically transfer to reading, nor should it be expected to.

The finding that invented spelling practice, with individually tailored feedback, promoted phoneme awareness just as much as phoneme awareness training is consistent with recent research employing similar methods (Ouellette & Sénéchal, 2008a; Silva & Martins, 2003; Sirois, Boisclair, & Giasson, 2008). This finding is also important theoretically because it provides evidence that the advantage in learning to read found for the invented spelling condition was not due to increased phoneme awareness alone as was suggested in previous paragraphs. As such, the present research provides some clarifying evidence about the underlying mechanisms behind the conclusion, based on meta-analytic syntheses, that phoneme awareness instruction is most beneficial when paired with alphabetic teaching (e.g., Ehri et al., 2001). As discussed in the introduction, most of this intervention research on phoneme awareness that included letters involved some form of spelling, but it did not include a phoneme awareness treatment without letters as a comparison group, nor did it measure phoneme awareness on posttest. In fact, only one of the 11 studies conducted with English-speaking kindergartners or preschoolers in the Ehri et al. meta-analysis, compared directly phoneme awareness training with and without letters, as well as included a phoneme awareness posttest measure. Hohn and Ehri (1983) showed that

phonetic-segmentation training with letters and without letters yielded comparable posttest performance in segmentation skills on untrained test items, but that both groups showed superior performance to an untreated group. Hence, the limited available evidence suggests that training phoneme awareness with letters does not seem to promote phoneme awareness more so than training phoneme awareness without letters.

There are limitations in the present research that are noteworthy. In the present research, children were randomly assigned to each condition three times until no differences in vocabulary were found across groups. This, however, is not the standard procedure in randomized controlled trials because it results in a more conservative test on the criterion selected, in this case, vocabulary. Even though vocabulary was a control variable not an outcome measure, any obtained difference on pretest after the initial randomization should have been addressed by using covariates in the post-test analyses. Moreover, there were two other deviations from standard procedure related to experimenter errors whereby one child was accidently not included in the intervention and one child was trained in the wrong condition. Using the intent-to-treat approach, we should have analyzed the data for these children in their randomly assigned condition to limit the possibility of erroneous conclusions. Unfortunately, we did not post-test the child who was accidently omitted from treatment and decided that imputing the entire set of posttest measures was not optimal. As for the other child, we reasoned that analyzing her performance in the condition in which she actually participated was less likely to bias conclusions than analyzing her performance in the condition in which she was assigned but did not participate. Nonetheless, these decisions result in a somewhat weaker research design given the gold standards of randomized controlled trials (Schulz, Altman, & Moher, 2010).

Another limitation is the inclusion of high-frequency irregular words in the word reading

task. It is possible that including highly decodable words would have resulted in word-reading benefits. The findings by Hohn and Ehri (1983), however, tamper this possibility because they did not find any group differences on decoding for children trained on phonetic-segmentation with letters, those trained without letters, and children in a control group. Also, Clarke (1988) reported that encouraging invented spelling in grade 1 correlated with improved reading for both decodable and irregular words.

In the present research, group differences were statistically significant and effect sizes were moderately strong, yet many differences represented modest change in actual behavior. Moreover, there remained considerable within-group variability, indicating that not all children benefitted equally from the offered instruction. We think that this reflects the reality of conducting a short intervention program with at-risk children. The role of individual differences in response to instructional approaches remains an important area for future research. In particular, it is of both theoretical and applied interest to identify individual characteristics that predict response to invented spelling instruction and the associated benefits in learning to read.

Young children who have strong early literacy skills in kindergarten tend to acquire reading more easily in grade 1 than children who have weaker literacy skills. In fact, early differences tend to be remarkably stable over time (Lonigan, Burgess, & Anthony, 2000; McBride-Chang, 1998; Scarborough, 1998; Sénéchal, 2006). As a result of this stability, it is important to enhance early literacy to ensure children's eventual success in learning to read efficiently. The research reported here both validated the teaching methodology of improving invented spelling and confirmed the role of invented spelling in learning to read. Importantly, it extended to children at risk of reading difficulty, previous findings with typically-developing children (Ouellette & Sénéchal, 2008a). To create invented spellings, children must translate an

auditory signal into printed letters. In doing so, they are faced with the task of breaking down the speech stream to map the segmented units into letters. This exploratory process enhances phoneme awareness and promotes the integration of phoneme and orthographic representations, an integration central in reading acquisition. With guidance and developmentally appropriate feedback, invented spelling provides a milieu for children to adopt an analytic stance to the relation between oral language and written symbols that can facilitate their entry in reading.

Appendix

Stimuli

Letters Taught in the Interventions

A, B, D, E, I, L, N, O, P, R, S, T, U, Y

Words Used in the Interventions

Sessions 1 and 2	ape	eel	on	in	no
Sessions 3 and 4	day	see	pie	add	toe
Sessions 5 and 6	rod	lap	pen	bib	sun
Sessions 7 and 8	sad	rip	nut	rat	net
Sessions 9 and 10	soap	nail	line	pole	seal
Sessions 11 and 12	rain	toad	date	rope	bite
Sessions 13 and 14	lady	ladder	apple	puppy	panda
Sessions 15 and 16	nest	spider	star	bird	snail

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Table 1

Pretest Performance as a Function of Intervention Condition

	Intervention Condition					
	Spell (*N* = 18)		PA (*N* = 19)		Story (*N* = 19)	
Measure (maximum)	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Invented spelling (30)	5.17	4.13	4.89	4.29	3.95	4.01
Phoneme awareness[a]	8.91	1.10	8.58	0.86	8.67	1.15
Word reading (5)	0.00	0.00	0.05	0.23	0.05	0.23
Letter sounds (27)	11.83	6.57	12.11	7.80	9.58	7.72
Decoding: Word attack (45)	0.00	0.00	0.00	0.00	0.00	0.00
Analytic intelligence	10.50	2.29	9.63	2.56	10.26	2.00
Oral vocabulary[b]	97.94	10.32	98.21	12.00	96.63	11.59

Spell = invented spelling; PA = phoneme awareness; Story = storybook reading

[a]Averaged standard scores for the CTOPP sound matching, elision, and blending subtests, test mean = 10

[a]PPVT-III, test mean = 100

Table 2

Posttest Performance as a Function of Intervention Condition

	Intervention Condition					
	Spell (*N* = 18)		PA (*N* = 19)		Story (*N* = 19)	
Measure (maximum)	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
Learn to read (10)	3.74	2.20	2.73	1.10	2.99	1.90
Invented spelling (30)	12.50	4.77	10.63	4.82	8.74	5.17
Phoneme awareness[a]	9.54	1.48	9.89	1.74	9.00	1.56
Word reading (8)	1.00	1.14	0.68	1.11	0.68	1.25
Letter sounds (27)	18.94	4.75	17.79	5.99	15.21	7.38

Spell = invented spelling; PA = phoneme awareness; Story = storybook reading

[a]Averaged standard scores for the CTOPP sound matching, elision, and blending subtests, test mean = 10