Published in final edited form as:

Early Child Educ J. 2016 February 1; 44(1): 11–19. doi:10.1007/s10643-014-0685-y.

Letter-Sound Reading: Teaching Preschool Children Print-to-Sound Processing

Gail Marie Wolf

Oregon Health & Science University, Portland, OR, USA

Gail Marie Wolf: wolfg@ohsu.edu

Abstract

This intervention study investigated the growth of letter sound reading and growth of consonant–vowel–consonant (CVC) word decoding abilities for a representative sample of 41 US children in preschool settings. Specifically, the study evaluated the effectiveness of a 3-step letter-sound teaching intervention in teaching pre-school children to decode, or read, single letters. The study compared a control group, which received the preschool’s standard letter-sound instruction, to an intervention group which received a 3-step letter-sound instruction intervention. The children’s growth in letter-sound reading and CVC word decoding abilities were assessed at baseline and 2, 4, 6 and 8 weeks. When compared to the control group, the growth of letter-sound reading ability was slightly higher for the intervention group. The rate of increase in letter-sound reading was significantly faster for the intervention group. In both groups, too few children learned to decode any CVC words to allow for analysis. Results of this study support the use of the intervention strategy in preschools for teaching children print-to-sound processing.

Keywords

Letter-sound reading; Print-to-sound processing; Decoding; Consonant–vowel–consonant (CVC) words; Beginning reading instruction; Letter-sound knowledge; Letter-sound reading knowledge; Automaticity

Introduction

Reading is the ability to orchestrate subskills that include the ability to independently decode print and the interpretation or comprehension of the print; it is a print-to-sound translation process that results in understanding of the text (Adams 1990; Cassidy et al. 2010; Chall 1967; Dickinson and Neuman 2006; The Report of the Commission on Reading 1985). There is consistent data showing failure to develop basic decoding skills by first grade is predictive of lifelong poor literacy (National Institute for Literacy [NIFL] 2008). The process of decoding print must become an automatic, subconscious, effortless habit so the

Correspondence to: Gail Marie Wolf, wolfg@ohsu.edu.

Conflict of interest The author has no conflicts of interest. The author alone is responsible for the content and writing of the paper.

Letter-sound reading is the ability to look at a lower-case letter in print and respond with the basic sound translation. Letter sound reading is the skill of single letter decoding as described by Biemiller (1977–1978).

mind is free for text comprehension (Chall 1967; Eldredge 2005; Fries 1962; Kuhn et al. 2010; LaBerge and Samuels 1974; Logan 1997). Unless early decoding skills move beyond mastery to become an automatic subconscious habit, reading is likely to remain poor (Kuhn et al. 2010; Logan 1997; National Institute of Child Health and Human Development [NICHD] 2000).

Beginning reading instruction should have a main goal of helping children learn and practice the print-to-sound decoding process (Kuhn et al. 2010; Rawson and Middleton 2009). A first step towards decoding involves teaching children about individual letters and the sounds the letters represent (Greaney and Arrow 2012; NIFL 2008; Turnbull et al. 2010). Researchers often refer to teaching children about letters and letter sounds as (a) letter-sound knowledge, and (b) phonics (Greaney and Arrow 2012; NICHD 2000). Nevertheless there are assumptions and inconsistencies in past reading research on exactly what is meant by letter-sound knowledge and what is meant by phonics instruction (Ehri et al. 2001; NICHD 2000). A main finding of the National Reading Panel's meta-analysis was that many studies "did not fully describe the features included as part of phonics instruction" (Ehri et al. 2001 p. 431). The Panel members recommended that researchers further explore elements of what phonics instruction entails (Ehri et al. 2001). Others echoed Ehri's et al. sentiments, asking for clarification and clearer descriptions of letter-sound knowledge, phonics and letter-sound instruction (Burkard 2010; Mesmer and Griffith 2005). Further, initial letter and letter-sound instruction that was described in studies often included teaching children to (a) name letters, (b) complete auditory tasks, listening for discrete sounds within a spoken word (phonemic awareness), and (c) use of pictures to learn letter-sounds (Dickinson and Neuman 2006; Levin and Ehri 2009; Gates and Yale 2011; Girolametto et al. 2012). These instructional strategies helped children practice a sound-to-print encoding process (Girolametto et al. 2012; Greaney and Arrow 2012; NIFL 2008). Encoding is the opposite of the print-to-sound decoding process (NIFL 2008). Encoding is a sound-to-print process of listening to a spoken word, or speech sound and determining what letters correspond to the verbalized sounds (Girolametto et al. 2012).

Letter-Sound Reading Knowledge

Decoding is defined as the ability to look at print and orally or silently respond with the proper sound translation; decoding is a print-to-sound process (Adams 1990; Fries 1962; De Graaff et al. 2009). A single letter can be decoded by looking at the letter and orally responding with the basic sound translation (Biemiller 1977–1978). In this study *letter-sound reading* is also the print-to-sound process of decoding a single letter, looking at a single, lowercase letter form and responding, not with the letter name, but with the basic sound translation (Wolf 2014).

Past research has shown that children who are better letter-sound readers are the better consonant–vowel–consonant (CVC) word decoders (Wolf 2014). Research has shown the faster letter-sound readers are the faster word decoders (Biemiller 1977–1978). Importantly, past research has shown children who learn letter-sound correspondences before attempting to read sight words have higher reading achievement than children who first learn to read words prior to learning letter-sound units (Tunmer et al. 1988). In addition, questions remain

on how children develop automatic decoding skills: What is happening in children's minds as they are first learning the print-to-sound process, and what helps children attain automatic decoding skills (NICHD 2000; Wyse and Goswami 2008).

Purpose of Study

Attaining automatic decoding skills, or print-to-sound processing, is important for proficient reading development. To attain automatic decoding skills, the print-to-sound processing must be practiced (NIFL 2008). This study builds on a previous quantitative descriptive study which showed children who could letter-sound read were the better CVC word decoders when compared to children who had low or no letter-sound reading abilities (Wolf 2014). The next step in reading research was to begin to determine what types of teaching strategies foster letter-sound reading. In this study the null hypothesis was: There will be no difference in growth of correct number of letter-sound reading responses when comparing participants who receive the letter-sound reading intervention and the control group who receive the regular letter-sound teaching strategies. This study had four research aims:

1. Evaluate effectiveness of a 3-step letter-sound teaching intervention (Appendix 1) in teaching preschool children to decode, or read, single letters.
2. Compare the growth of correct letter-sound decoding responses between children who receive the intervention to the control group who receive the classroom's regular letter-sound teaching,
3. Compare the growth of CVC word decoding ability between children who receive the intervention to the control group who receive the classroom's regular letter-sound teaching,
4. In phenomenological research terms, to learn from children's individual experiences as children spontaneously describe or comment on their own understanding of the phenomena of learning to letter-sound read and learning to read simple CVC words.

Method

Participants

A representative sample of 44 preschool aged children from four preschool settings participated in this study. Of the four rural preschool classrooms, two were Head Start classrooms two were Young Men's Christian Association classrooms. Consents were obtained from parents of children in the study. In the final analysis there were 15 girls (37 %) and 26 boys (63 %). The mean age of the children at baseline was 57.8 months or (4 years and 8 months; sd = 6.00 months). There was a minimum age of 43 months (3 years and 6 months) and maximum of 66 months (5 years and 6 months). The sample was stratified according to the socioeconomic background of the parents (lower income level having funding assistance for preschool attendance, and lower income level for Head Start eligibility). Next, of the four preschools, each was randomly assigned into the control or intervention group. Demographic information, age, sex, socioeconomic status (SES) was collected at baseline. Over the 8 week study, three children (6.8 %) dropped from the study

due to a move or the children dropping from the pre-school. The study ended with 41 participants with 20 participants in the control group (48.8 %) and 21 participants in the intervention group (51.2 %).

Setting

The study took place in the participants' preschool classroom with interventions taking place during free choice class time. Settings had a reading table set up for the literacy and intervention sessions. Standard instructional conditions for children in the control group classrooms were similar. Literacy teaching strategies were (a) letter naming activities (repeating the letter name after the teacher while looking at the letter form), (b) phonics activities (repeating a letter sound after the teacher while looking at the letter), (c) phonemic-awareness (rhyming activities) and, (d) language experiences (adults reading books to children one-on-one and in groups). Children in the control groups were given one-on-one and group letter-sound (phonics) instruction.

Materials

A baseline assessment of letter-sound reading knowledge was administered to all participants assessing the ability to look at laminated lowercase letter cards, presented in random order, and respond verbally with the basic sound translation. Basic sounds comprise the sounds in CVC spelling patterns (Fries 1962; Gates and Yale 2011). For children in the intervention group, the author-interventionist provided a 3-step letter-sound teaching intervention (Appendix 1). Children who could letter-sound-read 16 or more letters (there were two) were introduced to reading the CVC spelling pattern (Appendix 2).

During initial letter-sound lessons control groups and intervention groups were presented with the letters: m, s, o, a, r, n, t, v, f, and c; these letters were chosen because:

- Many of the letters (a, m, t, s, f, r) were determined as an acceptable sequence by previous reading researchers (Carnine et al. 1997; Johnston et al. 2009).
- Simple CVC words could be comprised of the letters: *mom, cat, fat, sat, rat, mat, can, fan, man, tan, ran, and van*.
- Many of the letters comprised words in the children's first linguistic reader written by Rasmussen and Gold-berg (1985).

Rationale for the 3-Step Letter-Sound Teaching Intervention—The 3-step letter-sound teaching intervention (Appendix 1) follows childhood learning theories of Jean Piaget, Lev Vygotsky, and Maria Montessori. Each of these three theorists recorded how children's learning is facilitated with use of organized and scaffolded learning materials (Montessori, trans. 1965; trans. 1966; Inhelder and Piaget, trans. 1958; Piaget, trans. 1952; Vygotsky, trans. 1978). The 3-step lesson was organized and scaffolded to determine if the child could: (1) repeat the sound after the teacher, (2) correctly point to a letter the teacher reads (sound-to-print processing), and (3) look at a single letter and respond with the basic sound translation (print-to-sound processing).

A second rationale for the 3-step intervention was to give children the tools to begin to independently attempt decoding and reading CVC words. It is important for young children to practice decoding the basic spelling pattern as weaknesses in the ability to decode basic spelling patterns by the end of first grade are predictive of life long poor literacy skills (Adams 1990; NICHD 2000; NILF 2008). In contrast, children who can decode the basic CVC spelling pattern in kindergarten typically are the better readers in 6th grade (Verhoeven and Leeuwe 2009).

Intervention Procedure—The intervention procedure for this study is outlined (Appendix 1). Each intervention session took about 3-min and averaged three sessions per week for each participant totaling around 9–12 min of intervention time per week.

Moments of Measure Instrumentation—The study used a moments of measure data collection procedure. Moments of measure is a process of using a pencil and paper to document children's oral accuracy of word decoding, and if wanted, a timing device to document speed of word decoding (Fleisher et al. 1979; Samuels 1985; Schwanenflugel et al. 2006; Tindal 2002). The process is a valid and reliable method because of the simplicity and unobtrusiveness of the procedure (Tindal 2002).

Data Collection—During the baseline assessment all participants were shown in the 26 lowercase letters in random order and asked, "Can you say the sound this letter makes?" During the baseline assessment, if children named a letter, praise was given along with a onetime prompt, "You know the letter name, good job!" "Do you know the *sound* this letter makes?" The number of correct responses was tallied. Next, children were shown words which all had one spelling pattern; the CVC spelling pattern (Appendix 2). How many words each child could read was tallied. The letter-sound reading assessment and CVC word decoding data collection process was repeated at weeks 2, 4, 6 and 8 of the study. During these assessments no verbal prompts or visual cues or instruction of any type were provided.

Results

Data were analyzed using a multilevel model to account for the interdependence of the data. The independent variables included time, group (intervention or control), the interaction of time and group, and the demographic variables. The dependent variable was (a) the letter-sound reading count, and (b) CVC word reading count. The child (ID) was a random effect. To test the null hypothesis, data were first plotted by time (in weeks) and number of letter sounds read for the control and intervention groups separately and separately for those who began with 0 baseline letter-sounds read and those who began with more than 0 letter-sounds read at baseline (see Figs. 1, 2, 3, 4). Figure 1 shows the course of children in the control group who started with zero letter sounds read. Most of these children learned some letter-sounds, the highest number was fewer than 10. Some children (the lowest lines on the graph) learned few or no letters at all.

Figure 2 shows the path of children who started with no sounds but were in the intervention group. Every child in this group learned at least some sounds by week 4; the maximum

number of sounds was about 15 and the typical path increased much faster than in Fig. 1, indicating these children learned sounds faster.

Figure 3 is for children in the control group who started with some sounds. Most knew a few more sounds at week 8 than at baseline; some forgot sounds as time progressed.

Figure 4 is for children in the intervention group who started with some sounds. First, note that two children started at baseline with over 16 letter-sounds read. Also, most of the Fig. 4 lines slope sharply upwards, indicating that the children were learning many sounds.

To answer the null hypothesis more formally a multilevel model was used with the child as a random effect and time (in weeks), group (control or intervention), the group time interaction, age and gender as fixed effects. This repeated measures analysis of variance, using multivariate tests with moments, aligns with other research analysis procedures of Verhoeven and Leewue (2009) and corresponds to the effect sizes calculated for experimental settings (Cohen 1988). A compound symmetric variance structure was chosen on the basis of the Akaike information criterion. The results are shown in Table 1.

What Table 1 implies is that (1) the number of letter sounds read goes up with time, (2) the number of letter sounds read is higher for the intervention group than the control, and (3) that the rate of increase in letter sounds read was faster for the intervention group than the control group. The letter sound reading count also goes up with age and was higher for girls, but these differences were not significant.

Sensitivity Analysis

In these data there were two children in the intervention group who started the study already knowing many more letter sounds than any of the others. When the multilevel model was run without the two children, results did change (see Table 2).

Table 2 data, analysis without the two participants who could already letter-sound read over 16 letters, shows the effect of time was unchanged, but the group effect was less than before. The data in Table 2 implies that (1) the number of letter-sounds read goes up with time; however, (2) the number of letter-sounds read is slightly higher but not significantly higher for the intervention group than the control, and (3) the rate of increase in letter-sounds read was still significantly faster for the intervention group than the control group. The letter-sound reading count also goes up with age and was higher for girls, but again, these differences were not significant.

Summary of Results

Children in the intervention group learned more sounds per week than children in the control group. Thus the rate of learning letter-sound decoding was faster for the intervention group. Too few children learned to decode any words to allow analysis to occur. At week 8 no children in the control group could decode any CVC words. At week 8, four children in the intervention group could independently decode two to eight CVC words. The children in the intervention group who were already accomplished letter-sound readers were able to

independently read (decode and comprehend) a linguistic reader by Donald Rasmussen and Lynn Goldberg (1985).

Discussion

Results of this study are encouraging due to data showing that children in the intervention group learned to letter-sound read more letters when compared to children in the control group. Most important was the statistically significant data showing children in the intervention group learned to letter-sound read at a faster rate than children in the control group. This preliminary data suggests the letter-sound teaching strategy was successful and that preschool children can learn to look at a letter and respond with the basic sound-translation. These data are consistent with prior research showing when learning to read, children can and should start out with mastering elementary print-to-sound decoding skills and then have opportunities to apply the elementary decoding skills towards reading simple words (Adams 1990; Gough et al. 1992; Verhoeven and Perfetti 2003; Verhoeven and Leeuwe 2009).

Phenomenological Data

Many children in the study, in both intervention and control groups could name letters. None of these “letter-namers” could decode CVC words unless there was also letter-sound reading knowledge. This data supports early research showing letter naming ability is not necessarily associated with decoding skill (Adams 1990; NICHD 2000).

Much can be learned from the four children who did begin reading CVC words, a phenomenon that links back to theorists Piaget, Montessori, and Vygotsky. Each theorist wrote about witnessing high emotion from children when an instant of internal intellectual growth occurred (Piaget, Trans. 1952; Montessori, trans. 1965; 1966; Vygotsky, trans. 1978). During the study, one child who could not letter-sound read looked at the word *mom* and named the letters, saying, “em- oh—em that’s mom”. Thus there was sight word recognition, but not word decoding ability. Another child who independently decoded *mom* said, “mmm o—mmm, Mom!” “I read it!” “I read a word! I want to read more!” This second child who was using, not rote-recognition, but rather decoding skills to construct *mom* became excited and wanted to attempt reading more words. During this study this intellectual emotion was witnessed from the four children who were applying and understanding the decoding process.

Automaticity

Relatively, little progress has been made in discovering how decoding skills develop in the minds of young children (NICHD 2000; Wyse and Goswami 2008). Children who practiced decoding CVC words did have spontaneous verbalizations that were similar

- “I hear the word in my head first and then I say it.”
- “I said it in my mind, and then the word came out my mouth.”
- “I sounded it out inside my brain so fast!”

Of the participants who were reading, the two slower decoders would consistently whisper when decoding, then voice the decoded word a second time in a louder voice, “Mmm—a—t, mat (whisper). Then loudly, “Mat!” The sequence of decoding suggests beginning reading teachers should let beginning decoding attempts be non-fluent and take each child’s individualized course. This interpretation is supported by research that showed some initial slower decoders later became more fluent readers (Deeney 2010; Hicks 2009).

The results of this study imply that exposing all children to letter-sound reading and CVC word reading could be beneficial. It may be that preschool teachers should not hold off exposure to reading instruction waiting until a child is “ready”. Rather, preschool children need exposure to letter-sound reading and word reading to allow the child’s own internal, individualized understanding determine reading readiness. Learning theories of Piaget, Vygotsky, and Montessori all support exposing young children to an organized learning environment and letting each child determine his or her own readiness to learn (Montessori, trans. 1965, 1966; Piaget 1952; Vygotsky 1978).

Another consistent phenomenon was noticed. As decoding skill progressed the skill became more fluent, “Rat, m-at, ssat, hat, fat.” Of the two children whose decoding developed more slowly, a shift in decoding was noted. At first decoding and blending the sounds into words was slow, “Mmm—aaaa—t; mmaaaa—t; mmmaaaa—t, mmmaaa; Mat.” When decoding became faster a shift to decoding words by the onset and rime occurred, “S—at, h—at, b—at, c—at, m—at.” This shift was noted with three of the four children. Soon after witnessing this onset-rime decoding, the children would begin decoding the words as one unit, “Can, Dan, man, ran, tan, van.” This phenomena suggests that automaticity in decoding CVC words might develop from the rime forward. This conclusion is supported by Walton and Walton’s (2002) study which explored beginning reading instruction using rime analogy teaching strategies.

Limitations

A main limitation of this study is the ability to generalize due to the 8 week time period, limited intervention time, and the small number of participants. Increased generalizability of the findings could be obtained through replication of the study for a longer period of time with a larger sample. Another limitation is in some preschool settings the teacher may not spend 5 min with one-on-one teaching. The 3-step intervention should be investigated with larger groups of children. Results may be different.

Implications for Future Research and Classroom Practice

The results of the study suggest that the 3-step letter-sound reading teaching strategy merits investigation on a larger, and longer time scale. Interesting too was the finding that many children from both the intervention group and control group could name letters yet could not decode CVC words unless letter-sound reading was a skill. These results are consistent with earlier research showing children who could letter-sound read were the better CVC word decoders (Wolf 2014). The results are also consistent with a multitude of prior research showing children who received letter name instruction alone did not improve in reading ability (Adams 1990). Of particular note is data showing that children who received letter

name and letter-sound instruction prior to instruction on sight words were the better readers when compared to children who received instruction on sight word recognition before letter sound and letter name instruction (Tunmer et al. 1988). Future research could compare children's reading achievement scores and long-term growth of reading ability between (a) children who initially learn to identify letters by the letter's most common sound translation (b) children who first learn to identify letters by the letter name, and (c) children who learn letter names and letter-sounds simultaneously.

This study's results are supported by research showing explicit instruction and decoding practice should focus on the print-to-sound process (NICHD 2000; Verhoeven and Leeuwe 2009). The study's outcomes also are supported by research showing differences in teaching methods and reading practice may contribute to the differences in children's ability to decode (Chui and McBride-Chang 2006; Foorman et al. 1998).

Preschool children can easily learn to look at a letter and respond with the basic sound translation. The study showed preschool children can learn to letter-sound read three letters in 3 min and retain the knowledge. Teachers should consider intentionally exposing children to print-to-sound activities in the classroom. Examples of print-to-sound activities could be (a) singing the Sound-a-Bet song (use sounds rather than names) and pointing to lower case letter cards (b) playing Go Fish with lower-case letter cards and teaching children to identify letters by the basic sound-translation, "Do you have a/s/?", and (c) playing a form of Concentration in which letter cards are placed on a table, if the child can turn a card over and correctly letter-sound read or decode the letter, the child gets the card.

Acknowledgments

This pilot study and publication was made possible by funding through Oregon Health and Science University's Oregon Clinical and Translational Research Institute (OCTRI), and National Institute of Health (NIH) CTSA Grant (UL1TR000128) funding.

References

- Adams, MJ. Beginning to read: Thinking and learning about print. Cambridge, MA: MIT Press; 1990.
- Akers TA, Lanier MM. Health policy and ethics epidemiological criminology: Coming full circle. *American Journal of Public Health*. 2009; 99(3):397–402. [PubMed: 19150901]
- Biemiller A. Relationship between oral reading rates for letters, words, and simple text in the development of reading achievement. *Reading Research Quarterly*. 1977–1978; 2(12):223–253.
- Burkard T. So why can't they read? *Literacy Today*. 2010; 64:9–10.
- Carnine, DW.; Silvert, J.; Kameenui, EJ. Direct instruction reading. 3. Columbus, OH: Merrill; 1997.
- Cassidy J, Valadez CM, Garret SD. Literacy trends and issues: A look at the five pillars and the cement that supports them. *The Reading Teacher*. 2010; 63(8):644–655.
- Chall, J. Learning to read: The great debate. New York, NY: McGraw Hill; 1967.
- Chui MM, McBride-Chang C. Gender, context and reading: A comparison of students in 43 countries. *Scientific Studies of Reading*. 2006; 10:331–362.
- Cohen, J. Statistical power analysis for the behavioral sciences. Hillsdale, NJ: Erlbaum; 1988.
- Currie D. Study finds link between low literacy, later childbearing among teens. *The Nation's Health*. 2013; 42(10):19–20.
- De Graaff S, Bosman AMT, Hasselman F, Verhoeven L. Benefits of systematic phonics instruction. *Scientific Studies of Reading*. 2009; 13(4):318–333.10.1080/10888430903001308

- Deeney TA. One-minute fluency measures: Mixed messages in assessment and instruction. *The Reading Teacher*. 2010; 63(6):440–450.10.1598/RT.63.6.1
- Dickinson, DK.; Neuman, SB. *Handbook of early literacy research*. Vol. 2. New York, NY: Guilford Press; 2006.
- Easton P, Entwistle VA, Williams B. Health in the ‘hidden population’ of people with low literacy. A systematic review of the literature. *BMC Public Health*. 2010;10.1186/1471-2458-10-459
- Ehri L, Nunes S, Stahl S, Willows D. Systematic phonics instruction helps students learn to read: Evidence from the National Reading Panel’s Meta-Analysis. *Review of Educational Research*. 2001; 71:393–447.10.3102/00346543071003393
- Eldredge JL. Foundations of fluency: An exploration. *Reading Psychology*. 2005; 26:161–181.10.1080/02702710590930519
- Fleisher LS, Jenkins JR, Pany D. Effects on poor readers’ comprehension of training in rapid decoding. *Reading Research Quarterly*. 1979; 1(15):30–48.
- Foorman BR, Francis DJ, Fletcher JM, Schatschneider C, Metham P. The role of instruction in learning to read: Preventing reading failure in at-risk children. *Journal of Educational Psychology*. 1998; 90:1–15.
- Fries, CC. *Linguistics and reading*. New York, NY: Holt, Rinehart and Winston; 1962.
- Gates L, Yale I. A logical letter-sound system in five phonic generalizations. *The Reading Teacher*. 2011; 64(5):330–339.10.1598/RT.64.5.3
- Girolametto L, Weitzman E, Greenberg J. Facilitating emergent literacy: Efficacy of a model that partners speech-language pathologists and educators. *American Journal of Speech-Language Pathology*. 2012; 21:47–63.10.1044/1058-0360(2011/11-0002 [PubMed: 22230181]
- Gough, P.; Ehri, L.; Treiman, R. *Reading acquisition*. Hillsdale, NJ: Erlbaum; 1992.
- Greaney K, Arrow A. Phonological-based assessment and teaching within a first year reading program in New Zealand. *Australian Journal of Language and Literacy*. 2012; 35(1):9–32.
- Hicks CP. A lesson on reading fluency learned from the tortoise and the hare. *The Reading Teacher*. 2009; 63(4):319–323.
- Inhelder, B.; Piaget, J. *The growth of logical thinking from childhood to adolescence*. Parsons, A.; Milgram, S., editors. USA and France: Basic Books, Inc; 1958.
- Johnston S, Davenport L, Kanarowski B, Rhodehouse S, McDonnell A. Teaching sound letter correspondence and consonant-vowel-consonant combinations to young children who use augmentative and alternative communication. *Augmentative and Alternative Communication*. 2009 Jun; 25(2):123–135.10.1080/07434610902921409 [PubMed: 19444683]
- Kuhn RM, Schwanenflugel PJ, Meisinger EB. Aligning theory and assessment fluency: Automaticity, prosody and definitions of fluency. *Reading Research Quarterly*. 2010; 45(2):230–251.10.1598/RRQ/45.2.4
- LaBerge D, Samuels SJ. Toward a theory of automatic information processing in Reading. *Cognitive Psychology*. 1974; 6:293–323.
- Levin I, Ehri L. Young children’s ability to read and spell their own and classmates’ names: The role of letter knowledge. *Scientific Studies of Reading*. 2009; 13(3):249–273.10.1080/10888430902851422
- Logan GD. Automaticity and reading: Perspectives from the instance theory of automatization. *Reading & Writing Quarterly*. 1997; 13(2):123–147.
- Mesmer A, Griffith P. Everybody’s selling it—But just what is explicit, systematic phonics instruction? *International Reading Association*. 2005;10.1598/RT.59.4.6
- Montessori, M. *The advanced Montessori method*. Simmonds, F., translator. Vol. 1. New York, NY: Schocken Books; 1965.
- Montessori, M. *The discovery of the child*. Johnstone, MA., translator. Thiruvanniyur, Madras: Kalakshetra Publications; 1966.
- National Institute for Literacy. *Developing early literacy: Report of the National Early Literacy Panel*. Jessup, MD: National Center for Family Literacy; 2008. p. 1-231.
- National Institute of Child Health and Human Development. *Report of the national reading panel: Teaching children to read; an evidence-based assessment of the scientific research literature on*

- reading and its implications for reading instruction. Washington DC: U.S. Government Printing Office of Health Publish No. 00-4754; 2000. NIH Publication No. 00-4769
- Piaget, J. The origins of intelligence in children. Piercy, M.; Berlyne, DE., translators. New York, NY: International Universities Press, Inc; 1952.
- Rasmussen, D.; Goldberg, L. Basic reading series. Chicago, IL: Science Research Associates, McGraw-Hill; 1985. A pig can jig. Part I.
- Rawson KA, Middleton EL. Memory-based processing as a mechanism of automaticity in text comprehension. *Journal of Experimental Psychology: Learning, Memory, and Cognition*. 2009; 35(2):353–370.
- Samuels, SJ. Automaticity and repeated reading. In: Osborn, J.; Wilson, PT.; Anderson, RC., editors. *Reading education: Foundations for a literate America*. Lexington, MA: Lexington Books; 1985. p. 215-230.
- Schwanenflugel PJ, Meisinger EB, Wisenbaker JM, Kuhn MR, Strauss GP, Morris RD. Becoming a fluent and automatic reader in the early elementary school years. *Reading Research Quarterly*. 2006; 41(4):496–522. [PubMed: 20072665]
- The Report of the Commission on Reading. *Becoming a nation of readers*. Washington, DC: The National Institute of Education; 1985.
- Therrien WJ, Hughes C. Comparison of repeated reading and question generation on student's reading fluency and comprehension. *Learning Disabilities: A Contemporary Journal*. 2008; 6(1):1–16.
- Tindal, G. The twelfth mental measurements yearbook. 2002. Review of the test of word reading efficiency. [electronic version]. Retrieved from the Burros Institute's Mental Measurements Yearbook online database
- Tunmer WE, Herriman ML, Nesdale AR. Metalinguistic abilities and beginning reading. *Reading Research Quarterly*. 1988; 23:134–158.
- Turnbull KLP, Bowels PR, Skibbe LE, Justice LM, Wiggins AK. Theoretical explanations for preschoolers' lowercase alphabet knowledge. *Journal of Speech, Language, and Hearing Research*. 2010; 53:1757–1768.
- Verhoeven L, Leeuwe JV. Modeling the growth of word-decoding skills: Evidence from Dutch. *Scientific Studies of Reading*. 2009; 13(3):205–223.
- Verhoeven L, Perfetti CA. The role of morphology in learning to read. *Scientific Studies of Reading*. 2003; 7:209–217.
- Vygotsky, LS. *Mind in society: The development of higher psychological processes*. Luria, AR., translator; John-Steiner, V.; Cole, M., editors. Cambridge, MA: Harvard University Press; 1978.
- Walton P, Walton L. Beginning reading by teaching rime analogy: Effects on phonological skills, letter-sound knowledge, working memory, and word-reading strategies. *Scientific Studies of Reading*. 2002; 6(1):79–115.
- Wolf G. Differences in mean number of consonant-vowel-consonant words decoded between letter-sound readers and non-letter-sound readers. *Open Journal of Nursing*. 2014; 4:409–450.10.4236/ojn.2014.46047
- Wyse D, Goswami U. Synthetic phonics and the teaching of reading. *British Educational Research Journal*. 2008; 34(6):691–710.10.1080/01411920802268912

Appendix 1. Letter-Sound Reading Intervention

A 3-Step Method for Teaching Children to Read a Single, Lowercase Letter

Step One See if the learner can pronounce a letter's most common, basic sound (**repeat-reading process**)

- Place three lower case letter-cards in front of the learner: s, m, o.
- Point to the first letter and say, "This letter says/s/when I read it. Can you say/s/?"

- Repeat with each letter. Record the response. Most children or learners who can talk can repeat a letter sound.

Step Two See if the learner can point to the letter that is being read (**sound-to-print processing**)

- Let the learner mix up the same three letter cards.
- Say, “Now I am going to read a letter and you point to the letter I read.”
- Read each letter and record the response. The lesson can end here on a positive note or can be repeated if needed, or the learner can review Step One.

Step Three See if the learner can read each letter (**print-to-sound processing**)

- Let the learner mix up the same three letter cards.
- Say, “Now I am going to point to a letter, and *you* read the letter.”
- Silently point to each letter and see if learner can independently respond with the most, common, basic sound-translation.

Appendix 2. Consonant–Vowel–Consonant (CVC) Basic Spelling-Pattern

/a/book

can, Dan, fan, man, Nan, pan, ran, tan, van, an; **bat**, cat, fat, hat, mat, pat, rat, sat, at; **ham**, Pam, ram, Sam, yam, am; **cab**, dab, gab, jab, lab, tab; **bag**, gag, hag, lag, nag, rag, sag, tag, wag; **bad**, dad, Dad, had, lad, mad, pad, sad, add; **cap**, gap, lap, map, tap, zap; **gal**, Hal, pal, Al; **gas**

/o/book

mom, Mom, Tom; **con**, Don, Ron, on; **cot**, dot, got, hot, jot, lot, not, pot, rot; **bob**, Bob, cob, job, lob, mob, rob, Rob, sob; **cog**, dog, fog, hog, jog, log; **cod**, god, God, nod, pod, rod, odd; **bop**, cop, hop, mop, pop, sop, top; **off**

/u/book

bun, fun, gun, nun, pun, run, sun; **but**, cut, gut, hut, jut, nut, rut; **bum**, gum, hum, rum, sum, yum; **cub**, hub, nub, pub, rub, sub, tub; **bud**, cud, dud, mud; **bug**, dug, hug, jug, lug, mug, rug; **cup**, pup; bus, Gus, pus; **us**

/i/book

fin, kin, pin, sin, tin, win, in; **bit**, fit, hit, kit, lit, nit, pit, quit, sit, it; **dim**, him, Jim, Kim, rim, Tim; **bib**, fib, rib; **big**, dig, fig, jig, pig, rig, wig; **bid**, did, hid, lid, Sid; **dip** hip, lip, nip, rip, sip, tip, zip; **ill**, sis, quiz

/e/book

Ben, den, hen, Ken, men, pen, ten; **bet**, get, jet, let, met, net, pet, set, vet, wet, yet; **web**, ebb;
beg, keg, leg, Meg, peg, Peg; **bed**, fed, Jed, led, Ned, red, Ted, wed, Ed; **pep**; **Les**, Wes, yes;
Mel, Nel, elf, elk, elm; **hem**

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Fig. 1.
Letter sounds read over time for children in the control group who started at 0

Fig. 2.
Letter sounds read over time for children in the intervention group who started at 0

Fig. 3.
Letter sounds read over time for children in the control group who started with some sounds

Fig. 4. Letter sounds read over time for children in the intervention group who started with some sounds

Table 1

Results of a multilevel model on letter sounds read

Effect	Estimate	Standard error	DF	T	P
Intercept	-8.13	7.66	37	-1.07	0.30
Time	0.44	0.08	162	5.63	<.0001
Group					
Intervention	2.73	1.58	37	1.73	0.09
Control	Reference level				
Time group					
Intervention	0.54	0.11	162	4.98	<.0001
Control	Reference level				
Age	0.14	0.13	37	1.09	0.28
Gender					
Female	1.81	1.59	37	1.14	0.26
Male	Reference level				

Table 2
Results of a multilevel model on letter sounds read, two participant outliers deleted

Effect	Estimate	Standard error	DF	T	P
Intercept	1.49	3.83	35	0.39	0.70
Time	0.44	0.08	154	5.72	< 0.0001
Group					
Intervention	0.80	0.86	35	0.93	0.36
Control	Reference level				
Time group					
Intervention	0.62	0.11	154	5.58	< 0.0001
Control	Reference level				
Age	-0.02	0.06	35	-0.33	0.74
Gender					
Female	1.03	0.79	35	1.30	0.20
Male	Reference level				