How Alphabet Knowledge Impacts Reading Development

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In this literature review, the relationship between alphabet knowledge and reading development will be explored. Key topics will include how alphabet knowledge is not only a predictor for future reading success, but also how letters and their sounds serve as a bridge from a pre-alphabetic phase into a partial alphabetic phase, and beyond. Since each phase is characterized by students' understanding of the alphabet system, which is central to word reading skill, movement within the phases helps support reading proficiency. Knowledge of these phases can support pre-service teachers, teachers and school leaders with instruction, assessment, differentiation, and intervention. This review provides a road map for how children develop the alphabetic principle through each phase, as well as instructional implications for pre-service teachers that could help inform professional development.

The English alphabet has 26 letters, called graphemes, and about 41-44 distinct sounds, called phonemes, depending on a given regional dialect (Foorman, 2023). Being able to recognize that words have letters and that these letters have sounds is called the alphabetic principle, and is a vital skill for beginning readers and writers (Foorman, 2023; Piasta, 2023). However, children may face difficulties acquiring the alphabetic principle for a myriad of reasons, including the acquisition of phonemic awareness and the understanding of the visual distinctness of letters, as well as the inconsistent nature of mappings between phonology and orthography (Foorman, 2023). Alphabet knowledge is the foundation of the alphabetic principle, and it includes children's understanding of the way the letter is formed, the names of the letters, and sounds that are associated with the letters. Alphabet knowledge is important because it not only can predict future reading and spelling skills, but it can also predict future reading challenges (Piasta, 2023). In "What We Know About Correlates with Reading," (Hammil, 2004), the author analyzed the combined results of three meta-analyses (more than 450 studies) which examined a variety of skills related to reading. Based on this review, the best predictors of reading fell under "other written language abilities," or abilities involving print, such as print awareness, letters, phoneme-letter correspondences, word recognition, and alphabet knowledge. Additionally, according to the National Early Literacy Panel, (2008), alphabet knowledge is one of the strongest predictors of later literacy success in decoding, spelling, and comprehension. Teacher candidates should be secure in their knowledge of foundational reading skills and they should understand how to explicitly support the phases of alphabetic development children go thorough on their way to being proficient readers.

Examining Ehri & McCormick's Phases of Word Learning (1998) can provide some insight into how alphabet knowledge relates to reading development, since each phase is characterized by students' knowledge of the alphabetic system, which is central to reading development. Though there are skills, and therefore ages, associated with each phase, the authors acknowledge that any children who are in need of literacy support may fall into a different phase that is outside of their age range. Also, the authors caution that phases may overlap, and proficiency in one phase may not be necessary to move into the next phase. Nonetheless, the phases that the authors outline

provide an extensive roadmap for how alphabet knowledge supports a child's reading development.

In the pre-alphabetic phase, which is typical for preschool and kindergarten, alphabet knowledge is not used to read words. Children at this phase have a limited understanding of knowledge and their related sounds, and they often "pretend read" words from memory or by guessing. Children at this phase may read words that they encounter in their environment, also known as environmental print (Ehri & McCormick, 1998). Environmental print could include community signs, labels on household items, and child-centered print, such as print on toys (Schwanenflugel & Flanagan Knapp, 2016). Examples of environmental print could include *stop* (as in a stop sign), the *Burger King* sign, or even the *Pepsi* logo (Ehri & McCormick, 1998). Because of the accessibility of environmental print, preschoolers from all different socioeconomic backgrounds have similar levels of environmental print knowledge, and they may begin to interact with this print before their second birthday (Schwanenflugel & Flanagan Knapp, 2016).

In a study conducted by Ehri and colleagues (Masonheimer et al., 1984, as cited in Ehri, 2020), preschoolers' ability to identify print in and out of the context of a logo was investigated. Preschoolers who could read words, such as *Pepsi*, within the context of its logo were unable to read the word *Pepsi*, when it was isolated from the logo. Additionally, when students were shown *Xepsi* printed on the *Pepsi* logo, preschoolers still read it as *Pepsi*, which shows that these readers were not attending to the individual letters in order to read the word. This demonstrates that students "read the environment" instead of the print because they recall non-alphabetic visual cues instead of letters in this phase. Another study by Levin & Ehri (2009) had similar findings. Israeli preschoolers were shown the names of the other students in their class attached to their individual cubbies, and many were able to read their names. However, when students were asked to read the names isolated from the cubbies, only the preschoolers who knew letters were able to read the names. Solely having environmental print knowledge does not ensure that students will develop literacy skills, but it can help students understand the function of print, and that print can be used to communicate, which can be an important starting point in their reading development. These studies demonstrate that students can move from the pre-alphabetic stage to the partial alphabetic stage by acquiring alphabet knowledge (Ehri, 2020).

Ehri & McCormick (1998) offer several instructional recommendations for students who are at the pre-alphabetic phase in order to move into the partial-alphabetic phase, and much research has been done to extend their findings since their original publication. They recommend that students learn both uppercase and lowercase letters, and that students should have opportunities to not only print these letters, but learn the names of these letters, which can improve word recognition learning (Jones & Reutzel, 2021; Piasta, 2012, 2023; Roberts, 2003). Letter name recognition is related to success in learning how to read (NICHD, 2008; Piasta, 2012). Additionally, a meta-analysis conducted by Piasta & Wagner (2010) concluded that letter name, letter sound, and letter writing instruction are most effective when they occur simultaneously, which best reflects the reciprocal relationships among these emergent literacy skills. This letter knowledge, accompanied by alphabet books, may support children into entering the partial-alphabetic stage of word recognition, which can promote the relationship between letters and sounds (Evans et al., 2009). Mnemonics have also been shown to support children in the pre-alphabetic stage (Ehri et al., 1984). Children that were taught with the associated pictures of

letters (mnemonics) learned more letter-sound and letter-picture associations because they linked letters, sounds, and pictures to memory, which supports the acquisition of the alphabetic principle. Additionally, teaching phonological awareness and phonemic awareness, also supports students in moving into the partial-alphabetic phase. Phonological awareness (Piasta & Wagner, 2010) and phonemic awareness (Byrne & Fielding-Barnsley, 1989) help develop grapheme-phoneme correspondence, and a deficiency in either may lead to word difficulties (NICHD, 2000). Lastly, activities that allow pre-alphabetic learners to utilize their alphabet knowledge to invent spellings of words brings attention to grapheme-phoneme connections (Ehri & Wilce, 1987b). This supports the alphabetic principle, and can help pre-alphabetic learners move into the partial-alphabetic phase (Ehri & McCormick, 1998), which can support reading development.

In the partial-alphabetic phase, which is typical for kindergarten and for children at the beginning of first grade, children can use partial alphabetic clues to read words from sight, based on their developing alphabet knowledge. This is different from the pre-alphabetic phase, since children can match some graphemes with phonemes, whereas in the pre-alphabetic phase, alphabet knowledge is non-existent when guessing words. Children may remember words by sight more effectively at this stage compared to the pre-alphabetic stage, since they have some alphabet knowledge that helps them form connections between letters and sounds. However, since this knowledge is limited, they only process partial grapheme-phoneme connections, which supports learning words by sight. They may still guess words based on context or non-alphabetic visual cues, because they still may be developing their word recognition skills, which requires more alphabetic knowledge than they might have at this stage. Also, students at this stage may read words backwards, as they are still developing positionality from left to right in their word reading. Decoding strategies for unfamiliar words are not available to students at this stage, since new words are often mistaken for previously learned words in a child's memory (Ehri & McCormick, 1998).

In two studies by Ehri & Wilce (1987a, 1987b), children in the partial-alphabetic phase were taught how to use their knowledge of letter-sound relationships to read words that had similar spellings, and to spell words. Children that were taught to explicitly discern the specific letters and sounds in words with similar letters and spellings were able to move into the full alphabetic phase from the partial-alphabetic phase. This shows the limitation of partial cues, based on a limited knowledge base, to read words, and that the ability to decode new words shows that students are entering the full alphabetic phase (Ehri, 2020), which supports their reading development. Lastly, Ehri and colleagues have done a few studies to determine why older struggling readers behave more like they are in the partial-alphabetic phase, as opposed to the full alphabetic phase. In one study, less proficient readers took more time and were less skilled at decoding nonwords than more proficient readers, and they also took longer to read familiar words, which implies that they were not reading words as whole units, which happens when the grapheme-phoneme connections are formed (Ehri & Wilce, 1983). Older students with a reading disability showed evidence of partial cue reading, where they noticed when initial and final letters were changed, but not medial (Ehri & Saltmarsh, 1995, as cited in Ehri, 2020). Children in the full alphabetic stage recognize when letters change positions in all parts of the word, which is central to reading development.

Ehri & McCormick (1998) offer several instructional recommendations for students who are at the partial-alphabetic phase to move into the full-alphabetic phase. They argue that since the English orthography system can be too complicated for many students to acquire naturally, explicit instruction in grapheme-phoneme correspondences, or phonics, is necessary. As children move into reading, they shift from visual to phonetic processing of words, and children need to know the names and sounds of letters in order for this shift to occur (Ehri & Wilce, 1985). Since many students in this phase focus on initial and final letters, students will need to learn how to process all of the letters in a word in order to not confuse similarly spelled words with one another, but also to decode new and/or unknown words. Teaching similarly spelled words together, such as *what* and *want*, are also helpful, since students are still developing positionality awareness within words, and pay more close attention to beginning and final letters, as opposed to medial letters (Ehri & Saltmarsh, 1995). Mnemonics, which were discussed in the pre-alphabetic stage, are also recommended in this phase, but specifically for vowels which are tricky for students to acquire at the partial-alphabetic phase, in order to link the shapes of letters to their sounds (Ehri et al., 1984). Encouraging students to write and use invented spellings in their writing, is also effective in this phase. Teaching students to stretch out the sounds in words and to select letters that represent those sounds helps bridge the gap between the partial-alphabetic stage and the full alphabetic stage (Ehri & Wilce, 1987b). Invented spelling is also helpful since the production of correct spellings from memory is not as common in the partial-alphabetic phase, as compared to the full-alphabetic phase, since children's alphabetic knowledge is vaster. Lastly, it can be supportive to have children read decodable text in order to apply their grapheme-phoneme knowledge, as well as their decoding strategies (Cheatham & Allor, 2012). Repeated readings of texts can be helpful for children since their memories can become activated (Ehri & McCormick, 1998).

In the pre-alphabetic phase and the partial-alphabetic phase, children lack knowledge of the alphabetic system, and will grapple with effective word recognition, and thus, reading development. In the full alphabetic phase, which is typical for first graders but could impact children beyond first grade, children are able to apply the knowledge of the alphabetic principle to words. Students must be able to demonstrate proficiency in the skills in the full alphabetic phase in order to move into the final two phases (Ehri & McCormick, 1998). Interestingly enough, emergent readers who are taught to read words in orthographies that have more regularity in terms of their grapheme-phone relationships, and who receive systematic phonics instruction, spend little if any time in the pre-alphabetic phase, as well as the partial-alphabetic phase (Schwanenflugel & Flanagan Knapp, 2016). At this phase, children are able to apply their knowledge of grapheme-phoneme relationships, as well as phonemic awareness, in order to decode unfamiliar words, and eventually store them as sight words into memory. Though they may read more slowly, children at this phase begin to increase their fluency with practice, and they can store words in their memory with little practice (Schwanenflugel & Flanagan Knapp, 2016). Additionally, due to the amount of practice they get from increased reading, because they have been able to crack the alphabetic code, children's vocabularies increase exponentially (Ehri & McCormick, 1998). Both fluency and vocabulary can increase comprehension (NICHD, 2000). With a developing alphabet knowledge base, children are able to develop their reading skills.

Ehri & McCormick (1998) offer several instructional recommendations for students who are at the full alphabetic phase to move into the consolidated alphabetic phase. At this phase, children must read a lot. This will help them to move from slower to faster decoding, where they will spend less time working through the grapheme-phoneme relationships. Additionally, with practice, these relationships become more rapid and automatic, and eventually get stored into memory as sight words. With less focus on decoding, students can focus their attention on fluency, vocabulary, and comprehension, which are all vital for reading development. Children at this phase also benefit from syllabication instruction, where they examine onsets and rimes. This practice can be helpful for students at this phase in order to determine if they know certain words (or word parts), and if they can be applied to unknown words to support word recognition. However, the utilization of onsets, rimes, and syllables to support word recognition are also prominent in the following phase, which will be discussed. Overall, students need a lot of time practicing reading at this phase (Ehri & McCormick, 1998), where they can apply all that they've learned about grapheme-phoneme correspondences.

In the consolidated alphabetic phase, which is typical for second graders but could impact children all the way to eighth grade (Ehri & McCormick, 1998), word learning matures. This phase actually begins to develop in the full-alphabetic phase, and is demonstrated when children are able to distinguish larger units out of letter-sound connections in different words. This could include affixes, root words, onsets, rimes, and syllables, which may be connected to their origins in order to note patterns and differences (Schwanenflugel & Flanagan Knapp, 2016). The first units that become internalized by children tend to be the units that occur most frequently in the texts that these children are reading. The awareness of these larger units can support children in decoding with more accuracy and speed, and eventually support sight word learning, as these units get stored in memory. In the full-alphabetic stage, children mostly recognize words at the grapheme-phoneme level, where consolidated-alphabetic readers utilize the grapheme-phoneme level, as well as the larger units within words, which helps to reduce processing.

In a study (Bhattacharya & Ehri, 2004), the researchers taught students in the treatment group how to segment and blend syllables in 100 multisyllabic words. They provided extensive practice with the hope that it would impact students' word recognition. There was also a group of students who received implicit instruction, where they read all of the multisyllabic words in whole units without the segmentation and blending, as well as a group that received no treatment, which was the control. The implicit instruction group had little growth, which showed that analyzing multisyllabic words as whole units was not supportive for children moving to the consolidated alphabetic phase. Instruction and practice with syllables in multisyllabic words was supportive for students moving into the consolidated alphabetic phase, as it helped these readers make generalizations about unknown words based on the syllable knowledge acquired from instruction and practice. Additionally, in a similar study (Gray et al., 2018), instruction and practice with not only syllables, but also morphology, were analyzed in a subset of multisyllabic words with a group of students. The group that was taught to examine morpheme and syllable units of words showed the highest gains of transfer tasks of reading both words and pseudowords. These studies imply that explicit instruction in word analysis not only supports students moving into the consolidated alphabetic phase, but specifically supports students with increasing their word knowledge (Ehri, 2020). Additionally, childrens' vocabularies continue to grow since they can form connections between familiar units of words, which get stored in their

memory. Children at this phase remember words in different combinations, including larger units, which can minimize confusion between words with similar spellings. And lastly, children acquire more complex understandings of spellings, implicitly and explicitly. In order to assess this, children can be asked to read pseudowords to see if they are applying a spelling rule (Ehri & McCormick, 1998). This allows children to demonstrate if they can decode words without considering familiarity or word meaning (Schwanenflugel & Flanagan Knapp, 2016). The application of spelling rules when reading is supportive for reading development because it allows children to invest less cognitive load while decoding, which makes the task less arduous.

Ehri & McCormick (1998) offer several instructional recommendations for students who are at the consolidated alphabetic stage to move into the automatic alphabetic phase. To bring attention to common spelling patterns, children can practice dividing words into units such as onsets, rimes, and syllables through word study activities. As children practice decoding multisyllabic words, they gain awareness that syllable breaks tend to appear in certain places within a word, and not necessarily between others. Analyzing multisyllabic words can help store them into memory, which can be used for automatic retrieval. It's vital at this stage that children engage in as much practice using their word learning strategies and various knowledge sources so that they can become as fluent and automatic as they can during reading so that attention can be focused on comprehension (Ehri & McCormick, 1998).

Lastly, in the automatic alphabetic phase, children recognize most words in text automatically by sight, and can rapidly apply various strategies successfully when faced with unfamiliar words (Ehri & McCormick, 1998). Automaticity in word reading has been measured through the use of the Stroop task. In a study by Ehri & Wilce (1979, as cited in Schwanenflugel & Flanagan Knapp, 2016), children were asked to name the object in a picture that had a distracting label written on it (for example, a picture of a lock labeled "drum"). As theorized in the study, a child who was an automatic reader would be slower when naming a picture with a distracting label, compared to naming the same picture without the distracting print. Findings from this study support students will read words automatically from memory. Since multiple sources are used to identify words, readers at this phase maintain a high level of reading accuracy and fluency which allows the reader to focus on comprehension (Ehri & McCormick, 1998), which is the basis for reading. Children at this stage should continue to read connected text, with an emphasis on fluency (Schwanenflugel & Flanagan Knapp, 2016). This is the final phase as outlined by Ehri & McCormick (1998).

Some researchers argue that there may be different factors and processes not included in Ehri & McCormick's (1998) phases that should be taken into consideration when thinking about how children learn how to read words, since children must draw connections between phonemes, orthography, and meaning automatically. One contributing factor might be orthographic learning or processing, which is the child's ability to discern the simple retrieval of sounds based on their knowledge of spelling patterns. For example, children with this type of knowledge would be able to distinguish *rane* from *rain* (Schwanenflugel & Flanagan Knapp, 2016). Orthographic learning or processing can be developed through print exposure, because the more children read, the more likely they will acquire an understanding of these regularities. Thus, "orthographic learning may be both a predictor of reading words and an outcome of having read lots of words" (Schwanenflugel & Flanagan Knapp, 2016, p. 66). In the Self-Teaching Hypothesis (Share,

2008), word recognition depends on how often the reader has been exposed to a particular word, and simply decoding a word provides children with the opportunity to create an orthographic representation of it. Orthographic learning/processing can also be acquired through statistical learning (Pacton et al., 2001, as cited in Schwanenflugel & Flanagan Knapp, 2016), where children become knowledgeable about regularities in the English orthography through print exposure, and use this knowledge to decode words. Children can develop this statistical learning as early as kindergarten though it does develop with age (Schwanenflugel & Flanagan Knapp, 2016). And lastly, word meanings support orthographic learning/processing. Children can read words that they know the meaning of faster (Duff & Hulme, 2012, as cited in Schwanenflugel & Flanagan Knapp, 2016), and children try to retrieve meaning as they read words (Schwanenflugel & Flanagan Knapp, 2016). These examples, coupled with the phases, explore the phenomenon of how children progress through their literacy experiences to eventually become proficient readers. Though, it all began with alphabet knowledge.

In "Kindergarten Predictors of Second Versus Eighth Grade Reading Comprehension Impairments" (2010), Adlof and colleagues sought to investigate kindergarten predictors of comprehension impairments in both second and eighth grades. The kindergarten measures that showed the strongest correlations with second grade reading comprehension included letter identification and sentence imitation, though letter identification was much less correlated with eighth grade reading comprehension than with second. This was also confirmed by the Language and Reading Research Consortium (LARRC, 2015a). This shows that letter identification is vital for reading comprehension for early readers, and other skills gain importance as readers acquire more literacy skills with age, but children must acquire alphabet knowledge in order to develop those other literacy skills. Since alphabetics is a constrained skill (Paris, 2005), mastery can be achieved. This limits how alphabetics can be compared to other literacy skills over time. For example, vocabulary is an unconstrained skill, and it's developed throughout one's life.

The importance of alphabet knowledge cannot be underscored, as it impacts a child's literacy trajectory for the rest of their schooling, and perhaps even the rest of their lives. Considering its importance, teacher preparation programs, as well as ongoing professional development, should continue to highlight not only the knowledge around teaching the alphabetic principle, but also how students move through the phases when considering central aspects of teaching, such as instruction, assessment, differentiation, and intervention.

References

Adlof, S. M., Catts, H. W., & Lee, J. (2010). Kindergarten Predictors of Second Versus Eighth Grade Reading Comprehension Impairments. *Journal of Learning Disabilities*, *43*(4), 332–345. https://doi.org/10.1177/0022219410369067

Bhattacharya, A., & Ehri, L.C. (2004). Graphosyllabic analysis helps adolescent struggling readers read and spell words. *Journal of Learning Disabilities*, *37*(4), 331–348. https://doi.org/10.1177/00222 194040370040501

Byrne, B., & Fielding-Barnsley, R. (1989). Phonemic Awareness and Letter Knowledge in the Child's Acquisition of the Alphabetic Principle. *Journal of Educational Psychology*, *81*(3), 313–321. https://doi.org/10.1037/0022-0663.81.3.313

Cheatham, J. P., & Allor, J. H. (2012). The influence of decodability in early reading text on reading achievement: A review of the evidence. *Reading & Writing, 25*, 2223-2245.

Duff, F.J., & Hulme, C. (2012). The role of children's phonological and semantic knowledge in learning to read words. *Scientific Studies of Reading, 16*(6), 504-525.

Ehri, L. C. (2020). The science of learning to read words: A case for systematic phonics instruction. *Reading Research Quarterly*, *55*(S1), S45–S60. https://doi.org/10.1002/rrq.334

Ehri, L. C., Deffner, N. D., & Wilce, L. S. (1984). Pictorial mnemonics for phonics. *Journal of Educational Psychology*, *76*(5), 880–893. https://doi.org/10.1037/0022-0663.76.5.880

Ehri, L. C., & McCormick, S. (1998). Phases of word learning: Implications for instruction with delayed and disabled readers. *Reading & Writing Quarterly*, *14*(2), 135–163. https://doi.org/10.1080/1057356980140202

Ehri, L.C., & Saltmarsh, J. (1995). Beginning readers outperform older disabled readers in learning to read words by sight. *Reading and Writing*, *7*(3), 295–326. https://doi.org/10.1007/BF03162082

Ehri, L.C., & Wilce, L.S. (1979a). Does word training increase or decrease interference in a Stroop task? *Journal of Experimental Child Psychology*, *27*(2), 352–364. https://doi.org/10.1016/0022-0965(79) 90055-9

Ehri, L.C., & Wilce, L.S. (1983). Development of word identification speed in skilled and less skilled beginning readers. *Journal of Educational Psychology*, *75*(1), 3–18. https://doi.org/10.1037/0022- 0663.75.1.3

Ehri, L. C., & Wilce, L. S. (1985). Movement into reading: Is the first stage of printed word learning visual or phonetic? *Reading Research Quarterly*, *20*(2), 163–179. https://doi.org/10.2307/747753

Ehri, L.C., & Wilce, L.S. (1987a). Cipher versus cue reading: An experiment in decoding acquisition. *Journal of Educational Psychology*, *79*(1), 3–13. https://doi.org/10.1037/0022-0663.79.1.3

Ehri, L.C., & Wilce, L.S. (1987b). Does learning to spell help beginners learn to read words? *Reading Research Quarterly*, *22*(1), 47–65. https://doi.org/10.2307/747720

Foorman, B. (2023). Learning the code. In Cabell, S.Q., Neuman, S.B., Terry, N.P. (Eds.). *Handbook on the science of early literacy*. New York: Guilford.

Evans, M. A., Saint-Aubin, J., & Landry, N. (2009). Letter names and alphabet book reading by senior kindergarteners: An eye movement study. *Child Development*, *80*(6), 1824–1841. https://doi.org/10.1111/j.1467-8624.2009.01370.

Gray, S.H., Ehri, L.C., & Locke, J.L. (2018). Morpho-phonemic analysis boosts word reading for adult struggling readers. *Reading and Writing, 31*(1), 75–98. https://doi.org/10.1007/s11145-017-9774-9

Hammill, D. D. (2004). What we know about correlates of reading. *Exceptional Children, 70*(4), 453–469. https://doi.org/10.1177/001440290407000405

Jones, C.D., & Reutzel D.R. (2012). Enhanced alphabetic knowledge instruction: Exploring a change of frequency, focus, and distributed cycles of review. *Reading Psychology, 33*(5), 448-464. DOI: 10.1080/02702711.2010.545260

LARRC (Language and Reading Research Consortium). (2015a). Learning to read: Should we keep things simple? *Reading Research Quarterly, 50,* 151-169.

Levin, I., & Ehri, L. C. (2009). Young children's ability to read and spell their own and classmates' names: The role of letter knowledge. *Scientific Studies of Reading, 13*(3), 249–273. https://doi.org/10.1080/10888430902851422

Masonheimer, P.E., Drum, P.A., & Ehri, L.C. (1984). Does environmental print identification lead children into word reading? *Journal of Reading Behavior, 16*(4), 257–271. https://doi.org/10.1080/10862 968409547520

National Early Literacy Panel. (2008). *Developing early literacy: Report of the National Early Literacy Panel: A scientific synthesis of early literacy development and implications for intervention*. Jessup, MD: National Institute for Literacy.

National Reading Panel (U.S.) & National Institute of Child Health and Human Development (U.S.). (2000). 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.

Paris, S.G. (2005). Reinterpreting the development of reading skills. *Reading Research Quarterly, 40*(2), 184-202 https://doi.org/10.1598/RRQ.40.2.3

Paxton, S., Perruchet, P., Fayol, M., & Cleeremans, A. (2001). Implicit learning in real world context: The case of orthographic regularities. *Journal of Experimental Psychology: General, 130,* 401-426.

Piasta, S. (2023). The science of early alphabet instruction: What we do and do not know. In Cabell, S.Q., Neuman, S.B., Terry, N.P. (Eds.). *Handbook on the science of early literacy*. New York: Guilford.

Piasta, S. B., Petscher, Y., & Justice, L. M. (2012). How many letters should preschoolers in public programs know? The diagnostic efficiency of various preschool letter-naming benchmarks for predicting first-grade literacy achievement. *Journal of Educational Psychology, 104*(4), 945–958. https://doi.org/10.1037/a0027757

Piasta, S. B., & Wagner, R. K. (2010). Developing early literacy skills: A meta-analysis of alphabet learning and instruction. *Reading Research Quarterly*, *45*(1), 8–38. https://doi.org/10.1598/RRQ.45.1.2

Piasta, S. B., & Wagner, R. K. (2010). Learning letter names and sounds: Effects of instruction, letter type, and phonological processing skill. *Journal of Experimental Child Psychology*, *105*(4), 324–344. https://doi.org/10.1016/j.jecp.2009.12.008

Roberts, T. A. (2003). Effects of alphabet-letter instruction on young children's word recognition. *Journal of Educational Psychology*, *95*(1), 41–51. https://doi.org/10.1037/0022-0663.95.1.41

Schwanenflugel, P. J., & Knapp, N. F. (2016). *The psychology of reading: Theory and applications*. New York: Guilford.

Share, D. L. (2008). Orthographic learning, phonological recoding, and the self-teaching hypothesis. *Advances in Child Development and Behavior*, 36, 31-82.