Multisensory Alphabet Instruction for Young Children

Dissertation

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Abstract

Little evidence exists on how best to support children's alphabet knowledge, which is a foundational early literacy skill. In this study, I investigated the impact of multisensory alphabet instruction on the alphabet learning of English monolingual and emergent bilingual (EB) children aged 3:5 to 5 years old. My primary aim was to examine whether multisensory alphabet instruction would improve young children's lowercase letter-name and letter-sound knowledge compared to non-multisensory alphabet instruction. One of my two secondary aims was to investigate whether children's language status, either EB or not EB, moderated the impact of multisensory alphabet instruction. For my other secondary aim, I examined whether the effects of instruction on lowercase letter learning were moderated by having knowledge of uppercase letters. I utilize an experimental, within- and between-subjects, pretest-posttest study design to address these aims. Thirty-six children were enrolled in the study and received 1:1 alphabet instruction on two sets of four letters, either using a multisensory or non-multisensory approach, with a final set of four letters serving as a control. Findings have shown that young children benefited from explicit and systematic alphabet instruction, whether multisensory or non-multisensory, in terms of improving their lowercase letter knowledge. EB and English monolingual children experienced a similar benefit from alphabet instruction, perhaps because they have similar background, including SES and language and literacy exposure. Children in general were more likely to know lowercase letters if they knew the corresponding uppercase letters.

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During my Ph.D. journey, there were many times I doubted myself and felt defeated. However, because of that time, I learned to focus on what I could do instead of what I could have done, believe in myself, and keep moving forward. This journey was a tremendous learning opportunity for me. I have developed my identity of scholar and educator that I wish to pursue, which is constantly being willing to learn and keep seeking.

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Fields of Study

Major Field: Education and Human Ecology: Teaching and Learning

Reading and Literacy in Early and Middle Childhood

Table of Contents

List of Tables

List of Figures

Chapter 1: Introduction

Alphabet knowledge, or the ability to recognize and produce letter names and sounds, is an emergent literacy skill critical for conventional reading and writing (Whitehurst & Lonigan, 1998). Substantial research has highlighted the association between children's alphabet knowledge and later reading (Bramlett, Rowell, & Mandenberg, 2000; Lonigan, Burgess, & Anthony, 2000; National Reading Panel, 2000) and shown that alphabet knowledge predicts children's later reading success (Georgiou, Torppa, Manolitsis, Lyytinen, & Parrila, 2012; National Early Literacy Panel, 2008). As national reports have emphasized alphabet knowledge as one of the "key early literacy and reading indicators" (National Early Literacy Panel, 2008, p. 60), much attention in early childhood education has focused on teaching code-based skills, including alphabet knowledge (Pearson & Hiebert, 2010). Correspondingly, federal, state, and professional organizations include alphabet knowledge in their learning standards (Ohio Department of Education, 2020; Piasta, Petscher, & Justice, 2012; U.S. Department of Health and Human Services, 2015).

Despite these efforts, up to 40% of U.S. children enter kindergarten without the skills they need to become successful readers (Fielding, Kerr, & Rosier, 2007). In particular, many children entering first grade still struggle with alphabet knowledge, in that they are not able to identify all letters by name, sound, or a word that starts with the letter (D'Agostino & Rodgers, 2017). Additionally, the Head Start Child Development and Early Learning Framework sets a benchmark of knowing 18 uppercase and 15

lowercase letters by the age of 60 months (U.S. Department of Health and Human Services, 2015) based on Piasta et al. (2012)'s work. However, one recent study reported that many children participating in a Head Start program did not meet this benchmark, identifying names of only about 11 uppercase letters, on average, in spring (Heilmann, Moyle, & Rueden, 2018). Additionally, children in the U.S. exhibit considerable individual differences in alphabet knowledge depending on their socioeconomic status (SES) and other characteristics (Piasta, 2014; Strang & Piasta, 2016). Strang and Piasta (2016), for example, reported that children from lower-SES families identified fewer letter names and letter sounds than their peers from higher-SES families. Children who experience challenges in acquiring alphabet knowledge may experience reading difficulties later in their academic careers (Piasta et al., 2012; Torppa, Poikkeus, Laakso, Eklund, & Lyytinen, 2006).

Supporting Children's Alphabet Knowledge

Despite the importance of alphabet knowledge, little evidence exists on how best to support children's alphabet knowledge development (National Early Literacy Panel, 2008; Piasta, 2014; Piasta & Wagner, 2010a). The National Early Literacy Panel (2008) identified only seven studies that examined the effects of instruction targeting children's alphabet knowledge and was not able to draw many implications about effective alphabet instruction, beyond noting that interventions targeting both phonological awareness and phonics showed greater effects on alphabet knowledge outcomes than interventions targeting only phonological awareness. Similarly, in their meta-analysis, Piasta and Wagner (2010a) also found only a handful of studies that specifically targeted alphabet knowledge; they found more studies that targeted improving children's alphabet

knowledge as a part of multicomponent instruction. They suggested that, within the available literature, school-based and small-group instruction showed more positive effects on children's alphabet knowledge compared with home-based and individual tutoring instruction. Subsequent literature suggests that teaching both letter names and letter sounds is effective for improving children's alphabet knowledge (Piasta, Purpura, & Wagner, 2010; Roberts, Vadasy, & Sanders, 2018) and that preschoolers learned more letter sounds when they received alphabet instruction not embedded in the context of storybook reading compared to when they were taught letter names and sounds in the context of storybook reading (Roberts, Vadasy, & Sanders, 2019a).

Not only are there few studies informing best practices for alphabet knowledge, but it may be challenging for educators to provide effective alphabet instruction that meets the various learning needs of children. Children's learning needs vary widely because of differences in letter and child characteristics (Piasta, 2014). Some letters are easier or more difficult for children to know (Drouin, Horner, & Sondergeld, 2012; Piasta, Phillips, Williams, Bowles, & Anthony, 2016), and this affects children's letter name learning (Piasta, Park, Fitzgerald, & Libnoch, 2022). For example, some letters appear more frequently in print in children's daily lives, which makes those letters more likely to be acquired compared to other letters (Turnbull, Bowles, Skibbe, Justice, & Wiggins, 2010). Also, some letter names cue their corresponding letter sounds. For example, the letter name for B starts with the sound /b/, in which children can identify the letter sound easier compared to other letters such as H in which the name does not cue the corresponding sound (Evans, Bell, Shaw, Moretti, & Page, 2006; Treiman & Broderick, 1998).

Differences derive not only from letters but also from child characteristics. For example, children tend to identify letters more readily when letters are included in their first name and, in particular, the first letter of their first name (e.g., Justice, Pence, Bowles, & Wiggins, 2006; Piasta et al., 2016; Treiman, Levin, & Kessler, 2012; Turnbull et al., 2010). Additionally, children are more likely to identify lowercase letters when they know the corresponding uppercase form (i.e., uppercase facilitation effect; e.g., Evans et al., 2006; F. L. Huang & Invernizzi, 2014; Treiman & Kessler, 2004; Turnbull et al., 2010), although this effect, along with other effects, is supported only by correlational, and not causal, evidence to date. Such differences across letters and children create great variability and may make it challenging for educators to provide alphabet instruction that fulfills the diverse learning needs of children. Together, questions remain as to how best to support children's alphabet knowledge, and more research is needed to examine what constitutes effective alphabet instruction.

Alphabet instruction for supporting emergent bilingual children

In U.S. classrooms, there is a growing number of emergent bilingual (EB) children who use more than one language in their daily lives (U.S. Department of Education, 2020), and these children also need support in their English alphabet knowledge development. Previous studies assesed the alphabet knowledge of EB children at the beginning of kindergarten and showed that children identified 9 to 13 letters on average (Cirino, Pollard-Durodola, Foorman, Carlson, & Francis, 2007; Ford, Cabell, Konold, Invernizzi, & Gartland, 2013). These findings are similar to the alphabet knowledge exhibited by English monolingal children enrolled in Head Start programs (Heilmann et al., 2018), indicating that these children may need more support to meet the

national benchmarks set by Head Start (U.S. Department of Health and Human Services, 2015). EB children may experience challenges acquiring alphabet knowledge because they are learning multiple languages at once and thus processing more information. For example, EB children learning multiple orthographies at the same time need to learn more orthographic units.

To date, most research on English alphabet instruction has focused on monolingual, English-speaking children (Piasta et al., 2022; Piasta et al., 2010; Piasta & Wagner, 2010b; Roberts & Sadler, 2019). Additionally, previous studies have shown conflicting findings as to whether EB children's early literacy development is similar to or different from that of English monolingual children (Crevecoeur, Coyne, & McCoach, 2014; Hammer et al., 2014; Lonigan, Farver, Nakamoto, & Eppe, 2013; Treiman, Levin, & Kessler, 2007). It is unclear whether effective evidence-based practices supporting English monolingual children's alphabet knowledge may also facilitate alphabet knowledge for EB children. Additionally, EB children may vary in their alphabet knowledge depending the language(s) that they use in addition to English, given that EB children's alphabet knowledge in their additional language(s) may be associated with their knowledge of the English alphabet (Cárdenas-Hagan, Carlson, & Pollard-Durodola, 2007). For instance, the similarity between EB children's orthographic systems may be related to their alphabet knowledge in English (Park & Piasta, 2022). Also, previous studies have reported that EB children's language and print exposure in their additional language(s) were related to their early language and literacy learning in English (Duursma et al., 2007; Reese, Garnier, Gallimore, & Goldenberg, 2000), suggesting that these might also be important to consider in relation to EB children's alphabet

knowledge. Therefore, it is important to determine whether alphabet instruction is effective for EB children as well as their English monolingual peers so that early childhood teachers can support the alphabet knowledge of children from all language backgrounds.

Purpose and Contributions of the Study

The present study addressed the issue of better supporting the alphabet knowledge of both English monolingual and EB children. With respect to the latter population, I intentionally included EB children from varying language backgrounds, to reflect the realities of language diversity in early childhood classrooms in the U.S.

The primary aim of this study was to examine one potentially effective means of supporting alphabet knowledge, multisensory instruction. Multisensory instruction is an approach that features activities targeting all of the following sensory modalities: visual, auditory, tactile, and kinesthetic. Multisensory instruction is hypothesized to be effective for children's learning in general (Campbell, Helf, & Cooke, 2008; Shams & Seitz, 2008). A handful of studies have shown that multisensory instruction may promote language and literacy learning (Andrä, Mathias, Schwager, Macedonia, & von Kriegstein, 2020; Repetto, Pedroli, & Macedonia, 2017), although the authors of one recent meta-analysis study questioned the postivie effect of multisensory instruction (E. A. Stevens et al., 2021). There is very limited evidence as to whether alphabet instruction that includes multisensory components is more effective than more typical alphabet instruction. Thus, this study contributes to the broader knowledge concerning evidence-based practices for facilitating young children's alphabet learning. In doing so, the study also makes a practical contribution, in that the findings may help early childhood administrators and

educators make decisions about what might be most effective for supporting the alphabet knowledge development of children enrolled in their programs.

Second, given the need to understand whether instructional practices are effective not only for English monolingual but also EB children, I investigated whether children's language status moderated the impact of multisensory alphabet instruction. As noted above, there is very little evidence to suggest evidence-based practices that are effective for supporting the alphabet knowledge development of EB children. Additionally, it is not clear whether the same practices that are effective for English monolingual children are also effective for EB children. Therefore, in this study, I empirically tested the extent to which EB status moderates the efficacy of multisensory instruction. In doing so, study findings provide practical information for early childhood educators as to whether this type of instruction may be beneficial for children from varying language backgrounds who may be enrolled in their classrooms or whether they will need to further differentiate instruction. To further contextualize results concerning effects for EB children, I have collected additional data concerning EB children's language and print exposure in their additional language(s) at home. This information may be important to consider, given previous studies indicating the potential of positive transfer among language literacy skills (Duursma et al., 2007; Reese et al., 2000). In considering EB children's language backgrounds along with the findings from my research questions, this study may point to future factors that need to be incorporated into research, including EB children.

Third, previous literature suggests that there is an uppercase facilitation effect (e.g., Evans et al., 2006; F. L. Huang & Invernizzi, 2014; Treiman & Kessler, 2004; Turnbull et al., 2010). However, this effect has not been tested using causal research

designs. Therefore, I investigated whether knowing uppercase letters moderates the impact of alphabet instruction. In testing this effect within an experimental design, I determined whether uppercase letter knowledge causally affects lowercase letter learning and thereby contribute to understanding mechanisms underlying children's alphabet learning. This also provides instructional information for early childhood educators considering using uppercase letter knowledge as a resource for teaching lowercase letter knowledge to young children.

Chapter 2: Review of Literature

One potential strategy to improve children's alphabet knowledge is using multisensory instruction. Multisensory instruction is expected to benefit children's learning because it affords opportunities to learn through multiple modalities (Campbell et al., 2008; Shams & Seitz, 2008). In this chapter, I first define multisensory instruction based on the literature and outline the effectiveness of multisensory instruction for early language and literacy learning, including alphabet learning. Then, I describe multisensory instruction as a means for supporting EB children and explain the uppercase facilitation effect.

Definition of Multisensory Instruction

Multisensory instruction involves "visual, auditory, and kinesthetic-tactile strategies used simultaneously to enhance learning" (Campbell et al., 2008, p. 269). This definition appears to be shared by other scholars (Bara, Gentaz, & Cole, 2007; Bara, Gentaz, Cole, & Sprenger-Charolles, 2004; Dev, Doyle, & Valente, 2002; DiLorenzo, Rody, Bucholz, & Brady, 2011; Kerins, Trotter, & Schoenbrodt, 2010; Lee, 2016; Magpuri-Lavell, Paige, Williams, Akins, & Cameron, 2014; Roberts, Vadasy, & Sanders, 2019b; Schneider & Evers, 2009; Stoner, 1991; Vennakkadan & Irudayasamy, 2014; Walet, 2011; Zettler-Greeley, Bailet, Murphy, DeLucca, & Branum-Martin, 2018). In practice, multisensory instruction can be applied in various ways. For example, in multisensory alphabet instruction, children might look at a letter on a card and then use their fingers to write or trace a letter in sand while listening to that letter's name/sound

and repeating it. Here, children use the visual modality when looking at a letter, the tactile modality when writing a letter in the sand, and the auditory modality when listening to and repeating the letter name or sound. As a second example, when teaching letter sounds to children, educators can use multiple modalities to represent the letter in addition to prompting children to repeat the letter sound, (e.g., jumping for J, /j/).

Some scholars refer to multisensory instruction as instruction that uses at least two modalities (Andrä et al., 2020; Marottoli-Heyman, 1995; Montgomery, 2008; Raspin, Smallwood, Hatfield, & Boesley, 2019; Schlesinger & Gray, 2017; Widyana, Astuti, Bahrussofa, & Githa, 2020). For example, some multisensory instruction has emphasized visual and auditory features (Marottoli-Heyman, 1995; Montgomery, 2008; Raspin et al., 2019). Raspin et al. (2019) indicated that their lessons featured at least two sensory modalities (i.e., visual, auditory, or kinesthetic/tactile) at a time. The definition of multisensory instruction used in these studies may align with a literal definition of the word "multisensory" as indicated in Collin's dictionary—involving more than one sense ("Multisensory," n.d.). However, given the nature of reading and literacy instruction, instruction using only two modalities—visual and auditory—may not be unique to multisensory instruction. Indeed, almost all alphabet instruction would naturally include visual and auditory features. For example, children are often encouraged to see a letter, to recognize its shape, and to say the name or sound of a letter. Thus, instruction targeting only visual and auditory modalities might not be considered "multisensory alphabet instruction."

Multisensory instruction is not explicitly defined in some studies examining the effect of multisensory instruction (Bailet, Repper, Piasta, & Murphy, 2009; Brand &

Dalton, 2012; Carreker et al., 2007; Fisher, 2012; Griva & Semoglou, 2012; Vickery, Reynolds, & Cochran, 1987; Zulhendri & Warmansyah, 2020). Brand and Dalton (2012), for instance, described their Universal Design for Learning as a multisensory curriculum and referred to multisensory as "multiple means of engagement and expression." Also, the authors highlighted the significance of multiple means of engagement and expression because they designed the multisensory curriculum to prepare children to derive enjoyment, meaning, and learning from their reading. However, I could not locate any explicit explanation of what features were included in their multiple means and expression. As another example, Fisher (2012) described programs that used a multisensory approach, including a multisensory spelling display and individualized multisensory reading/spelling activities; however, only an implicit definition of multisensory instruction was provided.

Although authors of several studies do not explicitly define their version of multisensory instruction, they referred to their program as multisensory because it is based on the Orton-Gillingham approach (Carreker et al., 2007; Vickery et al., 1987). The Orton-Gillingham approach is a well-known form of reading instruction that utilizes a multisensory approach. In the 1920s, Dr. Samuel Orton introduced multisensory instruction and further developed the Orton-Gillingham approach, which Campbell et al. (2008) explained as "a systematic, sequential, multisensory, synthetic, and phonics-based instruction to teaching reading" (p. 269). The key features of the multisensory Orton-Gillingham approach include visual, auditory, and kinesthetic or tactile learning modalities, which are referred to as the *Language Triangle* (Ritchey & Goeke, 2006). For example, in Orton Gillingham instruction, teachers encourage children to write letters

in the sand, finger-tap to segment new words into phonemes, and move their body to correspond to visual prompts to learn letter sounds (Kerins et al., 2010).

Together, the term multisensory instruction is used in various ways in the literature. There is no consensus on the definition or key features of multisensory instruction. Collectively, multisensory instruction is an instructional approach that includes multiple sensory activities. In this study, I defined multisensory instruction as an approach that features activities targeting all the following modalities: visual, auditory, tactile, and kinesthetic.

Theoretical and Practical Rationale for Multisensory Instruction

The theoretical rationale for multisensory instruction draws on information processing theory and neuroscience literature. People perceive a large amount of information through sensory systems; however, only a small portion of this information is processed in short-term memory and then stored in long-term memory (Atkinson & Shiffrin, 1968; Sperling, 1960). According to information processing theory, short-term memory, also known as working memory, is a storage structure where information is temporarily saved. Information is permanently stored in long-term memory. Cognitive load refers to the amount of information that short-term memory can hold at once. Because short-term memory has a limited capacity, cognitive load needs to be processed so that information to be transitioned from short- to long-term memory. As described by Atkinson and Shiffrin (1968), this occurs via active control processes, which are strategies that are used to process information in short-term memory such that it becomes encoded in long-term memory. Chunking, for example, is a strategy in which pieces of information are grouped together into a meaningful whole. Evidence suggests that

information received from different modalities can be more easily chunked (Bagui, 1998). Thus, information processing theory suggests that multisensory instruction, which uses multiple modalities to teach new information, may reduce cognitive load and increase the processing of information in short-term memory. In turn, this increased processing may facilitate permanently storing that information in long-term memory, which may lead to learning. For example, children may store the shape, name, and sound of a specific letter more easily in their long-term memory using multiple modalities. When children encounter that specific letter later, they can access the information related to the letter stored in long-term memory and therefore identify it. When such a process is repeated, children may become proficient in identifying a letter and understanding the concept of a letter, resulting in alphabet learning.

Additionally, although previous neuroscience studies showed that brain activation mapped to specific senses or modalities (Allman & Meredith, 2007; Jones & Powell, 1970), new research shows that multiple areas of the brain are activated when new information is processed (Beauchamp, 2005; Gibson & Maunsell, 1997; Sugihara, Diltz, Averbeck, & Romanski, 2006). In an early tracing study, for instance, researchers examined monkeys' cerebral cortices and found that the visual, tactile, and auditory sensory areas were associated with particular regions such as the occipital lobe (visual), postcentral lobe (tactile), and superior temporal (auditory) lobe (Jones & Powell, 1970). However, one new study reported that after monkeys learned to relate arbitrary auditory and visual stimuli, cells in monkeys' inferotemporal cortices reacted selectively to the trained multisensory stimulus (Gibson & Maunsell, 1997). This reaction indicates that multiple areas of the brain were activated when provided with multisensory stimuli. In

another study, Sugihara et al. (2006) examined whether neurons in the frontal lobes react to auditory or visual sensory stimuli. The findings showed that neurons in the frontal lobes reacted to not only one sensory modality but also to audiovisual stimuli. This finding indicates that the brain reacts to multisensory stimuli.

Additionally, Beauchamp (2005) reviewed previous research and noted that different parts of the human brain react to different combinations of sensory stimuli. For example, one part of the brain shows a strong activation from visual and tactile sensory inputs but not from auditory sensory input. Another part of the brain is activated in response to auditory, visual, and multisensory sensory inputs. Yet another part of the brain, one that is a critical region for information processing, reacts to visual and kinesthetic sensory inputs; however, it reacts weakly to tactile sensory input. As such, a new understanding of how the brain works suggests that certain areas of the human brain are activated by multiple senses. Thus, brain activation in multisensory areas could indicate that the human brain may operate optimally with multisensory input (Shams & Seitz, 2008). This supports the hypothesis that multisensory instruction may promote children's learning in early literacy.

There may also be practical reasons for using multisensory instruction. Scholars have suggested that, by including activities that use different modalities, multisensory instruction engages children who have different preferences in how they learn new information (Shams & Seitz, 2008). For instance, some children may prefer to see or hear new information. Thus, children may be more engaged and motivated in learning in the context of multisensory instruction. Griva and Semoglou (2012) descriptively reported that children's motivation and their willingness to learn words were high in the

context of multisensory instruction. Multisensory activities may also easily be integrated into practices that educators already use in their classrooms. For example, when teaching letter sounds to children, in addition to prompting children to repeat the letter sound, educators can use multiple modalities to represent the letter (e.g., jumping for J, /j/). Additionally, educators can demonstrate writing activities using multiple modalities such as visual, auditory, and kinesthetic/tactile. They can prompt children to say a letter name and its sound followed by writing the letter with a pen (i.e., using fine motor skills), writing the letter in the sand (i.e., tactile), or writing the letter in the air (i.e., using gross motor skills). However, despite these potential practical benefits, research evidence concerning the effectiveness of multisensory instruction is limited.

In sum, multisensory instruction may reduce cognitive load and thereby help children learn new information more easily. It may also align with how the human brain functions. Additionally, multisensory instruction may help educators engage children in learning and can be easily integrated into existing classroom practice.

Effects of Multisensory Instruction on Early Language and Literacy Skills

In September 2019, I conducted a literature search to locate empirical evidence concerning the effects of multisensory instruction on early language and literacy outcomes. First, I searched PsycInfo and ERIC using the following terms: (a) "literacy or reading or language or decoding" AND "multi-sensory or multisensory" AND "program or curricular or curriculum or instruction or intervention or practice" and (b) "learning or instruction or approach" AND "multi-sensory or multisensory" AND "review or synthesis." Additionally, to locate studies that did not refer to instruction as multisensory but still included activities featuring multiple modalities, I used the following search

terms: “The Spalding Method or Alphabetic Phonics or Dyslexia Training or Orton-Gillingham or Project Read Phonology or Read, Set Leap or BrightStart” AND “multisensory or effectiveness or program.” Next, I searched the term “multisensory” on the *Dyslexia* journal’s website, which is known to publish studies related to multisensory instruction, to double-check whether any articles were missing from the list obtained from PsycInfo and ERIC. I limited my search to studies published in English in peer-reviewed journals and published from 1968 to 2019. Initially, I obtained 157 studies. I reviewed the titles and abstracts of obtained studies and screened studies using the following inclusion/exclusion criteria: (a) included studies within the language and literacy domain, (b) included studies targeting young children from preschool to elementary grades, and (c) excluded studies that only included children with a disability in the sample. These screening criteria were applied to empirical studies, not for studies that conducted a literature review. After screening, I had 36 articles. I reviewed the full text of these 36 studies with the same criteria mentioned above to determine whether studies truly meet these criteria. As a result, I identified 19 studies. Below, I describe these studies with respect to effects on children’s language and literacy outcomes.

One-group Designs

Some studies used quasi-experimental designs that lacked a comparison group (Carreker et al., 2007; Dev et al., 2002; Fisher, 2012; Magpuri-Lavell et al., 2014; Raspin et al., 2019), which leads to a challenge in determining what would have happened without multisensory instruction (Shadish, Cook, & Campbell, 2002). Dev et al. (2002) used a one-group posttest-only design to examine the Orton-Gillingham program. The program included activities featuring visual, auditory, and kinesthetic elements as a

means of teaching letter sounds and sound blends to 11 first graders. Children who scored below average in the areas of reading, spelling, and mathematics on the Wide Range Achievement Test-III (WRAT-III; Wilkinson, 1993) participated in the study. The authors provided 25 to 30 minutes of individual instruction, two to three times a week, over two years. After receiving the intervention, all first graders except one child scored above grade level in spelling.

Raspin et al. (2019) examined a multisensory, computer-based literacy intervention intended to improve students' spelling and reading. The intervention included activities that featured visual and auditory elements. A total of 33 elementary grade children participated in the study and received six to 10 sessions over three to four weeks. Their reading and spelling skills were measured using the Schonell Reading and Spelling tests (Schonell, 1971). Children who received the intervention made measurable gains in their reading and spelling.

Magpuri-Lavell et al. (2014) investigated computer-based multisensory instruction. The instruction included activities that featured tactile or kinesthetic, auditory, and visual modalities to teach language-related concepts, such as the structure and use of sounds, syllables, words, sentences, and written discourse. A total of 39 elementary grade children aged seven to 11 participated in the study and received approximately 60 hr of reading instruction for a month. Participants' letter-sound knowledge and accuracy and automaticity of word reading skills were measured using the Word Identification and Spelling test (Wilson & Felton, 2004). Children gained skills in word reading, letter-sound knowledge, and oral reading fluency after receiving multisensory instruction.

Carreker et al. (2007) examined Orton-Gillingham-based instruction on 536 fifth-grade children's reading growth. Children's reading growth was measured using Texas Learning Index scores from the Texas Assessment of Basic Skills subtest. Children made positive growth in reading comprehension after receiving instruction.

Fisher (2012) examined a three-tiered reading and spelling program, including one tier that used a multisensory approach. Based on pretest scores, children were placed into one of three groups, depending on their reading spelling scores: (a) Group 1, in which reading and spelling scores matched or exceeded the children's chronological age; (b) Group 2, in which reading and spelling scores differed between one to two years below/above the benchmark for children's chronological age; and (c) Group 3, in which reading and spelling scores differed by at least two years below/above the benchmark for children's chronological age. A total of 350 children aged 7 to 11 participated in the study, and their reading and spelling scores were assessed using the Helen Arkell Spelling test (Helen Arkell Dyslexia Centre, 1999). A three-tiered program was provided to children differently depending on the group in which they were placed. All children received a classroom-based structured Tier 1 instruction, including individualized multisensory reading and spelling activities. No further description concerning the multisensory activities was indicated. Children in Groups 2 and 3 received additional weekly, one-to-one Tier 2 instruction focused on vocabulary, and those in Group 3 received additional one-to-one or small-group Tier 3 instruction. Children aged 8 to 10 showed gains in measured skills after receiving Tier 1 multisensory instruction; however, children 11 years of age did not show a significant gain in spelling.

The authors from the studies mentioned above argued that participating children improved their reading and spelling skills after receiving multisensory instruction. However, determining whether such improvements are because of multisensory instruction is difficult because there is no comparison group. Such research designs cannot rule out many threats to internal validity (e.g., selection bias, history, maturation, and regression). Thus, learning may occur for other reasons unrelated to receiving instruction (Shadish et al., 2002). For example, children may have gained skills as they matured or became familiar with assessments from their pretest assessment experiences.

Multiple-group Quasi-experimental Designs

Other studies have used designs that included a comparison group. Stoner (1991) used a two-group posttest-only design to investigate multisensory instruction based on the Orton-Gillingham program. The instruction included activities that featured visual, auditory, and kinesthetic elements. A total of 86 first-, second-, and third-grade children at risk for reading failure participated in the study. Children were not randomly assigned to either treatment or comparison group. Researchers recruited treatment group children from the first year of the research project and the comparison group children were identified as at-risk readers in the year prior. Children's reading scores on the Stanford Achievement Test (Madden, Gardner, & Collins, 1982) were compared to a group of children who were identified as at-risk in the prior year. The findings showed that children who received instruction outperformed the children in the comparison group in the total reading score and the subtests of word study skills, word reading, and reading comprehension. However, there is no information regarding the pretest scores of children in two groups. A two-group posttest-only quasi-experimental design is threatened by

history, maturation, and selection bias, which makes it difficult to determine whether the results are due to the treatment (Shadish et al., 2002). There may be alternative explanations for findings due to unequal baselines of the two groups. For example, children from the treatment group could outperform those in the control group because they had initially higher skills, not because the instruction was effective.

DiLorenzo et al. (2011) examined multisensory instruction that included activities featuring visual, auditory, and kinesthetic modalities. The study included children from three classes to serve as an intervention group (n = 43) and children from one class to serve as a comparison group (n = 18). Children in the intervention group received daily, 90-min block multisensory instruction during language arts activities. Those in the comparison group received business-as-usual instruction. Participants' initial sound fluency, phoneme segmentation fluency, and nonsense word fluency skills were assessed using the Dynamic Indicators of Basic Early Literacy Skills (DIBELS; Good, Simmons, Kame'enui, Kaminski, & Wallin, 2002). The results showed that children in the intervention group outperformed those in the comparison group in initial letter-sound recognition, phoneme segmentation, and nonsense word decoding skills. Like Stoner (1991), DiLorenzo et al. (2011) used two-group posttest-only quasi-experimental design. As mentioned above, such design is threatened by history, maturation, and selection bias, which makes it difficult to determine whether the results are due to the treatment (Shadish et al., 2002).

Lee (2016) compared two multisensory interventions using a quasi-experimental design. One intervention provided multisensory instruction via a touch-screen tablet computer, and another intervention provided multisensory instruction using a physical

letter card. Both multisensory interventions included activities featuring tactile and kinesthetic elements. A total of 56 emergent bilingual Malay– and English- speaking second graders participated in the study and received 20-min lessons. Children were not randomly assigned to groups; importantly, however, the two groups had equal pretest scores on literacy skills (e.g., letter naming, single-word reading, passage reading). Children's blending and segmenting skills were assessed at posttest, and the findings showed that children made significant gains in blending and segmenting skills in both types of multisensory interventions. However, the findings did not indicate whether multisensory instruction was effective or not because the difference between the two conditions was the multisensory instruction's delivery format: either via a touch-screen tablet or a physical letter card. Furthermore, given that children were not randomly assigned to groups, the findings are threatened by history, maturation, and selection bias (Shadish et al., 2002). Even if children had equivalent skills at pretest, other unmeasured factors may differ and therefore represent alternative explanations for findings. For instance, the treatment group children may have outperformed the comparison group children because they received a richer literacy environment in their classrooms.

Bara et al. (2004) included 60 French monolingual kindergarten-aged children in their quasi-experimental study and assigned them to one of three groups that received alphabet and phonemic awareness instruction with the following types of activities: (a) visual and auditory elements; (b) visual, auditory, and kinesthetic elements using traditional letter cards; (c) and visual, auditory elements with a computer screen. Children received a 25-min session twice per week for seven weeks. Their alphabetic principle and metaphonological awareness abilities were measured with a pseudo-word

decoding test, a test requiring the recognition of alphabet letters, a rhyme identification test, and two phoneme identification tests. The findings showed no differences among the three groups' pretest scores, indicating initial equivalence between groups. Additionally, the results showed that including kinesthetic elements to instruction helped kindergarteners improve skills in pseudo-word decoding but not in letter recognition, phoneme identification, or rhyming. Even though the authors indicated no difference in pretest scores between the two groups, threats to internal validity such as history and maturation could not be entirely ruled out. Because children were not randomly assigned to groups, selection bias still exists, and there may be alternative explanations for findings.

Bara et al. (2007) conducted another quasi-experimental study testing the effect of the same multisensory instruction mentioned above with 132 kindergarten-aged children from low SES backgrounds. Children in the intervention group received multisensory instruction with activities featuring visual and kinesthetic elements. Children in the control group received instruction with only visual and auditory elements. There was no difference between the two groups' pretest scores, indicating skill equivalence between the groups. The findings showed that children in the intervention group scored higher in a letter-recognition task compared to those in the control group, suggesting that adding kinesthetic features to instruction may be effective for increasing children's alphabet knowledge. Again, the authors indicated no difference in pretest scores between the two groups; yet, there are threats to internal validity such as history, maturation, and selection bias given that children were not randomly assigned to groups.

Experimental Designs

Some studies used a randomized controlled trial (Bailet et al., 2009; Griva & Semoglou, 2012; Kerins et al., 2010; Labat, Vallet, Magnan, & Ecalle, 2015; Roberts et al., 2019b; Widyana et al., 2020; Zettler-Greeley et al., 2018; Zulhendri & Warmansyah, 2020) or single-case design (Campbell et al., 2008; Schlesinger & Gray, 2017) to examine multisensory instruction. Such experimental designs are the most rigorous for causally testing effects of instruction (Shadish et al., 2002).

Zulhendri and Warmansyah (2020) examined multisensory instruction for a total of 67 first graders. Although further information regarding the intervention group was not given, the authors mentioned that children were randomly assigned to either an intervention group or a control group in which children received business-as-usual instruction. The authors did not describe what comprised the multisensory instruction, nor did they provide pretest scores for the children in the two groups. Children's skills were assessed in alphabet knowledge, word concepts, spelling, and decoding words. The findings showed that children who received multisensory instruction outperformed children in the control group in early reading skills, including alphabet knowledge. The limitation of this study was that there were no pretest scores. Although the intervention and control groups are theoretically equated on all measured and unmeasured variables, whether children in the two groups had any initial differences in their early literacy skills were not established. The extent to which that equated baseline of the random group assignment holds true depends on how large the sample size is. Therefore, considering the study included a small sample size coupled with not having pretest information, it may be challenging to confirm an equal baseline of two groups; thus, there may be a limitation on the effects of the multisensory instruction.

In their study, Zettler-Greeley et al. (2018) included a total of 476 preschoolers who were at-risk for reading difficulties, and randomly assigned these children to either an intervention group or a comparison group. Children in the intervention group received two small-group 30- to 40-min pull-out lessons per week for nine weeks targeting print and letter knowledge and phonological awareness; the intervention included activities featuring visual, auditory, kinesthetic, and tactile modalities. Children in the comparison group received business-as-usual instruction. Children's skills in print knowledge, phonological awareness, rhyme knowledge were measured using the Test of Preschool Early Literacy (Lonigan, Wagner, & Torgesen, 2007) and the Assessment of Literacy and Language (Lombardino, Lieberman, & Brown, 2005). The findings showed that children who received supplemental multisensory instruction scored higher in print knowledge, elision, blending, and rhyming than those in the comparison group.

Bailet et al. (2009) studied the same intervention and randomly assigned 220 preschoolers who were identified as at-risk for reading difficulties into either an immediate intervention or delayed intervention group (comparison group). The participants' print awareness, alphabet knowledge, beginning phonological awareness skills, picture naming, rhyming, and alliteration were measured using the Get Ready to Read! (Whitehurst, 2001) and Get it, Got it, Go! (Research and Development of Individual Growth and Development, 1998) screening tools. The findings showed that preschoolers in the immediate intervention group made significant gains in rhyme and alliteration recognition skills, but not in picture naming, compared to those in the comparison group. There was no effect on the Get Ready to Read! outcome.

Kerins et al. (2010) used a randomized controlled trial to investigate the effect of small-group reading instruction, based on the Orton-Gillingham multisensory approach, on first-grade children's phonemic awareness skills. Twenty-three children identified as having below-average reading or phonemic-awareness skills were randomly assigned to either an intervention or control group. Children in the intervention group received 30 min of phonological awareness instruction for two months and another 30 min of multisensory phonics instruction for 17 weeks. Multisensory phonics instruction included activities featuring visual, auditory, tactile, and kinesthetic elements. Children in the control group received business-as-usual reading instruction. Participants' skills in phonological awareness, alphabetic comprehension, reading fluency, phonemic awareness skills, and comprehension were assessed using three measures: DIBELS (Good et al., 2002), Individual Language Assessment (i.e., a teacher-administered assessment conducted at schools), and Running Records (Clay, 2000). The findings showed no significant differences between children's gains in the intervention and control groups.

Griva and Semoglou (2012) also used a randomized controlled trial to test the efficacy of multisensory instruction based on the Orton-Gillingham program teaching phonemic awareness and phonics. Instruction included activities that featured visual, auditory, tactile, and kinesthetic features. A total of 44 second-grade Greek children learning English participated in the study and were randomly assigned to either an intervention or comparison group. Children received intervention for three hr per week for four months. Children in the comparison group received business-as-usual reading instruction. The researchers measured participants' word production, understanding of

environmental print, ability to produce a word within a sentential context, and understanding of language functions and performance. The results showed no significant differences in children's gains between the intervention and comparison groups, indicating no effects of multisensory instruction.

Widyana et al. (2020) used a randomized controlled trial to compare two multisensory interventions: One intervention associated each letter sound with a kinesthetic movement, and the other included activities featuring visual, auditory, kinesthetic and tactile modalities. Although the specific sample size was not given, the authors mentioned that the sample was fewer than 50 children. The authors suggested that both types of multisensory interventions improved kindergarteners' gains in pre-reading skills, including the ability to identify letters. The authors did not present several details, including the exact sample size and description of two types of multisensory instruction. Moreover, there was no control group, such that an alternative explanation of study findings could be that children simply gained literacy skills over time as they matured. Thus, the findings of this study cannot speak to whether multisensory instruction improved children's pre-literacy skills.

Labat et al. (2015) conducted a randomized controlled trial to compare the effect of multisensory approaches on enhancing children's alphabet knowledge. A total of 50 five-year-old monolingual French-speaking children participated in the study and were randomly assigned to one of five groups that received (a) a multisensory approach that included activities featuring visual and tactile modalities; (b) a multisensory approach that included activities featuring visual and kinesthetic elements; (c) an instructional approach that included activities featuring only visual element; (d) an instructional

approach that included activities featuring only tactile element; or (e) an instructional approach that included activities featuring only kinesthetic element. Children's skills in pseudo-word reading and spelling were measured. The findings showed that children who received either of the multisensory approaches outperformed the children who received other instructional approaches in pseudo-word reading and spelling skills.

Roberts et al. (2019b) conducted a randomized controlled trial to investigate the effect of letter-name and letter-sound instruction. Although these researchers did not explicitly frame their study as testing the effects of multisensory instruction, the instruction they provided used a multisensory approach. A sample of 94 preschoolers participated in the study and were randomly assigned to one of the following three groups: (a) letter-name and sound paired–associate instruction, which featured visual and auditory modalities; (b) letter-name and sound paired–associate instruction with an additional writing activity, which featured visual and auditory modalities; (c) letter-name and sound paired–associate instruction with additional practice activities using mouth gestures when saying letter sounds, which featured visual, auditory, and kinesthetic modalities. Children received a 12- to 15-minute lesson four times per week for 10 weeks. Their letter-name and letter-sound knowledge, rapid letter naming, and letter writing were assessed. The findings showed that children who received letter-name and sound paired–associate instruction outperformed children in other groups on letter name, letter sound, and rapid letter naming tasks, indicating that the additional multisensory components in the other instructional groups did not provide additional benefits for children's letter-name and letter-sound learning.

Two studies used multiple baseline single-subject designs to examine multisensory instruction (Campbell et al., 2008; Schlesinger & Gray, 2017). Campbell et al. (2008) examined whether adding multisensory components to a supplemental reading program could enhance six second-grade children's decoding skills. Multisensory components in instruction included visual, auditory, and kinesthetic features (i.e., finger tapping, letter formation onto carpet squares, and the use of magnetic letters). Participants' abilities to decode nonsense-words were measured using the DIBELS (Good et al., 2002). The findings showed that children's decoding fluency increased as a result of adding multisensory features to instruction.

Schlesinger and Gray (2017) also used a multiple baseline single-subject design to test whether a multisensory intervention provides children with an advantage in alphabet knowledge, reading, and spelling skills. A total of 11 second graders, including children with typical development (n = 6) and those with dyslexia (n = 5), participated in the study. During one treatment phase, children received a multisensory intervention, including activities that featured at least two visual, auditory, tactile, and kinesthetic elements. The children received 30-min sessions, three times per week, over six to seven weeks. During the other treatment phase, the children received a structured language intervention, which did not include activities featuring any multisensory elements. The children's skills in producing letter names and sounds, reading words, and spelling words were measured. The findings showed that, in general, the multisensory intervention did not provide an advantage over the structured intervention for children with typical development or dyslexia.

Summary and Limitations of Previous Literature on Multisensory Instruction

Although the findings have been inconsistent, the body of literature suggests the promise of multisensory instruction on children's early language and literacy outcomes (Bailet et al., 2009; Bara et al., 2004, 2007; Campbell et al., 2008; Labat et al., 2015; Roberts et al., 2019b; Zettler-Greeley et al., 2018). However, there are a number of key limitations. First, most of the studies have not used robust research designs that allow for causal claims. Some quasi-experimental studies lacked either a comparison group or pretest scores (Carreker et al., 2007; Dev et al., 2002; DiLorenzo et al., 2011; Magpuri-Lavell et al., 2014; Raspin et al., 2019; Stoner, 1991; Zulhendri & Warmansyah, 2020) and only a few quasi-experimental studies included a comparison and pretest scores (Bara et al., 2004, 2007; Lee, 2016). Either way, quasi-experimental studies cannot provide strong evidence concerning multisensory instruction because children were not randomly assigned to groups. When group assignment is not random, selection bias may occur, and group equivalence is not guaranteed (Shadish et al., 2002). Although many of these studies showed no difference in pretest scores between groups, selection bias is not completely ruled out, and the results may be caused by an alternative reason other than the intervention.

Second, there have been three studies that included a counterfactual that afforded testing whether adding multisensory components leads to better early language and literacy outcomes relative to instruction without multisensory elements (Bara et al., 2004, 2007; Roberts et al., 2019b). However, the findings were mixed; Bara and colleagues found that adding a kinesthetic modality to instruction led to positive outcomes (Bara et

al., 2004, 2007), whereas Roberts et al. (2019b) found no effect of multisensory instruction on children's alphabet learning.

Third, most randomized controlled trial studies included a business-as-usual condition as a control (Bailet et al., 2009; Griva & Semoglou, 2012; Kerins et al., 2010; Labat et al., 2015; Zettler-Greeley et al., 2018). This may not be an adequate counterfactual for examining the effect of the multisensory component of instruction. In other words, such research designs examine the effects of multisensory instruction—as a whole—relative to typical practice, but cannot indicate the effects of multisensory instruction relative to non-multisensory instruction. In group comparison research designs, researchers observe "what did happen" when participants received treatment, and the counterfactual refers to "what would happen" to those same participants if they did not receive the treatment (Shadish et al., 2002). Key tasks in research design are creating "high-quality but necessarily imperfect sources of counterfactual inference to understand how this source differs from the treatment condition" (Shadish et al., 2002, p. 6). In other words, to test the impact of multisensory instruction, the counterfactual condition would need to provide similar instruction to children without the multisensory component and compare the results of the two groups of children who did and did not receive instruction using the multisensory approach.

Fourth, several studies have considered a variety of early language and literacy outcomes when examining the effects of multisensory instruction. However, very few studies have specifically targeted alphabet knowledge as part of instruction (Bailet et al., 2009; Bara et al., 2004, 2007; Labat et al., 2015; Roberts et al., 2019b; Widyana et al., 2020; Zettler-Greeley et al., 2018). Furthermore, even fewer studies have targeted

alphabet knowledge as part of instruction and measured it as an outcome (Bara et al., 2004, 2007; Roberts et al., 2019b; Widyana et al., 2020). Also, findings are inconsistent. Bara and colleagues found that their multisensory alphabet instruction improved children's letter-name recognition skill (Bara et al., 2004, 2007) whereas Roberts et al. (2019b) found no effect of multisensory alphabet instruction on children's letter-name knowledge.[1]

Finally, another limitation of the previous literature is the lack of language diversity in studies' samples. Most studies included monolingual English-speaking children only (Bailet et al., 2009; Campbell et al., 2008; Dev et al., 2002; DiLorenzo et al., 2011; Kerins et al., 2010; Magpuri-Lavell et al., 2014; Raspin et al., 2019; Schlesinger & Gray, 2017; Stoner, 1991; Zettler-Greeley et al., 2018; Zulhendri & Warmansyah, 2020). Only four studies included monolingual children speaking languages other than English, such as Greek and French (Bara et al., 2004, 2007; Griva & Semoglou, 2012; Labat et al., 2015). Additionally, only three studies included EB children (Carreker et al., 2007; Lee, 2016; Roberts et al., 2019b). Furthermore, of the studies that included EB children in the sample, only one study used a research design with a comparison group and an adequate counterfactual. Overall, the current literature does not allow for generalization of findings to populations other than those who are monolingual English-speaking. I address this particular issue in more detail in the next section.

[1] Widyana et al. (2020) reported that they measured children's letter identification skills, but no further details were described.

Supporting Emergent Bilingual Children's Alphabet Knowledge

As the population of EB children in the U.S. grows, an increasing number of studies have examined approaches to instruction that can improve EB children's language and literacy development (Babinski, Amendum, Knotek, Sánchez, & Malone, 2018; Bowers & Vasilyeva, 2011; Buysse, Castro, & Peisner-Feinberg, 2010; T. A. Gibson, Peña, & Bedore, 2014; Leśniewska & Pichette, 2016; Limlingan, McWayne, Sanders, & López, 2019; Lindholm-Leary, 2014; Roberts et al., 2018, 2019b; Yeung & Savage, 2020). However, to my knowledge, only three studies have investigated whether instruction can enhance EB children's alphabet knowledge (Roberts et al., 2018, 2019b; Soto, Crucet-Choi, & Goldstein, 2020).

Soto et al. (2020) conducted a multiple-baseline, single-case study to examine the effect of a supplemental intervention that targets phonological awareness and alphabet knowledge. Four Latinx preschool-aged children participated in the study. All four children had above average Spanish and English receptive and expressive language skills, as measured by the subtests of the Bilingual English-Spanish Assessment (BESA; Peña, Gutiérrez-Clellen, Iglesias, Goldstein, & Bedore, 2018). All but one met the benchmark for Spanish and English narrative skills, as measured by the Spanish and English version of the Test of Narrative Retell from the Narrative Language Measure Preschool (Petersen & Spencer, 2012). In terms of their home language exposure, children tended to have high Spanish exposure (input-output percentage of 67% to 87% as measured using the Bilingual Input-Output Survey from the BESA), with somewhat less English exposure (13% to 33%). In the study, children received 10-min supplemental lessons four to five times a week for 12 to 17 weeks. Stimuli were provided during lessons and these were

16 letters shared in Spanish and English and 18 words (12 words from Spanish and six words from English). Three lessons comprise one unit; the first three units included Spanish instruction with Spanish stimuli followed by English stimuli to facilitate cross-language generalization of emergent literacy skills. The last unit included Spanish instruction with only English stimuli. The children's phonological awareness and alphabet knowledge skills in both English and Spanish were measured using English and Spanish versions of researcher-developed curriculum-based measures (CBMs; Soto et al., 2020), the Individual Growth and Development Indicators-Spanish (IGDIs-S; Wackerle-Hollman et al., 2012), and the DIBELS (Good et al., 2002). The findings indicated that children showed improved scores in the English-sound identification subtest of IGDIs in the last unit, which included Spanish instruction with only English stimuli. However, no effects were found in children's English-sound identification skills measured by IGDIs in other unites, children's phonological awareness knowledge measured from DIBELS, or English letter naming skills evaluated from the subtest of the IGDIs. The results also showed no evidence of cross-linguistic transfer from Spanish to English in letter-naming skills.

Additionally, one research team conducted two randomized controlled trials to investigate the impact of alphabet instruction on preschool-aged children's English alphabet knowledge (Roberts et al., 2018, 2019b). Roberts et al. (2018) included a total of 83 preschoolers, including 30 EB children. The EB children's English oral proficiency was evaluated using the IDEA, Pre IPT Oral Language Proficiency Test (Pre-IPT; R. Stevens, 2010); however, Roberts et al. (2018) did not report information about participating children's English oral proficiency. No other language background

information was reported. Children were randomly assigned to one of four different conditions. Each group was taught the alphabet as follows: (a) letter-name only, (b) letter-sound only, (c) both letter names and sounds, and (d) business-as-usual alphabet instruction. Each child in the treatment groups was taught 12 letters. Researchers measured children's alphabet knowledge for the 12 letters taught, including letter naming and letter-sound production tasks, letter naming speed, and letter writing. The authors found no significant differences in pretest scores between the EB children and their English monolingual peers. Outcomes indicated that EB children who received letter-name only intervention scored higher in letter-naming production task, and those who received letter-sound only intervention scored higher in letter-sound production tasks as compared to those who received business-as-usual alphabet instruction. Additionally, EB children who received both letter name and sound intervention scored higher on a letter naming production task than those who received business-as-usual alphabet instruction. Moreover, the instruction was not differentially effective for monolingual versus EB children across all three instructional conditions. As noted, the study included minimal information about EB children, and it is thus unclear who was included in this study sample (e.g., demographic background, language background, English proficiency, proficiency in additional language[s]).

Roberts et al. (2019b), also described in the previous section, included 35 EB children in their overall sample of 94 preschool-aged children. The EB children's English oral proficiency was evaluated as in Roberts et al. (2018) using the Pre-IPT. Ten of the EB children demonstrated a beginning level of English proficiency, 20 showed an intermediate level of English proficiency, and five showed an advanced level of English

proficiency. As described above, Roberts et al. (2019b) randomly assigned children into one of the following three groups: (a) letter-name and sound paired–associate instruction, which featured visual and auditory modalities; (b) letter-name and sound paired–associate instruction with an additional writing activity, which featured visual and auditory modalities; (c) letter-name and sound paired–associate instruction with additional practice activities using mouth gestures when saying letter sounds, which featured visual, auditory, and kinesthetic modalities. Children received 12- to 15-min lessons four times per week for 10 weeks. Their letter-name and letter-sound knowledge, rapid letter naming, and letter writing were assessed. The findings showed that children who received letter-name and sound paired–associate instruction outperformed children in other groups in letter knowledge, which does not provide evidence supporting multisensory instruction. The findings also showed that there was no moderation effect based on language status (i.e., whether children were EB or English monolingual) on the effect of interventions. Thus, the effects of alphabet instruction for EB children were not different from that for English monolingual children.

In sum, the previous literature shows that instruction targeting alphabet knowledge and phonological awareness, instruction focusing on exclusively letter-name or letter-sound, and letter-name and sound paired–associate instruction may be beneficial for improving EB children's English alphabet knowledge (Roberts et al., 2018, 2019b; Soto et al., 2020). However, the findings are not entirely consistent. For example, Roberts and colleagues found that their instruction was effective for both EB children's letter name and letter sound knowledge (Roberts et al., 2018, 2019b), whereas Soto et al. (2020) found that instruction was only effective in supporting EB children's letter sound

knowledge. Furthermore, only two studies examined the effect of alphabet instruction on both EB and monolingual English-speaking children (Roberts et al., 2018, 2019b); it remains unclear whether alphabet instruction that is effective for monolingual English-speaking children will also be effective for EB children given the limited number of studies.

Multisensory Instruction for Supporting Emergent Bilingual Children

Multisensory instruction may be beneficial for EB children. Based on information processing theory, using multiple modalities in instruction may offer EB children more efficient ways to store and retrieve information about English letters. It may be especially important for EB children because they are learning multiple languages and simultaneously processing more information than their peers. In addition to processing more language information, EB children may also have more orthographic units to learn if they are learning multiple orthographies at once (e.g., all the letters of the English alphabet plus the orthographic symbols of their additional languages). Challenges from learning multiple languages may lead to greater cognitive load when processing alphabet knowledge for EB children as compared to their monolingual peers. As discussed, multisensory instruction may help these children chunk information to reduce that load.

Findings from previous studies investigating the effect of multisensory instruction on EB children's learning are mixed. One research team has suggested that multisensory instruction may promote stronger connections among information when learning different languages (Andrä et al., 2020; Repetto et al., 2017). Andrä et al. (2020), for instance, conducted three within-subjects experiments to examine the effects of gesture-based and

picture-based instruction for teaching new English and German vocabulary to 8-year-old German-speaking children. In the first two experiments, a gesture-based multisensory intervention, including activities featuring auditory and kinesthetic elements, was compared to a non-multisensory intervention. In the third experiment, the gesture-based multisensory intervention was compared with a picture-based intervention, including activities that featured visual and auditory elements. In each experiment, the children received 35-min lessons over five consecutive days. The children's vocabulary was assessed by their recall of learned vocabulary words. The findings showed that gesture-based instruction enhanced the participating children's new vocabulary learning compared to children who received the non-multisensory intervention. These findings mirror those reported by Repetto et al. (2017), whose sample included multilingual young adults.

Conversely, Roberts et al. (2019b), as mentioned above, found that adding multisensory components to instruction did not affect English monolingual or EB children's gains in letter name and letter sound knowledge relative to letter-name and sound paired–associate instruction. Despite their empirical results, their findings showed that EB children gained alphabet knowledge across all conditions, including conditions in which children received multisensory instruction using mouth gestures and featuring letterforms through writing. Thus, the authors suggested further research examining the effect of multisensory instruction on EB children.

To sum, multisensory instruction may be especially useful for EB children (Andrä et al., 2020). However, only three studies have examined the effect of multisensory instruction on EB children's language and literacy learning (Andrä et al., 2020; Repetto

et al., 2017; Roberts et al., 2019b), and, to my knowledge, only one study specifically focused on supporting EB children's alphabet knowledge (Roberts et al., 2019b). Furthermore, the findings are mixed. Andrä et al. (2020) found a positive impact of multisensory instruction on EB children's learning whereas Roberts et al. (2019b) did not. Additionally, most of the previous literature examining alphabet instruction lacks language diversity in study samples, making it difficult to generalize findings to the broader population of children served in U.S. early childhood classrooms.

Moreover, of the few studies in which EB children were included in the samples (Roberts et al., 2018, 2019b; Soto et al., 2020), only one study considered and measured EB children's language backgrounds (Soto et al., 2020). Previous studies have indicated that EB children's skills in additional language(s) other than English are related to their early English language and literacy skills (e.g., Buysse, Castro, West, & Skinner, 2005; Durán, Roseth, & Hoffman, 2010; B. H. Huang, Bedore, Ramírez, & Wicha, 2021; Páez & Rinaldi, 2006), which may indicate the importance of understanding EB children's additional language(s). B. H. Huang et al. (2021), for instance, examined whether Spanish and English oral language skills affected Spanish-English speaking EB children's English reading skills. The findings showed that Spanish oral language skills predicted English decoding skills. Thus, the authors argued that EB children's oral language skills in their additional language Spanish contributed to children's English reading outcomes. This leads to an argument that understanding EB children's additional language, such as literacy skills and level of proficiency, may inform their English literacy skills.

Furthermore, the idea of linguistic transfer, which refers to EB children's primary language as a resource for acquiring languages and literacy skills in another language (Cummins, 1981), may also highlight the importance of understanding EB children's additional language(s). Previous studies have shown that language and literacy skills in one language facilitated learning another language (e.g., Bengochea, Justice, & Hijlkema, 2017; Cárdenas-Hagan et al., 2007; Kim & Piper, 2019; Lindahl & Sayer, 2018; O'Brien, Mohamed, Yussof, & Ng, 2019; Verhoeven, 2007). Bengochea et al. (2017), for example, examined the linguistic transfer of 84 three- to four-year-old Maya- and Spanish-speaking EB children in print and alphabet knowledge. The findings showed that children's Maya letter-name knowledge was significantly correlated with Spanish letter-name and letter-sound knowledge. Although preliminary, these findings provide an understanding of the cross-language relations regarding alphabet knowledge. Cárdenas-Hagan et al. (2007) also investigated 1,016 kindergarten-aged, Spanish- and English-speaking EB children's early literacy skills in English and Spanish. The findings showed that Spanish-speaking children who scored higher on Spanish letter name and letter sound assessments also scored higher on English letter name and letter sound assessments. Cross-language relations found in the previous studies suggest the potential need to understand both languages that EB children use. For instance, understanding whether their additional language uses a similar orthographic system to English (i.e., Latin-based language) may help understand how EB children obtain literacy skills in English.

More specifically, EB children's language and print exposure in language(s) other than English may be important for understanding their early language and literacy skills (Duursma et al., 2007; Reese et al., 2000). Duursma et al. (2007), for instance, examined

the relation between home literacy and language environment and EB children's English and Spanish vocabulary. A total of 96 fifth-grade Spanish- and English- speaking children participated in the study, and the findings showed that children from families whose parents and siblings preferred to use English at home tend to be highly proficient in English vocabulary tasks. Additionally, Reese et al. (2000) conducted a longitudinal study to examine factors that predict children's Spanish literacy and oral English proficiency. A total of 66 EB children participated in the study and the findings showed that the grandparents' level of education was positively associated with family literacy practices and children's emergent Spanish literacy and oral English proficiency. As such, EB children's language background and language and print exposure to additional language(s) other than English may be critical in understanding their early literacy learning. Together, considering the potential transfer from one to another language, it may be necessary to describe EB children's language use and print exposure in their additional language at home to understand children's English alphabet learning.

Uppercase Facilitation Effect

Another factor that might moderate impacts of alphabet instruction is knowledge of uppercase letter forms. Young children tend to be less knowledgeable about lowercase forms compared to uppercase forms (Evans et al., 2006; Turnbull et al., 2010; Worden & Boettcher, 1990). Evans et al. (2006), for example, found that almost 50% of the participating children identified all uppercase letter names, whereas only 12% of the participating children identified all lowercase letter names. Moreover, studies have shown that knowing an uppercase letter positively predicts knowing the corresponding lowercase letter (e.g., F. L. Huang & Invernizzi, 2014; Treiman & Kessler, 2004;

Turnbull et al., 2010). Turnbull et al. (2010), for instance, used a cross-sectional design to examine whether children are more likely to know lowercase letter names if they knew the corresponding uppercase letter names. A total of 461 3- to 5- year-old children participated in the study, and their alphabet knowledge was assessed using a subtest of the Phonological Awareness Literacy Screening for Preschool (Invernizzi, Sullivan, Meier, & Swank, 2004). The findings showed that children were 16 times more likely to know the name of a lowercase letter if they knew the corresponding uppercase letter.

Similarly, F. L. Huang and Invernizzi (2014) examined whether knowledge of uppercase and lowercase letters are related in a sample of 5020 kindergarten children. Children's alphabet knowledge was measured using the Phonological Awareness Literacy Screening – Kindergarten (Invernizzi, Swank, Juel, & Meier, 2003). The findings showed that children were three times more likely to know lowercase letter names when those were visually similar to corresponding uppercase letters. Park and Piasta (2022) examined the uppercase familiarity effect specifically with EB children. A total of 56 EB children participated in the study, and their English letter name knowledge was measured. The findings showed that EB children tended to be more familiar with lowercase letter names when they already knew the corresponding uppercase letter name.

Similar to the argument for multisensory instruction based on information processing theory, this uppercase facilitation effect may be due to the benefits of having one concept (i.e., knowledge of a letter name or letter sound) stored in multiple ways (i.e., two forms of the letter) and thus multiple ways to access the letter in long-term memory. Yet, previous studies were all correlational; moreover, this research has not been conducted in the context of learning letters over time but rather knowing letters at

one point in time. Thus, none of the studies can support causal claims concerning potential instructional benefits of uppercase facilitation on lowercase letter learning. Furthermore, to my knowledge, only one study (Park & Piasta, 2021) examined the uppercase facilitation effect for EB children's alphabet knowledge.

Aims of the Current Study

My overall objective in this study was to understand what constitutes effective alphabet instruction for English monolingual and EB children aged 3:5 to 5-year-old. I had one primary aim and two secondary aims. My primary aim was to examine whether multisensory alphabet instruction improves young children's lowercase letter name and letter sound knowledge compared to non-multisensory alphabet instruction. I specifically focused on lowercase letters because young children tend to have less knowledge about lowercase forms (Evans et al., 2006; Turnbull et al., 2010; Worden & Boettcher, 1990). Based on information processing theory and the existing literature mentioned above, I hypothesized that the impact of multisensory instruction on children's lowercase letter knowledge would be greater than non-multisensory instruction. Additionally, I hypothesized that children would gain more lowercase letter knowledge in both instructional conditions compared to the control condition.

One of my secondary aims was to investigate whether children's language status moderated the impact of multisensory alphabet instruction. Based on information processing theory and existing literature demonstrating the promise of multisensory instruction for EB children, I hypothesized that the impact of multisensory instruction would be greater for EB children than English monolingual children. Additionally, I explored EB children's language and print exposure at home in their additional

language(s) other than English to contextualize findings concerning their alphabet learning. I expected that this information would be helpful in understanding for whom the alphabet instruction may or may not be beneficial.

For my final secondary aim, I examined whether the effects of instruction were moderated by knowledge of uppercase letters. Commensurate with the uppercase facilitation effect (e.g., F. L. Huang & Invernizzi, 2014; Treiman & Kessler, 2004; Turnbull et al., 2010), I hypothesized that the impact of alphabet instruction, regardless of whether it is multisensory, on lowercase letter knowledge would be greater when a child knows the corresponding uppercase letter form than when the child does not know the uppercase form.

Chapter 3: Method

This study involved an experimental, within- and between-subjects, pretest-posttest design to address the following three aims:

(1) To examine whether multisensory alphabet instruction impacts monolingual and EB children's alphabet knowledge;

(2) To investigate whether impacts of multisensory alphabet instruction are moderated by language status;

(3) To examine whether impacts of alphabet instruction are moderated by knowledge of uppercase letters.

I provided alphabet instruction to all participating children, with some letters taught using a multisensory approach and other letters taught using a non-multisensory approach; additional letters were not taught at all and served as an additional control. For the first research aim, instructional condition was the within-subject factor of interest. For the second, time, instructional condition, and language status were the within- and between-subject factors of interest. I also considered additional information concerning EB children's language and print exposure to further contextualize findings related to the second research aim, and build a preliminary understanding of whether language and print exposure in additional language(s) may be important in the context of learning the English alphabet.

Participants

To recruit participants, I partnered with local early childhood programs to distribute an informational flier about the study, consent forms, and demographic survey to caregivers. I reached out to directors of three early childhood programs, described the purpose and procedures of the project, and asked whether they were willing to participate. When directors of such programs agreed to participate, I asked program directors and/or classroom teachers to send out study materials to caregivers of children who may not yet have mastered the alphabet. I sent out an informational flier, caregiver consent form, and demographic survey to those children's families.

I also recruited children using snowball sampling. I contacted students and alumni of the college who were caregivers of 3:5-5 years old children via email, newsletter, and an informational flier. The Office of Academic Services in the Department of Teaching and Learning assisted me by distributing an information flier to students. In addition, I used EHE News in distributing study information to alumni. With administrator permission, fliers also were distributed at local community centers (e.g., church). When caregivers expressed interest in the project, I contacted these caregivers via email or phone and set a time to meet at their homes or public locations (e.g., library). At this meeting, I answered any questions about the study and distributed caregiver consent forms and demographic surveys.

Fifty-nine caregivers provided informed consent for their child to participate. I reviewed demographic surveys to determine whether these children met the eligibility criteria for this study. Eligibility criteria were (a) caregiver's consent to participate, (b) between 3:5-5 years of age, (c) free of profound disabilities, (d) ability to understand instructional directions and communicate in English, and (e) unfamiliar with both the

name and the sound of at least 12 lowercase letters. Criteria (c) and (d) were to ensure that the alphabet lessons, which were delivered in English, were appropriate for participating children.

For criterion (a), I ensured that caregivers agreed to have their child participate on the signed consent form. For criterion (b), I used information reported by caregivers on a demographic survey to determine children's ages. For criterion (c), I used information reported by caregivers on two questions. Caregivers were asked whether their child had an Individualized Educational (IEP) Plan or 504 plan. Also, if children had an IEP or 504 plan, caregivers were asked to rate whether the impact of the disability on their children's functioning was high, moderate, or low. Children were eligible for the study if they did not have an IEP or 504 plan, or, if they did, if caregivers rated the impact of disability on child's functioning as low or moderate. I determined whether children met the fourth criterion (d) by information reported by caregivers on demographic surveys. Children whose primary language was English were included in the study. If a child's primary language was not English, I administered the IDEA, Pre IPT Oral Language Proficiency Test (Pre-IPT; R. Stevens, 2010) to determine whether these children met criterion (d). Further information about the measure is provided in the Measures section. This assessment was conducted before proceeding with additional study activities. Children who scored at proficiency levels between B to E, indicating intermediate to advanced proficiency, were eligible for the study. Among the 14 EB children whose primary language were not English (n = 11), 9 children scored level B, 1 child scored level C, and 1 child scored level E. Two children were excluded based on criterion (b). No child was excluded based on criterion (c) and (d).

For the 57 children who met criteria (a) through (d), I assessed each child's ability to produce the names and sounds for both the uppercase and lowercase forms of each letter to determine whether these children met the final eligibility criterion (e): unfamiliar with both the name and the sound of at least 12 lowercase letters. I focused on teaching children's lowercase letter knowledge in this study because young children tend to have less knowledge about lowercase forms (Evans et al., 2006; Turnbull et al., 2010; Worden & Boettcher, 1990). I enrolled 42 children meeting all eligibility criteria in the study. Six children did not complete the study because they no longer attended the childcare program (n = 4) or had frequent absences (n = 2). Among the four children who no longer attended the childcare program, two left the program before they received the alphabet lessons. The other two dropped out after going partway through the alphabet lessons. For two children who had frequent absences, I decided that there were too many absences to continue when they did not come to the childcare center for more than 2 weeks in a row.

Thirty-six children completed the study and were included in analyses. Fifty percent of children were girls and the average age was 50 months (SD = 7.12; range = 41 to 65). Forty-two percent were Black, 22% were White, and 25% were Asian (11% unreported). The highest degrees earned by children's female caregivers included a high school diploma (39%), an Associate's degree (11%), a Bachelor's degree (8%), or a graduate degree (9%); 20% of children's female caregiver did not hold a high school diploma (13% unreported). Annual family incomes were less than $25,000 for 47% of children, $25,001 to $55,000 for 39% of children, $55,001 to $75,000 for 3% of children, and more than $75,001 for 9% of children (2% unreported). One child had an IEP. On

the initial screening, out of 26 uppercase and lowercase letters, the number of correctly named uppercase letters that the children were able to identify ranged from 0 to 23 (M = 6.50, SD = 6.27), while their knowledge of lowercase letters ranged from 0 to 14 (M = 4.31, SD = 4.24). In terms of sound production, the children were able to produce 0 to 5 uppercase letter sounds (M = .64, SD = 1.38) and 0 to 2 lowercase letter sounds (M = .28, SD = .57). Fourteen children were EBs, based on a caregiver's indication in each case on the demographic survey that the child used a language other than English at home. The EB children's language background represented a variety of languages, including Korean (n = 1), Berber and Arabic (n = 1), Spanish (n = 3), and Nepali (n = 10). Table 1 displays the demographic information for the EB and English monolingual children.

Intervention

Letter Selection

Based on the screening data, I selected 12 lowercase letters unknown to each child based on letter difficulty, using the letter difficulty values from Drouin et al. (2012). Letter difficulty values represent the relative difficulty of knowing a letter. For each child, I rank ordered unknown letters from lowest to highest difficulty values and divided into four groups of similar difficulty values, with three letters randomly selected from each group to obtain 12 letters in total. I randomly assigned the three letters from each of the four groups to three sets: one set of four letters were taught using multisensory instruction (MSI), one set of four letters were taught using non-multisensory instruction (nMSI), and one set of four letters were not taught to serve as a control. As such, letters in each set had approximately equivalent letter difficulty values. Across all participating children, the average difficulty value of letters selected was 2.08 (SD = .86) for the MSI

set, 2.03 (*SD* = .81) for the nMSI set, and 1.99 (*SD* = .72) for the control set. I conducted a one-way ANOVA to ensure that selected letters were equated on letter difficulties across sets: $F = 1.72$, $p = .182$. Thus, children received instruction on sets of letters that had similar difficulty values. Selected letters for MSI, nMSI, and control sets for each child are indicated in Appendix A.

Alphabet Instruction

The alphabet instruction was provided during the pandemic. Instructors wore special protection gear during lesson implementation (i.e., a mask with a plastic window and/or face shield). All participating children, including those who were English monolinguals and EBs, received 1:1 alphabet instruction on the two sets of MSI and nMSI letters. Children received no instruction on the set of control letters. In the MSI condition, children were taught letters using various sensory modalities including visual, auditory, tactile, and kinesthetic. Multisensory activities included hearing and saying the names and sounds of letters, seeing letter shapes, tracing letter shapes using sandpaper cards, writing letters with various writing materials, associating kinesthetic gestures with letters and sounds, feeling the vocal cords/breath/voicing when articulating letter sounds, and feeling/seeing the mouth shape when articulating letter sounds. In the nMSI condition, children were taught letters by hearing and saying the names and sounds of letters, seeing letter shapes, and writing letters on regular paper but without using the other multisensory activities mentioned above.

Lessons were provided by research team members to each child at a quiet location at the child's respective early childhood education program/home/local library. For seven children, the instructor was changed to another due to project member change in

the middle of providing intervention. All lessons were videotaped in order to code for fidelity to the lesson plans. All alphabet lessons were designed to last 10 – 15 min. The number of times the instructor prompted the child to provide each letter name and letter sound were equated across conditions. Instructors were trained to ask each letter name 13 times and letter sound 13 times in each lesson. In the MSI condition, the instructor prompted the child to provide each letter name 12.54 times on average (*SD* = 1.41) and to provide each letter sound 12.50 times on average (*SD* = 1.50). In the nMSI condition, the instructor prompted the child to provide each letter name 12.69 times on average (*SD* = 1.17) and to provide each letter sound 12.63 times on average (*SD* = 1.28). One-way ANOVA results showed that the number of attempts the instruction asked the child to provide letter name (F [1, 237] = 0.84, p = .359) and letter sound (F [1, 237] = 0.58, p = .447) between the two conditions were not significantly different from each other; thus, instructors asked the child to say/repeat letter names and letter sounds equally across conditions. To avoid an order effect, for each child, I randomly determined which set (MSI or nMSI) of letters was taught first. Of the 36 participating children, 16 children were taught the MSI set first and then taught the nMSI set; remaining children completed the nMSI set first and then the MSI set. Additionally, for each child, I randomly selected the order of letters to be taught within the MSI and nMSI sets.

Lesson Outline

Three letter lessons were provided per letter. For every letter after the first in a set, two review lessons were provided. Appendix B provides examples of letter lessons and review lessons for the MSI and nMSI conditions. No more than two lessons were

provided to a child on the same day. Letter lessons included three components—an introduction, reading practice and application, and writing practice and application.

In the introduction component, the first letter lesson included introducing the lowercase form, letter name, letter sound, and a keyword easily associated with the letter being learned. In the MSI condition, a child learned noticing the mouth gestures and movements (e.g., feeling the vocal cords/breath/voicing) when articulating letter sounds and linking the taught letter to an action (e.g., a jumping action for *J*). In the second and third letter-learning lessons, each child practiced noticing lowercase forms, saying letter names, producing letter sounds, and saying keywords. The child was asked to locate the letter in environmental printed cards (e.g., stop sign for *S*). In the MSI condition, the child was also asked to practice noticing mouth gestures when producing letter sounds, linking action to the letter being taught.

In the reading practice and application portion, the first and second letter lessons included locating a taught letter in a letter book, alphabet book, nursery rhyme, or children's magazine. For the MSI condition, the children were asked to notice the mouth movements when articulating letter sounds. In the third letter lesson, the child sorted pictures by initial sound of the object in the picture. For the MSI condition, the child was asked to notice mouth movements when producing letter sounds.

In the writing practice and application portion, the first letter lesson included introducing verbal paths for letter formation (e.g., slant down and up for *V*). For the MSI condition, the child was asked to trace the letter with their finger on sandpaper. In contrast, in the nMSI condition, tracing was completed on a plain letter keyword card. In the second letter lesson, the child practiced verbal paths for letter formation (e.g., slant

down and up for *V*) while writing the letter using with various writing implements (e.g., chalk, marker, crayon, paintbrush). For the MSI condition, the child had opportunities to associate tactile and kinesthetic movements (e.g., writing the letter in the air using arms, feeling bumps when writing the letter on the paper as placing a material underneath the paper) when writing the letter. In the third letter lesson, the child practiced verbal paths for letter formation (e.g., slant down and up for *V*) and labeled pictures that began with that letter. For the MSI condition, the children had opportunities to associate tactile movements with writing a letter (e.g., feeling bumps as writing a letter on the paper as placing a material underneath the paper).

Starting after the second letter was taught, two review lessons were provided after completing all three letter-lessons for a taught letter. Review lessons also included three components—as before, an introduction, reading practice and application, and writing practice and application. In the introduction component, both review lessons included providing the names and sounds of letters taught to that point. In the reading practice and application portion, the first review lesson included locating, naming, and producing sounds for each already-taught letter in an alphabet book. The second review lesson included sorting magnetic letters. In terms of writing practice and application, the first review lesson included tracing the previously taught letters. For the MSI condition, the child traced letters on sandpaper, whereas the nMSI condition involved tracing letters on plain letter cards. In the second review lesson, the child used picture cards that begin with taught letters to write a grocery list. For the MSI condition, the child had opportunities to associate tactile movements with writing a letter (e.g., feeling bumps as writing a letter on the paper as placing a material underneath the paper).

Instructors Training

An undergraduate research assistant and I served as instructors and provided the lessons to the participating children. Before providing any lessons, the undergraduate research assistant completed training. First, she reviewed the following documents: a) a summary of the differences in the lesson outlines between the MSI and nMSI lessons, b) three MSI and three nMSI lesson plans for the alphabetical letter *J*, c) a document describing the mouth movements, and verbal paths used throughout the MSI lessons, and d) lesson videos of me providing lessons to a child (three MSI letter lessons, three nMSI letter lessons, two MSI review lessons, and two nMSI review lessons). After reviewing the relevant documents, the research assistant and I met and discussed any questions that she had, along with the logistics involved in implementing lessons, including checking out video materials and lesson material kits, how to communicate with teachers and/or directors, establishing rapport with children, securely storing the video data, and/or any other potential issues. Then, I shadowed the research assistant as she implemented lessons (i.e., specifically, at least one lesson each for MSI and nMSI) and provided feedback.

Lesson Implementation

I used lesson videos to measure multiple aspects of lesson implementation, including adherence, duration, and frequency. Unfortunately, a technical issue led to the deletion of 5 days' worth of lesson videos (29 videos) from the SD card of a camera. To measure adherence, I randomly selected 25% of the existing lesson videos (120 MSI and 120 nMSI) and coded lesson implementation fidelity using a checklist (See Appendix C for the checklists used for implementing lesson fidelity). The checklist included items

asking whether the instructor followed the specified instructional behaviors. Additionally, the checklist contained items asking whether the instructor provided multisensory or non-multisensory instructional behaviors as intended. Each item was marked "yes" if the behavior was observed, "no" if the behavior was not observed, or "not applicable" if the behavior was not applicable to the lesson observed.

Each semester, two active coders checked lesson implementation fidelity. A total of three research team members—two undergraduate research assistants and I—coded lesson implementation using the checklist. The research assistants and I reviewed the protocol and checklists. We watched six pre-selected letter-lesson videos (three for MSI and three for nMSI), coded those videos using the implementation checklist, compared the scores, and discussed any disagreements until a consensus was reached. The goal was to achieve at least 90% reliability. Then, we watched four review lesson videos (two for MSI and two for nMSI), coded those videos using the implementation checklist, compared the scores, and discussed any disagreements until a consensus was reached. Twenty percent of the coded lessons were randomly selected to determine interrater agreement (MSI $n = 45$; nMSI $n = 46$). Interrater agreement was 95% ($SD = 9.07$) for MSI and 98% for nMSI ($SD = 6.04$). Across MSI lessons, lesson implementation fidelity averaged 95% ($SD = 8.54$), with a range of 61% to 100%. For nMSI, lesson implementation fidelity averaged 97% ($SD = 5.98$), with a range of 56% to 100%. One-way ANOVA results showed that the lesson fidelity between the two conditions was significantly different, $F(1, 341) = 6.79$, $p = .010$. According to the findings, the lesson fidelity for the nMSI condition was higher than that of the MSI condition.

While analyzing data, I thought that an additional factor, the instructors' enthusiasm during lessons, may influence the effects of alphabet lessons. For example, if instructors were more enthusiastic during the specific condition of lessons (MSI or nMSI), this may lead to one condition showing more impacts on alphabet learning. Therefore, I conducted a post hoc analysis to check whether the instructors were more or less enthusiastic when providing lessons across conditions. One of the trained coders, who was blind to the research hypothesis, reviewed lesson videos selected for interrater agreement and checked whether the instructor was more enthusiastic when providing multisensory or non-multisensory instruction. She evaluated the instructor's enthusiasm using a 7-point Likert scale, with 1 for the least enthusiastic and 7 for the most excited. According to the results, the instructors demonstrated the same enthusiasm when providing lessons: an average score of 6.4 (*SD* = .95) when providing nMSI and 6.11 (*SD* = 1.02) when providing MSI. One-way ANOVA results showed that instructors' enthusiasm scores during lessons were not different across conditions (F [1, 86] = 2.12, p = .149).

In the cases of three of the participating children, minor incidents occurred when providing intervention. For one child, the letters selected for MSI and nMSI were switched. For another child, the lesson order was switched one time. Last, in the third case, one nMSI lesson was provided twice for a letter. In addition to measuring adherence, I also tracked lesson duration and frequency. The average duration of lessons using MSI selected for fidelity coding was 8 min 36 s (*SD* = 2 min 47 s), while that of lessons using nMSI selected for fidelity coding was 7 min 53 s (*SD* = 2 min 19 s). One-way ANOVA results showed that the duration of lessons across conditions was different

from each other (F [1, 341] = 6.45, p = .012). The findings showed that the average duration of MSI lessons was longer than that of nMSI lessons. Children participated in the intervention for 83 days, on average (SD = 32.29), with a range of 34 to 188 days. The wide range of duration may be because the intervention was provided during the pandemic; for example, three children were absent due to quarantine, and the classroom was closed because of the Covid-19 exposure for 10 days. The frequency of MSI lessons was 4.10 times a week, on average; in comparison, the frequency for nMSI lessons was slightly higher, at 4.38 times a week. As each child received MSI and nMSI lessons, I conducted a paired-samples t test to ensure that the frequency of lessons provided per week across conditions was similar: $t(35) = -1.18$, p = .247, 95% CI [−.76, .20].

Measures

All child assessments were implemented by me and an undergraduate research assistant at a quiet location at the child's early childhood education program/home. Each child assessment took approximately 5 to 10 minutes to complete. Child assessments were conducted at three time points. Screening and pretest assessments were administered before providing alphabet lessons to children. After children received all alphabet lessons for both sets of letters, posttest assessments were administered. Children's caregivers also completed a demographic survey when they provided consent to study participation. This survey took approximately 15 to 20 minutes for caregivers to complete.

Letter Name and Sound Production

The following assessments were administered to assess letter name and sound production: (a) uppercase letter name production, in which children were asked to give

the name for a depicted uppercase letter, (b) uppercase letter sound production, in which children were asked to say the sound associated with a depicted uppercase letter, (c) lowercase letter name production, in which children were asked to give the name for a depicted lowercase letter, and (d) lowercase letter sound production, in which children were asked to say the sound associated with a depicted lowercase letter. All 26 letters were assessed at screening/pretest whereas only the selected 12 letters were assessed at posttest. Each letter was presented by form, first 26 lowercase letters and then 26 uppercase letters.

Within each assessment, each letter was presented in a random order. Assessors shuffled letter cards, presented each letter to a child, and asked, "What is the name of this letter?" followed by, "What sound does this letter represent?" If a child provided a name when asked for the sound, assessors prompted the child with "That's a letter name, but what is the sound of the letter?" Similar prompts were provided when a child provided a sound when asked for the name (i.e., "That's a letter sound, but what is the name of the letter?"). One point was given for each correct response, and sum scores across letters were also computed for each assessment. For letters with multiple sounds, assessors considered the sound taught during lessons as correct (e.g., /g/ for *G*, short vowel sounds).

Previous studies have used similar tasks successfully with children of this age, and reported internal consistencies ranging from .65 to .96 (Evans et al., 2006; Piasta et al., 2010). For this study sample, internal consistencies (Cronbach's α) were .92 for uppercase letter naming, .86 for lowercase letter naming, .71 for uppercase letter sound production, and .16 for lowercase letter sound production, based on the pretest

assessment of all 26 letters. The low reliability for lowercase letter-sound production may be because of the low performance on the screening assessment, which was one of the eligibility criteria for the current study.

Letter Writing

A letter writing task adapted from Puranik and Lonigan (2011) was administered. This task was administered before letter name and sound production tasks to ensure that children do not see the letter shapes before being asked to write the letters. The child was asked to write each of the 12 selected letters at pretest and posttest. Assessors named each of 12 selected letters in a random order and children were asked to write each letter. Responses were coded using a scale of 0 to 2 based on previous work (Puranik & Lonigan, 2011). Responses were scored 0 when there was no attempt at writing the letter, the written letter was unrecognizable, or the wrong letter was written. Responses were scored 1 when the written letter included most of the key features of the correct letter yet the written letter was in the wrong orientation, or the written letter could be recognized only in the context of the assessment. Responses were scored 2 when the written letter could be easily recognized and included all the key features of the correct letter.

An undergraduate research assistant and I were trained to code writing responses. Training began with reviewing the training protocol and verbal path document. Coders then used a document to study scoring examples of each alphabet letter. Next, we completed a practice set of coding writing responses and completed the test set of coding writing responses. The test sets were compared with an answer key to calculate agreement. If agreement was at least 90%, the coder proceeded with coding letter writing

responses. If not, the coder completed a second practice set and test set, on which they were required to meet the 90% agreement criterion. I randomly selected fifteen percent of the letter writing assessments (n = 17) and these assessments were double coded to measure ongoing interrater agreement, which was 97%. Prior work reported the internal consistency (α) as .93 (Puranik & Lonigan, 2011). For the current study, I am unable to provide reliability estimates because I selected 12 different letters for each child by design.

Language Background and Language and Print Exposure

Information about children's language backgrounds and language and print exposure at home was collected from a demographic survey completed by caregivers. This survey provided demographic information (e.g., gender, race/ethnicity, maternal education levels, and family income) and information concerning eligibility to participate in the study (e.g., age, IEP, 504 plan, language spoken at home, English proficiency).

Language status was coded from an item asking caregivers whether their child spoke any languages besides English at home; this was dummy coded such that responses of "yes" = 1. If caregivers indicated that their child spoke any additional language(s) besides English at home, they responded to survey items requesting information about their child's additional language(s). I collected this additional information about EB children's language use and print exposure at home for the descriptive purpose (see Appendix D) and adapted existing surveys to develop these survey items (Kang, 2015; Schwartz, 2008; Sevinç, 2016). Caregivers of EB children reported their children's dominant language(s), whether English and/or other languages. They also noted how frequently their child speaks their language(s) per day with various family members (e.g.,

mother/female guardian, father/male guardian, siblings, grandparents). If EB children's additional language(s) besides English used an alphabet for writing, caregivers reported how many alphabet letters their child knew in their additional language(s). Caregivers also responded to items requesting information about the language(s) their child typically uses and/or hears during different daily activities (e.g., an adult or older sibling speaking to the child, reading books, telling a story, watching TV, listening to songs, playing games).

English Oral Language Proficiency

For EB children whose primary language were not English, I assessed their English oral language proficiency using the IDEA, Pre IPT Oral Language Proficiency Test (Pre-IPT; R. Stevens, 2010) during screening. The Pre-IPT is an age-appropriate developed assessment for children ages 3-5. It measures vocabulary, syntax, discourse, and pragmatic aspects of English. The assessment is designed such that child have oral interactions with an assessor in a story context. An assessor uses a storyboard depicting a scene of a playground, picnic table, and pond, and cardboard characters. As written in the scoring booklet, the assessor asks children questions. For example, the assessor pointed to a girl and a boy character in turn and said "She is a girl. He is a ____" to prompt a child to say "boy." A total of 40 questions are asked, along with a story. The story has four sections, and each section is matched with a particular proficiency level (i.e., B, C, D, E). Within each section, depending on the number of errors a child makes, the assessment continues or is terminated. The maximum possible score is 42, and children are assigned one of five proficiency levels ranging from A to E; A is beginning, B and C are intermediate, and D and E are advanced. The technical manual reports an

internal consistency is .77; I am unable to calculate study-specific reliability estimates because each child completes a different number of questions.

Chapter 4: Results

Preliminary Analyses

Descriptive statistics for each of the intervention conditions on screening, pretest, and posttest measures are reported in Table 2. Preliminary analyses indicated that English monolingual and EB children did not differ in terms of gender, χ^2 (1, N = 36) = 0; age, $F(1, 35) = 0.49$, $p = .491$, $d = 0.24$, maternal education, Welch's test, $F(1, 30) = 0.21$, $p = .654$, or annual income, Welch's test, $F(1, 34) = 0.22$, $p = .647$. Similarly, the two groups of children did not differ in screening/pretest scores (uppercase letter-name production, $F(1, 35) = 0.35$, $p = .556$, $d = -0.20$; uppercase letter-sound production, $F(1, 35) = 0.96$, $p = .334$, $d = -0.33$; lowercase letter-name production, $F(1, 35) = 0.12$, $p = .736$, $d = -0.12$; lowercase letter-sound production, $F(1, 35) = 0.28$, $p = .599$, $d = -0.19$; letter-writing task, $F(1, 35) = 0.02$, $p = .885$, $d = 0.05$). Except for uppercase letter-sound production, all Cohen's d values were less than 0.25, which satisfied baseline equivalence among the two groups based on What Works Clearinghouse's baseline equivalence requirement (What Works Clearinghouse, 2020, January). For uppercase letter-sound production, the English monolingual children yielded a higher mean score (M = .82) than the EB children (M = .36) for the screening assessment.

Correlations among measures for the full sample are provided in Table 3; those for English monolingual and EB children are provided in Table 4. Scores from pretest to posttest were relatively stable in the full sample. Uppercase letter-name production, lowercase letter-name production, and letter writing were generally positively correlated

in terms of assessment points. Uppercase and lowercase letter-sound scores were generally not correlated, given the low scores on the screening assessment. I also used correlations to determine which variables to consider as covariates. Age and total duration of intervention tended to be unrelated to outcomes. Additionally, as noted in the previous chapter, children were recruited from three early childhood programs and seven children experienced in the change of the instructor instruction. Dummy coded variables for the change in the instructor and outcomes was unrelated. In addition, a dummy-coded variable for the different early childhood programs that the children were attending was also unrelated to the outcomes. Thus, these factors were not considered covariates in analyses. The English monolingual children showed similar correlation patterns among variables compared to the full sample. The EB children's assessments did not tend to correlate with one another, which might have been due to the small sample size. As in the full sample, age, total duration of the intervention, and the applicable childcare center tended to be unrelated to the EB children's outcomes. No correlations were calculated for change in instructor because none of the EB children experienced this situation.

Impact of Alphabet Instruction

Table 5 presents descriptives of the number of letter names and letter sounds that children knew, along with their letter writing scores for the selected letters. For letter-naming and letter sound production, the children identified none at screening for all three conditions, given these were a part of the eligibility criteria. On the posttest, the children identified roughly two letter names for those that were taught (i.e., MSI and nMSI) and about one letter name for control letters. In terms of letter sound production, the children produced approximately one letter sound for those that were taught (i.e., MSI and nMSI)

and none for control letters. Lastly, for letter writing, the children scored < 1 on the pretest for all conditions. On the posttest, the children scored around 2 for letters that were taught (i.e., MSI and nMSI) and around 1 for control letters.

To address the primary research aim concerning the effect of MSI, I analyzed the data using a repeated measures ANOVA. The dependent variables were the number of lowercase letter names produced correctly (letter-name), the number of lowercase letter sounds produced correctly (letter-sound), and the letter-writing scores (letter-writing) on the posttest. For the lowercase letter-name- and letter-sound dependent variables, the letter condition (i.e., MSI, nMSI, control) was included as a within-subject factor of interest. Time was not included because the number of lowercase letter names and sounds produced correctly was zero for the screening assessment. To compare three sets of two conditions (i.e., MSI vs. nMSI, MSI vs. control, nMSI vs. control), I conducted a pairwise comparison post hoc analysis using the Bonferroni procedure. For letter writing, both letter condition (i.e., MSI, nMSI, control) and time (i.e., pretest, posttest) were included as within-subject factors of interest. I considered the interaction effect of letter condition and time. To compare three sets of two conditions (i.e., MSI vs. nMSI, MSI vs. control, nMSI vs. control), I used confidence intervals to determine whether conditions differed from each other.

The results of repeated measures ANOVAs for the outcome variables and post hoc analysis are provided in Tables 6 and 7 (see also Figures 1, 2, and 3). The main effects for condition revealed differences between the conditions in the children's learning in terms of lowercase letter-name production, $F(1, 35) = 4.48$, $p = .015$, and lowercase letter-sound production, $F(1, 35) = 12.66$, $p < .001$. Specifically, the children

in the MSI condition learned more lowercase letter names than those in the control condition, $F(1, 35) = 0.67$, $p = .011$, $d = 0.53$. Children also learned more lowercase letter sounds in the MSI condition, $F(1, 35) = 1.06$, $p < .001$, $d = 1.00$, and the nMSI condition, $F(1, 35) = 0.69$, $p = .002$, $d = 0.72$, than the control condition. Additionally, the results demonstrated no significant difference between the MSI and nMSI conditions. Meanwhile, for the letter-writing task, no significant interaction effect emerged between time and condition in terms of the gains children made from the pretest to the posttest, $F(1, 35) = 1.72$, $p = .187$, indicating no differential gains existed in lowercase letter writing between conditions.

Language Status as a Moderator of the Impact of Alphabet Instruction

Descriptives for the number of letter names and letter sounds that EB and English monolingual children knew, and their letter writing scores for the selected letters, are presented in Table 7. For all three conditions (i.e., MSI, nMSI, control), English monolingual children knew slightly more lowercase letter names than EB children at the posttest. For lowercase letter sound production, EB and English monolingual children demonstrated similar scores at the posttest. For letter writing, EB children scored slightly higher than English monolingual children at the posttest.

To address the secondary aim of whether the children's language status moderated the impact of instruction, I analyzed the data using a within–between mixed ANOVA, in which the dependent variables were the number of lowercase letter names produced correctly, the number of lowercase letter sounds produced correctly, and the letter-writing scores on the posttest. For the lowercase letter-name and letter-sound dependent variables, the letter condition (i.e., MSI, nMSI, control) was included as a

within-subject factor of interest. As mentioned earlier, time was not included because the number of lowercase letter names and sounds correctly produced was zero at the time of the screening. Language status was included as a between-subjects factor of interest. Specifically, I considered the interaction effect of letter condition and language status. For the letter-writing dependent variable, both letter condition (MSI, nMSI, control) and time (pretest, posttest) were included as within-subject factors of interest. Language status was included as a between-subjects factor of interest. I considered the interaction effects among letter condition, time, and language status. First, I examined the overall interaction effect. In the case of a significant interaction, I planned to conduct a simple slope test to investigate whether there was a difference in the impact of letter condition (MSI, nMSI, control) for children who were and were not EB.

Table 7 provides the results of the analyses (see also Figures 4, 5, and 6). No significant interaction effect was observed between letter condition and language status in terms of the gains children made from the pretest to the posttest on the lowercase letter-name and letter-sound production tasks, $F(1, 35) = 0.98$, $p = .382$; $F(1, 35) = 0.15$, $p = .861$, respectively. There was also no interaction effect among time, letter condition, and language status in the letter-writing task in terms of the gains children made from the pretest to the posttest, $F(1, 35) = 0.56$, $p = .574$. According to these outcomes, EB and English monolingual children benefited similarly from multisensory and non-multisensory instruction.

Although no interaction effects were found, I calculated Cohen's *d* of each outcome for the EB and English monolingual children (see Table 8). This post hoc analysis was done due to the small sample size of EB children, given that there might not

have been not enough power to detect significant interaction effects. Cohen's *d* was generally similar for the EB and English monolingual children. For letter-name production, Cohen's *d* comparing the MSI and control conditions for the EB children demonstrated a small to medium effect size of 0.36. The same comparison for English monolingual children yielded a modest to a large effect size of 0.68. When comparing the nMSI and control conditions, Cohen's *d* for the EB children was 0.49, while for the same comparison in the case of the English monolingual children, *d* was 0.23. When comparing the MSI and nMSI conditions, Cohen's *d* for the EB children was -0.11. In contrast, conducting the same comparison for the English monolingual children yielded a *d* value of 0.37. For letter-sound production, Cohen's *d* comparing the MSI and control conditions for the EB children demonstrated a modest to large effect size of 0.83. The same comparison for English monolingual children also yielded a modest to large effect size of 1.11. When comparing the nMSI and control conditions, Cohen's *d* for the EB children was 0.75, while for the same comparison in the case of the English monolingual children, *d* was 0.67. When comparing the MSI and nMSI conditions, Cohen's *d* for the EB children was 0.15. In contrast, conducting the same comparison for the English monolingual children yielded a *d* value of 0.37.

Language Background of EB Children

For the EB children, to further contextualize the findings concerning the effect of multisensory alphabet instruction on their alphabet learning, I also descriptively analyzed the information collected about their language background, including language use and print exposure at home. First, I asked caregivers which language(s) was/were considered the children's dominant language and how often they used the language(s) in daily life.

Out of 14 EB children, 10 of them used both English and an additional language as their dominant languages. Among nine of these children, seven used Nepali, and two used Spanish as their additional language. The last child's additional language was not reported. One EB child's dominant language was recounted to be only English. Three EB children's dominant language was indicated to be a language other than English: Korean (n = 1), Spanish (n = 1), or Berber (n = 1). Caregivers noted that the EB children used English in everyday life rarely (n = 3), sometimes (n = 4), frequently (n = 2), or all the time (n = 3); two were not reported. Additionally, the caregivers responded that the EB children used an additional language rarely (n = 1), sometimes (n = 2), frequently (n = 4), or all the time (n = 4; three unreported). Two caregivers stated that their children used a third language (one reported Arabic; one was not reported) never (n = 1) or rarely (n = 1). The children used a mixture of English and an additional language(s) rarely (n = 1), sometimes (n = 2), frequently (n = 4), or all the time (n = 3).

I further asked with whom EB children lived and how often they used particular languages with each family member. For the reader's convenience, I have divided this usage into several tables: EB children's language use with their female guardian (Table 9), male guardian (Table 10), sibling (Table 11), grandparents (Table 12), and other family members (Table 13). The EB children tended to use their additional language(s) more often than English with female guardians, male guardians, and grandparents. Contrariwise, EB children tended to use English more often than their additional language(s) with their siblings. The frequency of using a mixture of English and additional language(s) was fairly distributed from never to all the time with female

guardians, siblings, and grandparents. With male guardians, the EB children tended to use a mixture of English and additional language often.

Additionally, in the case of EB children whose additional language(s) used an alphabetic writing system, I asked caregivers how knowledgeable their children were about the alphabet in their additional language. Three of the caregivers reported that these children's additional language(s) were Korean (n = 1) and Nepali (n = 2). These caregivers further noted that their EB children knew 0–19% (n = 3) of the total number of letters in the additional language.

Finally, I collected information about the language and print exposure that the EB children had at home while engaging in various activities (see Figure 7). Many caregivers did not respond to these items; the missing data ranged from 29 to 64%. Among the responses that were reported, the EB children tended to use mostly English in their oral language (e.g., when speaking, when adults told stories to children, when watching television, when listening to songs). Regarding literacy exposure and activities, the EB children tended to use mostly additional language(s) and some English when they read books with adults. However, they tended to use equal or mostly English when reading or looking at books alone. For other activities, such as playing games, using electronic devices, and participating in church activities, the children tended to use English.

Uppercase Facilitation Effect

At screening, the children's scores for uppercase letter names ranged from 0 to 9 (M = 1.81, SD = 2.23), while scores for uppercase letter sounds ranged from 0 to 1 (M = 0.03, SD = 0.17) among 12 selected letters. Based on these descriptive statistics, showing

that children knew almost no uppercase letter sounds at screening, I addressed the secondary aim concerning the uppercase facilitation effects in the context of learning for letter names only. I analyzed the letter name data using multilevel logistic regression, given that letters (Level 1) are nested within children (Level 2). The purpose of the analysis was to examine the likelihood of responding correctly to a given lowercase letter at posttest, considering both whether the lowercase letter was taught and whether the child knew the corresponding uppercase form at the time of the screening. Because I examined whether the lowercase letter was taught, I considered taught letters as letters that were selected for either the MSI or nMSI condition. Multilevel analysis was necessary because this technique accounted for the two sources of variance simultaneously: between children and between letters (Piasta & Wagner, 2010b; Richter, 2006). I used this analysis to determine whether uppercase letter knowledge moderated lowercase letter learning. A dummy-coded variable indicating whether the child responded correctly to each lowercase letter on the posttest was the outcome variable (1 = correct response, 0 = incorrect response). Whether the child correctly responded to the uppercase letter during the screening (1 = correct response, 0 = incorrect response), the letter type (taught [either MSI or nMSI] = 1, control = 0), and the uppercase letter response × letter type interaction were added as the Level-1 predictors. The model estimated coefficients of correct responses for lowercase letters, depending on each predictor. I have converted the log-odds using coefficients via the following formula: Log odds = e^{coeff}.

The results are presented in Table 14. For letter-naming, no significant interaction effect was evident, $\beta = 0.18$, $p = .789$. However, main effects emerged for

letter type (β = 0.72, p = .009) and whether children correctly responded to the uppercase letter during the screening (β = 1.27, p = .020). In other words, knowing uppercase letters predicted knowing the corresponding lowercase letter, but it did not depend on whether the lowercase letters were taught or not. The children were 2.05 times more likely to know the name of a lowercase letter on the posttest if the lowercase letter was taught than if it was not taught. Additionally, children were 3.55 times more likely to know the name of a lowercase letter on the posttest if they knew the name of the corresponding uppercase letter on the screening assessment than if they did not. The log-odds were 0.29 when a lowercase letter was not taught and the child did not know the corresponding uppercase form. The log-odds were 1.03 when a lowercase letter was not taught and the child knew the corresponding uppercase form. When a lowercase letter was taught but the child did not know the corresponding uppercase form, the log-odds were 0.59. When a lowercase letter was taught and the child knew the corresponding uppercase form, the log-odds were 2.51.

Chapter 5: Discussion

In this study, I investigated the impact of multisensory alphabet instruction on the alphabet learning of English monolingual and EB children aged 3:5 to 5 years old. My primary aim was to examine whether multisensory alphabet instruction would improve young children's lowercase letter-name and letter-sound knowledge compared to non-multisensory alphabet instruction using an experimental, within-subject, pretest–posttest design. One of my two secondary aims was to investigate whether children's language status moderated the impact of multisensory alphabet instruction. For my other secondary aim, I examined whether the effects of instruction were moderated by having knowledge of uppercase letters.

Impact of Alphabet Instruction

Little evidence exists on how best to support children's alphabet knowledge development (National Early Literacy Panel, 2008; Piasta & Wagner, 2010a), despite its importance to children's later reading success (Bramlett et al., 2000; Lonigan et al., 2000; National Reading Panel, 2000). In that sense, this study contributes to expanding the knowledge of evidence-based practices for facilitating young children's alphabet learning by conducting a rigorous within-subject research design investigating whether children benefited from alphabet instruction. As hypothesized, children generally gained more lowercase letter knowledge in both instructional conditions (MSI and nMSI) compared to the control condition, with the exception of letter-naming for the non-multisensory condition. The findings indicate that children learn from explicit and systematic alphabet

instruction, similar to other alphabet instruction that research has suggested to be effective (Piasta, 2014). In both instructional conditions, the instructors explicitly taught the children letter names and letter sounds. Lessons for both conditions were also designed to be systematic. For example, the sequence of teaching letters included three letter-lessons per letter followed by two review lessons; moreover, each letter lesson comprised three components.

Specifically, when comparing the learning of letters taught via multisensory instruction compared to that of control-condition letters, the children demonstrated better performance in producing lowercase letter names and letter sounds in the former case. These findings were statistically significant; moreover, Cohen's *d* was 0.53 for letter-naming and 1.00 for letter-sound production. In the case of non-multisensory instruction, children gained more lowercase letter-sound production skills ($d = 0.72$) in learning letters compared to the control condition for learning letters. These effect sizes indicate the magnitude and practical significance of the effects of the alphabet instruction on the children's lowercase letter knowledge. The effect sizes of this study exceeded the modest effect sizes reported for alphabet instruction in a meta-analysis conducted by Piasta and Wagner (2010a). Additionally, the current study's effect sizes were generally similar to or above those reported in the previous studies focused on alphabet instruction that noted this approach as effective for improving children's alphabet knowledge. For example, Piasta et al. (2010) reported Cohen's *d* of 0.19 and 0.47 for letter-naming and letter-sound production, Roberts et al. (2018) indicated Cohen's *d* of 0.67 and 0.83 for letter-naming and letter-sound production, and Piasta et al. (2022) showed a range of 0.99 to 1.55 for

letter knowledge outcomes when comparing the treatment condition where children received alphabet instruction to the control condition.

Interestingly, in the current study found no significant difference in lowercase letter-naming when comparing letters taught via non-multisensory instruction versus control letters. The current study intentionally equalized the number of attempts in which the instructor asked a child to provide letter names and letter sounds across conditions. Despite the controlled number of attempts in terms of asking the child for letter names, non-multisensory instruction did not show a significant difference compared to the control condition, whereas multisensory alphabet instruction did. One potential explanation is that MSI lessons lasted longer than nMSI lessons for each session, which may lead to a significant difference of effects only shown for comparing the MSI condition and control condition. Another way to consider this outcome is that this may indicate the potentially greater benefit of multisensory instruction for teaching letter-naming learning over non-multisensory instruction and maybe a topic worthy of further attention or additional research.

Another notable aspect specific to letter writing was that no interaction effect emerged from the findings of the current study. In other words, the children's gains in letter writing from the pretest to the posttest did not statistically differ among the three conditions. This outcome may align with Roberts et al. (2019b)'s findings that adding a writing component to alphabet instruction did not lead to a better outcome for children's letter-name and letter-sound knowledge. However, the current study's findings are at odds with other work showing that alphabet instruction had a positive effect on letter-writing skills (Piasta et al., 2022). Intriguingly, the alphabet lessons from the study were

adapted from Piasta et al.'s lessons. Alphabet lessons in Piasta et al. (2022) were similar to the lessons in the multisensory instruction but did not include noticing mouth movements or writing letters in the air using a kinesthetic modality. Given the conflicting findings around letter-writing skills, further research may be needed.

In brief, the findings show that the children learned lowercase letter names and sounds by receiving explicit, systematic instruction that included reading and writing activities. This study also offers a practical contribution in that early childhood administrators and educators may provide such support to children enrolled in their programs to help their alphabet knowledge development.

Impact of Multisensory Alphabet Instruction

The limitations of the previous literature concerning multisensory instruction aimed to enhance children's early language and literacy development include a lack of robust research designs that allow for causal claims. This study used a rigorous within-subject design, including a counterfactual that afforded testing whether adding a multisensory component would lead to better alphabet learning relative to instruction without multisensory elements. I hypothesized that the impact of multisensory instruction on children's lowercase letter knowledge would be greater than that of non-multisensory instruction. However, the findings revealed no significant difference in the children's gains in terms of lowercase letter-naming, letter-sound knowledge, and letter-writing skill between the MSI and nMSI conditions. These findings align with the reports of previous studies (Foorman & Moats, 2004; Roberts et al., 2019b; Schlesinger & Gray, 2017; E. A. Stevens et al., 2021), yet they differ from the outcomes of other studies (Bara et al., 2007; DiLorenzo et al., 2011; Magpuri-Lavell et al., 2014).

On the one hand, some prior studies have demonstrated that multisensory instruction did not affect children's early literacy skills, like the findings that emerged from the current study. For example, Roberts et al. (2019b) found that no significant benefit resulted from adding a writing activity or a mouth gesture emphasis to alphabet instruction for the purpose of promoting English monolingual children's alphabet knowledge. Bara et al. (2004) also demonstrated that adding kinesthetic activities in alphabet and phonemic awareness instruction did not benefit children in learning letter-naming. Moreover, a recent meta-analysis investigated the effects of a multisensory reading intervention based on the Orton-Gillingham approach (E. A. Stevens et al., 2021). According to the study findings, Orton-Gillingham reading interventions did not statistically significantly enhance children's foundational reading skills, including phonological awareness, phonics, fluency, and spelling. However, the authors also pointed out the limitations of previous studies, such as small sample sizes, and stated that those studies with small sample sizes reported an average effect size of 0.22. Considering the notable effect sizes combined with the potential lack of power due to the small sample size, the authors suggested the need for further investigation of the effects of this type of multisensory instruction. As such, it may be worth taking effect sizes into account when seeking to understand the effect of multisensory instruction.

On the other hand, other studies have reported positive effects on children's letter knowledge from multisensory instruction. For instance, Bara and colleagues found that alphabet and phonemic awareness instruction demonstrated positive effects on letter-naming in children with low-SES backgrounds, unlike their peers who did not come from low-SES households (Bara et al., 2007). DiLorenzo et al. (2011) and Magpuri-Lavell et

al. (2014) also reported that children gained letter-sound knowledge after receiving multisensory instruction; nevertheless, these studies lack either a comparison group or pretest assessment, leading to potential selection bias. As such, the findings regarding the effects of multisensory instruction on children's alphabet knowledge are mixed. The current study used a rigorous experimental research design with an adequate counterfactual comparing multisensory and non-multisensory instruction and showed that multisensory instruction did not affect differently from non-multisensory instruction to children's alphabet learning. Considering that no one study can provide definitive answers to any research questions, this topic may offer a promising opportunity for continued research to replicate the previous research findings.

Although not statistically significant, a notable effect size for letter-sound learning was observed, specifically when comparing multisensory and non-multisensory instruction and favoring multisensory instruction (d = 0.28). The fact that this difference was not statistically significant might have been due to the large variability in the children's letter-sound production (SD = 1.29 for MSI; SD = 1.24 for nMSI). Moreover, as reported in Chapter 4, the lesson fidelity of non-multisensory instruction was significantly higher than that of multisensory instruction. Interestingly, despite the higher lesson fidelity for non-multisensory instruction, the effect size for letter-sound learning appeared to favor multisensory instruction. If it were the case that the lesson fidelity was equal across two conditions, it might have shown a larger magnitude of effects for multisensory instruction. However, it would be wise to exercise caution in drawing a conclusion since this finding was not statistically significant.

Additionally, as mentioned earlier in this discussion, I found it interesting that the letter-writing component did not seem to be effective. This finding is particularly notable because the multisensory instruction was developed to leverage the writing opportunity to integrate multisensory components. Also, a large body of literature recommends including a letter-writing activity (e.g., Hall, Simpson, Guo, & Wang, 2015; Puranik, Patchan, Lemons, & Al Otaiba, 2017). The fact that I did not find effects of letter writing in multisensory instruction aligns with Roberts et al. (2019b)'s findings that adding a letter-writing activity to alphabet instruction did not provide additional benefits to bolster children's alphabet knowledge. Therefore, it is possible that neither multisensory nor non-multisensory instruction added benefit in improving the children's letter-writing skills. Nonetheless, it may be the case that the letter-writing component of the instruction itself was not effective in terms of improving children's letter knowledge. One potential explanation is that the current study had a different input of letter writing opportunities than the previous study, which has shown the positive effects of alphabet instruction on children's letter-writing development (Piasta et al., 2022). Specifically, Piasta et al. (2022) provided alphabet instruction teaching both uppercase and lowercase forms, and children had opportunities to practice writing both forms of a letter during alphabet lessons. On the other hand, the current study only focused on a lowercase form of a letter, thus providing only about half of the opportunities for children to practice writing a letter. Nonetheless, when measuring letter writing skills, children's letter-writing samples were scored regardless of uppercase or lowercase forms. Typically, acquiring letter writing of uppercase forms is more manageable than that of lowercase forms (e.g., Worden & Boettcher, 1990). Thus, children may need more time and opportunities to

learn lowercase letter writing skills. Under these conditions, drawing a conclusion about whether multisensory or non-multisensory instruction was ineffective for developing children's letter-writing skills is challenging; therefore, future research may be needed.

The current study was designed to test the effects of multisensory instruction on children's learning in the area of cognitive literacy skills —specifically, lowercase letter knowledge. However, anecdotally, I noticed that the children might have been more engaged and motivated when they received multisensory instruction compared to when they received non-multisensory instruction. This observation is notable because the existing body of work showing how motivation and engagement are crucial for early literacy achievement (Lepola, 2004; Lepola, Poskiparta, Laakkonen, & Niemi, 2005; Morgan & Fuchs, 2007), including alphabet learning (Roberts & Sadler, 2019). Typically, those previous studies have demonstrated that motivation and engagement could facilitate children's learning. It may be necessary to recognize that engagement and motivation might be critical end goals in their own right. It may be the case that children who are more motivated and engaged have more positive views of literacy (e.g., Griva & Semoglou, 2012), and such a view may, in turn, facilitate children's long-term reading success. For example, Griva and Semoglou (2012) investigated the effects of a program that included interactive psychomotor activities to promote second-grade English learners' language skills. The students' engagement was measured through participating teachers' journals documenting the students' behavior, such as showing interest, participating, and exhibiting a positive attitude. According to the authors' findings, the students expressed a positive attitude and demonstrated more active engagement when using multisensory activities.

The study's exploration of the potential benefit of multisensory instruction was based on the theory that the children might more easily store information in long-term memory by acquiring that information through multiple modalities. As such, even if the participants showed no immediate improvement in lowercase letter learning during the study time frame, enhanced lowercase letter learning might eventually emerge in the longer term if the study activities caused lowercase letter knowledge to be stored in long-term memory. In that vein, taking such non-cognitive outcomes into consideration and investigating the impact of a multisensory approach in terms of elevating children's motivation toward early literacy learning may be a fruitful topic for future research.

Language Status as a Moderator of the Impact of Alphabet Instruction

U.S. classrooms are seeing a growing number of EB children, highlighting the need to support these children in promoting alphabet knowledge. However, there is relatively limited evidence supporting EB children's alphabet knowledge; moreover, the findings of the previous studies are mixed, as mentioned in earlier chapters. One of this study's contributions to the field is its adding to the literature on understanding effective evidence-based practices to promote EB children's alphabet knowledge. Specifically, my investigation compared the benefit of multisensory alphabet instruction between EB children and their English monolingual peers. In that context, one of my secondary aims was to investigate whether the children's language status moderated the impact of multisensory alphabet instruction. Based on information processing theory and the existing literature that has demonstrated the potential benefit of multisensory instruction for EB children, I hypothesized that the impact of multisensory instruction would be greater for EB children than for English monolingual children.

I sought to confirm whether the two groups of children had an equal baseline using descriptive statistics, which revealed that the English monolingual and EB children did not differ in terms of gender, age, maternal education, annual income, and all screening/pretest scores with the exception of uppercase letter-sound production. The findings revealed no moderation effect of the children's language status on the effect of multisensory alphabet instruction. In other words, no difference emerged between the English monolingual and the EB children regarding the impact of multisensory instruction. The finding is in line with Roberts et al.'s (2019b) study that found alphabet instruction was equally effective for both EB and English monolingual children in their letter-name and letter-sound knowledge. This absence of a difference between the two groups of children may be attributable to several reasons.

One potential reason for no difference in multisensory instruction results between EB and English monolingual children could be the equivalent SES of two groups of children. As mentioned previously in this discussion, the current study's findings revealed similarities between the EB and English monolingual children in terms of maternal education and annual household income. The previous literature has demonstrated SES to be significantly associated with early language and literacy skills, including alphabet knowledge (Hoff, 2003; Strang & Piasta, 2016). For example, Strang and Piasta (2016) observed that children from lower-SES households produced fewer letter names and sounds than their peers from higher-SES households. Similarly, in the case of children who are learning and using English as their additional language(s), SES plays a critical role in their language and literacy outcomes (Butler, 2014; Hamid, 2011; B. Huang, Chang, Niu, & Zhi, 2018). Together, the difference in SES may lead to

differences in children's early literacy skills. Thus, one reason that the two groups of children from the study showed similar letter learning after receiving multisensory instruction might have been because they had similar SES backgrounds.

Another reason for an equal effect resulting from multisensory alphabet instruction for both EB and English monolingual children might be the similar language background and exposure across the two groups of children. Based on the preliminary results concerning the EB children's language background and exposure, they were largely using English in daily life. Among 14 EB children, 11 caregivers reported that their EB children's dominant language(s) included English. Moreover, when the EB children were communicating with the family members living with them, English was used substantially (e.g., with siblings) or at least as one of two or more dominant languages (e.g., with female guardian, male guardian, grandparents). In essence, the EB children in the current study resembled their English monolingual peers in that their dominant language appeared to be English. Additionally, although the response rate was low, the EB children's language exposure showed similar patterns. For instance, the EB children primarily spoke only English when speaking to an adult or older siblings, an adult or older sibling mostly used English alone when telling a story to these children, and the EB children mostly used English only when participating in church services. Furthermore, the EB children mostly used English and some additional language when they read or looked at books on their own, and they used mostly English or at least equal amounts of English and an additional language when watching TV as well as listing to songs. Language exposure also substantially centered around English for the EB children, which may be similar to the background of the English monolingual children.

In addition to their dominant language and language exposure, the EB children might have had literacy-related exposure similar to that of their English monolingual peers. The premise concerning the possible benefits of multisensory alphabet learning for EB children was that those children might have a larger cognitive load due to learning multiple sets of letters; hence, multisensory alphabet instruction was proposed to have the effect of reducing the cognitive load. However, EB children who were not yet learning letters in their additional language(s), as well as learning similar numbers of letters across languages in comparison to the English monolingual children, might experience a benefit similar to that of their English monolingual peers. According to the preliminary results, many of the EB children's caregivers did not respond to items related to literacy activities, which may indicate that the caregivers had not yet begun to work on literacy activities with their EB children at home. Additionally, even though the responses were limited, the collected data revealed that most of the EB children had not yet learned letters in their additional language. However, this argument must be approached with caution because the available data concerned the percent of alphabets EB children "knew" in their additional languages if their additional language used an alphabetic orthography. Thus, this information cannot be said to represent whether the EB children were "learning" the orthographies of their additional language.

According to the study findings, the EB and English monolingual children benefited similarly from alphabet instruction. This result has educational implications for early childhood administrators and educators in that alphabet instruction for both EB and English monolingual children may be equally effective for children who have similar characteristics, including gender, SES, and language and literacy exposure. Thus,

educational administrators and educators may find that an effective approach involves first determining EB children's language-learning context, such as their household background and literacy experiences at home, before providing the same instruction already established for their English monolingual children.

Moreover, very few studies that have examined the alphabet knowledge of EB children have included information about their language background, yet this information may be critical in contextualizing the findings. This study included a description of the EB children's language and literacy exposure in their households to facilitate a more thorough interpretation of the study's findings. Thus, among this study's contributions is that it has taken the EB children's additional language into account in examining their alphabet learning. A further suggestion that arises from this context would be to consider such factors as alphabet knowledge related to EB children's additional language in future research when working with this population of children.

Although it should be interpreted carefully due to the lack of statistical significance, some effect sizes for the differences in lowercase letter learning between the EB and English monolingual children may be notable. Lack of statistical significance may be due to the small sample sizes for the two groups of children, which may have imposed difficulty in detecting enough power. For letter-naming, when comparing letters taught via multisensory or non-multisensory instruction, the direction of effect sizes was opposite between the EB and English monolingual children. Specifically, effect sizes for the English monolingual children favored multisensory instruction ($d = 0.37$), whereas those for the EB children showed a slight advantage in the case of non-multisensory instruction, although the effect size was minimal ($d = -0.11$). More interestingly, the

effect sizes for the English monolingual children were larger (d = 0.68) than for the EB children (d = 0.36) when comparing letters taught via multisensory instruction and control letters. Nevertheless, the effect sizes for the EB children were more notable (d = 0.49) than those of the English monolingual participants (d = 0.23) when comparing letters taught via non-multisensory instruction and control letters. One potential reason for this finding may reflect how the multisensory and non-multisensory alphabet lessons were structured. Although multisensory and non-multisensory alphabet lessons had the same number of attempts asking letter names to the child, in the multisensory alphabet lessons, producing letter names was followed by several other activities. These activities included saying the letter name and then performing gestures while saying the letter sounds, as well as saying the letter name and then repeating the verbal paths while tracing the letter. Arguably, EB children might have found these multiple associated activities confusing in learning letter names, especially considering they may be experiencing a larger cognitive load in learning several languages simultaneously.

Another notable aspect regarding effect sizes is lowercase letter-sound skills. Regarding both comparisons of letters taught via multisensory instruction and non-multisensory instruction and of letters taught via multisensory instruction and control letters, effect sizes for the English monolingual children were more notable (d = 0.37, d = 1.11, respectively) than those for the EB children (d = 0.15, d = 0.83, respectively). This outcome may have arisen from the differences in the screening assessment of uppercase letter-sound production. The English monolingual children demonstrated a higher mean score than the EB children on the screening assessment. A large body of literature supports that uppercase alphabet knowledge predicts corresponding lowercase alphabet

knowledge (e.g., F. L. Huang & Invernizzi, 2014; Treiman & Kessler, 2004; Turnbull et al., 2010). Although the previous studies examined letter-name knowledge, this concept may be applied to letter-sound knowledge since these two aspects of letter knowledge are related (e.g., Evans et al., 2006; McBride-Chang, 1999). In this case, higher uppercase letter-sound knowledge may have led to larger effect sizes for lowercase letter-sound knowledge in the case of the English monolingual children. However, the small sample size of EB children and lack of statistical significance complicates any attempt to draw a conclusion regarding this aspect of the study; therefore, future research may be necessary to replicate the finding.

Uppercase Facilitation Effect

To investigate my other secondary aim involving the uppercase facilitation effect, I examined whether uppercase letter knowledge moderated lowercase letter learning. Previous correlational studies that have measured children's alphabet knowledge at a single timepoint demonstrated that a child was more likely to learn a lowercase letter when they knew the corresponding uppercase form than when they did not know the uppercase form (e.g., F. L. Huang & Invernizzi, 2014; Treiman & Kessler, 2004; Turnbull et al., 2010). In this study, I extended the prior findings by confirming that children who knew the name of an uppercase letter were more likely to know the name of the corresponding lowercase letter about 3 months later than if they did not know the name of the uppercase letter. This outcome may indicate the benefits of having one concept of knowing a letter name stored in two forms of the letter—uppercase and lowercase—thus offering multiple ways to access the letter in long-term memory.

However, there is a caveat to interpreting this finding because there was no significant moderation effect of uppercase letter knowledge on learning lowercase letter knowledge. In other words, the uppercase facilitation effect emerged for all selected letters, even for letters that were not taught. The fact that there were no significant moderation effects might have been because the children knew fewer than two uppercase letter names at the time of the screening, resulting in a small variance to detect the statistical power. Alternatively, the children might have learned letters outside of the study intervention, referring to letters not taught during the intervention that could have been taught in the children's classrooms.

Moreover, I was unable to test the uppercase facilitation effect for letter-sound knowledge because of the floor effect for uppercase letter-sound knowledge at the time of the screening assessment. To my knowledge, all prior work only examined letter-name knowledge for the uppercase facilitation effect but did not include letter-sound knowledge (e.g., F. L. Huang & Invernizzi, 2014; Treiman & Kessler, 2004; Turnbull et al., 2010). Future research is needed to replicate this work to unpack the uppercase facilitation effect on children's letter-sound learning. The study findings thus contribute to the field through their critical implications in terms of informing early childhood educators to consider children's uppercase letter knowledge as a resource for teaching lowercase letter knowledge. For example, educators may start by identifying the existing knowledge of uppercase letters possessed by the children in their classrooms. Armed with that understanding, the educators could go on to teach lowercase letters corresponding to the children's knowledge of uppercase letters before teaching other lowercase letters.

Limitations

The current study had many strengths, such as its rigorous research design that provided causal information concerning whether alphabet instruction impacted the children's alphabet knowledge. Using a within-subject design decreased threats to internal validity because this approach tested each child in all treatment conditions. Specifically, regarding the primary research question that concerned examining the effect of multisensory instruction, no issues involving selection bias or non-equivalence across conditions were involved because each child experienced each condition.

Nevertheless, the study also has some limitations. First, all lessons were presented by trained research team members, which allowed the lessons to be delivered in a comparable manner to the participating children. However, I delivered a major portion of the lessons, which might have posed a threat to internal validity. Specifically, the fact that I was aware of the study research questions and hypotheses might have introduced researcher/experimenter bias. My understanding might have led me to unconsciously favor multisensory instruction in various ways, such as being more enthusiastic when providing particular lessons. As a part of checking for research bias, I coded the instructor's enthusiasm when providing alphabet lessons to children. While the preliminary evidence suggested no difference across multisensory and non-multisensory instruction, this measure did not include reliability and/or validity evidence. I did not have a second coder to check for interrater reliability in terms of checking the instructor's enthusiasm; however, future research may need to consider this aspect.

The second point is related to the first point in that it concerns the fact that all lessons were provided by trained research staff, which might impose a threat to external

validity. Although delivering lessons in a comparable manner might have enhanced the internal validity of the study, in practice, most educators deliver lessons in real-life educational settings. Thus, educators may vary in terms of delivering lessons in a comparable manner in contrast to trained research members.

Third, having the same instructor deliver the instruction for both conditions (MSI and nMSI) might have resulted in treatment diffusion. In order to counter this threat, I ensured that the research staff members watched videotaped lessons and checked lesson fidelity so that the lessons would be provided to the children as intended and without favoring the research questions/hypothesis. Additionally, while ensuring lesson fidelity, the intended instructional behaviors for MSI and nMSI lessons were also monitored to reduce treatment diffusion in providing MSI and nMSI. Anecdotally, I do not recall any incidents in which treatment diffusion happened when providing lessons across conditions; nonetheless, I did not have a specific measure to check this aspect. Thus, future studies may need to measure this factor to preclude the possibility of treatment diffusion in providing lessons across conditions.

Fourth, I included both EB and English monolingual children in the study to enhance external validity. That said, this study was conducted on a small scale and featured a relatively small sample size. Thus, the study sample is not a representative sample, leading to limitations in generalizing the findings. Most of the participants were recruited from one state, which limited generalizing the findings to a nationwide population. Additionally, the sample of EB children had diverse language backgrounds in that these children used five different additional languages. These factors limit the

ability to generalize the findings for EB children who speak a particular additional language, thus prompting the call for future research.

Fifth, although the current study included preliminary data regarding the EB children's language use in their households, the available information about the EB children's literacy skills in their additional language(s) was limited. In retrospect, it would have been helpful to have data about the caregivers' expectations as well as their support in terms of any efforts they might have made at home to help the EB children learn about the alphabet in their additional language. For example, some of the EB children used additional languages that did not involve a Latin-based alphabet orthography like English (e.g., Korean, Arabic, Nepali). Considering the idea of linguistic transfer (Cummins, 1981), EB children's alphabet knowledge in their additional language(s) may positively or negatively transfer to English alphabet knowledge depending on the orthography of their additional language and/or their knowledge of such a language (e.g., Cárdenas-Hagan et al., 2007; Park & Piasta, 2022). Moreover, in this study, no additional language that the EB children used included non-alphabetic orthography. That said, information about the children's language system—in particular, details concerning EB children's additional language(s) if they used non-alphabetic orthography—would also be helpful. Therefore, some of these aspects may need to be considered and included in future work.

Finally, the current study was designed based on an a priori power analysis detecting a medium effect size (f = .25; d = 0.5) with 80% power. In other words, the study was able to detect enough power for effect sizes that were medium or large but potentially not for smaller effects. It could be the case that smaller but meaningful effect

sizes existed in terms of representing the differences between two conditions but were not found in the study.

Conclusion

In conclusion, the findings of the current study suggest that young children benefited from explicit and systematic alphabet instruction, regardless of multisensory or non-multisensory, in terms of improving their alphabet knowledge. This study highlights that EB and English monolingual children may experience a similar benefit from alphabet instruction when they have similar background, including SES and language and literacy exposure. Moreover, the uppercase facilitation effect was evident in the study, indicating that children in general may be more likely to know lowercase letters if they knew the corresponding uppercase letters.

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Appendix A

Tables and Figures

Table 1

Demographic Information of EB and English Monolingual Children

Variable	English monolingual (n = 22)		EB (n = 14)	
	M	%	*M*	%
Age (months)	49.36 (SD = 7.62)		51.07 (SD = 6.38)	
Girl		50		50
Race				
Black		68		0
White		27		15
Asian		0		64
Unreported		5		21
Maternal education				
High school diploma		55		15
Associate's degree		9		14
Bachelor's degree		9		7
Graduate degree		9		7
Not hold a high school diploma		9		36
Unreported		9		21
Annual family income				
Less than $25,000		50		46
$25,001 - $55,000		36		46
$55,001 - $75,000		5		0
More than $75,001		9		8
Unreported		0		7
IEP		5		0

Note. EB = emergent bilingual. IEP = Individualized Educational Program.

Table 2

Descriptive Statistics

Measure	Full sample (N = 36)			English monolingual (n = 22)			EB (n = 14)		
	M	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	Range
Demographic									
Age (months)	50	7.12	41 - 65	49.36	7.62	41 - 65	51.07	6.38	42 - 63
Screening									
Uppercase									
LN	6.50	6.27	0 – 23	7.00	6.90	0 – 23	5.71	5.27	0 – 14
LS	.64	1.38	0 - 5	.82	1.53	0 – 5	.36	1.08	0 – 4
Lowercase									
LN	4.31	4.24	0 – 14	4.50	4.41	0 – 14	4.00	4.11	0 – 13
LS	.28	.57	0 - 2	.32	.57	0 - 2	.21	.58	0 - 2
Pretest									
LW task	1.36	2.19	0 - 8	1.32	2.42	0 - 8	1.43	1.87	0 - 6
Posttest									
Uppercase									
LN	5.69	4.13	0 – 12	4.77	4.08	0 – 11	7.14	3.90	0 – 12
LS	2.53	2.60	0 - 10	2.77	2.71	0 - 10	2.14	2.48	0 - 8
Lowercase									
LN	4.67	3.21	0 – 12	3.77	2.69	0 - 8	6.07	3.54	0 - 12
LS	2.47	2.55	0 - 9	2.36	2.26	0 - 7	2.64	3.03	0 - 9
LW task	5.13	5.25	0 - 20	4.05	4.55	0 - 18	6.86	5.97	0 - 20

Note. Screening assessments were conducted with 26 letters; pretest and posttest assessments were conducted with 12 selected letters. EB = emergent bilingual. LN = letter name production; LS = letter sound production; LW = letter writing

Table 3

Correlations Among Screening, Pretest, and Posttest Measures

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age (months)	–	-.39*	-.16	.13	.04	.40*	.03	.52**	.11	.02	.07	-.01	-.01	.44**
2. Total duration of intervention		–	.37*	-.57**	-.24	-.08	-.22	-.18	-.06	-.19	.03	-.13	.04	-.12
3. Change in instructors			–	-.39*	-.17	-.10	-.19	-.22	.10	.11	.11	.00	.15	.12
4. Childcare center				–	.09	-.27	.06	-.27	-.03	.36*	-.10	.41*	.03	.20
Uppercase														
5. T1 LN production					–	.32	.95**	.28	.39*	.68**	.45**	.52**	.43**	.32
6. T1 LS production						–	.34*	.87**	.18	.08	.24	.04	.17	.19
Lowercase														
7. T1 LN production							–	.32	.48**	.63**	.37*	.44**	.35*	.25
8. T1 LS production								–	.26	.06	.27	.04	.24	.20
9. T1 LW task									–	.39*	.20	.25	.23	.39*
Uppercase														
10. T2 LN production										–	.61**	.90**	.65**	.67**
11. T2 LS production											–	.60**	.82**	.50**
Lowercase														
12. T2 LN production												–	.74**	.71**
13. T2 LS production													–	.55**
14. T2 LW task														–

Note. $N = 36$. T1 = screening or pretest; T2 = posttest. LN = letter name; LS = letter sound; LW = letter writing.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 4

Correlations Among Screening, Pretest, and Posttest Measures for EB and English Monolingual children

Measure	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Age (months)	–	-.42*	-.15	.01	.03	.41	.07	.63**	.15	-.10	-.05	-.24	-.16	.38
2. Total duration of intervention	-.26	–	.29	-.44*	-.34	-.24	-.33	-.39	-.04	-.09	-.16	-.01	-.05	-.04
3. Change in instructors	.b	.b	–	-.31	-.26	-.20	-.29	-.35	.13	.29	.09	.21	.27	.34
4. Childcare center	.03	-.50	.b	–	.29	.01	.33	.01	-.03	.11	.01	.1	.07	-.27
Uppercase														
5. T1 LN production	.09	-.22	.b	.30	–	.45*	.98**	.47*	.35	.73**	.54*	.70**	.58**	.27
6. T1 LS production	.46	.15	.b	-.69**	-.12	–	.48*	.84**	.24	.28	.24	.27	.20	.44*
Lowercase														
7. T1 LN production	-.02	-.08	.b	.12	.89**	-.02	–	.52*	.36	.70**	.49*	.68**	.56**	.26
8. T1 LS production	.37	.20	.b	-.70**	-.13	.97**	-.03	–	.41	.26	.27	.21	.20	.47*
9. T1 LW task	.02	-.11	.b	.11	.49	.03	.77**	-.02	–	.42	.30	.46*	.48*	.67**
Uppercase														
10. T2 LN production	.17	-.08	.b	.51	.79**	-.21	.65*	-.19	.36	–	.71**	.93**	.77**	.51*
11. T2 LS production	.38	.44	.b	-.03	.23	.18	.14	.25	-.01	.61*	–	.67**	.86**	.40
Lowercase														
12. T2 LN production	.20	.09	.b	.41	.48	-.17	.28	-.08	-.05	.86**	.75**	–	.78**	.50*
13. T2 LS production	.19	.33	.b	-.07	.25	.18	.10	.31	-.15	.55*	.84**	.77**	–	.47*
14. T2 LW task	.51	.07	.b	.28	.54*	-.05	.30	-.06	-.01	.82**	.79**	.85**	.64*	–

Note. English monolingual $n = 22$; EB $n = 14$; correlations for EB children are shown below the diagonal; .b refers to not calculated because EB children did not experienced changed in instructors; T1 = screening or pretest; T2 = posttest. LN = letter name; LS = letter sound; LW = letter writing. *$p < .05$. **$p < .01$. ***$p < .001$.

Table 5

Impact of Alphabet Instruction

Measure	Condition	T1		T2		*SS*	*df*	*MS*	*F*	*p*
		M (SD)	Range	*M (SD)*	Range					
Lowercase LN production	MSI	0.00 (.00)	0	1.86 (1.38)	0 – 4	8.17	2	4.08	4.48	.015
	nMSI	0.00 (.00)	0	1.61 (1.46)	0 – 4					
	Control	0.00 (.00)	0	1.19 (1.14)	0 – 4					
Lowercase LS production	MSI	0.00 (.00)	0	1.31 (1.39)	0 – 4	20.72	2	10.36	12.66	<.001
	nMSI	0.00 (.00)	0	.94 (1.24)	0 – 4					
	Control	0.00 (.00)	0	.25 (.55)	0 – 2					
LW task	MSI	.72 (1.50)	0 – 6	1.78 (2.15)	0 – 8	3.90	2	1.95	1.72	.187
	nMSI	.42 (.84)	0 – 3	2.06 (2.06)	0 – 8					
	Control	.22 (.54)	0 – 2	1.31 (1.85)	0 – 7					

Note. *N* = 36. T1 = screening or pretest; T2 = posttest. MSI = multisensory instruction; nMSI = non-multisensory instruction. LN = letter name; LS = letter sound; LW = letter writing. T1 LN and LS production tasks were conducted with 26 letters; T2 LN and LS production tasks, T1 and T2 LW tasks were conducted with 12 selected letters. *SS* indicates sum of squares. *df* indicates degree of freedom. *MS* indicates mean square.

Table 6

Pairwise Comparisons of Conditions

Measure	MSI Adj. *M*		nMSI Adj. *M*		Control Adj. *M*		MSI vs. nMSI				MSI vs. Contol				nMSI vs. Control			
	T1	T2	T1	T2	T1	T2	*dff*	*p*	95% CI [UB, LB]	*d*	*dff*	*p*	95% CI [UB, LB]	*d*	*dff*	*p*	95% CI [UB, LB]	*d*
Lowercase LN production	.00	1.86	.00	1.61	.00	1.19	.25	.990	[-.39, .89]	0.18	.67	.011	[.13, 1.21]	0.53	.42	.148	[-.10, .93]	0.32
Lowercase LS production	.00	1.31	.00	.94	.00	.25	.36	.438	[-.25, .97]	0.28	1.06	<.001	[.54, 1.58]	1.00	.69	.002	[.23, 1.16]	0.72
LW	.72	1.78	.42	2.06	.22	1.31	-.28	.603	[-.81, .26]	-0.13	.47	.509	[-.38, 1.32]	0.23	.75	.065	[-.04, 1.54]	0.38

Note. *N* = 36. T1 = screening or pretest; T2 = posttest. MSI = multisensory instruction; nMSI = non-multisensory instruction. LN = letter name; LS = letter sound; LW = letter writing. *dff* indicates mean differences. UB and LB indicates the upper- and lower- bound of the 95% confidence interval, respectively. T1 LN and LS production tasks were conducted with 26 letters; T2 LN and LS production tasks, T1 and T2 LW tasks were conducted with 12 selected letters. *d* is Cohen's measure of effect size indicating mean differences between conditions; Reference group is presented first in the title of each column.

Table 7

EB Status Moderator on Impact of Multisensory Alphabet Instruction

Measure	Condition	EB Status	T1		T2		*SS*	*df*	*MS*	*F*	*p*
			M (SD)	Range	*M (SD)*	Range					
Lowercase LN production	MSI	nEB	.00 (.00)	0	1.68 (1.32)	0 – 4	1.78	2	.89	.98	.382
		EB	.00 (.00)	0	2.14 (1.46)	0 – 4					
	nMSI	nEB	.00 (.00)	0	1.18 (1.40)	0 – 4					
		EB	.00 (.00)	0	2.29 (1.33)	0 – 4					
	Control	nEB	.00 (.00)	0	.91 (.92)	0 – 3					
		EB	.00 (.00)	0	1.64 (1.34)	0 – 4					
Lowercase LS production	MSI	nEB	.00 (.00)	0	1.32 (1.29)	0 – 4	.25	2	.13	.15	.861
		EB	.00 (.00)	0	1.29 (1.59)	0 – 4					
	nMSI	nEB	.00 (.00)	0	.86 (1.21)	0 – 4					
		EB	.00 (.00)	0	1.07 (1.33)	0 – 4					
	Control	nEB	.00 (.00)	0	.23 (.53)	0 – 2					
		EB	.00 (.00)	0	.29 (.61)	0 – 2					
LW task	MSI	nEB	.68 (1.43)	0 - 4	1.55 (1.99)	0 – 8	1.29	2	.64	.56	.574
		EB	.79 (1.67)	0 – 6	2.14 (2.41)	0 – 8					
	nMSI	nEB	.41 (.85)	0 – 3	1.68 (1.99)	0 – 8					
		EB	.43 (.85)	0 – 2	2.64 (2.10)	0 – 7					
	Control	nEB	.23 (.53)	0 – 2	.82 (1.26)	0 – 4					
		EB	.21 (.58)	0 – 2	2.07 (2.37)	0 – 7					

Note. English monolingual *n* = 22; EB *n* = 14. T1 = screening or pretest; T2 = posttest. nEB = English monolingual; EB = emergent bilingual. MSI = multisensory instruction; nMSI = non-multisensory instruction. LN = letter name; LS = letter sound; LW = letter writing. T1 LN and LS production tasks were conducted with 26 letters; T2 LN and LS production tasks, T1 and T2 LW tasks were conducted with 12 selected letters. *SS* indicates sum of squares. *df* indicates degree of freedom. *MS* indicates mean square. *d* is Cohen's measure of effect size indicating mean differences between English monolingual and EB children.

Table 8

Pairwise Comparisons of Conditions for EB and English monolingual Children

Measure		MSI Adj. *M*		nMSI Adj. *M*		Control Adj. *M*		MSI vs. nMSI			MSI vs. Contol			nMSI vs. Control		
		T1	T2	T1	T2	T1	T2	*dff*	95% CI [UB, LB]	*d*	*dff*	95% CI [UB, LB]	*d*	*dff*	95% CI [UB, LB]	*d*
Lowercase LN production	EB	.00	2.14	.00	2.29	.00	1.64	-.14	[-1.16, .87]	-0.11	.50	[-.37, 1.37]	0.36	.64	[-.19, 1.47]	0.49
	nEB	.00	1.68	.00	1.18	.00	.91	.50	[-.31, 1.31]	0.37	.77	[.08, 1.47]	0.68	.27	[-.39, .93]	0.23
Lowercase LS production	EB	.00	1.29	.00	1.07	.00	.29	.21	[-.78, 1.21]	0.15	1.00	[.53, 1.85]	0.83	.79	[.03, 1.55]	0.75
	nEB	.00	1.32	.00	.86	.00	.23	.46	[-.34, 1.25]	0.37	1.09	[.42, 1.77]	1.11	.64	[.03, 1.24]	0.67
LW task	EB	.79	2.14	.43	2.64	.21	2.07	-.50	[-1.36, .36]	-0.22	.07	[-1.29, 1.43]	0.03	.57	[-.70, 1.85]	0.25
	nEB	.68	1.55	.41	1.68	.23	.82	-.14	[-.83, .55]	-0.07	.73	[-.36, 1.81]	0.44	.86	[-.15, 1.88]	0.52

Note. *n* = 14. nEB = English monolingual children; T1 = screening or pretest; T2 = posttest. EB = emergent bilingual. MSI = multisensory instruction; nMSI = non-multisensory instruction. LN = letter name; LS = letter sound; LW = letter writing. T1 LN and LS production tasks were conducted with 26 letters; T2 LN and LS production tasks, T1 and T2 LW tasks were conducted with 12 selected letters. *dff* indicates mean differences. UB and LB indicates the upper- and lower- bound of the 95% confidence interval, respectively. *d* is Cohen's measure of effect size indicating mean differences between conditions; Reference group is presented first in the title of each column.

Table 9

Frequency of EB children's Language Use with Female Guardian

Frequency	Never	Rarely	Sometimes	Frequently	All the time
Child					
			English		
1		X			
2			X		
3			-		
4			-		
5		X			
6			X		
7					X
8			-		
9		X			
10			-		
11			X		
12			-		
13		X			
14		X			
			Additional language		
1		X			
2			X		
3			-		
4			-		
5		X			
6			X		
7					X
8			-		
9		X			
10			-		
11			X		
12			-		
13		X			
14		X			
			English and additional language		
1			X		
2		X			
3					X
4			-		
5				X	
6				X	
7				X	

8			-		
9			X		
10			-		
11			-		
12			-		
13		X			
14			-		
			Total		
English	0	5	3	0	1
Additional language	0	5	3	0	1
English and Additional language	0	2	2	3	1

Note. $N = 14$. Caregivers' responses for each child are presented with 'X.' No response is presented with '-.' Total numbers of responses for each category of frequencies are presented bottom of the table.

Table 10

Frequency of EB children's Language Use with Male Guardian

Frequency	Never	Rarely	Sometimes	Frequently	All the time
Child					
			English		
1			X		
2		X			
3			-		
4			-		
5		X			
6			X		
7				X	
8			X		
9		X			
10			-		
11			X		
12			X		
13		X			
14		X			
			Additional language		
1				X	
2				X	
3			-		
4			-		
5				X	
6			-		
7				X	
8					X
9					X
10			-		
11					X
12			-		
13			X		
14					X
			English and additional language		
1					X
2		X			
3			-		
4			-		
5				X	
6				X	
7				X	

8	X
9	X
10	-
11	-
12	-
13	-
14	-

	Total				
English	0	5	5	1	0
Additional language	0	0	1	4	4
English and Additional language	0	1	2	3	1

Note. $N = 14$. Caregivers' responses for each child are presented with 'X.' No response is presented with '-.' Total numbers of responses for each category of frequencies are presented bottom of the table.

Table 11

Frequency of EB children's Language Use with Siblings

Frequency	Never	Rarely	Sometimes	Frequently	All the time
Child					
			English		
1	X				
2					X
3					X
4			-		
5			-		
6				X	
7			-		
8			-		
9				X	
10			-		
11			X		
12			-		
13			-		
14				X	
			Additional language		
1					X
2		X			
3			-		
4			-		
5			-		
6			-		
7			-		
8			-		
9			X		
10			-		
11					X
12			-		
13			X		
14				X	
			English and additional language		
1	X				
2	X				
3				X	
4			-		
5			-		
6			X		
7			-		

8			-		
9				X	
10			-		
11			-		
12			-		
13			-		
14			-		
			Total		
English	1	0	1	3	2
Additional language	0	1	1	1	2
English and Additional language	2	0	1	2	0

Note. $N = 14$. Caregivers' responses for each child are presented with 'X.' No response is presented with '-.' Total numbers of responses for each category of frequencies are presented bottom of the table.

Table 12

Frequency of EB children's Language Use with Grandparents

Frequency Child	Never	Rarely	Sometimes	Frequently	All the time
			English		
1		X			
2			-		
3			-		
4			-		
5			-		
6		X			
7			-		
8			-		
9	X				
10			-		
11			-		
12			-		
13			-		
14	X				
			Additional language		
1					X
2			-		
3			-		
4			-		
5			-		
6				X	
7			-		
8			-		
9				X	
10			-		
11			-		
12			-		
13			-		
14					X
			English and additional language		
1		X			
2			-		
3			-		
4			-		
5			-		
6			-		
7			-		
8			-		

9			X		
10			-		
11			-		
12			-		
13			-		
14			-		
			Total		
English	2	2	0	0	0
Additional language	0	0	0	2	2
English and Additional language	0	1	1	0	0

Note. $N = 14$. Caregivers' responses for each child are presented with 'X.' No response is presented with '-.' Total numbers of responses for each category of frequencies are presented bottom of the table.

Table 13

Frequency of EB children's Language Use with Another Family Member

Frequency	Never	Rarely	Sometimes	Frequently	All the time
Child					
			English		
1			-		
2			X		
3			-		
4			-		
5			-		
6				X	
7			-		
8			-		
9			-		
10			-		
11			-		
12			-		
13			-		
14			-		
			Additional language		
1			-		
2					X
3			-		
4			-		
5			-		
6			-		
7			-		
8			-		
9			-		
10			-		
11			-		
12			-		
13			-		
14			-		
			English and additional language		
1			-		
2		X			
3			-		
4			-		
5			-		
6			X		
7			-		
8			-		

9			-		
10			-		
11			-		
12			-		
13			-		
14			-		
			Total		
English	0	0	1	1	0
Additional language	0	0	0	0	1
English and Additional language	0	1	1	0	0

Note. $N = 14$. Caregivers' responses for each child are presented with 'X.' No response is presented with '-.' Total numbers of responses for each category of frequencies are presented bottom of the table.

Table 14

Examining Uppercase Facilitation Effect Using Multilevel Logistic Regression Model

	Lowercase Letter Name			
	Coeff *(SE)*	*p*	Odds ratio	CI
Intercept	-1.24 (0.29)	<.001	0.29	[0.16, 0.52]
Taught letter	0.72 (0.27)	.009	2.05	[1.20, 3.51]
Uppercase letter known	1.27 (0.54)	.020	3.55	[1.22, 10.28]
Taught letter x Uppercase letter known	0.18 (0.66)	.789	1.19	[0.33, 4.36]

Note. N = 36. 12 selected letters were nested with each child. Coeff = coefficient. CI = confidence interval. Estimates were not calculated for the lowercase letter sound outcome because the children knew almost no uppercase letter sounds in the screening assessment.

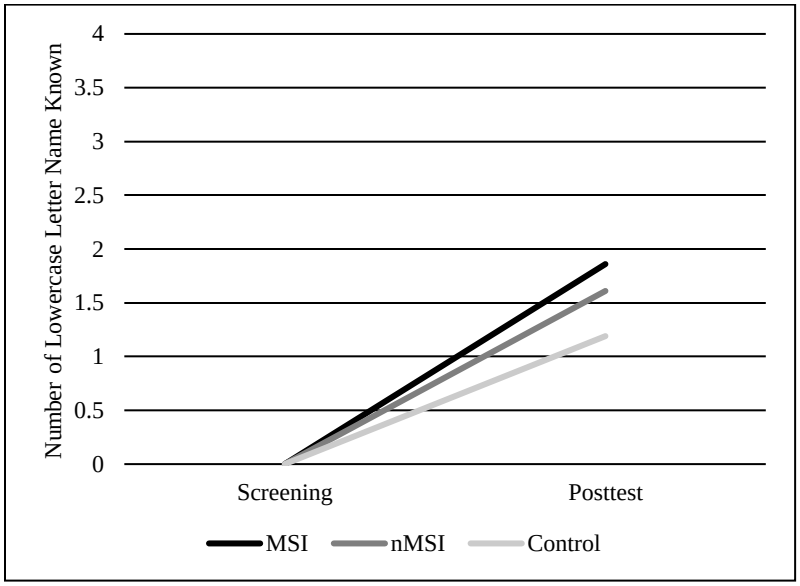

Figure 1. Lowercase letter name known among MSI, nMSI, and Control conditions.

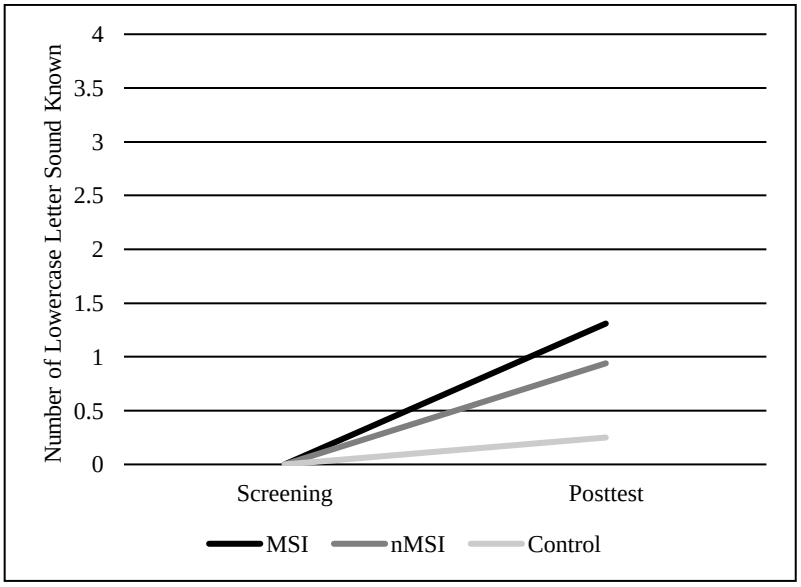

Figure 2. Lowercase letter sound known among MSI, nMSI, and Control conditions.

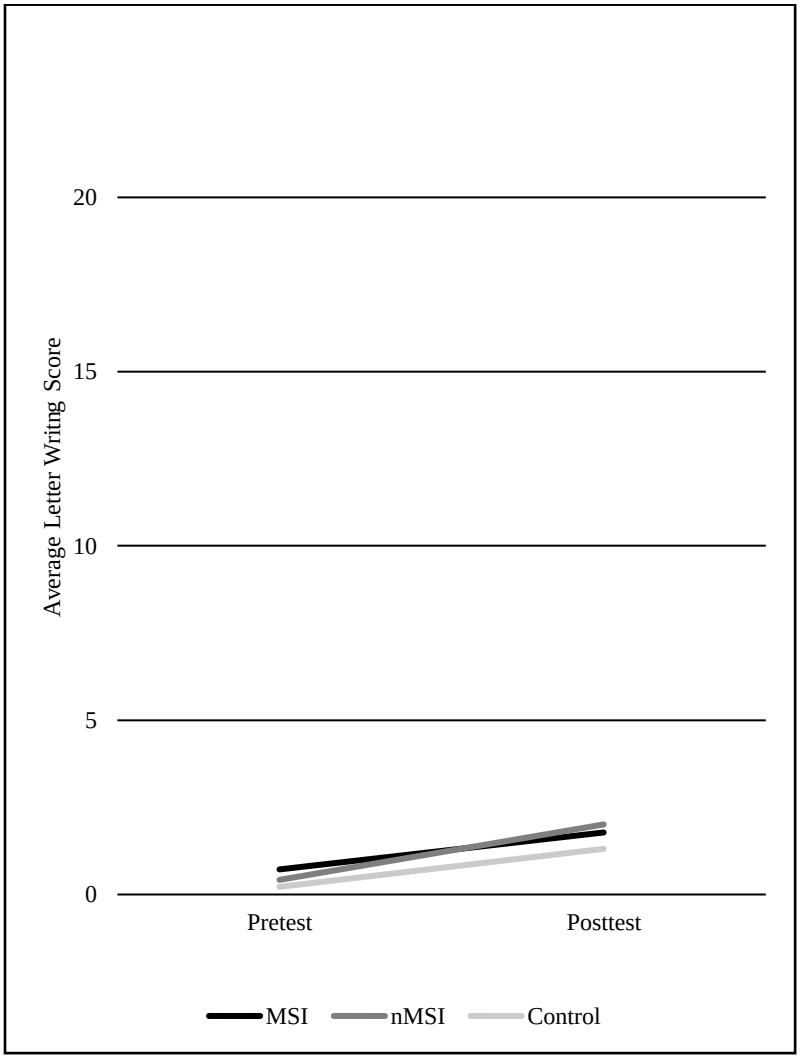

Figure 3. Average letter writing score among MSI, nMSI, and Control conditions.

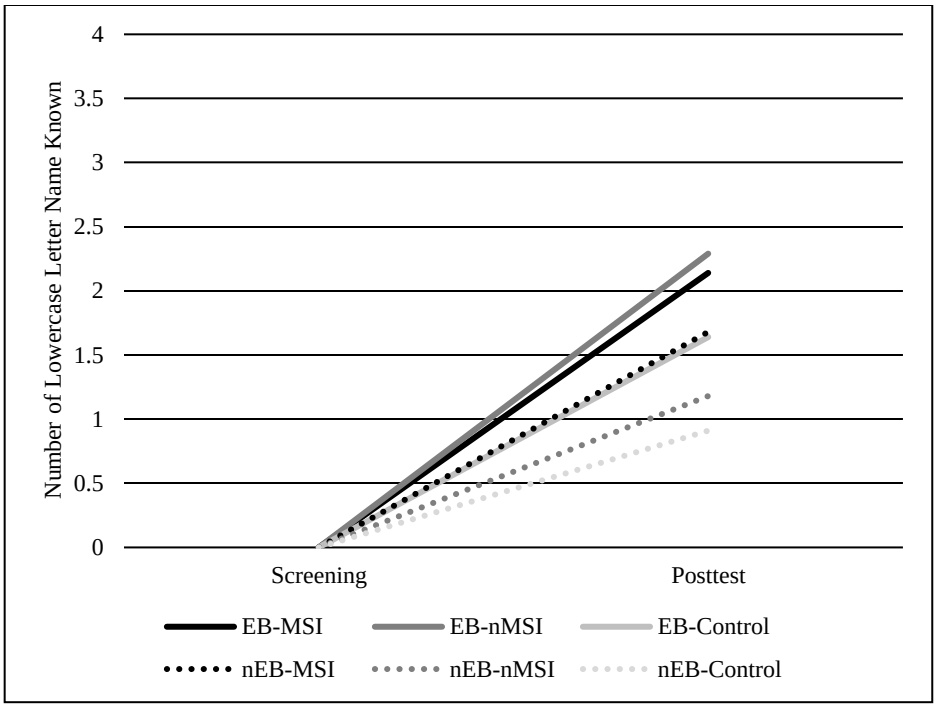

Figure 4. EB and English monolingual children's lowercase letter name known among MSI, nMSI, and Control conditions.

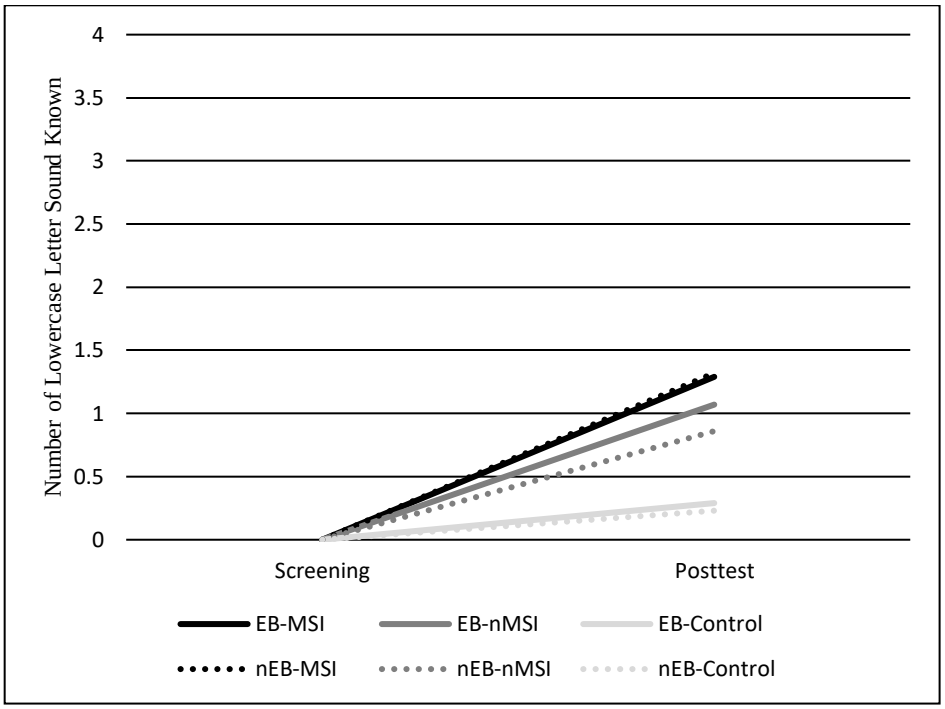

Figure 5. EB and English monolingual children's lowercase letter sound known among MSI, nMSI, and Control conditions.

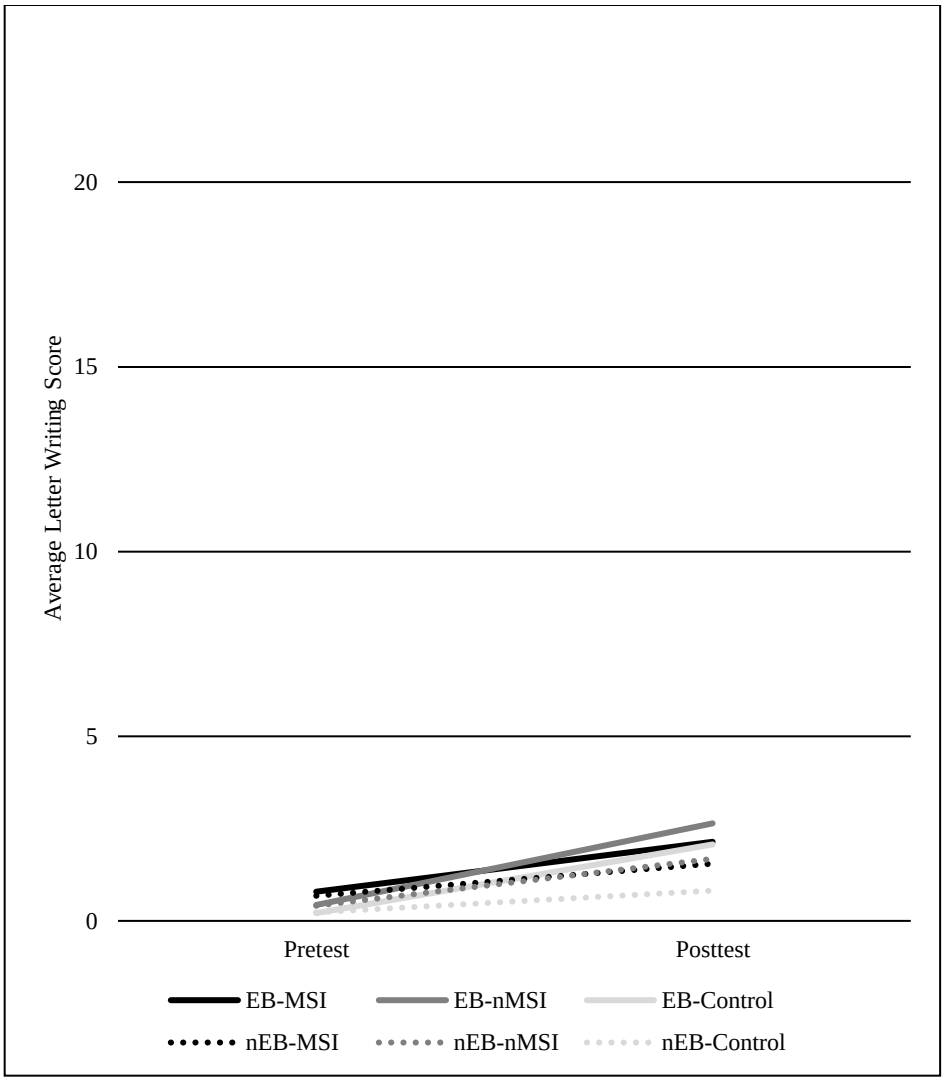

Figure 6. EB and English monolingual children's gains of average letter writing score among MSI, nMSI, and Control conditions.

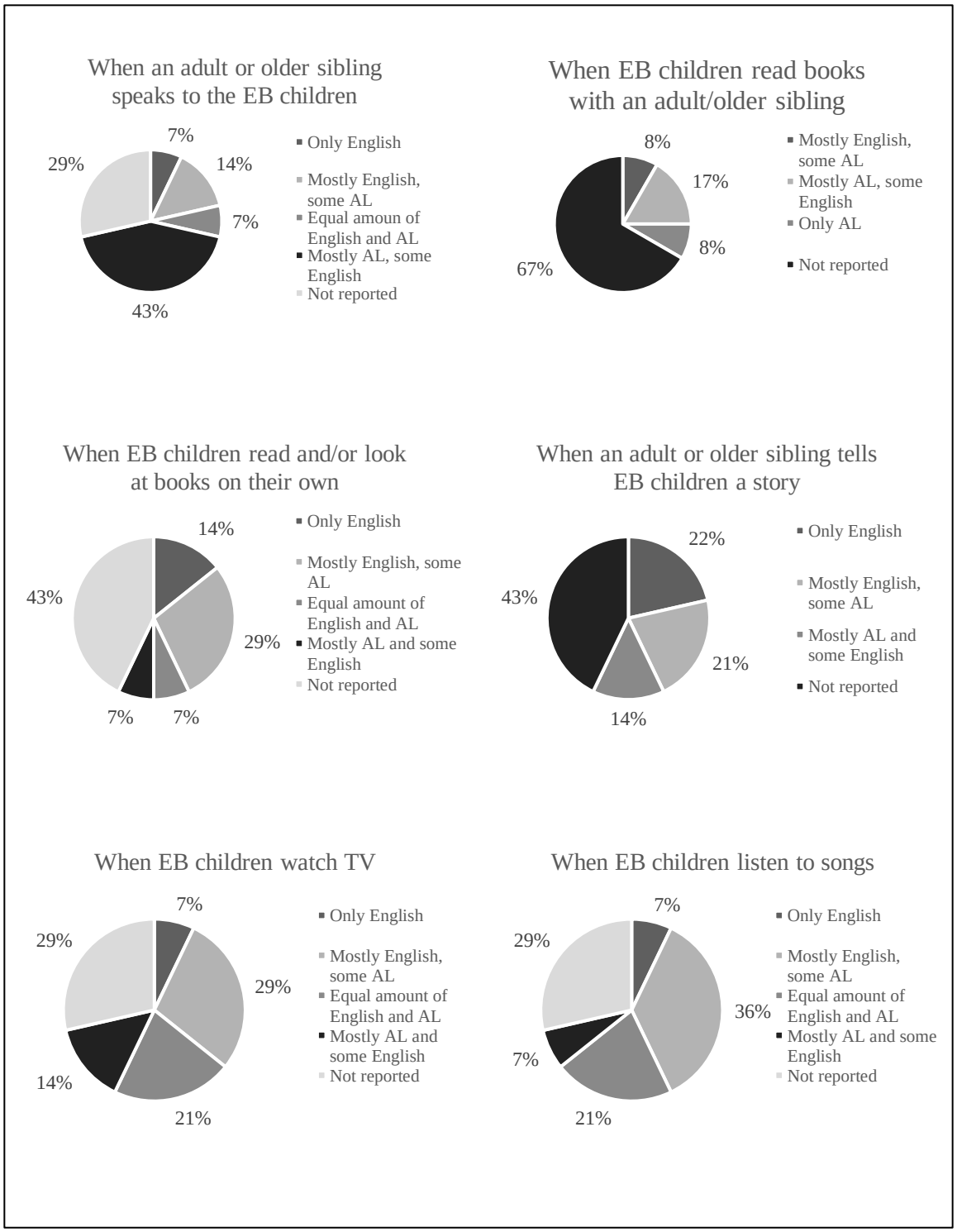

Figure 7 - Continued

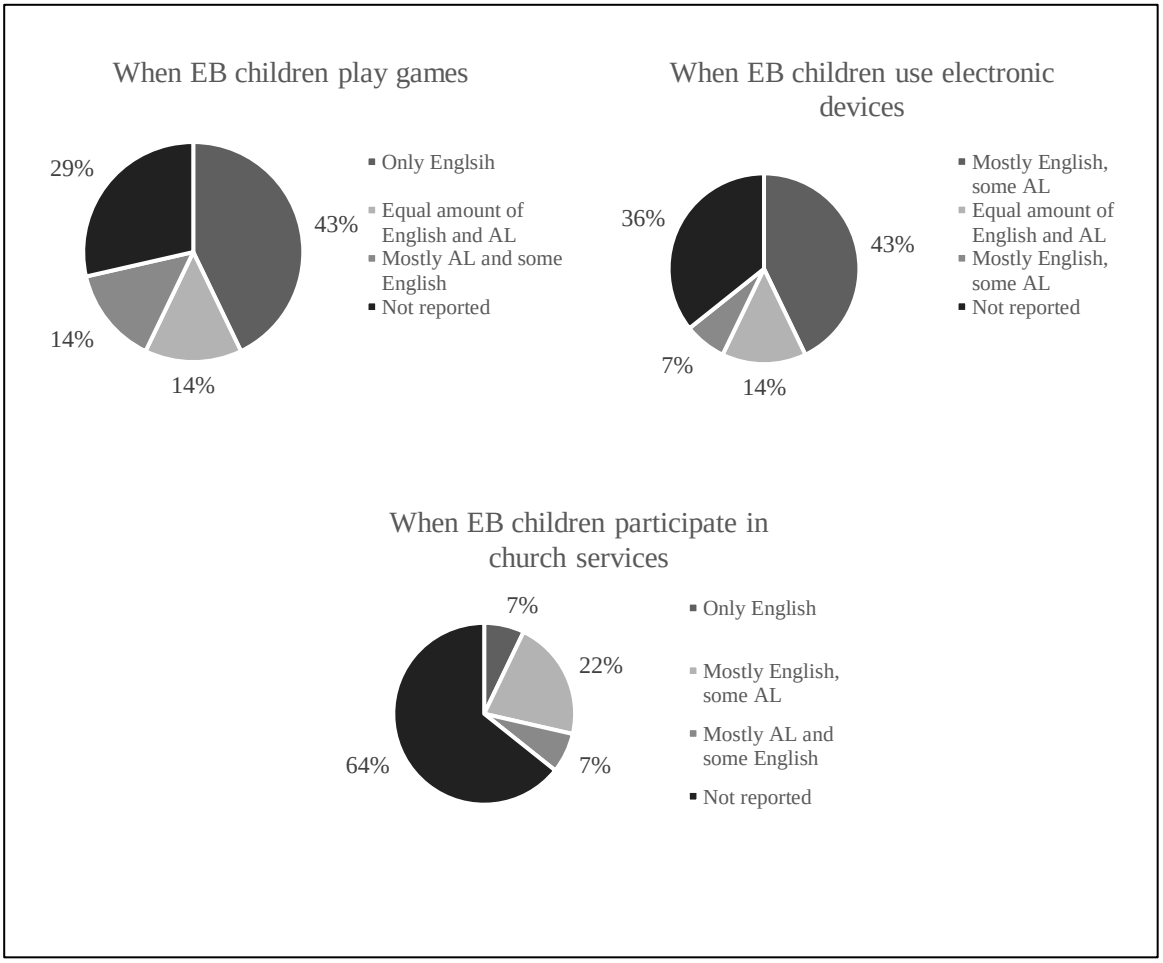

Figure 7. Language and print exposure the EB children have at home while doing various activities. AL = Additional language.

Appendix B

Selected Letter for Each Child and Average Letter Difficulty Values

C #	MSI					nMSI					Control				
	L1	L2	L3	L4	*M* *(SD)*	L1	L2	L3	L4	*M* *(SD)*	L1	L2	L3	L4	*M* *(SD)*
1	z	y	d	q	2.66 (1.78)	e	l	k	h	2.30 (1.23)	n	g	a	x	1.95 (.70)
2	e	l	a	x	2.18 (1.20)	f	s	n	r	2.01 (.58)	u	w	v	j	2.07 (.74)
3	r	l	v	z	2.14 (1.32)	u	a	e	k	1.80 (.87)	n	b	p	x	1.85 (.68)
4	k	v	g	l	2.25 (1.24)	n	t	m	d	2.12 (.49)	u	i	f	s	2.13 (.70)
5	e	n	p	k	1.81 (.77)	u	z	t	r	1.82 (.96)	y	w	a	x	1.92 (.68)
6	n	m	v	k	1.88 (.75)	o	r	l	t	1.95 (1.48)	u	e	p	z	1.83 (.95)
7	y	v	j	r	1.96 (.61)	w	a	x	n	1.92 (.69)	u	d	p	k	1.92 (.89)
8	u	x	a	r	1.96 (.79)	y	z	t	w	1.79 (.86)	n	e	p	k	1.81 (.77)
9	v	r	u	j	2.04 (.74)	d	y	k	p	1.85 (.78)	n	w	a	x	1.92 (.69)
10	c	e	u	b	2.11 (.66)	w	f	s	n	2.04 (.58)	y	d	m	k	1.96 (.76)
11	r	u	t	x	1.93 (.80)	k	n	p	e	1.81 (.77)	y	b	a	z	1.77 (.83)
12	v	n	d	x	1.99 (.67)	w	s	y	f	2.04 (.58)	u	i	a	k	1.96 (.89)

13	g	t	u	f	2.19 (.61)	e	d	j	l	2.35 (1.12)	n	h	r	p	2.17 (.48)
14	t	u	x	w	1.96 (.81)	y	z	a	r	1.78 (.84)	n	e	p	k	1.81 (.77)
15	p	n	k	e	1.81 (.77)	y	z	a	r	1.78 (.84)	n	e	p	k	1.81 (.77)
16	t	d	f	u	2.18 (.61)	l	e	p	m	2.38 (1.03)	n	r	v	s	1.99 (.56)
17	l	b	g	c	2.40 (1.06)	t	u	m	h	2.22 (.61)	n	y	v	a	2.24 (.55)
18	t	u	m	w	2.18 (.60)	z	g	f	e	1.75 (.71)	l	d	b	v	2.50 (.94)
19	j	q	r	g	2.64 (1.65)	m	h	k	l	2.28 (1.24)	n	y	f	z	2.02 (.95)
20	b	v	n	s	1.98 (.58)	p	l	k	e	2.11 (1.28)	u	r	a	j	1.98 (.76)
21	l	j	g	f	2.33 (1.13)	d	v	u	x	2.06 (.78)	n	w	a	k	1.87 (.77)
22	u	s	t	r	1.98 (.74)	a	k	y	b	1.82 (.75)	n	e	p	j	1.89 (.65)
23	s	u	w	v	2.10 (.70)	l	c	a	r	2.25 (1.13)	n	d	f	j	2.02 (.63)
24	k	q	m	d	2.53 (1.75)	g	n	e	t	2.15 (.49)	l	i	r	x	2.34 (1.15)
25	t	x	l	r	2.15 (1.22)	n	a	z	d	1.83 (.86)	u	e	p	k	1.88 (.88)
26	z	u	d	a	1.90 (.96)	x	t	y	r	1.86 (.68)	n	e	p	k	1.81 (.77)
27	e	d	k	l	2.27 (1.23)	n	a	h	t	2.07 (.56)	u	g	f	j	2.11 (.74)

28	w	y	t	x	1.89 (.70)	p	k	n	e	1.81 (.77)	u	r	a	z	1.85 (.95)
29	v	d	x	u	2.06 (.78)	w	j	a	l	2.24 (1.17)	n	i	f	k	1.96 (.77)
30	a	k	d	y	1.87 (.77)	p	e	n	j	1.89 (.65)	u	r	t	s	1.98 (.74)
31	f	n	j	r	1.98 (.62)	l	a	t	g	2.35 (1.08)	u	d	v	c	2.13 (.67)
32	e	k	n	p	1.81 (.77)	t	x	u	m	1.91 (.80)	y	r	a	z	1.78 (.84)
33	b	i	k	y	1.97 (.77)	p	q	a	r	2.58 (1.64)	l	e	f	t	2.36 (1.04)
34	k	f	d	y	1.94 (.76)	a	s	u	r	2.00 (.72)	n	w	v	j	2.00 (.63)
35	e	k	p	n	1.81 (.77)	b	a	y	x	1.94 (.79)	u	r	t	z	1.82 (.96)
36	x	n	v	w	1.98 (.67)	j	v	a	i	1.96 (.66)	l	r	f	k	2.20 (1.24)

Note. C = child; L1, L2, L3, L4 are four letters taught using MSI or nMSI. *M(SD)* is the average and standard deviation of letter difficulty values within MSI or nMSI condition.

Appendix C

Sample Lesson Plans

MSI Condition

Letter *J*: MSI Lesson 1

MATERIALS

Keyword letter card (*Jj* jar) and magnetic letters (*j*)
Keyword letter card for previous letter taught (if applicable)
J alphabet book
j cut from sandpaper
2 hand mirrors

REVIEW

(**If this is the student's very first letter lesson, skip directly to Introduction*):

We have been working together to learn different letters. Here is the last letter that we learned.

Show the keyword card for the previous letter learned and point to the corresponding letter on the card as you review with the student.

Repeat after me.
Lowercase (target letter).

Allow time for the student to repeat.

(Target letter) represents the sound: /X/X/X/ like (letter's action). You say its sound and practice the action.

Allow time for the student to repeat the sound and the action.

(Keyword) begins with the (target letter). You say (keyword).

Allow time for the student to repeat the keyword.

Now let's look at a new letter that we will be learning.

INTRODUCTION

Say Letter Name, Sound, and Keyword
Display the keyword letter card for *Jj*.
I Do

Today we're going to learn about a new letter. This is a lowercase *J.*

Point to lowercase *j*.

J represents the /j/ sound. (Look at the mirror) I see the shape of my mouth changes as I say the sound. (Put a hand to vocal cords) I feel vibration on my front neck /j/ /j/ /j/.

Point to the jar.

That is the same sound we hear at the beginning of the word *jar*. *J*, /j/ /j/ /j/, *jar*.

(Note: If the student's name begins with *J* /j/, use his/her name instead of the word *jar*:

This is a letter *J*. It represents the /j/ sound. That is the same sound we hear at the beginning of your name! *J*, /j/ /j/ /j/, [student's name].)

We Do

Say the letter name after me.

Point to lowercase *j*.

Lowercase *j*.

Allow time for the student to repeat the letter name.

***(*Put a hand to vocal cords) *J* represents the sound /j/ /j/ /j/. You say its sound and notice the shape of your mouth or feel vibration on your front neck.**

Allow time for the student to repeat the letter sound.

Point to the jar.

Jar begins with J. You say *jar*.

Allow time for the student to repeat the word.

You Do

Now you try by yourself.

Point to lowercase *j*.

What letter is this?

What sound does *J* represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

What word begins with *J*?

If the student is not ready to say the correct name, sound, and keyword (or another word that begins with *J*/j/) independently, repeat the task at the We Do level of support.

Introduce Action Affiliated with J/j/

I Do

Now, I'm going to teach you an action to help you remember the sound letter *J* represents. The letter *J* represents the /j/ sound, like jump. /j/ /j/ /j/ *jump*. I'm going to jump. /j/ /j/ /j/.

We Do

Let's say the letter name together. *J*.

Let's practice the action together. /j/ /j/ /j/

Say the letter name and stand up and jump (on two feet) with student while making the /j/ sound.

You Do

Now it's your turn to say the letter name and practice the action by yourself. Remember to say the letter name and make the sound *J* represents.

If the student is not ready to say the letter name and/or perform the jumping action while making the /j/ sound independently, repeat the task at the We Do level of support.

PRACTICE/APPLICATION

Reading: Alphabet Book

Have a small, simple alphabet book that contains a few words that begin with the letter *j* (e.g. Bella and Rosie's alphabet books from Pioneer Valley)

I Do

Show the letter book.

Next, I'm going to read this book filled with words that begin with the letter *J*. Listen to how these words all start with /j/.

Read the first two pages of the book, pointing under each word. Draw attention to and isolate the /j/ sound on each page.

***Jeep.* There is the *j*. *(*put a hand to vocal cords) /j/ /j/ /j/ *jeep*.**

***Jam*. There is the *j*. *(*put a hand to vocal cords) /j/ /j/ /j/ *jam*.**

We Do

Help me find the letter *j* on the rest of the pages.

Read the word on each of the remaining pages and invite the student to find the letter *j*.

Example: ***Jellybeans*. Find the lowercase *j* in *jellybeans*. Yes, that is a lowercase *j*!**

You say the name of that letter. What sound does *J* represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

If student is not ready to find the *j* independently, show a model of the letter (a magnetic letter or letter card).

Find the letter that looks like this *j*.

You Do

Now it's your turn to read this book by yourself.

Allow the student time to read the book. Encourage the student to point to each word. Ask student to locate the letter *j* in at least three words on various pages using the prompt below at the We Do/You Do level of support, depending on the independence of the student.

What letter did you find? What sound does it represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

If student is not ready to read the book independently, read it to him/her.

After finding all the letters, ask the child the name and the sound of the letter.

What letter did you find? What sound does it represent?

WRITING: Letter Formation Using Finger

I Do

Place sandpaper *j* in front of you.

The last thing we will do is practice tracing *J*. Watch as I use my finger to trace this lowercase *J* on sandpaper. Lowercase letters always start at the top.

Model tracing the sandpaper *J* as you say the verbal path.

Pull down, curve around, dot. Lowercase *J*.

We Do

Let's keep practicing. Use your finger to trace over the lowercase *J*. Remember, we always start lowercase letters at the top. Repeat after me:

Help student trace over the lowercase *J* with his/her finger while saying the verbal path:

Pull down, Give student time to repeat and trace.
curve around, Give student time to repeat and trace.
dot. Give student time to repeat and trace.
Lowercase *J*. You say its name. Give student time to repeat.
***J* represents the /j/ sound. You say the sound and notice the shape of your mouth or put your hand on your front neck to feel the vibration.** Give student time to repeat the sound and feel vibration on the vocal cord.

You Do

Now try tracing lowercase *J* by yourself. Remember to start at the top.

The student should say something like "Pull down, curve around, dot, /j/ /j/ J." If the student is not ready to trace lowercase *J* independently, or traced the letter with an incorrect formation, repeat the task at the We Do level of support. If the child traces but does not say the letter name and/or sound, use the following prompts:

You say the name of that letter. What sound does *J* represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

Do at least 3 repetitions of lowercase *J* at the We Do/You Do level of support, depending on the independence of the student.

After completing, allow a child to say the letter name and sound.

What letter did you trace? What sound does *J* represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

After completing the lesson, show the student a sheet of letter stickers (make sure it contains the letter just learned).

You worked so hard today, let's get a sticker for you.
Find the letter that we learned today.

Allow student time to find the appropriate letter. If the student needs assistance finding the correct letter, show the student the keyword card or a magnetic letter as a model. Have child place the sticker in a visible place (back of hand, front of shirt).

Now you can show everyone what letter you are learning.

Letter *J*: MSI Lesson 2

MATERIALS

Keyword letter card (*Jj* jar) and magnetic letters (*j*)
Environmental print cards for *J:* Jell-O, Juicy Juice, Jif, Jelly Belly
"3 Jellyfish" rhyme (print from page 4 of this lesson plan or write on chart paper)
2 hand mirrors
Red word screen

INTRODUCTION

Say Letter Name, Sound, and Keyword
Display the keyword letter card for *Jj*.
I Do
Point to lowercase *J*. Complete a jumping action as you make the /j/ sound.

Today, we're going to practice a special letter. Do you remember this letter? This is a lowercase *J*. It represents the sound /j/ /j/ /j/.

Point to the jar.

That is the same sound we hear at the beginning of the word *jar*. *J*, /j/ /j/ /j/, *jar*.

(Note: If the student's name begins with *J*/j/, use his/her name instead of the word *jar*:

This is a letter *J*. It represents the /j/ sound. That is the same sound we hear at the beginning of your name! *J*, /j/ /j/ /j/, [student's name].)

We Do

Say the letter name after me.

Point to lowercase *j*.

Lowercase *j*.

Allow time for the student to repeat the letter name.

J represents the sound /j/ /j/ /j/ like *jump*. You say its sound and pretend to jump.

Allow time for the student to repeat the letter sound and complete the jumping action.
Point to the jar.

Jar begins with J. You say *jar*.

Allow time for the student to repeat the word.
You Do

Now you try by yourself.

Point to lowercase *j*.

What letter is this?
What sound does *J* represent? Show me the action as you say its sound.
What word begins with *J*?

If the student is not ready to say the correct name, sound, and keyword (or another word that begins with *J*/j/) independently, repeat the task at the We Do level of support.

Link to Environmental Print

I Do/We Do

We see the letter *J* in lots of important words.

Display the environmental print cards for *J*.

Have you seen any of these before?

Allow student to identify any known environmental print. Select one of the cards the student accurately identifies. (Note: If the student does not correctly identify any of the environmental print, introduce the word on one of the cards to him/her.) Mention that the word includes the letter *J*, but do not point the letter out. Say the sound the letter represents.

Example: **Look at this Jell-O symbol. I see a letter *J* in the word *Jell-O*. You say the name of that letter. *J* represents the /j/ sound. (look at the mirror) I see the shape of my mouth changes as I say the sound. (put a hand to vocal cords) I also feel vibration in my front neck /j/ /j/ /j/. You say the sound and notice the shape of your mouth or feel vibration on your front neck.**

You Do

Point to the letter *J* in the word [environmental print word (e.g., *JIF)*. What letter did you find? What sound does *J* represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

If the student is not ready to find the *J* independently, show a model of the letter (a magnetic letter or letter card).

Find the letter that looks like this *J*.

Repeat process with a second environmental print card of the student's choosing.

PRACTICE/APPLICATION

Reading: Nursery Rhyme

Display the "3 Jellyfish" rhyme.

I Do

Now, I'm going to teach you a rhyme to help you remember the way the letter *J* looks and the sound it represents.

(Put a hand on the vocal cord) The letter *J* represents the /j/ /j/ /j/ sound. Look and listen as I read/sing the rhyme:

Point to the words as you say/sing the rhyme. Slow down slightly and enunciate the words that begin with the /j/ sound so the student can see and hear the link.

Three jellyfish, three jellyfish.
Three jellyfish sitting on a rock.
One fell off.

Two jellyfish, two jellyfish.
Two jellyfish sitting on a rock.
One fell off.

One jellyfish, one jellyfish.

One jellyfish sitting on a rock.
One fell off.

No jellyfish, no jellyfish.
No jellyfish sitting on a rock.

We Do/You Do

Let's practice the rhyme together.

Sing each line of rhyme. Have student either (1) repeat or (2) sing with you.

Where do you see the letter *J* in our rhyme?

Help student locate the lowercase forms of *j* in the rhyme. Use a magnetic letter/card as a model if necessary.

Can you point to a lowercase *J*? Nice job! Tell me what the name of that letter is. What sound does it represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

Repeat three times for lowercase letter *J*.

After completing, prompt the student to say the letter name and sound.

What letter did you find? What sound does it represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

WRITING: Letter Formation Using Implement

I Do

Display the magnetic letter for lowercase *J*.

The last thing we will do is practice writing *J* with the marker. First, let's practice writing the letter *J* with our arms and then choose a color to write the lowercase j.

Write *J* in air as you say the verbal path:

Pull down, curve around, dot. Lowercase *J*.

Place the red word screen underneath a sheet of blank paper. Write *J* with a marker on a sheet of blank paper as you say the verbal path:

Now, I will choose a color to write the lowercase j on the paper. I feel bumpy as I write the letter.
Pull down, curve around, dot. Lowercase *J*.

We Do

Let's try it together. Write the lowercase *J* in air with me.
Say the words while you write: Pull down, curve around, dot. Lowercase *J.* You say the name. *J* represents /j/ sound. You say the sound as you write.

Allow student time to write *J* in air with you.

Now you choose a color. Trace over the lowercase *j* I wrote and feel bumpy as you write the letter.

Say the words while you write: Pull down, curve around, dot. Lowercase *J*. You say the name. *J* represents /j/ sound. You say the sound as you notice the shape of your mouth or feel vibration on your front neck.

Place the red word screen underneath a sheet of blank paper. Allow student time to trace over the j you wrote.

You Do

Now you make your own lowercase *J*.

Place the red word screen underneath a sheet of blank paper and let the child write a letter. If the student is not ready to write uppercase *J* independently, return to the We Do level of support.

What letter did you write? What sound does *J* represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

Do at least 3 repetitions of lowercase *J* at the We Do/You Do level of support, depending on the independence of the student.

After completing, prompt the student to say the letter name and sound.

What letter did you write? What sound does *J* represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

After completing the lesson, show the student a sheet of letter stickers (make sure it contains the letter just learned).

You worked so hard today, let's get a sticker for you.

Find the letter that we learned today.

Allow student time to find the appropriate letter. If the student needs assistance finding the correct letter, show the student the keyword card or a magnetic letter as a model. Have child place the sticker in a visible place (back of hand, front of shirt).

Now you can show everyone what letter you are learning.

Letter *J*: MSI Lesson 3

MATERIALS

Keyword letter card (*Jj* jar) and magnetic letters (*j*)
Environmental print cards for *J:* Jell-O, Juicy Juice, Jif, Jelly Belly
Soup sorter cards: *j*, jar, jam, jacket, jet, juice, buttons, vacuum, yo-yo
Blank sheet of paper, red word screen, pencil
2 hand mirrors
Red word screen

INTRODUCTION

Say Letter Name, Sound, and Keyword

Display the keyword letter card for *Jj*.

I Do

Let's talk about a letter we are learning.

Point to lowercase *j*. Complete a jumping action as you make the /j/ sound.

This is a lowercase *j*. It represents the sound /j/ /j/ /j/.

Display an image of a jar. (Note: If the student's name begins with *J* /j/, use his/her name instead of the word *jar*.)

That is the same sound we hear at the beginning of the word *jar*. *J*, /j/ /j/ /j/, *jar*.

We Do

Say the letter name after me.

Point to lowercase *j*.

Lowercase *j*.

Allow time for the student to repeat the letter name.

***J* represents the sound /j/ /j/ /j/ like *jump*. You say its sound and pretend to jump.**

Allow time for the student to repeat the letter sound and complete the action.

Point to the jar.

Jar begins with J. You say *jar*.

Allow time for the student to repeat the word.

You Do

Now you try by yourself.

Point to lowercase *j*.

What letter is this?

What sound does *J* represent? (Put hand to vocal cord.) Show me the action as you say the sound.

What word begins with *J*?

If the student does is not ready to say the correct name, sound, and keyword (or another word that begins with *J*/j/) independently, repeat the task at the We Do level of support.

Link to Environmental Print

I Do/We Do

We see the letter *J* in lots of important words. Last time we met, we noticed that [environmental print student practiced during the last lesson (e.g., *Jell-O* and *JIF*)] have the letter *J* in them.

Display another environmental print card that the student accurately identified during the previous *J* lesson. (Note: If the student did not correctly identify any of the environmental print, introduce the word on one of the cards to him/her.) Mention that the word includes the letter *J*, but do not point the letter out. Say the sound the letter represents.

Example: **This says *Jelly Belly*. I see a letter *J* in the word *Jelly*. You say the name of that letter. *J* represents the /j/ sound. *Jelly*. (Look at the mirror) I see the shape of my mouth changes. (Put a hand to vocal cords) I also feel vibration on my front neck /j/ /j/ /j/.**

You say the sound and notice the shape of your mouth or feel vibration on your front neck.

You Do

Point to the letter *J* in the word [environmental print word]. What letter did you find? What sound does *J* represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

If the student is not ready to find the *J* independently, show a model of the letter (a magnetic letter or letter card).

Find the letter that looks like this *J*.

Repeat process with a second environmental print card of the student's choosing.

PRACTICE/APPLICATION

Reading: Initial Sound Sort

Show student the soup sorter card with the letter *j* on it.

Now, let's play a game with picture cards! This is the letter *j*. It represents the sound (put a hand on the vocal cord) /j/ /j/ /j/. You say its name. You say its sound and notice the shape of your mouth or feel the vibration on your front neck.

Let's find some words that begin with that sound.

First, let's look through the pictures.

Identify the object on each card as you show it to the child.

I Do

Show student the soup sorter card with a picture of a jacket on it.

This is a jacket.

***Jacket*. /j/ /j/ /j/ *jacket*.**

Point to the letter *j* card.

(Put a hand on the vocal cord) /j/ /j/ /j/ *j*.

I think *Jacket* starts with /j/. Let's flip the card. (Point to the *J*). Yes, it starts with *J*, so I will put it under the *j* card.

Place the jacket card under the *j* card.

Show student the soup sorter card with a picture of buttons on it.

These are buttons.

***Buttons*. /b/ /b/ /b/ *buttons*.**

Point to the *j* card.

/j/ *j*.

Point to the buttons card and then to the *j* card.

/b/ /j/.

***Buttons* does not start with /j/ so I will not put it under the *j* card.**

Place the buttons card to the side.

We Do

Let's do this next one together.

Show the student the soup sorter card with a picture of a jet on it.

What is this?

Correct the student if they are incorrect.

This is a jet.

We can say the first sound as you feel vibration on your front neck. /j/ /j/ /j/ *jet*. You say: /j/ *jet*.

Does /j/ *jet* start like /j/ *j*?

Allow student time to respond.

Yes, I think /j/ *jet* starts like /j/ *j*. Let's flip the card. Does it start with *j*? You point to the letter *J* and say the name of that letter. What sound does letter *J* represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound. Let's put it under the *j* card.

<u>You Do</u>

Show student another soup sorter card.

Now you try the next one. What is the first sound? What letter makes that sound? Do you think it starts with the letter j? Let's flip the card. Does it start with /j/ *j*? You say the name of the letter. Let's put it where it belongs.

Allow student to complete the task at least three times. If the student is not ready to articulate the first sound independently, drop back to <u>We Do</u> level of support and complete the task together.

Repeat procedure with the remaining soup sorter cards.

WRITING: List

Set the *J* picture cards from the previous activity in front of the student (jar, jam, jacket, jet, juice).

<u>I Do</u>

The last thing we will do is write a list of words that begin with *J*. We can write the words for these pictures. I see a jar, /j/, *jar*. *Jar* starts with a /j/, so I am going to write a *J* first. I feel bumpy as I write the letter.

Use a blank sheet of paper to write the word. Write lowercase *J* putting a paper on the red word screen and using the same verbal path as before.

Pull down, curve around, dot.

I feel bumps as I write the letter. And this is the rest of the word, *jar*.

Model writing the rest of the word for the student. Place the picture card on the left edge of the page next to the matching word so the student can reread the words on the list with picture support.

<u>We Do</u>

What other word can we write together?

Allow student to choose a different soup sorter card.

Good. Let's write that word together.

Say [word student identifies (e.g., jam, jacket, jet, juice)]. Listen for the first sound. Say /j/ [word student identifies].

Yes, it starts with a *J*. You say the name of that letter and then write it. You can feel bumpy as you write the letter.

Allow time for student to write the first letter of the word with putting a paper on the red word screen. Support as necessary with formation. Write the rest of the word for the student. If the word includes previously taught letters, guide the child to write them (e.g., If the student identifies the *jam* and has learned about letter *m* in a previously taught lesson:

Write the *J*. The next letter in the word *jam* is *a*. I will write the *a*. After the *a* comes an *m*. Do you remember how to write the letter *m*? Write it next to the *a*. Pull down, up, over, down and up, over, and down. *J-a-m. Jam*.) Place the picture card on the left edge of the page next to the matching word so the student can reread the words on the list with picture support.

You Do

Look for another word that starts with /j/*J*. Write the first letter of that word. What letter did you write? What sound does it represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

Place the red word screen underneath a sheet of blank paper. Allow time for the student to find and label the first letter of words with the /j/ sound. Write the rest of the word for the student. Allow student to write the letter at least three times. If the word includes previously taught letters, guide the student to write those letters. Place the picture card on the left edge of the page next to the matching word so the student can reread the words on the list with picture support.

If the student is not ready to write *J* independently, drop back to We Do level of support and complete the task together.

Once the list is complete:

Let's read our list together.

Read the finished list with the student, using the picture supports, as you point to each word.

What letter do all of our words start with? What sound does it represent? Do you notice the shape of your mouth makes? You can also feel the vibration on your front neck as you say its sound.

After completing the lesson, show the student a sheet of letter stickers (make sure it contains the letter just learned).

You worked so hard today, let's get a sticker for you.
Find the letter that we learned today.

Allow student time to find the appropriate letter. If the student needs assistance finding the correct letter, show the student the keyword card or a magnetic letter as a model. Have child place the sticker in a visible place (back of hand, front of shirt).

Now you can show everyone what letter you are learning.

MSI Review Lesson 1:
(Include all the target letters within the condition, either MSI or nMSI, you have been working on up to this point)

MATERIALS

Keyword letter cards for target letters
Sandpaper letter cards for target letters
Verbal path for each target letter
ABC Books: *The Alphabet Book* (P.D. Eastman) and *A to Z* (Sandra Boynton)

PRACTICE/APPLICATION

Lay out the keyword cards for letters that have been recently taught. You may want to limit this to no more than four letters that were most recently taught.

We have been learning about lots of different letters: (target letter name 1), (target letter name 2), ...
(Point to target letter 1) You say the letter name. What sound does it represent?

Repeat for other target letters if applicable.

Today we are going to find these letters in a book.
Which book would you like to use to look for our letters?

Allow student time to choose one of the two alphabet books.

Which letter would you like to find first in our book?

Allow student time to choose of the letters from the keyword cards laid out.

Yes, let's start with (target letter). You say the letter name.
What sound does it represent?

With the child's help, flip through the book to the page containing the target letter chosen by the student.

Here it is! This is (target letter). You say the letter name.

Read the text on the page(s) as you run your finger under the words.

Let's look for words on this page that have the letter (target letter).
What letter did you find? What sound does it represent?

If student is not ready to locate the target letter independently, point to the model letters on the page or keyword card and ask him/her to find the letter in each word that looks like the models.

After the student has found at least 2 examples of the lowercase target letter, move on to a writing activity.

Now let's practice writing this same letter with our sandpaper letters.
I'll say the words and you trace the letter.

Say the verbal path as the student traces over the letter. Guide correction formation as necessary. After the student traces the letter, point to the letter.

Good. /[sound]/ /[sound]/ /[sound]/ [target letter]. You say its sound and name.

Allow the student the opportunity to trace each letter at least 2 times.

After the student finishes tracing, prompt the student to say the letter name and sound.

What letter did you trace? What sound does it represent?

After completing the lesson, show the student a sheet of non-letter stickers.

You worked so hard today, let's get a sticker for you.

MSI Review Lesson 2:
[Include all the taught letters within the condition, either MSI or nMSI, you have been working on up to this point]

MATERIALS

Keyword letter cards for target letters
Magnetic letters for sorting: 3 of each lowercase target letter
White board
Pictures of food items that begin with target letters (e.g., If reviewing *B* and *W*, you might use the following pictures: banana, bread, watermelon, water)
Red Word Screen
Blank paper and pencil

REVIEW:

Now we are going to look at these letters together.

Show keyword letter cards or magnetic letters, lowercase, for the target letters that have been taught.

We have been learning about these letters.
This is [target letter]. It represents the [sound] sound.
Say the letter name with me as I point to it.

Point to lowercase target letter.

Lowercase [target letter].
[Target letter] represents the sound /[sound]/ /[sound]/ /[sound]/.
You say the [target letter] sound.

Point to the keyword picture.

Let's say the word that begins with [target letter]. [keyword].

Repeat with all target letters incorrectly identified in assessment.

PRACTICE/APPLICATION

Reading: Sorting Magnetic Letters

Place one magnetic letter for each lowercase target letter at the top of the board to serve as models. Then place two of each lowercase target letter, in random order, at the bottom of the board.

<u>I Do</u>

Now, let's play a game to practice matching the letters.

Point to a lowercase model letter at the top of the board.

This is lowercase [target letter].

What sound does it represent?

We can find other letters that look like this.

I can find another lowercase [target letter]. Watch.

Find another lowercase target letter. Place it next to the model to compare.

They look the same. This is the letter [target letter].

Place the letter you found directly below the model letter.

We Do/You Do

Let's find another lowercase [target letter].

Allow a few seconds for the student to find a lowercase target letter. If the student is not ready to do so independently, point to the model lowercase target letter at the top of the board.

Does this letter look the same? Is this another lowercase [target letter]?

Encourage the student to compare the letter to the model letter at the top of the board.

Yes, they look the same.

If the student chooses the wrong letter, allow him/her to put it next to the model and show how they are different.

Let's trace this letter with our finger. Is it the same as lowercase [target letter]?

No, this is not lowercase [target letter]. Try again.

If the student chooses the wrong letter again, allow him/her to hold the model letter and move it over the other letters in order to find the matching letters.

When the student chooses the correct letter, confirm the work.

What letter did you find?

Yes, you found another lowercase [target letter].

What sound does [target letter] represent?

Have the student place the letter he/she found directly below the model letter.

Continue the task at the We Do/You Do level of support with the remaining lowercase target letters.

WRITING: Grocery List

I Do/We Do

Lay out pictures of food items that begin with the target letters.

The last thing we'll do is practice writing! Let's pretend we are going to the grocery store and we need to buy these things. Let's write a grocery list so we do not forget anything.

Identify the food item in each picture. Then choose one of the pictures.

Let's write this word first.

Set the picture on the left side of a sheet of paper. Then say the word, emphasizing the initial sound.

We Do/You Do

Let's write that word together.

Say [grocery list item (e.g., banana, bread, watermelon, water)]. What sound do you hear at the beginning of that word? Say /[sound]/[grocery list item].

What letter does that sound represent?

If the student is not ready to identify the initial letter independently, give him/her choices. Then have the student write the letter.

Example: **Does it begin with a *B* or a *W*? Yes, it starts with a *B*! We need to write a *B* first. You write the *B* and feel bumps as you write the letter.**

Put the red word screen under the sheet of the paper. Allow time for student to write the first letter of the word. Support as necessary with formation (e.g., show the magnetic letter or guide with verbal path of letter formation.

And this is the rest of [grocery list item].

Write the rest of the word for the student and then read the word aloud. If the word includes previously taught letters, guide the child to write them (e.g., If the student identifies *banana* and has learned about letter *n* in a previously taught lesson:

Write the *B*. The next letter in the word *banana* is *a*. I will write the *a*. After the *a* comes an *n*. Do you remember how to write the letter *n*? Write it next to the *a*. Pull down, up, over, and down. Next comes another *a*. I'll write it. Now, write another *n* after my *a*. Last is another *a*. *B-a-n-a-n-a. Banana*.)

Now you choose something to add to our list.

Repeat activity with the remaining pictures, as time permits.

Let's read our grocery list together.

Point to and read each word on the list together.

When finished, point to the first letter of each word and ask the child to identify the letter name and sound.

What letter is this? What sound does it represent?

After completing the lesson, show the student a sheet of non-letter stickers.

You worked so hard today, let's get a sticker for you.

Letter J: nMSI Lesson 1

MATERIALS

Keyword letter card (Jj jar) and magnetic letters (j)
Keyword letter card for previous letter taught (if applicable)
J alphabet book

REVIEW

(*If this is the student's very first letter lesson, skip directly to Introduction):

We have been working together to learn different letters. Here is the last letter that we learned.

Show the keyword card for the previous letter learned and point to the corresponding letter on the card as you review with the student.

Repeat after me.
Lowercase (target letter).

Allow time for the student to repeat.

(Target letter) represents the sound: /X/X/X/. You say its sound.

Allow time for the student to repeat the sound.

(Keyword) begins with the (target letter). You say (keyword).

Allow time for the student to repeat the keyword.

Now let's look at a new letter that we will be learning.

INTRODUCTION

Say Letter Name, Sound, and Keyword

Display the keyword letter card for Jj.

<u>I Do</u>

Today we're going to learn about a new letter. This is a lowercase j.

Point to lowercase j.

J represents the /j/ sound.

Point to the jar.

That is the same sound we hear at the beginning of the word jar. J, /j/ /j/ /j/, jar.

(Note: If the student's name begins with J /j/, use his/her name instead of the word jar:

This is a letter J. It represents the /j/ sound. That is the same sound we hear at the beginning of your name! J, /j/ /j/ /j/, [student's name].)

<u>We Do</u>

Say the letter name after me.

Point to lowercase j.

Lowercase j.

Allow time for the student to repeat the letter name.

J represents the sound /j/ /j/ /j/. You say its sound.

Allow time for the student to repeat the letter sound.
Point to the jar.

Jar begins with J. You say jar.

Jump also begins with J. You say jump.

Allow time for the student to repeat the word.
Repeat We do one more time.

Nice job! Let's try one more time.

Say the letter name after me.

Point to lowercase j.

Lowercase j.

Allow time for the student to repeat the letter name.

J represents the sound /j/ /j/ /j/. You say its sound.

Allow time for the student to repeat the letter sound.
Point to the jar.

Jar begins with J. You say jar.

Jump also begins with J. You say jump.

Allow time for the student to repeat the word.
You Do

Now you try by yourself.

Point to lowercase j.

What letter is this?

What sound does J represent?

What word begins with J?

Repeat You do one more time.

Nice job. Let's try one more time.

Point to lowercase j.

What letter is this?

What sound does J represent?

What is another word that begins with J?

If the student is not ready to say the correct name, sound, and keyword (or another word that begins with J/j/) independently, repeat the task at the We Do level of support.

PRACTICE/APPLICATION

Reading: Alphabet Book
Have a small, simple alphabet book that contains a few words that begin with the letter j (e.g., Bella and Rosie's alphabet books from Pioneer Valley)
I Do
Show the letter book.

Next, I'm going to read this book filled with words that begin with the letter J.

Listen to how these words all start with /j/.

Read the first two pages of the book, pointing under each word. Draw attention to and isolate the /j/ sound on each page.

Jeep. There is the j. /j/ /j/ /j/ jeep.

Jam. There is the j. /j/ /j/ /j/ jam.

We Do

Help me find the letter j on the rest of the pages.

Read the word on each of the remaining pages and invite the student to find the letter j.

Example: **Jellybeans. Find the lowercase j in jellybeans. Yes, that is a lowercase j! You say the name of that letter. What sound does J represent?**

If student is not ready to find the j independently, show a model of the letter (a magnetic letter or letter card).

Find the letter that looks like this j.

You Do

Now it's your turn to read this book by yourself.

Allow the student time to read the book. Encourage the student to point to each word. Do at least 3 repetitions of finding a lowercase J at the We Do/You Do level of support, depending on the independence of the student. Prompt the child to say the letter name and sound saying:

What letter did you find? What sound does it represent?

If student is not ready to read the book independently, read it to him/her.

After completing, allow a child to say the letter name and sound.

What letter did you find? What sound does it represent?

WRITING: Letter Formation Using Finger

I Do

Place the keyword letter card J in front of you.

The last thing we will do is practice tracing J. Watch as I use my finger to trace this lowercase J on the card. Lowercase letters always start at the top.

Model tracing the keyword letter card J as you say the verbal path.

Lowercase J. Pull down, curve around, dot. Lowercase J.

We Do

Let's keep practicing. Use your finger to trace over the lowercase J. Remember, we always start lowercase letters at the top. Repeat after me:

Help student trace over the lowercase J with his/her finger while saying the verbal path:

Pull down, Give student time to repeat and trace.

curve around, Give student time to repeat and trace.

dot. Give student time to repeat and trace.

Lowercase J. You say its name. Give student time to repeat.

J represents the /j/ sound. You say the sound. Give student time to repeat the sound.

You Do

Now try tracing lowercase J by yourself. Remember to start at the top.

The student should say something like "Pull down, curve around, dot, /j/ /j/ J." If the student is not ready to trace lowercase J independently, or traced the letter with an incorrect formation, repeat the task at the We Do level of support. If the child traces but does not say the letter name and/or sound, use the following prompts:

You say the name of that letter. What sound does J represent?

Do at least 3 repetitions of lowercase J at the We Do/You Do level of support, depending on the independence of the student.

After completing, allow a child to say the letter name and sound.

What letter did you trace? What sound does J represent?

After completing the lesson, show the student a sheet of letter stickers (make sure it contains the letter just learned).

You worked so hard today, let's get a sticker for you.

Find the letter that we learned today.

Allow student time to find the appropriate letter. If the student needs assistance finding the correct letter, show the student the keyword card or a magnetic letter as a model.

Have child place the sticker in a visible place (back of hand, front of shirt).

Now you can show everyone what letter you are learning.

Letter J: nMSI Lesson 2

MATERIALS

Keyword letter card (Jj jar) and magnetic letters (j)

Environmental print cards for J: Jell-O, Juicy Juice, Jif, Jelly Belly

"3 Jellyfish" rhyme (print from page 4 of this lesson plan or write on chart paper)

Blank paper and markers

INTRODUCTION

Say Letter Name, Sound, and Keyword

Display the keyword letter card for Jj.

I Do

Point to lowercase j and make the /j/ sound.

Today, we're going to practice a special letter. Do you remember this letter?

This is a lowercase j. It represents the sound: /j/ /j/ /j/.

Point to the jar.

That is the same sound we hear at the beginning of the word jar. J, /j/ /j/ /j/, jar.

(Note: If the student's name begins with J/j/, use his/her name instead of the word jar:

This is a letter J. It represents the /j/ sound. That is the same sound we hear at the beginning of your name! J, /j/ /j/ /j/, [student's name].)

We Do

Say the letter name after me.

Point to lowercase j.

Lowercase j.

Allow time for the student to repeat the letter name.

J represents the sound /j/ /j/ /j/. You say its sound.

Allow time for the student to repeat the letter sound.
Point to the jar.

Jar begins with J. You say jar.

Jump also begins with J. You say jump.

Allow time for the student to repeat the word.
You Do

Now you try by yourself.

Point to lowercase j.

What letter is this?

What sound does J represent?

What two words begins with J?

If the student is not ready to say the correct name, sound, and keyword (or another word that begins with J/j/) independently, repeat the task at the We Do level of support.

Link to Environmental Print
I Do/We Do

We see the letter J in lots of important words.

Display the environmental print cards for J.

Have you seen any of these before?

Allow student to identify any known environmental print. Select one of the cards the student accurately identifies. (Note: If the student does not correctly identify any of the environmental print, introduce the word on one of the cards to him/her.) Mention that the word includes the letter J, but do not point the letter out. Say the sound the letter represents.

Example: **Look at this Jell-O symbol. I see a letter J in the word Jell-O. You say the name of that letter. J represents the /j/ /j/ /j/ sound. You say the sound.**

You Do

Point to the letter J in the word [environmental print word (e.g., JIF). What letter did you find? What sound does J represent?

If the student is not ready to find the J independently, show a model of the letter (a magnetic letter or letter card).

Find the letter that looks like this J.

Repeat process with a second environmental print card of the student's choosing.

PRACTICE/APPLICATION

Reading: Nursery Rhyme
Display the "3 Jellyfish" rhyme.
I Do

Now, I'm going to teach you a rhyme to help you remember the way the letter J looks and the sound it represents.

The letter J represents the /j/ /j/ /j/ sound. Look and listen as I read/sing the rhyme:

Point to the words as you say/sing the rhyme. Slow down slightly and enunciate the words that begin with the /j/ sound so the student can see and hear the link.

Three jellyfish, three jellyfish.
Three jellyfish sitting on a rock.
One fell off.

Two jellyfish, two jellyfish.
Two jellyfish sitting on a rock.
One fell off.

One jellyfish, one jellyfish.
One jellyfish sitting on a rock.
One fell off.
No jellyfish, no jellyfish.
No jellyfish sitting on a rock.

We Do/You Do

Let's practice the rhyme together.

Sing each line of rhyme. Have student either (1) repeat or (2) sing with you.

Where do you see the letter J in our rhyme?

Help student locate the lowercase forms of j in the rhyme. Use a magnetic letter/card as a model if necessary.

Can you point to a lowercase J? Nice job! Tell me what the name of that letter is. What sound does it represent?

Repeat three times for lowercase letter J.

After completing, prompt the student to say the letter name and sound.

What letter did you find? What sound does it represent?

WRITING: Letter Formation Using Implement

I Do

Display the magnetic letter for lowercase J.

The last thing we will do is practice writing J. Let's practice writing the letter J with markers.

Write J with a colorful marker as you say the verbal path:

Pull down, curve around, dot. Lowercase J.

We Do

Now you try. Trace the lowercase J.
Say the words while you write: Pull down, curve around, dot. Lowercase J. You say the name. J represents /j/ sound. You say the sound.

Allow student time to trace over the J you wrote.

You Do

Point to a blank space on the paper (or use a new sheet of paper).

Now you make your own lowercase J. Choose which marker you want to use.

If the student is not ready to write lowercase J independently, return to the We Do level of support.

What letter did you write? What sound does J represent?

Do at least 3 repetitions of lowercase J at the We Do/You Do level of support, depending on the independence of the student.

After completing, prompt the student to say the letter name and sound.

What letter did you write? What sound does J represent?

After completing the lesson, show the student a sheet of letter stickers (make sure it contains the letter just learned).

You worked so hard today, let's get a sticker for you.

Find the letter that we learned today.

Allow student time to find the appropriate letter. If the student needs assistance finding the correct letter, show the student the keyword card or a magnetic letter as a model.

Have child place the sticker in a visible place (back of hand, front of shirt).

Now you can show everyone what letter you are learning.

Letter J: nMSI Lesson 3

MATERIALS

Keyword letter card (Jj jar) and magnetic letters (j)
Environmental print cards for J: Jell-O, Juicy Juice, Jif, Jelly Belly
Soup sorter cards: j, jar, jam, jacket, jet, juice, buttons, vacuum, yo-yo
Blank sheet of paper, pencil

INTRODUCTION

Say Letter Name, Sound, and Keyword

Display the keyword letter card for Jj.

I Do

Let's talk about a letter we are learning.

Point to lowercase j and make the /j/ sound.

This is a lowercase j. It represents the sound /j/ /j/ /j/.

Display an image of a jar. (Note: If the student's name begins with J /j/, use his/her name instead of the word jar.)

That is the same sound we hear at the beginning of the word jar. J, /j/ /j/ /j/, jar.

We Do

Say the letter name after me.

Point to lowercase j.

Lowercase j.

Allow time for the student to repeat the letter name.

J represents the sound /j/ /j/ /j/. You say its sound.

Allow time for the student to repeat the letter sound.

Point to the jar.

Jar begins with J. You say jar.
Jump also begins with J. You say jump.

Allow time for the student to repeat the word.

You Do

Now you try by yourself.

Point to lowercase j.

What letter is this?
What sound does J represent?
What two words begins with J?

If the student does is not ready to say the correct name, sound, and keyword (or another word that begins with J/j/) independently, repeat the task at the We Do level of support.

Link to Environmental Print

I Do/We Do

We see the letter J in lots of important words. Last time we met, we noticed that [environmental print student practiced during the last lesson (e.g., Jell-O and JIF)] have the letter J in them.

Display another environmental print card that the student accurately identified during the previous J lesson. (Note: If the student did not correctly identify any of the environmental print, introduce the word on one of the cards to him/her.) Mention that the word includes the letter J, but do not point the letter out. Say the sound the letter represents.

Example: **This says Jelly Belly. I see a letter J in the word Jelly. You say the name of that letter. J represents the /j/ sound. Jelly. You say the sound.**

You Do

Point to the letter J in the word [environmental print word]. What letter did you find? What sound does J represent?

If the student is not ready to find the J independently, show a model of the letter (a magnetic letter or letter card).

Find the letter that looks like this J.

Repeat process with a second environmental print card of the student's choosing.

PRACTICE/APPLICATION

Reading: Initial Sound Sort

Show student the soup sorter card with the letter j on it.

Now, let's play a game with picture cards! This is the letter j. It represents the sound /j/ /j/ /j/. You say its name. You say its sound.
Let's find some words that begin with that sound.
First, let's look through the pictures.

Identify the object on each card as you show it to the child.

I Do

Show student the soup sorter card with a picture of a jacket on it.

This is a jacket.

Jacket. /j/ /j/ /j/ jacket.

Point to the letter j card.

/j/ /j/ /j/ j.

I think Jacket starts with /j/. Let's flip the card. (Point to the J). Yes, it starts with J, so I will put it under the j card.

Place the jacket card under the j card.

Show student the soup sorter card with a picture of buttons on it.

These are buttons.

Buttons. /b/ /b/ /b/ buttons.

Point to the j card.

/j/ j.

Point to the buttons card and then to the j card.

/b/ /j/.

Buttons does not start with /j/ so I will not put it under the j card.

Place the buttons card to the side.

We Do

Let's do this next one together.

Show the student the soup sorter card with a picture of a jet on it.

What is this?

Correct the student if they are incorrect.

This is a jet.

We can say the first sound. /j/ /j/ /j/ jet. You say: /j/ jet.

Does /j/ jet start like /j/ j?

Allow student time to respond.

Yes, I think /j/ jet starts like /j/ j. Let's flip the card. Does it start with j? You point to the letter J and say the name of that letter. What sound does letter J represent? Let's put it under the j card.

You Do

Show student another soup sorter card.

Now you try the next one. What is the first sound? What letter makes that sound? Do you think it starts with the letter j? Let's flip the card. Does it start with /j/ j? Let's put it where it belongs.

Allow student to complete the task at least three times. If the student is not ready to articulate the first sound independently, drop back to We Do level of support and complete the task together.

Repeat procedure with the remaining soup sorter cards.

WRITING: List

Set the J picture cards from the previous activity in front of the student (jar, jam, jacket, jet, juice).

I Do

The last thing we will do is write a list of words that begin with J. We can write the words for these pictures. I see a jar, /j/, jar. Jar starts with a /j/, so I am going to write a J first.

Use a blank sheet of paper to write the word. Write lowercase J using the same verbal path as before.

Pull down, curve around, dot.

And this is the rest of the word, jar.

Model writing the rest of the word for the student. Place the picture card on the left edge of the page next to the matching word so the student can reread the words on the list with picture support.

We Do

What other word can we write together?

Allow student to choose a different soup sorter card.

Good. Let's write that word together.

Say [word student identifies (e.g., jam, jacket, jet, juice)]. Listen for the first sound. Say /j/ [word student identifies].

Yes, it starts with a J. You say the name of that letter and then write it.

Allow time for student to write the first letter of the word. Support as necessary with formation. Write the rest of the word for the student. If the word includes previously taught letters, guide the child to write them (e.g., If the student identifies the jam and has learned about letter m in a previously taught lesson:

Write the J. The next letter in the word jam is a. I will write the a. After the a comes an m. Do you remember how to write the letter m? Write it next to the a. Pull down, up, over, down and up, over, and down. J-a-m. Jam.)

Place the picture card on the left edge of the page next to the matching word so the student can reread the words on the list with picture support.

You Do

Look for another word that starts with /j/ J. Write the first letter of that word.

What letter did you write? What sound does it represent?

Allow time for the student to find and label the first letter of words with the /j/ sound. Write the rest of the word for the student. Allow student to write the letter at least three times. If the word includes previously taught letters, guide the student to write those letters. Place the picture card on the left edge of the page next to the matching word so the student can reread the words on the list with picture support.

If the student is not ready to write J independently, drop back to We Do level of support and complete the task together.

Once the list is complete:

Let's read our list together.

Read the finished list with the student, using the picture supports, as you point to each word.

What letter do all of our words start with? What sound does it represent?

After completing the lesson, show the student a sheet of letter stickers (make sure it contains the letter just learned).

You worked so hard today, let's get a sticker for you.

Find the letter that we learned today.

Allow student time to find the appropriate letter. If the student needs assistance finding the correct letter, show the student the keyword card or a magnetic letter as a model. Have child place the sticker in a visible place (back of hand, front of shirt).

Now you can show everyone what letter you are learning.

nMSI Review Lesson 1:
(Include all the target letters within the condition, either MSI or nMSI, you have been working on up to this point)

MATERIALS

Keyword letter cards for target letters
Verbal path for each target letter
ABC Books: The Alphabet Book (P.D. Eastman) and A to Z (Sandra Boynton)

PRACTICE/APPLICATION

Lay out the keyword cards for letters that have been recently taught. You may want to limit this to no more than four letters that were most recently taught.

We have been learning about lots of different letters: (target letter name 1), (target letter name 2), ...
(Point to target letter 1) You say the letter name. What sound does it represent?

Repeat for other target letters if applicable.

Today we are going to find these letters in a book.
Which book would you like to use to look for our letters?

Allow student time to choose one of the two alphabet books.

Which letter would you like to find first in our book?

Allow student time to choose of the letters from the keyword cards laid out.

Yes, let's start with (target letter). You say the letter name. What sound does it represent?

With the child's help, flip through the book to the page containing the target letter chosen by the student.

Here it is! This is (target letter). You say the letter name.

Read the text on the page(s) as you run your finger under the words.

Let's look for words on this page that have the letter (target letter).
What letter did you find? What sound does it represent?

If student is not ready to locate the target letter independently, point to the model letters on the page or keyword card and ask him/her to find the letter in each word that looks like the models.

After the student has found at least 2 examples of the lowercase target letter, move on to a writing activity.

Now let's practice writing this same letter with the same letter card.
I'll say the words and you trace the letter.

Say the verbal path as the student traces over the letter on the keyword letter card. Guide correction formation as necessary. After the student traces the letter, point to the letter.

Good. /[sound]/ /[sound]/ /[sound]/ [target letter]. You say its sound and name.

Allow the student the opportunity to trace each letter at least 2 times.
After the student finishes tracing, prompt the student to say the letter name and sound.

What letter did you trace? What sound does it represent?

After completing the lesson, show the student a sheet of non-letter stickers.

You worked so hard today, let's get a sticker for you.

Review Lesson 2:
[Include all the taught letters within the condition, either MSI or nMSI, you have been working on up to this point]

MATERIALS

Keyword letter cards for target letters
Magnetic letters for sorting: 3 of each lowercase target letter
White board
Pictures of food items that begin with target letters (e.g., If reviewing B and W, you might use the following pictures: banana, bread, watermelon, water)
Blank paper and pencil

REVIEW:

Now we are going to look at these letters together.

Show keyword letter cards or magnetic letters, lowercase, for the target letters that have been taught.

We have been learning about these letters.
This is [target letter]. It represents the [sound] sound.
Say the letter name with me as I point to it.

Point to lowercase target letter.

Lowercase [target letter].
[Target letter] represents the sound /[sound]/ /[sound]/ /[sound]/.
You say the [target letter] sound.

Point to the keyword picture.

Let's say the word that begins with [target letter]. [keyword].

Repeat with all target letters incorrectly identified in assessment.

PRACTICE/APPLICATION

Reading: Sorting Magnetic Letters

Place one magnetic letter for each lowercase target letter at the top of the board to serve as models. Then place two of each lowercase target letter, in random order, at the bottom of the board.

I Do

Now, let's play a game to practice matching the letters.

Point to a lowercase model letter at the top of the board.

This is lowercase [target letter].

What sound does it represent?

We can find other letters that look like this.

I can find another lowercase [target letter]. Watch.

Find another lowercase target letter. Place it next to the model to compare.

They look the same. This is the letter [target letter].

Place the letter you found directly below the model letter.

We Do/You Do

Let's find another lowercase [target letter].

Allow a few seconds for the student to find a lowercase target letter. If the student is not ready to do so independently, point to the model lowercase target letter at the top of the board.

Does this letter look the same? Is this another lowercase [target letter]?

Encourage the student to compare the letter to the model letter at the top of the board.

Yes, they look the same.

If the student chooses the wrong letter, allow him/her to put it next to the model and show how they are different.

Let's trace this letter with our finger. Is it the same as lowercase [target letter]?

No, this is not lowercase [target letter]. Try again.

If the student chooses the wrong letter again, allow him/her to hold the model letter and move it over the other letters in order to find the matching letters.

When the student chooses the correct letter, confirm the work.

What letter did you find?

Yes, you found another lowercase [target letter].

What sound does [target letter] represent?

Have the student place the letter he/she found directly below the model letter.

Continue the task at the We Do/You Do level of support with the remaining lowercase target letters.

WRITING: Grocery List

I Do/We Do

Lay out pictures of food items that begin with the target letters.

The last thing we'll do is practice writing! Let's pretend we are going to the grocery store and we need to buy these things. Let's write a grocery list so we do not forget anything.

Identify the food item in each picture. Then choose one of the pictures.

Let's write this word first.

Set the picture on the left side of a sheet of paper. Then say the word, emphasizing the initial sound.

We Do/You Do

Let's write that word together.

Say [grocery list item (e.g., banana, bread, watermelon, water)]. What sound do you hear at the beginning of that word? Say /[sound]/[grocery list item]. What letter does that sound represent?

If the student is not ready to identify the initial letter independently, give him/her choices. Then have the student write the letter.

Example: **Does it begin with a B or a W? Yes, it starts with a B! We need to write a B first. You write the B.**

Allow time for student to write the first letter of the word. Support as necessary with formation (e.g., show the magnetic letter or guide with verbal path of letter formation.

And this is the rest of [grocery list item].

Write the rest of the word for the student and then read the word aloud. If the word includes previously taught letters, guide the child to write them (e.g., If the student identifies banana and has learned about letter n in a previously taught lesson:

Write the B. The next letter in the word banana is a. I will write the a. After the a comes an n. Do you remember how to write the letter n? Write it next to the a. Pull down, up, over, and down. Next comes another a. I'll write it. Now, write another n after my a. Last is another a. B-a-n-a-n-a. Banana.)

Now you choose something to add to our list.

Repeat activity with the remaining pictures, as time permits.

Let's read our grocery list together.

Point to and read each word on the list together.

When finished, point to the first letter of each word and ask the child to identify the letter name and sound.

What letter is this? What sound does it represent?

After completing the lesson, show the student a sheet of non-letter stickers.

You worked so hard today, let's get a sticker for you.

Appendix D

Checklist for Implementing Lesson Fidelity

Implementation Fidelity Checklist: Individual Letter Lessons

1. Observer:
2. Date:
3. Video ID:
4. Lesson Condition: MSI ☐ nMSI ☐
5. Letter Taught: ☐
6. Lesson Number (1, 2, or 3): ☐
7. Lesson Length: ☐☐ min ☐☐ sec
8. Coding: Primary ☐ Double ☐

INTRODUCTION

	Yes	No	N/A	Comments
9. Teacher reviews previous letter taught (lesson 1 only, if not very first lesson)				
I DO				
10. Teacher says letter's name				
11. Teacher says letter's sound				
12. Teacher says letter's keyword or child's name, if name begins with sound				
13. Teacher says or does letter's action (MSI lessons only; Note: Action is explained at end of lesson 1 introduction but is embedded within introduction for lessons 2 and 3)				
14. Teacher says or notice mouth gestures (MSI lessons only; Note: mouth gesture is explained at beginning of lesson 1 introduction but is				

embedded within Link to Environment Print for lessons 2 and 3)				
WE DO				
15. Child repeats letter's name				
16. Child repeats letter's sound				
17. Child repeats letter's keyword				
18. Child repeats letter's action (MSI lessons only; Note: Action is explained at end of lesson 1 introduction but is embedded within introduction for lessons 2 and 3)				
19. Child attempts to notice mouth gestures (MSI lessons only; Note: mouth gesture is explained at beginning of lesson 1 introduction but is embedded within Link to Environment Print for lessons 2 and 3)				
YOU DO or repeated WE DO				
20. Child says or repeats letter's name				
21. Child says or repeats letter's sound				
22. Child says or repeats letter's keyword				
23. Child says, does, or repeats letter's action (MSI lessons only; Note: Action is explained at end of lesson 1 introduction but is embedded within introduction for lessons 2 and 3)				
24. Child attempts to notice mouth gestures (MSI lessons only; Note: mouth gesture is explained				

at beginning of lesson 1 introduction but is embedded within Link to Environment Print for lessons 2 and 3)				
25. Child finds the letter in two environmental print cards (lessons 2 and 3 only)				
26. Was the child ever defiant or disengaged during this section, unwilling to complete tasks?				If yes, explain:

READING: LESSONS 1 and 2

	Yes	No	N/A	Comments
27. Teacher uses book/poem outlined in script				
I DO				
28. Teacher locates the letter in print				
29. Teacher says letter name				
30. Teacher says or asks for letter's sound				
WE DO/YOU DO				
31. Child locates the letter in print, with or without a model/assistance				
32. Child locates the letter in print at least 3 times				
33. Child attempts to notice mouth gestures (MSI lessons only)				
34. Was the child ever defiant or disengaged during this section, unwilling to complete tasks?				If yes, explain:

READING: LESSON 3

35. Teacher uses soup sorter cards outlined in script (lesson 3)				
I DO				
36. Teacher says letter's name				

37. Teacher says letter's sound				
38. Teacher demonstrates sorting a card that begins with the letter's sound				
39. Teacher demonstrates sorting a card that does not begin with the letter's sound				
WE DO/YOU DO				
40. Child says letter's sound				
41. Child attempts to notice mouth gestures (MSI lessons only)				
42. Child sorts at least one card that begins with the letter's sound, with or without support				
43. Child sorts at least one card that does not begin with the letter's sound, with or without support				
44. Was the child ever defiant or disengaged during this section, unwilling to complete tasks?				If yes, explain:

WRITING:

	Yes	No	N/A	Comments
45. Teacher uses writing medium outlined in script				
I DO				
46. Teacher says verbal path of lowercase letter				
47. Teacher traces or writes lowercase letter				
WE DO				
48. Child attempts to repeat verbal path of lowercase letter (lessons 1 and 2 only)				
49. Child attempts to notice mouth gestures (MSI lessons only)				
50. Child attempts to write a letter using tactile and/or				

kinesthetic movement (MSI lessons only)				
YOU DO or repeated WE DO				
51. Child attempts to say verbal path of lowercase letter (lessons 1 and 2)				
52. Child traces or writes the lowercase letter at least 3 times				
53. Child attempts to notice mouth gestures (MSI lessons only)				
54. Child attempts to write a letter using tactile and/or kinesthetic movement (MSI lessons only)				
55. Child receives a sticker of the letter taught				
56. Throughout the lessons, the child was asked and response to say 13 times total of the name of the letter (Note: If not, indicate the number of attempts in the Comments)				
57. Throughout the lessons, the child was asked and response to say 13 times total of the sound of the letter (Note: If not, indicate the number of attempts in the Comments)				
58. Was the child ever defiant or disengaged during this section, unwilling to complete tasks?				If yes, explain:
TOTAL SCORE:				

59. Total Score:

MSI Lesson 1 with review: ☐ / 36

nMSI Lesson 1 with review: ☐ / 25

MSI Lesson 1 without review: ☐ / 35

nMSI Lesson 1 without review: ☐ / 24

MSI Lesson 2: ☐ / 36

nMSI Lesson 2: ☐ / 25

MSI Lesson 3: ☐ / 36

nMSI Lesson 3: ☐ / 25

60. Percent Adherence: ☐

- % Adherence = $\frac{\text{Number of related questions marked as Yes}}{\text{Total possible score}}$

Implementation Fidelity Checklist: Review Lesson 1

1. Observer: ☐
2. Date: ☐
3. Video ID: ☐
4. Lesson Condition: MSI ☐ nMSI ☐
5. Letter(s) Taught: ☐
6. Lesson Number (1 or 2): ☐
7. Lesson Length: ☐☐ min ☐☐ sec
8. Coding: Primary ☐ Double ☐

READING:

	Yes	No	N/A	Comments
9. Teacher uses alphabet book outlined in script				
10. Child locates review letter 1 in print				
11. Child says or repeats name of letter 1				
12. Child says or repeats sound of letter 1				
13. Child locates review letter 2 in print				
14. Child says or repeats name of letter 2				
15. Child says or repeats sound of letter 2				
16. Child locates review letter 3 in print				
17. Child says or repeats name of letter 3				
18. Child says or repeats sound of letter 3				
19. Child locates review letter 4 in print				

20. Child says or repeats name of letter 4				
21. Child says or repeats sound of letter 4				

WRITING:

	Yes	No	N/A	Comments
22. Teacher and/or child uses correct verbal path of formation for review letter 1				
23. Teacher uses a sandpaper as writing medium (MSI only)				
24. Child practices tracing letter 1				
25. Child says or repeats name of letter 1				
26. Child says or repeats sound of letter 1				
27. Teacher and/or child uses correct verbal path of formation for review letter 2				
28. Teacher uses a sandpaper as writing medium (MSI only)				
29. Child practices tracing letter 2				
30. Child says or repeats name of letter 2				
31. Child says or repeats sound of letter 2				
32. Teacher and/or child uses correct verbal path of formation for review letter 3				
33. Teacher uses a sandpaper as writing medium (MSI only)				
34. Child practices tracing letter 3				

35. Child says or repeats name of letter 3				
36. Child says or repeats sound of letter 3				
37. Teacher and/or child uses correct verbal path of formation for review letter 4				
38. Teacher uses a sandpaper as writing medium (MSI only)				
39. Child practices tracing letter 4				
40. Child says or repeats name of letter 4				
41. Child says or repeats sound of letter 4				
42. Was the child ever defiant or disengaged during this section, unwilling to complete tasks?				If yes, explain:
TOTAL SCORE:				

43. Total Score:

MSI: Reviewing 2 letters: ☐ / 17 nMSI: Reviewing 2 letters: ☐ / 15

MSI: Reviewing 3 letters: ☐ / 25 nMSI: Reviewing 3 letters: ☐ / 22

MSI: Reviewing 4 letters: ☐ / 33 nMSI: Reviewing 4 letters: ☐ / 29

44. Percent Adherence: ☐

- % Adherence = $\frac{\text{Number of related questions marked as Yes}}{\text{Total possible score}}$

Implementation Fidelity Checklist: Review Lesson 2

1. Observer: ☐
2. Date: ☐
3. Video ID: ☐
4. Lesson Condition: MSI ☐ nMSI ☐
5. Letter(s) Taught: ☐
6. Lesson Number (1 or 2): ☐
7. Lesson Length: ☐☐ min ☐☐ sec
8. Coding: Primary ☐ Double ☐

READING:

	Yes	No	N/A	Comments
9. Teacher identifies name of review letter 1				
10. Teacher identifies sound of review letter 1				
11. Teacher identifies keyword of review letter 1				
12. Teacher identifies name of review letter 2				
13. Teacher identifies sound of review letter 2				
14. Teacher identifies keyword of review letter 2				
15. Teacher identifies name of review letter 3				
16. Teacher identifies sound of review letter 3				
17. Teacher identifies keyword of review letter 3				
18. Teacher identifies name of review letter 4				

19. Teacher identifies sound of review letter 4				
20. Teacher identifies keyword of review letter 4				
I DO (sorting letters)				
21. Teacher finds matching letter for lowercase review letter 1				
22. Teacher finds matching letter for lowercase review letter 2				
23. Teacher finds matching letter for lowercase review letter 3				
24. Teacher finds matching letter for lowercase review letter 4				
WE DO/YOU DO (sorting letters)				
25. Child finds matching letter for lowercase review letter 1, with or without assistance				
26. Child says or repeats name of lowercase review letter 1				
27. Child finds matching letter for lowercase review letter 2, with or without assistance				
28. Child says or repeats name of lowercase review letter 2				
29. Child finds matching letter for lowercase review letter 3, with or without assistance				
30. Child says or repeats name of lowercase review letter 3				
31. Child finds matching letter for lowercase review letter 4, with or without assistance				
32. Child says or repeats name of lowercase review letter 4				
I DO (writing grocery list)				

33. Teacher demonstrates saying the first sound				
34. Teacher uses a red word screen (MSI only)				
WE DO/YOU DO (writing grocery list)				
35. Child practices saying the first sound for word related to review letter 1				
36. Child practices writing the first letter for word related to review letter 1				
37. Child practices saying the first sound for word related to review letter 2				
38. Child practices writing the first letter for word related to review letter 2				
39. Child practices saying the first sound for word related to review letter 3				
40. Child practices writing the first letter for word related to review letter 3				
41. Child practices saying the first sound for word related to review letter 4				
42. Child practices writing the first letter for word related to review letter 4				
Final Review of Letters				
43. Child says or repeats the name for review letter 1.				
44. Child says or repeats the sound for review letter 1.				
45. Child says or repeats the name for review letter 2.				
46. Child says or repeats the sound for review letter 2.				
47. Child says or repeats the name for review letter 3.				
48. Child says or repeats the sound for review letter 3.				

49. Child says or repeats the name for review letter 4.				
50. Child says or repeats the sound for review letter 4.				
51. Was the child ever defiant or disengaged during this section, unwilling to complete tasks?				If yes, explain:
TOTAL SCORE:				

52. Total Score:

MSI: Reviewing 2 letters: ☐ / 22 nMSI: Reviewing 2 letters: ☐ / 21

MSI: Reviewing 3 letters: ☐ / 32 nMSI: Reviewing 3 letters: ☐ / 31

MSI: Reviewing 4 letters: ☐ / 42 nMSI: Reviewing 4 letters: ☐ / 41

53. Percent Adherence: ☐

- % Adherence = $\frac{\text{Number of related questions marked as Yes}}{\text{Total possible score}}$

Appendix E

Survey Items for EB Children's Language Use and Print Exposure at Home

1. What language(s) do/does the mother/female guardian of your child consider to be her dominant language(s)? Please respond even if the child's mother/female guardian does not live in the household. If a same-sex-parent household with two mothers, and the mothers differ in their language interactions with the child, please respond with respect to the mother who used additional languages the most. Dominant language(s) refers to language(s) she is most fluent in and speaks most comfortably. Select one option only.

   (0) Both English and additional language(s) - Please specify additional language(s) below:

   a. _____

   (1) English only

   (2) Additional language(s) other than English - Please specify additional language(s) below:
   b. _____

2. Please circle how frequently your child speaks each of their languages per day:

   For language(s) other than English that are used at home, please write the specific additional language on the line. If your child speaks English and only one additional language, please fill out the first, second, and fourth rows; if your child uses two additional languages, please fill out all rows.

	(0) Never	**(1) Rarely**	**(2) Sometimes**	**(3) Frequently**	**(4) All the time**
English	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Mixing English and additional language(s)	0	1	2	3	4

3. Please indicate how often your child uses each language when speaking with family members. For language(s) other than English that are used at home, please write the specific additional language on the lines in each table. If your child speaks English and only one additional language, please fill out the first, second, and fourth rows of each table; if your child uses two additional language(s), please fill out all rows of each table.

   1) Does the child have a mother/female guardian? Please respond even if the child's mother/female guardian does not live in the household.

   (1) Yes (0) No

   1-1) If you checked 'Yes,' please circle how often your child uses each language when speaking with **mother/female guardian.** If a same-sex-parent household with two mothers, and the mothers differ in their language interactions with the child, please respond with respect to the mother who used additional languages the most.

	(0) Never	**(1) Rarely**	**(2) Sometimes**	**(3) Frequently**	**(4) All the time**
English	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Mixing English and additional language(s)	0	1	2	3	4

   2) Does the child have a father/male guardian?

   (1) Yes (0) No (-777) Not applicable

   2-1) If you checked 'Yes,' please circle how often your child uses each language when speaking with **father/male guardian.** If a same-sex-parent household with two fathers, and the mothers differ in their language interactions with the child, please respond with respect to the mother who used additional languages the most.

	(0) Never	(1) Rarely	(2) Sometimes	(3) Frequently	(4) All the time
English	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Mixing English and additional language(s)	0	1	2	3	4

3) Does your child have siblings?

(1) Yes (0) No

3-1) If you checked 'Yes,' please circle how often your child uses each language when speaking with **siblings:**

	(0) Never	(1) Rarely	(2) Sometimes	(3) Frequently	(4) All the time
English	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Mixing English and additional language(s)	0	1	2	3	4

4) Does your child have grandparents living in the household?

(1) Yes (0) No

4-1) If you checked 'Yes,' please circle how often your child uses each language when speaking with **grandparents:**

	(0) Never	(1) Rarely	(2) Sometimes	(3) Frequently	(4) All the time
English	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Mixing English and additional language(s)	0	1	2	3	4

5) Does your child live with other family members not indicated in the above? If your child lives with more than one other family member besides mother, father, siblings, or grandparents, list one here and another in 6) below.

(1) Yes – please specify below (0) No

(_____)

5-1) If you checked 'Yes,' please circle how often your child uses each language when speaking with this **other family member:**

	(0) Never	(1) Rarely	(2) Sometimes	(3) Frequently	(4) All the time
English	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Mixing English and additional language(s)	0	1	2	3	4

6) Is there more than one other family member living with your child in the household?

(1) Yes – please specify below (_____) (0) No

6-1) If you checked 'Yes,' please circle how often your child uses each language when speaking with this **other family member:**

	(0) Never	**(1) Rarely**	**(2) Sometimes**	**(3) Frequently**	**(4) All the time**
English	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Additional language(s) (_____)	0	1	2	3	4
Mixing English and additional language(s)	0	1	2	3	4

29. Do any of your child's additional language(s) besides English use an alphabet for writing? For example, Spanish, Somali, Korea, French, Arabic, Russian, Vietnamese, Twi, Punjabi, and Hindi use an alphabet. Chinese and Japanese characters are not an alphabet.

(1) Yes (0) No

a. If you answered yes to #29, please specify the additional language that uses an alphabet for writing below. If your child has more than one additional language that uses an alphabet for writing, list one here and another in 29c below.

_____

b. How many alphabet letters does your child know in their additional languages indicated above?

(0) 0~19% of total letters in the additional language

(1) 20~39% of total letters in the additional language

(2) 40~59% of total letters in the additional language

(3) 60~79% of total letters in the additional language

(4) 80~100% of total letters in the additional language

c. If your child uses more than one additional language and you answered yes to #29, please specify another additional language that uses an alphabet for writing below:

_____

d. How many alphabet letters does your child know in this additional language?

(0) 0~19% of total letters in the additional language

(1) 20~39% of total letters in the additional language

(2) 40~59% of total letters in the additional language

(3) 60~79% of total letters in the additional language

(4) 80~100% of total letters in the additional language

e. Please indicate the language(s) your child typically uses and/or hears during the following activities. The abbreviation "AL" refers to "additional language[s] other than English."

	Only in English	Mostly English and some in AL	Equally amount of English and AL	Mostly in AL and some English	Only in AL	Not applicable
a. An adult or older sibling speaking to your child	0	1	2	3	4	N/A
b. Your child reading books with an adult/older sibling	0	1	2	3	4	N/A

c. Your child reading and/or looking at books on his/her own	0	1	2	3	4	N/A
d. An adult or older sibling telling your child a story	0	1	2	3	4	N/A
e. Your child watching TV	0	1	2	3	4	N/A
f. Your child listening to songs	0	1	2	3	4	N/A
g. Your child playing games	0	1	2	3	4	N/A
h. Your child using electronic devices (e.g., cellphone, iPad, computer)	0	1	2	3	4	N/A
i. Your child participating in church services (e.g., weekend school)	0	1	2	3	4	N/A