Defining a Language and Early Literacy Domain for Assessment of Three-Year-Olds: Alphabet Knowledge

Technical Report #2

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Expanding Individual Growth & Development Indicators of Language and Early Literacy for Universal Screening in Multi-Tiered Systems of Support with Three-Year-Olds

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Updated:

Authors' Note: This work was supported by Grant Number R305A160034, *Expanding Individual Growth & Development Indicators of Language and Early Literacy for Universal Screening in Multi-Tiered Systems of Support with Three-Year-Olds* from the National Center for Educational Research, Institute of Education Sciences to the University of Minnesota, Scott McConnell, Principal Investigator.

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McConnell, Wackerle-Hollman and colleagues developed assessment tools and related resources known as *Individual Growth & Development Indicators,* described here. This intellectual property has been licensed by the Univesity of Minnesota to Early Learning Labs, Inc., and the authors and University have equity and/or royalty interests in ELL. These relationships have been reviewed and are being managed by the University of Minnesota in accordance with its conflict of interest policies.

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Project Introduction

This report presents the results of a systematic review of literature on development of alphabet knowledge, including concepts of print and environmental print, with 3-year-olds. Specific attention is paid to the skills and competencies demonstrated by 3-year-olds in these areas to produce operationalized construct definitions relevant for this age group. In turn, outcomes of this review will guide the development of early language and literacy tasks intended to measure alphabet knowledge and concepts of print among 3-year-old children.

Alphabet Knowledge

Alphabet knowledge is broadly indicated by children's abilities to discriminate environmental print, letter forms, letter names, and letter sounds (Justice, 2006; Piasta & Wagner, 2010). The National Early Literacy Panel (NELP; 2008) more specifically defined alphabet knowledge as "knowledge of names and sounds associated with printed letters" (p. vii). Alphabet knowledge is a critical aspect of the broader alphabetic principle, which requires awareness that printed words consist of letters that can be mapped to sounds, and is an important component of models of early literacy (Whitehurst & Lonigan, 1998) and general reading competence (Scarborough, 1998). Instruction and measurement in alphabet knowledge typically focus on the total number of letter names and sounds known (i.e., sums of 0 to 26), as well as knowledge of letter writing, concepts of print, environmental print, and name familiarity.

Alphabet knowledge is one of the strongest predictors of later reading proficiency among young children. Longitudinal studies have indicated that substantial variance in reading proficiency can be attributed to early alphabet knowledge from preschool to kindergarten (Lonigan, Burgess, & Anthony, 2000), preschool to later elementary school (Puolakanaho et al., 2007), and from kindergarten to later elementary school (Hammil, 2004; Schatschneider, Fletcher, Francis, Carlson, & Forman, 2004). Associations between alphabet knowledge and later elementary school success have been noted for decoding, spelling, and reading comprehension outcomes (National Early Literacy Panel, 2008).

It should also be noted that difficulty in acquiring alphabet knowledge has similarly been associated with subsequent challenges in learning to read. Children considered to be at familial risk of dyslexia have presented minimal or delayed alphabetic knowledge (Snowling, Gallagher, & Frith, 2003; Torppa, Poikkeus, Laakso, Eklund, & Lyyytinen, 2006) as well as children who are later identified with other reading disabilities (Catts, Fey, Zhang, & Tomblin, 2001). Within the alphabetic language of English, the understanding of letters and their corresponding sounds is a fundamental precursor to decoding larger units of connected text and, without which, students are likely to continue to experience reading-related difficulty.

Upon entering kindergarten, children typically demonstrate a wide range of differences in their alphabetic knowledge. These differences can be associated with both child-level characteristics such as speech and language impairments (Anthony, Aghara, Dunkelberger, Anthony, Williams, & Zhang, 2011) or environmental conditions such as learning English as a second language or limited print exposure (Evans, Williamson, &

Pursoo, 2008; Lonigan, Farver, Nakamoto, & Eppe, 2013). Importantly, alphabet knowledge has also proven a successful early literacy target such that when it is established as an instructional goal, focused instruction typically produces significant gains in alphabet knowledge among young students (Lonigan, Farver, Philips, & Clancy-Menchetti, 2011; Lonigan, Purpua, Wilson, Walker, & Clancy-Menchetti, 2012).

Given the importance of alphabet knowledge to later reading success, the diverse range in alphabetic knowledge among preschool and kindergarten-aged students, and the amenable nature of alphabet knowledge to instruction, exploration of alphabet knowledge at its earliest occurrence is a compelling endeavor. Since much of the literature on alphabet knowledge occurs with four and five-year-olds, this review will examine the competencies in alphabet knowledge demonstrated by 3-year-olds in an effort to strengthen early intervention and prevention efforts in this area. As such, the purpose of this review is to identify the components of alphabet knowledge demonstrated by 3-year-olds to produce an operationalized definition that meaningfully reflects the competencies of students at this age.

Concepts of Print

Concepts of print, as a construct, is generally associated with a basic understanding about reading that includes top-to-bottom and left-to-right processing of English text, the constructive relation between letters, words, sentences, and pictures, and the general purpose of text and reading (Clay, 1985). These competencies highlight what emergent readers need to understand to successfully access printed language. Beginning concepts of print can include the awareness that print carries meaning and that books are typically organized with a cover, title, author, and are read in a certain direction. From

there, concepts of print can evolve to understanding distinctions between words and sentences, identifying lowercase and uppercase letters, and the functions of punctuation.

Many aspects of concepts of print can be learned at an early age, prior to formal schooling. For young children, knowledge of the concepts of print is highly dependent on general literacy exposure and may vary greatly among preschool and kindergarten-aged students. Teachers can support students' development in this area by explicitly highlighting features of written language, the nature of books and text organization, and by providing a print-rich environment. Young children can gain concepts of print by experiencing opportunities to use print for meaning, such as the use of labels, names, dictation, or charts and messages. They can also learn through print-to-speech experiences such as shared storybook reading. In sum, concepts of print are a fundamental first step to understanding the roles of reader and writer and can be thought of as a necessary yet insufficient precursor to decode text.

Methods of Review

A review of the literature and select graduate theses was conducted to include references found in databases as well as select focused searches. We searched an array of databases typically citing developmental and early education research, including Educational Resources Information Center (ERIC), PsycINFO, and Google Scholar. Searches of these databases were conducted using search terms compiled from relevant research (e.g., Anthony, Lonigan, Burgess, Driscoll, Phillips, & Cantor, 2002).

Search Procedures

Bibliographic databases were queried using variants of five search terms across titles, abstracts, and full articles.: "*alphabet knowledge,*" "*alphabet identification,*"

"*concepts of print,*" "*environmental print,*" and "*alphabetic principles*." Additionally, the terms "*literacy*" and "*three-year-olds*" were included with the variants mentioned previously when searching Google Scholar in order narrow the results further. When searching for eligible literature, results were included that were (a) written in English; (b) scholarly, peer-reviewed empirical publications or theses; (c) involving monolingual English speaking 3-year-old children with no identified disabilities; and (d) discussed AK or related concept (i.e., concepts of print or environmental print).

Results were screened first by relevancy of the title by scanning the titles for combinations of identified keywords. Abstracts of selected articles were then reviewed for evidence of inclusion of 3-year-olds in study sample, and the discussion of the development of AK. With the small pool of articles that were determined to be applicable based on the abstract, the entire article was read and documented in a spreadsheet as relevant or not relevant (see Figure 1 for the breakdown of eligibility determinations).

Our initial search of PschINFO, ERIC, and Google Scholar yielded 1,337 articles, 113 of which were screened at the full text level (see Figure 1). This resulted in 21 articles that were eligible for inclusion in the current review: Anthony et al. (2002); Chaney (1998); Coursin (2012); Lonigan, Burgess, and Anthony (2000); Masonheimer (1981); Piasta, Petscher, and Justice (2012); Puranik, Petscher, and Lonigan (2014); Strang and Piasta (2016); and Xu, Chin, reed, and Hutchinson (2014); Lomax and McGee (1987); Worden and Boettcher (1990); Kaderavek, Guo, and Justice (2014); Neumann, Hood, and Ford (2013); Neumann and Neumann (2014); Morgan (1987); McLachlan and Arrow (2014); Cabell, Justice, Konold, and McGinty (2011); Puranik and Lonigan

(2011); Masonheimer, Drum, and Ehri (1984); Bader and Hildebrand (1991); Hiebert, Cioffi, and Antonak (1984).

For a summary of obtained results across studies with 3-year-olds, including the behaviors measured see Table 1. Nineteen of these articles measured AK through letter naming tasks, seven through letter writing, seven through letter sounds, nine through concepts of print, four through environmental print, and three used alternate measures of AK (see Table 1). Of these articles, nine reported results specific to 3-year-olds, while the remaining twelve reported results for an age range that included 3-year-olds.

Results of Review

The purpose of this review is to identify research findings that illuminate the substantive features, skills, and measurement tasks that relate to AK for 3-year-old children. A broad overview of available research suggests that skills of 3-year-olds are measured using tasks that assess: letter name knowledge, letter sound knowledge, letter writing knowledge, concepts of print, environmental print knowledge, and name familiarity. These subareas of AK consistently reoccurred throughout the different articles identified as relevant. Based on findings, 3-year olds learn capital letter names, lower-case letter names, and letter sounds in a sequential, but overlapping fashion.

With this in mind, we turn to review of observed child performance in each of these subsequent areas, including letter naming, letter sounds, letter writing, concepts of print, and environmental print. Studies reporting findings in each of these sections are summarized in Tables 2 through 7; studies that assessed more than one component of AK may be listed in multiple tables.

Letter Name Knowledge

Our review identified 19 published works that examined letter naming knowledge in children under four years of age (see Table 2). These studies examined children's expressive and receptive knowledge of the letters of the alphabet. Children were asked to recite or identify letters. Studies varied on their use of upper- or lower-case letters and how they were presented to children (e.g., children were shown letters individually on flashcards or randomized on a piece of paper).

Reciting Letters. Bader and Hildebrand (1991) measured children's understanding of the alphabet by asking them to "do the ABC's." Across the 24 three-year-olds in the study, children recited an average of 35% of the alphabet. Sixty-seven percent of the children attempted this task with 54% singing the alphabet and 13% speaking the letters of the alphabet. While this task demonstrated a floor effect for 33% of participating children, the majority of 3-year olds knew at least part of the alphabet. Additionally, children were more likely to sing the alphabet as compared to speaking the letters and did so with an accuracy rate of 35%.

Letter Naming. Four studies used a combined measure for alphabet knowledge that included both upper- and lower-case letters. Across the studies specific to 3-year olds, it was found that children could correctly identify 12% to 24% of the alphabet when prompted using flash cards or a randomized list on paper (see Table 2; Baer & Hildebrand, 1991; Masonheimer, 1981; Masonheimer et al., 1984). In order to better understand the limits of young childrens' alphabet knowledge, Masonheimer (1981) assessed the types of errors and found that naming errors including random letter naming

decreased with age, but featural errors (e.g., confusing d and b) increased with age, across 139 children between the ages of two and five years old.

In a study conducted with 57 two-and-a-half to five-year olds, children correctly identified 48% of letters when presented with eight random upper- and lower-case letters (Strang & Piasta, 2016). Additionally, Strang and Piasta reported an average gain of 0.17 letter names per month. When considering socioeconomic status (SES), children from lower SES families knew fewer letter names as compared to children from middle-income families; however, children across SES had similar growth rates for letter naming (Strang & Piasta, 2016).

Across studies, the proportions of children between the ages of two and five who were able to identify upper-case letters as compared to lower-case letters varied. Findings suggested that young children identified between 8% and 68% of capital letters (Anthony et al., 2002; Cabel et al., 2011; Coursin, 2012; Kaderavek, Guo, & Justice, 2014; Lonigan et al., 2000; Morgan, 1987; Neumann et al., 2013; Neumann & Neumann, 2014; Piasta et al., 2012; Puranik et al., 2014; Worden & Boettcher, 1990; Xu et al., 2014), as compared to the identification of 0% to 72% of lower-case letters (Hiebert et al., 1984; McLachlan & Arrow, 2014; Morgan, 1987; Nuemann & Neumann, 2014; Piasta et al., 2012; Worden & Boettcheer, 1990; Xu et al., 2014). Out of the four studies that separately measured both upper- and lower-case letters, three found that young children could identify more upper- than lower-case letters (Morgan,1987; Neumann & Neumann, 2014; Piasta et al., 2012), but Xu and colleagues (2014) found that children between the ages of three and four could identify a higher number of lower-case letters as compared to capital letters.

In order to better understand limits of alphabet knowledge, Neumann and Neumann (2014) analyzed the errors of 69 children between the ages of three and four years old. For upper-case letters, it was reported that 65% of children used non-conventional labels (e.g., random words), 22% of children used symbolic labels (e.g., a mix of numerical and conventional letter names), and 13% of children used conventional letter names with gradual mastery. Additionally, Neumann and Neumann (2014) reported that 67% of young children were able to identify at least one upper-case letter correctly. In comparison, Piasta et al. (2012) reported that 97% of the 371 three and four year olds in their study were able to correctly identify at least one capital letter. For lower-case letters, Neumann and Neumann (2014) found that 78% of children used non-conventional labels, 9% used some sort of symbolic label, and 13% used letter names only. It was reported that 61% of children correctly identified at least one lower-case letter, as compared to the 92% reported by Piasta and colleagues (2012).

Specific to 3-year olds, Worden and Boettcher (1990) found that an average of 16% of upper-case letters could be identified across the 38 three-year old participants, as compared to 11% of lower-case letters. Puranik and colleagues (2014) reported that 84% of the 148 three-year olds in their study could identify at least one capital letter, with an average identification rate of 38%. On the other hand, Hiebert et al. (1984) reported that 39% of lower-case letters were identified by the 20 three-year olds in their study. Additionally, Lomax and McGee (1987) assessed 3-year-olds' letter discrimination by showing a stimulus letter, and asking children to identify the same letter given four options. Findings suggest that 3-year-olds could complete this task with 80% accuracy.

Summary of letter naming assessments. Available investigations of letter naming in samples including children under the age of four indicate evidence of expressive identification of letter names. The majority of 3-year olds can recite at least part of the alphabet, with more children singing their response as compared to speaking it (Bader & Hildebrand, 1991). While results varied, the majority of studies that compared upper-and lower-case letter identification concluded that young children knew slightly more capital letters (Morgan, 1987; Neumann & Neumann, 2014; Piasta et al., 2012). Despite higher SES being associated with a larger number of known letters in young children, growth rates remained consistent across low- and high-SES (Strang & Piasta, 2016). Lastly, it appears that the majority of errors are random for young children on letter naming tasks, but a smaller proportion of children make symbolic errors (i.e., say different number or letter names in place of the correct response; Neumann & Neumann, 2014).

Letter Sound Knowledge

Our review identified seven published works that examined letter sound knowledge in children under four years old (see Table 3). These studies examined children's expressive knowledge of the letter sounds through asking children to say the sound associated with different letters. Studies varied on their use of upper- or lower-case letters and how they were presented to children (e.g., children were shown letters individually on flashcards or randomized on a piece of paper).

Four studies used upper-case letters only to measure the percentage of letter sounds two through five-year olds can identify. On average, young children knew between 2% and 26% of letter sounds for upper-case letters (Anthony et al., 2002; Lonigan et al., 2000; Neumann et al., 2013; Puranik et al., 2014). Three studies used a

combined measure that included both upper- and lower-case letters to assess young children's letter sound knowledge. Findings suggested that young children knew between 1% and 34% of letter sounds for upper- or lower-case letters (Strang & Piasta, 2016; Worden & Boettcher, 1990; Xu et al., 2014). Additionally, Strang and Piasta (2016) reported an average gain of 0.19 letter sounds per month across SES.

Specific to 3-year olds, Puranik and colleagues (2014) reported that children could correctly say 14% of letter sounds associated with capital letters. Additionally, 48% of the 148 three-year olds in their study correctly said at least one letter sound. Worden and Boettcher (1990) also reported findings specific the 3-year olds. In their study of 38 three-year olds, Worden and Boettcher found that children knew less than 1% of letter sounds when presented with either upper- or lower-case letters. Additionally, Worden and Boettcher used a word test with 3-year-olds in order to assess their ability to match letter names with words that start with the same letter; however, this task proved difficult for 3-year olds and resulted in less than 1% accuracy.

Summary of letter sound assessments. Available investigations of letter sounds in samples including children under the age of four indicate evidence of expressive identification of letter sounds. While no studies included letter sound knowledge for both upper- and lower-case letters, findings suggest that young children knew slightly more sounds for capital letters. Multi-step expressive tasks, such as the word test used by Worden and Boettcher (1990), may be too difficult for 3-year-olds. Additionally, despite higher SES being associated with a larger number of known letter sounds for young children, growth rates remained consistent across low- and high-SES (Strang & Piasta, 2016).

Letter Writing Knowledge

Our review identified four published works that examined letter writing knowledge in children under four years old (see Table 4). These studies examined children's expressive knowledge of the letter writing through asking children to either write the ABC's or write specific letters from the alphabet.

According to Neumann and colleagues (2014), young children between the ages of three and four could write 3% of their upper and lower case letters. Specific to 3-year-olds, children were able to write between 2% and 16% of letters across studies (Bader & Hildebrand, 1991; Puranik & Lonigan, 2011; Puranik, et al., 2014). Additionally, Puranik and colleagues (2014), reported that 53% of 3-year olds in their study could correctly write at least one letter.

Summary of letter writing assessments. Available investigations of letter writing in samples including children under the age of four indicate evidence for expressive letter writing. While findings suggest lower rates of letter writing as compared to letter naming or letter sound identification, about half of 3-year olds are able to write at least one letter.

Concepts of Print Knowledge

Our review identified nine published works that examined concepts of print in children under four years old (see Table 5). These studies examined children's print awareness (e.g., book orientation, reading left-to right, reading top-to bottom, letter orientation), and purposes of print (e.g., distinguish between print and pictures, identify letters, words, and sentences).

Six studies used print awareness (i.e., book orientation) to assess concepts of print for children between the ages of two and five years old. On average, young children

demonstrated average accuracy between 12% and 51% across tasks (Anthony et al., 2002; Cabell et al., 2011; Chaney, 1998; Lomax & McGee, 1987; Lonigan et al., 2000; Neumann et al., 2013). Morgan (1987) examined book orientation for 23 two through four year olds and found 83% of children identified the back and front of the book, 43% of children knew to read the left page before the right, 22% of children knew to start at the top of the page, and none of the children knew to read from left to right.

Studying 24 three-year olds, Bader and Hildebrand (1991) reported that 88% of children understood book orientation and 50% of children identified the beginning. Lomax and McGee (1987) found that the 20 three-year olds in their study were able to identify the correct orientation for letters with 47% accuracy. Additionally, participating children averaged 20% accuracy when asked about book orientation, and print direction. Chaney (1998), reported an average accuracy of 50% on print awareness (i.e., children were asked to sort and name shapes, numbers, and letters, and asked questions about books and reading) for the 43 three-year olds in his study.

Three studies measured purpose of print specific to 3-year olds. Findings suggested that 3-year old children identify the difference between writing, reading, and drawing, and can identify letters, words and sentences with between 16% and 39% accuracy (Hiebert et al., 1984; Lomax & McGee, 1987). Additionally, 54% three-year olds identified a narrative, 64% pointed to print, 17% identified words, and 42% distinguished between writing and a drawing.

Summary of concepts of print assessments. Available investigations of concepts of print, in samples including children under the age of four, indicate evidence for book orientation and differentiating print from drawings. Most aligned to the alphabet, results

suggested that 3-year-olds were able to identify the correct orientation of letters just under half of the time. However, tasks in this category varied making interpretation and synthesis of results difficult.

Environmental Print Knowledge

Our review identified seven published works that examined environmental print for children under four years old (see Table 6). These studies examined children's expressive knowledge of reading labels and signs in context to their environment (e.g., children were asked to identify common logos such as M&Ms, milk, and EXIT).

Across all studies, accuracy ranged from 6% to 81% (Anthony et al, 2002; Hiebert et al., 1984; Lomax & McGee, 1987; Lonigan et al., 2000; Masonhemier et al., 1984; Morgan, 1987; Neumann et al., 2013). However, no two studies used the same prompts or stimuli representing environmental print. Thus, it is impossible to compare findings across studies. Masonhemier and colleagues (1984) studied 102 children between the ages of three and five years old, and reported that accuracy decreases when print is taken out of environmental context: children correctly identified 81% of labels in full context, 67% of logo plus labels, and only 23% of labels alone. Similarly, Morgan (1987) found that accuracy was higher in sign recognition (16%) as compared to label recognition (6%) for children between the ages of two and four years old.

Summary of environmental print assessments. Available investigations of environmental print, in samples including children under the age of four, indicate evidence for "reading" or identifying logos in environmental contexts. However, logos in this category varied across studies making interpretation and synthesis of results difficult.

Interestingly, results do indicate early "reading" or identification of logos when in an environmental context.

Own Name Knowledge

Our review identified seven published works that examined alphabet knowledge for children under four years old using own name familiarity (see Table 7). These studies examined children's knowledge of recognizing their own name (e.g., children were asked to pick out their name), spelling their own name, and writing their own name (e.g., children were asked to write their name).

Two studies assessed young children's ability to recognize their own name. Morgan (1987) found that 57% of children between the ages of two and four-years old were able to recognize their own name given four options. Similarly, McLachlan and Arrow (2014) found that 67% of three and four year olds were able to read their name when shown on a piece of paper. Additionally, young children were able to spell their name with 33% accuracy in the same study.

Four studies measured name writing accuracy in young children between the ages of three and five years old. Findings suggested that young children could write their name with 47% to 64% accuracy (Cabell et al., 2011; Kaderavek et al., 2014; Puranik et al., 2014; Xu et al., 2014). Specific to 3-year-olds, Bader and Hildebrand (1991) reported that 4% of 3-year olds could write their entire name and 13% of children were able to write at least the first letter of their name. However, 83% of 3-year olds did not respond when asked to spell their name. On the other hand, Puranik and colleagues (2014) found that 30 three-year old children were able to write their names with 47% accuracy.

Summary of additional assessments. While these own name familiarity tasks provide information, results suggest that name identification is the most age appropriate task beyond the more traditional assessments (i.e., letter naming and letter sounds) for young children. Across studies more than half of children were able to recognize their own name when shown on a piece of paper. Additional information can be gathered from name writing tasks; however, despite higher average accuracy rates, one study found that the majority of 3-year olds did not even attempt to write their name (Bader & Hildebrand, 1991).

Discussion

This review of published and graduate thesis research yielded 21 articles with empirical evaluations of alphabet knowledge in children under age four. In general, these findings support and extend assumptions made prior to our detailed review: although variable, 3-year-old children can perform alphabet knowledge and concept of print tasks; onset of performance of these tasks generally emerges in an overlapping fashion starting with familiar letters (i.e., the letters in their name), followed by letter naming, and identifying letter sounds. Additionally, receptive tasks yielded higher accuracy rates as compared to expressive tasks, and young children appear to learn their upper case letters prior to their lower case counterparts.

While typical ages of onset for performance in any one subarea are not known nor relevant to the current review, evidence that all five areas (i.e., letter name, letter sound, concepts of print, environmental print, and own name knowledge) can be performed by 3-year-olds is noted. Further, evidence that receptive performance is evident before expressive performance, within and across tasks, is apparent. However, it is unclear if

receptive tasks in the domain of alphabet knowledge may actually be too simple for 3-year-olds thus resulting in ceiling effects.

Given the plan to produce multi-item samples of child performance in the broad domain of alphabet knowledge for 3-year-olds, these findings suggest the likely utility of: a) more receptive than expressive tasks, although the latter may offer more "ceiling" in assessment; b) perhaps more emphasis on familiar letters; and c) concept of print tasks that are more specifically aligned to the alphabet as compared to reading (i.e., letter orientation and find).

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Table 2. Summary of literature involving the study of 3-year-olds' letter name knowledge.

Source	Age Range	Behaviors Measured	Corresponding Tasks	Results
Letter Name Knowledge				
Anthony, Lonigan, Burgess, Driscoll, Phillips, & Cantor (2002)	2.3 – 3.11 year olds	Letter-Name Knowledge	Children were presented with 26 upper case letters on flash cards and asked to respond verbally with a discontinue rule of 5 consecutive unknown letter names	Children correctly identified 17% of upper case letters
Bader & Hildebrand (1991)	3.6 – 3.11 year olds	Reciting Letters	Children were asked to "do the ABC's"	Children correctly recited 35% of the alphabet
				54% of children sang the alphabet
				13% spoke the letters of the alphabet
				33% did not respond
		Reading Letters	Children were asked to name letters presented to them in a scrambled order	Children correctly identified 12% of upper case letters
Cabell, Justice, Konold, & McGinty (2011)	3.6 – 5.0 year olds	Alphabet Knowledge (PALS)	Children were asked to name the 26 upper-case letters presented in a random order	Children correctly identified 31% of upper case letters
Coursin (2012)	2.10 – 4.11 year olds	Alphabet Knowledge (PALS)	Children were asked to name the 26 upper-case letters presented in a random order	Children correctly identified 23% of upper case letters
Hiebert, Cioffi,& Antonak (1984)	3 year olds	Letter Naming	Children were asked to name the 26 lower-case letters when presented with a stimulus	Children correctly identified 39% of lower case letters
Kaderavek, Guo, & Justice (2014)	3.5 – 4.9 year olds	Alphabet Knowledge (PALS)	Children were asked to name the 26 upper-case letters presented in a random order	Children correctly identified 34% of upper case letters

Lomax & McGee (1987)	3 year olds	Letter Discrimination	Shown a stimulus letter, children were asked to identify the same letter	Average accuracy rating of 80%
Lonigan, Burgess, & Anthony (2000)	2.1 – 5.1 year olds	Letter-Name Knowledge	Children were presented with 26 upper case letters on flash cards and asked to respond verbally	Children correctly identified 56% of upper case letters
Masonheimer (1981)	3 year olds	Alphabet Knowledge	Children were presented with 52 upper- and lower-case cards and asked to respond verbally	Children correctly identified 13% of upper and lower case letters
				Naming errors including random letter naming decreased with age, but featural errors increased with age
Masonheimer, Drum, & Ehri (1984)	3 year olds	Alphabet Knowledge	Children were asked to identify all upper- and lower-case letters	Children correctly identified 24% of upper and lower case letters
McLachlan & Arrow (2014)	3.0 – 4.10 year olds	Letter Knowledge	Children were asked to name the 26 lower-case letters presented in a random order. If at least 12 correct, moves onto letter sounds	Children correctly identified 22% of lower case letters
Morgan (1987)	2.6 – 4.2 year olds	Capital Letter Recognition	Children were asked to identify upper case letters	Children correctly identified 8% of upper case letters
		Lower Case Letter Recognition	Children were asked to identify lower case letters	Children correctly identified 0% of lower case letters
Neumann, Hood, & Ford (2013)	3.5 – 4.8 year olds	Letter Name Knowledge	Children were presented with 26 upper case letters on flash cards and asked to respond verbally	Children correctly identified 21% of upper case letters
Neumann & Neumann (2014)	3.2 – 4.8 year olds	Upper Case Letter Naming	Children were presented with 26 upper case letters on flash cards and asked to respond verbally	67% of children correctly identified at least one letter
				Children correctly identified 20% of upper case letters
				65% of children used non-conventional labels
				22% of children used symbolic differentiation using a mix of

				conventional letter and numeral names	
				13% of children used conventional letter names with gradual mastery	
		Lower Case Letter Naming	Children were presented with 26 lower case letters on flash cards and asked to respond verbally	61% of children correctly identified at least one letter	
				Children correctly identified 17% of lower case letters	
				78% of children used non-conventional labels	
				9% of children used symbolic differentiation using a mix of conventional letter and numeral names	
				13% of children used conventional letter names with gradual mastery	
Piasta, Petscher, & Justice (2012)	3.6 – 4.11 year olds	Upper-Case Letter Naming Ability	Children were presented with 26 upper case letters on a sheet and asked to respond verbally	Children correctly identified 68% of upper case letters	
				97% of children correctly completed at least one item	
		Lower-Case Letter Naming Ability	Children were presented with 26 lower case letters on a sheet and asked to respond verbally	Children correctly identified 57% of lower case letters	
				92% of children correctly completed at least one item	
Puranik, Petscher, & Lonigan (2014)	3 year olds	Letter Naming	Children were presented with 26 upper case letters on flash cards and asked to respond verbally	Children correctly identified 38% of upper case letters	
				84% of children correctly completed at least one item	
Strang, & Piasta (2016)	2.6 – 5.1 year olds	Letter Name Knowledge	Children were asked to respond to eight upper- and lower-case letters	Children correctly identified 48% of the letters	Children from lower SES families

				Average gain of .17 letter names per month	new a lower number of letter names, but had similar rates of growth
Worden & Boettcher (1990)	3 year olds	Upper-Case Letter Naming Ability	Children were presented with 26 upper case letters on a sheet and asked to respond verbally	Children correctly identified 16% of upper case letters	
		Lower-Case Letter Naming Ability	Children were presented with 26 lower case letters on a sheet and asked to respond verbally	Children correctly identified 11% of lower case letters	
Xu, Chin, Reed, & Hutchinson (2014)	3 – 4 year olds	Upper-Case Recognition (PALS)	Children were asked to name the 26 upper-case letters presented in a random order. If at least 16 correct, moves onto lower-case letters	Children correctly identified 57% of upper case letters	
		Lower-Case Recognition (PALS)	Children were asked to name the 26 lower-case letters presented in a random order. If at least 9 correct, moves onto lower-case letters	Children correctly identified 72% of lower case letters	

Table 4. Summary of literature involving the study of 3-year-olds' letter writing knowledge.

Source	Age Range	Behaviors Measured	Corresponding Tasks	Results
Letter Writing Knowledge				
Bader & Hildebrand (1991)	3.6 – 3.11 year olds	Writing Letters	Children were asked to write the ABC's	Children correctly wrote 2% of letters
Neumann, Hood, & Ford (2013)	3.5 – 4.8 year olds	Letter Writing	Children were asked to write each of the 26 letters in both upper and lower case	Children correctly wrote 3% of upper and lower case letters
Puranik & Lonigan (2009)	3 year olds	Letter Writing	Children were asked to write the letters B, D, S, T, O, A, H, K, M, & C using paper and pencil	Children correctly wrote 16% of the letters
Puranik, Petscher, & Lonigan (2014)	3 year olds	Letter Writing	Children were asked to write each of the 26 uppercase letters	Children correctly wrote 11% of the upper case letters 53% of children correctly completed at least one item

Table 3. Summary of literature involving the study of 3-year-olds' letter sound knowledge.

Source	Age Range	Behaviors Measured	Corresponding Tasks	Results	
Letter Sounds Knowledge					
Anthony, Lonigan, Burgess, Driscoll, Phillips, & Cantor (2002)	2.3 – 3.11 year olds	Letter-Sound Knowledge	Children were presented with 8 upper case letters on flash cards and asked to respond verbally with a prompt if the child responded with the name or word that starts with that letter	Children correctly identified 2% of upper case letter sounds	
Lonigan, Burgess, & Anthony (2000)	2.1 – 5.1 year olds	Letter-Sound Knowledge	Children were presented with 26 upper case letters on flash cards and asked to respond verbally with a prompt if the child responded with the letter name or word that starts with that letter	Children correctly identified 26% of upper case letter sounds	
Neumann, Hood, & Ford (2013)	3.5 – 4.8 year olds	Letter Sound Knowledge	Children were presented with 26 upper case letters on flash cards and asked to respond verbally	Children correctly identified 3% of upper case letter sounds	
Puranik, Petscher, & Lonigan (2014)	3 year olds	Letter Sounds	Children were presented with 26 upper case letters on flash cards and asked to respond verbally with a prompt if the child responded with the letter name during the first two trials	Children correctly identified 14% of upper case letter sounds	
				48% of children correctly completed at least one item	
Strang, & Piasta (2016)	2.6 – 5.1 year olds	Letter Sound Knowledge	Children were asked to respond to six upper- and lower-case letters	Children correctly identified 28% of the letter sounds	Children from lower SES families new a lower number of letter sounds, but had similar rates of
				Average gain of .19 letter sounds per month	

					growth
Worden & Boettcher (1990)	3 year olds	Sound Test	Children were presented with either upper- or lower-case letters on a page (determined by the letter naming task) and asked to produce the corresponding sounds	Children correctly identified less than 1% of letter sounds	
		Word Test	Children were asked to name a word beginning with each letter when pointed to on a piece of paper	Average accuracy rating of less than 1%	
Xu, Chin, Reed, & Hutchinson (2014)	3 – 4 year olds	Letter Sounds (PALS)	Children were asked to make the sound of the 26 letters, presented in a random order	Children correctly identified 34% of letter sounds	

Table 5. Summary of literature involving the study of 3-year-olds' concepts about print.

Source	Age Range	Behaviors Measured	Corresponding Tasks	Results
Concepts About Print				
Anthony, Lonigan, Burgess, Driscoll, Phillips, & Cantor (2002)	2.3 – 3.11 year olds	Concepts About Print	Children were asked to demonstrate an understanding of left-to-right, top-to-bottom, cover, pages, pictures, print, and punctuation	Average accuracy rating of 12%
Bader & Hildebrand (1991)	3.6 – 3.11 year olds	Concepts About Print	Children were given a book and asked a series of questions	88% of children understood book orientation
				50% of children identified the beginning
				54% of children identified a plausible narrative
				64% of children pointed to print
				17% of children pointed to a word
				42% of children distinguished between drawing and writing
Cabell, Justice, Konold, & McGinty (2011)	3.6 – 5.0 year olds	Print Concepts (PWPA)	Assesses children's knowledge of book and print organization, concept of letter, and print function	Average accuracy rating of 33%
Chaney (1998)	3 year olds	Print Awareness	Children were asked to sort and name shapes, numbers, and letters, and asked questions about the structure of books and how to read print	Average accuracy rating of 50%
Hiebert, Cioffi,& Antonak (1984)	3 year olds	Purposes of Print	Children were asked to identify the act of reading, self-assess own reading ability, and distinguish between pictures and print	Average accuracy rating of 26%
Lomax & McGee (1987)	3 year olds	Concepts About Print (Stones)	Children were asked about book-orientation and print-direction	Average accuracy rating of 20%

			concepts	
		Recognizing Literacy Behavior	Children were asked to distinguish between reading, writing, drawing, and viewing	Average accuracy rating of 39%
		Technical Language of Literacy	Children were asked to identify letters, words, and sentences	Average accuracy rating of 16%
		Letter Orientation	Children were asked to identify the correctly oriented letter on a flash card	Average accuracy rating of 47%
Lonigan, Burgess, & Anthony (2000)	2.1 – 5.1 year olds	Concepts About Print	Children were asked to demonstrate an understanding of left-to-right, top-to-bottom, cover, pages, pictures, print, and punctuation	Average accuracy rating of 30%
Morgan (1987)	2.6 – 4.2 year olds	Book Orientation	Children were asked various book orientation questions	83% of children identified the back and front
				43% of children knew to read the left page before the right
				22% of children knew to start at the top of the page
				0% of children knew to read left to right
Neumann, Hood, & Ford (2013)		Print Concepts	Children were asked to answer questions regarding book handling, and concepts of letter and words	Average accuracy rating of 51%

Table 6. Summary of literature involving the study of 3-year-olds' environmental print knowledge.

Source	Age Range	Behaviors Measured	Corresponding Tasks	Results
Environmental Print Knowledge				
Anthony, Lonigan, Burgess, Driscoll, Phillips, & Cantor (2002)	2.3 – 3.11 year olds	Environmental Print	Children were presented with 11 pictures of print in the environment (e.g., a stop sign) and asked what they said. The same words were also presented out of context	Average accuracy rating of 22%
Hiebert, Cioffi,& Antonak (1984)	3 year olds	Processes of Print	Children were presented with pictures of print in the environment in a game format: package labels, stop signs, street signs, signs on buildings, and directions	Average accuracy rating of 38%
Lomax & McGee (1987)	3 year olds	Environmental Word Reading	Children were asked to read popular logos (i.e., McDonald's, Coke, Stop sign, Pac-Man, Sesame Street, M&Ms, cookies, milk, University sticker, 7-Eleven)	Average accuracy rating of 74%
Lonigan, Burgess, & Anthony (2000)	2.1 – 5.1 year olds	Environmental Print	Children were presented with 11 pictures of print in the environment (e.g., a stop sign) and asked what they said. The same words were also presented out of context	Average accuracy rating of 47%
Masonheimer, Drum, & Ehri (1984)	3 – 5 year olds	Environmental Print	Children were asked to identify words given full context, labels and logos, and just labels	Children correctly identified 81% of full context logo labels
				Children correctly identified 67% of logo labels with the label plus logo
				Children correctly identified 23% of logo labels with the label alone

Morgan (1987)	2.6 – 4.2 year olds	Label Recognition	Children were shown labels from household items and asked to identify	Average accuracy rating of 6%
		Sign Recognition	Children were shown signs and asked to identify	Average accuracy rating of 16%
Neumann, Hood, & Ford (2013)	3.5 – 4.8 year olds	Environmental Print Reading	Ten environmental print words were selected from the local area (i.e., MILO, EXIT, FROOT LOOPS, LEGO, CORN FLAKES, SUBWAY, RICE BUBBLES, STOP, NUTRI-GRAIN, PEPSI), and children were asked to read each word.	Average accuracy rating of 17%

Table 7. Summary of literature involving the study of 3-year-olds' own name knowledge.

Source	Age Range	Behaviors Measured	Corresponding Tasks	Results
Own Name Knowledge				
Bader & Hildebrand (1991)	3.6 – 3.11 year olds	Writing Name	Children were asked to write their name	4% of children wrote their name
				13% of children wrote the first letter of their name
				83% of children did not respond
Cabell, Justice, Konold, & McGinty (2011)	3.6 – 5.0 year olds	Name Writing (PALS)	Children are asked to draw a picture and then write their name (only name is scored)	Average accuracy rating of 54%
Kaderavek, Guo, & Justice (2014)	3.5 – 4.9 year olds	Name Writing (PALS)	Children are asked to draw a picture and then write their name (only name is scored)	Average accuracy rating of 58%
McLachlan & Arrow (2014)	3.0 – 4.10 year olds	Own Name Reading	Children were shown a piece of paper with their name on it and asked what it said	Average accuracy rating of 67%
		Own Name Spelling	Children were asked to spell their name	Average accuracy rating of 33%
Morgan (1987)	2.6 – 4.2 year olds	Name Identification	Children were asked to pick their own name given four options on flash cards	57% of children could identify their own name
Puranik & Lonigan (2009)	3 year olds	Name Writing	Children were asked to write their names using paper and pencil	Average accuracy rating of 47%
Xu, Chin, Reed, & Hutchinson (2014)	3 – 4 year olds	Name Writing (PALS)	Children are asked to draw a picture and then write their name (only name is scored)	Average accuracy rate of 64%

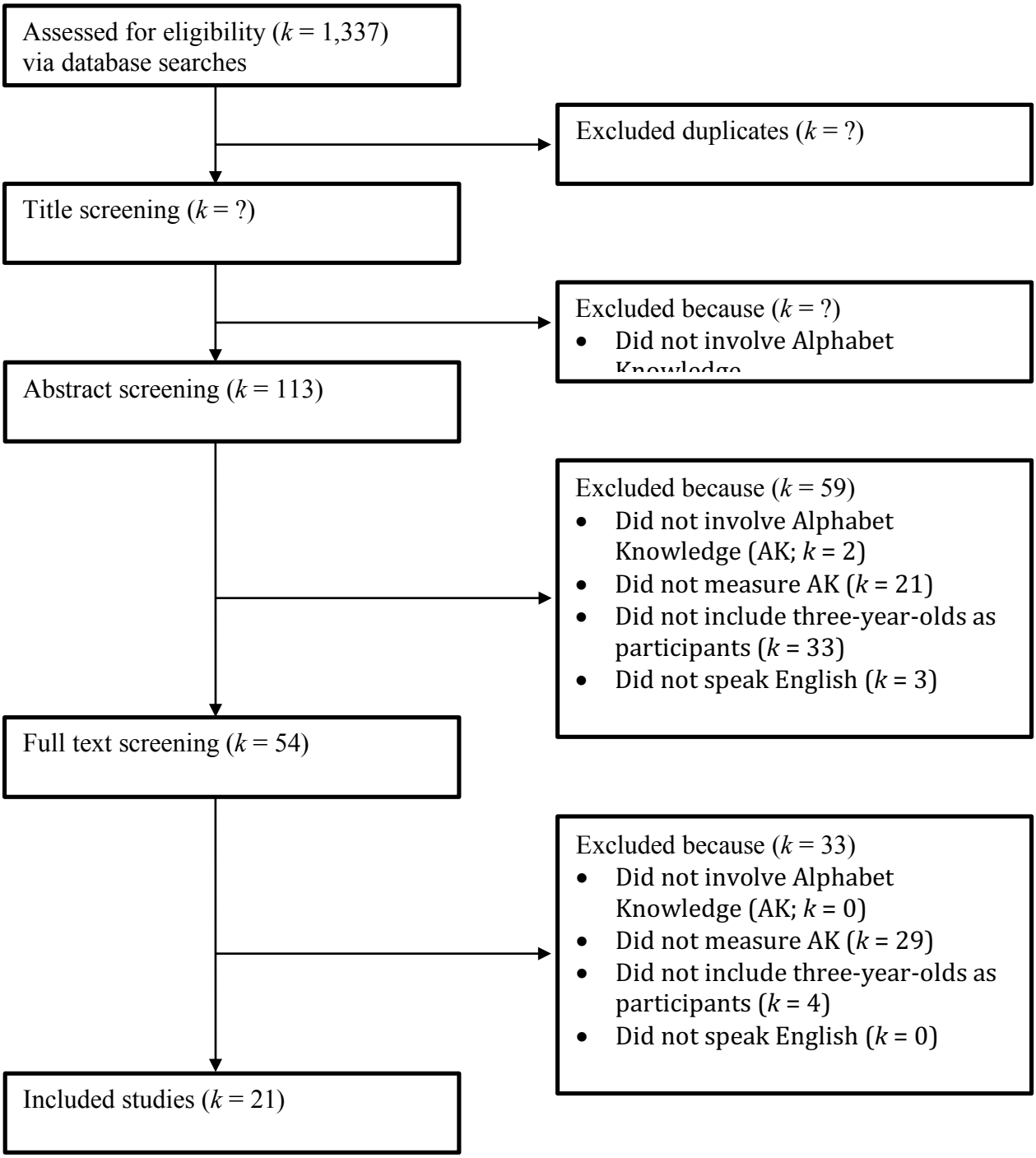

Figure 1. Review process for determining eligible studies.