Letter and Numeral Identification:

Their Relationship with Early Literacy and Numeracy Skills

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Abstract

The relationship between letter and numeral identification is reviewed to determine whether early identification of these symbols impact upon both literacy and numeracy development. Numerals and letters share similar perceptual properties such as geometric features and arbitrary labels. Through early socio-cultural experiences with surrounding print, children learn to differentiate between these symbols and name them. This knowledge prepares them for the acquisition of conventional literacy and numeracy skills. Studies show that numeral and letter identification are correlated at an early age. Moreover, numeral identification predicts early literacy skills such as word reading. Also, some evidence shows a relationship between letter identification and numeracy skills. The implications of the relationships between letter and numeral identification and subsequent literacy and numeracy skills for research and education are discussed, although further research is warranted. Practical strategies for fostering both numeral and letter identification in young children are suggested.

Keywords: Numeral and letter identification, literacy skills, numeracy skills, print strategies, preschoolers.

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Children are surrounded by print from the moment they are born (Teale and Sulzby, 1986). The print children see consists of arbitrary symbols dictated by cultural conventions (Gazzaniga, Ivry, and Mangun 2002; Polk and Farah 1998; Tolchinsky Landsmann and Karmiloff-Smith 1992). Written language systems are composed of printed symbols that may be non-alphabetic (e.g., Chinese; use of characters or logographs to represent syllables or whole words) or alphabetic (e.g., English; Latin letters that have names and represent individual sounds; Jackson and Coltheart, 2001). Children's appreciation of the symbolic communicative function of print within their socio-cultural contexts is evident when they begin to point it out and ask "What does this say?" (Adams, 1990; Clay, 1975). This perspective is in accord with the notion of *emergent* literacy whereby print learning begins very early in a child's life with these skills (e.g., letter identification) being the precursors to conventional reading (Teale and Sulzby, 1986; Whitehurst and Lonigan, 1998). From a similar perspective, early recognition and identification of some or all numerals from 1 to 10 has also been referred to as *emergent* numeral identification by Wright, Martland, and Stafford (2006). In the present article, the relationship between early literacy and numeracy skills is examined.

Most research on the relationship between early literacy and numeracy skills has examined the learning of the English alphabetic system of Latin letters and Arabic numerals, therefore these print types will be focused upon. However, it should be noted that different developmental pathways for literacy and numeracy may exist for different cultures and writing systems. For example, Levin and Bus (2003) showed that written productions (e.g., circle-like shapes, wavy, and vertical lines) were similar in Israeli and Dutch children until age 4 years,

after which they produced distinct Hebrew or Latin pseudoletters, respectively. However, Yamagata (2007) found that Japanese children as young as two years old could produce marks specific to Japanese notational systems (e.g., numerals and characters). Although differences in written language development may exist with respect to age and culture, it has been established that children in general visually process, label, and produce printed symbols from an early age (Chan, Zi Juan, and Lai Foon, 2008; Levin and Bus, 2003; Marzolf and DeLoache 1994; Woodrome and Johnson, 2009; Yamagata, 2007; Tolchinsky, 2003; Treiman, Levin, and Kessler, 2007).

The two main types of print children learn to differentiate early in their development are letters and numerals (Tolchinsky, 2003). The term *numeral* refers to the symbols that represent number names, for example, '25' represents the number name "twenty-five" (Liebeck, 1990; Wright, Martland, and Stafford 2006). The term *digit* refers to only single numerals (e.g., '2') so the more inclusive term numeral will be used throughout this review. The terms *numeral* and *letter identification* refer to the child's ability to state the name of a numeral or letter, respectively (Wright et al. 2006). Over time, children learn to differentiate and classify numerals and letters into the notational systems of numeracy and literacy and use this knowledge for more sophisticated purposes such as calculating mathematical problems and reading words and sentences (Cook 1996; Munn 1994).

There are good reasons to suggest that numeral identification may relate to literacy skills (e.g., alphabet knowledge, spelling, and word reading) and letter identification may relate to numeracy skills (e.g., numeral identification, shape sorting, patterning, and sequencing). Jackson and Coltheart (2001) argued that experience in visual feature analysis of abstract letter units of the reading system is the gateway to reading. Although they referred only to letters, it seems

reasonable that the same process of early visual analysis applies to other print symbols like numerals. Numerals and letters share common physical and visual features in that they are of similar sizes and shapes, contain straight lines, right angles, acute angles, discontinuous curves, and continuous curves (e.g., A, 4, E, 3, L, 7, B, 8). Both can be identified by their shape and may be difficult to distinguish for young children; for example, the numeral '101' looks similar to the letters 'lOl' (Tolchinsky 2003). The context or activity that occurs around the print may also help children determine whether the print is related to 'reading' or 'counting' (Tolchinsky 2003). A developing ability to distinguish between these symbols based on their physical features may contribute towards a child's identification of them. The process of early identification of letter and numeral symbols through visual feature analysis may lead to improved literacy outcomes (e.g., reading a word on a sign) and numeracy outcomes (e.g., reading the price of a product).

Marzolf and Deloache (1994) suggest that children's early understanding of the symbolic function of pictures may also facilitate their understanding of symbols such as letters and numerals and that, over time, children may begin looking for relationships between these symbols. With increasing experience, this ability to differentiate between letters and numerals and understand that they hold different communicative functions paves the way for understanding these representational systems (Yamagata 2007). Thus, it is plausible that children's early numeral and letter identification skills emerge from a common origin and are related to one another (Munn 1994) and that the cognitive skills used in the early learning of numerals and letters are similar (Scanlon and Vellutino 1996).

It is well established that letter identification is related to the acquisition of literacy skills (e.g., Adams 1990) and numeral identification to numeracy skills (e.g., Wright et al. 2006). However, the relationship between these two functionally different symbol systems is not clear.

Therefore, the present paper reviews the evidence for a relationship between numeral identification and literacy skills and between letter identification and numeracy skills. The review will begin by describing children's emerging awareness of print from birth. The differentiation of these symbols and labeling of letters and numerals in the preschool years and how that leads to the conventional use of these symbols for communication, will also be examined. Studies that have investigated the relationships between early letter and numeral identification skills and subsequent literacy and math skills will be examined. The review will conclude with a discussion of ways in which both numeral and letter identification skills could be fostered in young children, implications of the relationship between numeral and letter identification and literacy and numeracy skills, and directions for future research.

Emergence of the Symbol Systems

Figure 1 proposes a sequence through which children move from emerging symbol awareness (specifically letters and numerals) to conventional use in literacy and numeracy activities. Phase A represents children's initial exposure to print in their environment from birth. Early visual perceptual development that leads to the ability to attend to process, discriminate, and recognize letters (Glass 2002) lays the foundation for later literacy development (Ferguson 1975; Gibson, Gibson, Pick, and Osser 1962). If there is a relationship between numeral identification and literacy skills, it would be expected that the ability to perceptually distinguish between different numerals and letters originates from a similar developmental root. While this follows logically from the fact that numerals and letters share similar perceptual characteristics (e.g., straight lines, curves, angles; Gazzaniga et al. 2002) and the visual perception of such symbols does not require an understanding of their functions, there is little empirical research that has tested this claim.

Insert Figure 1 about here

Coldren and Haaf (2000) presented 4-month-old infants with pairs of similar capital letters (e.g., E, F). The infants could perceptually distinguish between the different letter shapes. Furthermore, they showed a novelty preference for a letter with a distinguishing feature present (i.e., E) rather than absent (i.e., F). Thus, 4-month-old infants have the ability to discriminate reliably between visual symbols following sufficient familiarization time (25 to 30 seconds). As noted earlier, numerals are also visual symbols that share perceptual characteristics with letters. As such, these results would be expected to generalize to a stimulus set that consisted of numerals, although further research would be required to empirically verify this. Nevertheless, it can be concluded that normally developing infants have the basic ability to visually perceive and process fine patterns and symbolic shapes very early in life.

Children are exposed to and explore printed materials containing both letters and numerals in their surroundings from birth (Adams 1990; Harste, Burke, and Woodward 1981; Teale and Sulzby 1986; Yannicopoulou, 2006). This includes book print and environmental print such as that found on signs (e.g., FRUIT $2.35, 60km/h), car number plates (e.g., 378 MVC), and product labels (e.g., TOY STORY 3; for a review see Neumann, Hood, Ford, and Neumann in press; Vukelich, Christie, and Enz 2008). Over time, via exposure to and socio-cultural interactions with surrounding print, children become aware that these graphic symbols possess meaning and function (Goodman 1986; Baghban 1984). In addition, it is suggested that infants exposed to a range of notational input may be at an advantage in differentiating between them (Karmiloff-Smith 1992).

Children pass into Phase B (see Figure 1) when they begin to identify letters and numerals, by recognizing their shapes and labeling these arbitrary symbols by their names (Bialystok 1992). Children also need to learn that graphic variations may occur for a single letter, for example, A, a and ɑ are all labelled by the same name ā, or numeral, for example, 4, 4 and 𝍸 all denote "four". In this phase, children also begin to differentiate letters and numerals based on their functions, which are shaped by the activities that take place around the print (Tolchinsky 2003; Bialystok 1992). For example, through rote learning of the alphabet or counting songs children become aware that letters are for reading and numbers are for counting (Tolchinsky 2003). During this phase, children have not yet mastered letter sound knowledge or understanding of numerical principles such as cardinality (when a numeral represents a quantity; Liebeck 1990) and ordinality (where a numeral represents place order, e.g., 7 comes before 8 and after 6; Liebeck 1990). However, children are beginning to use their existing knowledge of letters and numerals in their written productions. For example, Tolchinsky (2003) described how a 4-year-old girl drew four vertical sticks to represent 4 cars; and a 6-year-old girl wrote 55555 next to a string of letters (TROCNILI) to represent the numeral and word for '5 wheels', respectively, evidencing her ability to differentiate between letters and numerals, although unconventionally. In addition, Tolchinsky also observed that 4- and 5-year-olds naturally mix letters and numerals when writing, indicating that their ability to differentiate their functions is still limited. Children also begin to discover that strings of letters should not contain the same letters (e.g., aaa) to be valid, although strings of numerals can contain the same numeral (e.g., 222), evidencing children's increasing sensitivity to different conventions associated with these two forms of printed symbols (Tolchinsky 2003). Through daily interactions with print, children

continually test their hypotheses about the functions of print in order to match them with conventionality (Harste, Woodward, and Burke 1984).

When children pass into Phase C (see Figure 1), formal instruction at school helps them consolidate their knowledge about letters and numerals and develop their ability to manipulate and use the symbol systems conventionally. For example, use of letters for word decoding, sentence construction, and fluent reading, and numerals for representation of cardinality, ordinality, part-whole schemes (fractions, decimals), and place value (e.g., in the number 12, the 1 represents 10-units and the 2, 2-units). McMullen and Darling (1996) argued from Piagetian (1983) and Vygotskian (1962) perspectives that experience with one symbol system should assist in the development of others such that competence in one type of symbolic skill will be predictive of other forms of symbolic competence. Therefore, it is possible that learning to identify numerals may benefit letter identification and vice versa.

The relationship between numeral and letter identification

Scanlon and Vellutino (1996) suggested that learning numeral and letter names are similar as they both require children to associate verbal labels with visual symbols. They make the same cognitive skill demands on visual and verbal memory. However, few researchers have specifically examined the correlation between numeral and letter identification in the same sample, although some studies that were primarily focused on examining literacy skills have also measured numeracy skills.

Durkin (1968) described the outcomes of a preschool curriculum on academic growth in 36 children aged 4 to 5 years of age from a U.S. Midwestern community. Over the year, children participated in a daily 30-minute academic session. Children were not pressured to learn as they engaged in activities such as chalk board writing, puzzles, and card games that were selected

based upon the child's interests and abilities. Letter identification was taught by using surrounding print such as children's names, book titles, bulletin boards, labels on boxes and food packaging, and street signs. Numerals were taught using book pages, children's ages, birthdates, addresses, and calendars. These resources were employed because they were similar to those encountered in children's home activities. At the beginning and end of the preschool year, children were assessed on their letter (26 letters in both upper and lower case form) and numeral (numerals from 0 to 20) identification. There was a strong correlation between letter and numeral identification at the end of the year (r = .80) suggesting that knowledge of one symbol system was positively associated with the other.

Using a longitudinal design, Aarnoutse, van Leeuwe, and Verhoeven (2005) examined a range of literacy skills, including letter knowledge and rapid naming of letters and numerals in Dutch children (N = 243). The letter knowledge test consisted of identifying 21 letters. The rapid naming test measured how quickly children could name familiar letters and numerals. Children were tested at the beginning of year 1 and 2. At the beginning of year 1, there was a moderate to strong correlation between rapid numeral naming and both letter knowledge (r = .45) and rapid letter naming (r = .69). At the beginning of year 2, rapid numeral naming was still moderately correlated with letter knowledge (r = .32). The positive association between early letter and numeral identification in these studies supports the proposed relationship indicated in the differentiation Phase B seen in Figure 1.

The relationship between numeral and letter identification and literacy and numeracy skills

Wright et al. (2006) suggested that numeral identification is an important component of early literacy development. Numeral and letter identification may both be measures of

rudimentary reading skills (Scanlon and Vellutino 1996). In support of this, two studies (Durkin 1968; Scanlon and Vellutino 1996) found that numeral identification is related to word reading. Durkin (1968) assessed this by using 37 words selected from home reader books. At the end of the preschool year, numeral and word identification were as strongly correlated (r = .83) as letter and word identification (r = .81). However, given that numeral and letter identification were strongly correlated (r = .80), it is unclear if the relationship between numeral and word identification was independent of that with letter identification. The authors did not report any analyses that partialled out the influence of letter identification, making the unique contribution of numeral identification unclear.

Similarly, Scanlon and Vellutino (1996) found that preschool letter and numeral identification skills in U.S. children (from middle to upper class communities) were equally predictive of first grade word identification (r = .59 and r = .56, respectively). Like Durkin (1968), though they did not examine the predictive ability of numeral identification after accounting for letter identification. Furthermore, Scanlon and Vellutino argued that these results should not be taken to suggest that letter and numeral identification skills alone predict reading ability, but that average or above average performance on letter and numeral identification probably reflect the child's print experiences prior to school and their interest in and motivation to learn about these symbol systems. This interpretation highlights the potential impact that a third variable or other external influences can have on the apparent relationship between numeral identification and literacy skills like word knowledge.

Scanlon and Vellutino (1996) suggested that children who begin school having already learned the names associated with numerals and letters have a strong foundation for Grade 1 instruction. Numeral identification may thus be associated with not just word knowledge, but

other literacy skills and general academic achievements. Indeed, Betts, Pickert, and Heistad (2009) suggested that a multivariate approach in which both numeracy and literacy skills are measured during the pre-Grade 1 year may provide a more complete picture of children's early academic achievements than the measurement of literacy skills alone. More complex analyses than just reporting simple correlations are needed to begin to tease out the causal relationships between numeral identification and literacy skills. For example, Berghout Austin, Blevins-Knabe, and Lokteff (2011) showed that letter awareness mediated the relationship between early math skills and receptive language in U.S children. They suggested that this provides some evidence that learning of the numerical symbol system may influence children's understanding of letters and vice-versa. In their longitudinal study, Aarnoutse et al. (2005) found differences in the predictive relationships between rapid number and letter naming and year 2 literacy skills in Dutch children. Rapid letter naming predicted word reading ability (r = .49), whereas rapid number naming predicted spelling ability (r = .39). These data demonstrate a relationship between numeral identification and subsequent literacy skills as proposed in Figure 1.

There is also evidence that early numeracy skills beyond simple numeral identification are predictive of literacy skills. Duncan et al. (2007) conducted a meta-analysis of six longitudinal data sets (of children from U.S., Great Britain, and Canada) and found that early knowledge of numbers and math concepts had the greatest power in predicting later school reading and math achievement. Recently, Welsh, Nix, Blair, Bierman, and Nelson (2010) investigated academic school readiness in 164 children (14% Latino American, 30% African American, and 56% European American). They found moderate to strong correlations between numeracy skills (counting and quantity, addition and subtraction of small numbers) and early literacy skills (print knowledge, blending) at the beginning (mean age of children 4.49 years old)

and end of pre-kindergarten (r = .55 and .47, respectively). Pre-kindergarten numeracy and literacy skills were equally predictive of kindergarten reading (r = .40) and math achievement (r = .54 and .50, respectively). These findings provide further evidence that early letter and number skills show similar strength relationships with later reading and math ability.

To our knowledge, only one study has documented a link between letter identification and numeracy skills. Betts et al. (2009) examined the relationship between numeracy and literacy skills as assessed by the Minneapolis Kindergarten Assessment (Minneapolis Public Schools 2004). The assessment of 2180 U.S. children in kindergarten showed that letter identification was significantly correlated with number sense (r = .58), patterning/functions (r = .45), and spatial sense/measurement (r = .47). Betts et al. suggested that early educational programs should be designed that integrate the learning of both letter and numeracy skills, which would help foster later reading and math outcomes. There is also some limited evidence that other early literacy skills are predictive of numeracy skills. Betts et al. found that letter sound knowledge was correlated with number sense (r = .51), patterning/functions (r = .39) and spatial sense/measurement (r = .41). Welsh et al. (2010) also found that pre-kindergarten literacy skills were predictive of kindergarten math achievement (r =.50).

However, the basis of these correlational relationships between early literacy and numeracy skills is not clear as sequences of letters and digits communicate quite different information. For example, a sequence of two letters (e.g., AN) spells a word where each letter represents a sound /a/ and /n/ blended together. A sequence of two digits, for example, 27 represents two aspects of quantity or magnitude; the 2 represents the number of 10-units and the 7 represents the number of 1-units. Therefore, while both letter and numeral identification begin with similar visual perceptual processes, they necessitate different conceptual understanding if

they are to lead to literacy and numeracy skills. The question then is why relationships might exist between identification of either type of symbol and subsequent literacy and numeracy skills. Further research on this is needed, and that research must control for other important variables such as general intelligence and home literacy and numeracy experiences, which may provide an explanation for such correlations. Other important factors that may influence children's literacy and numeracy development include the socio-economic and ethnic backgrounds of families. For example, children from backgrounds with little experience with print or access to printed materials (e.g., books) may be delayed in their acquisition of literacy and numeracy skills (Snow, Burns, and Griffin, 1998).

Fostering numeral and letter identification in young children

Both emergent numeracy and literacy development may be highly dependent upon a young child's growing ability to understand and manipulate the associated symbol systems (Cook 1996). Munn (1994) argued that a basic understanding of visual symbols is necessary for preschool aged children to develop both emergent numeracy and literacy skills. Tolchinsky (2003) also suggested that children who begin formal instruction in literacy and numeracy with the letter and number systems differentiated may be at an advantage in the acquisition of subsequent reading and math skills. This knowledge may develop naturally in the home through parent-child interactions with surrounding print (Otto 2008). For example, children's early introduction to letters and numerals has been observed to occur through everyday social interactions with surrounding print (McGee and Richgels 1989; Sinclair and Golan 2002; Neumann and Neumann in press). Through meaningful early interactions with print, children begin to use their knowledge about spoken language to help them make sense of these symbols by naming them according to adult convention (Cook 1996). These important *scaffolded*

adult/parent-child interactions with surrounding print may be viewed within the framework of Vygotsky's (1978) socio-cultural theory. Scaffolding is where the child is provided with tools or strategies to help them achieve a goal (e.g., identify a letter or numeral) that would otherwise be beyond his or her unassisted efforts (Wood, Bruner, and Ross, 1976).

For example, Cook (1996) examined whether social play contexts in which adults initiated talk or action, or responded to the child during print interactions, can foster a child's knowledge of numerals. Children at local nurseries were initially video-taped over a 3-month period playing in a kitchen setting (pre-enhancement condition). Next, a new dramatic play setting (the enhancement condition) was introduced and video-taped. The enhancement condition was a birthday party setting that contained greeting cards with numerals, candles, cakes and cake tins in the shape of numerals, and numeral shaped biscuits to which children had free access. Children's numeracy related utterances were coded. Children's construction and recognition of numerals (e.g., "It's a 3") showed the most significant increase from the pre-enhancement (kitchen) to the post-enhancement condition (birthday party). Children were also observed pointing out other numerals in their nursery room such as numerals on the clock, telephone, and jigsaw puzzles during the play session. These findings showed that children were naturally interested in and aware of the role that numerals play in everyday life. Cook suggested that because talk, numerals, letters, and drawings were all comparable in their origin and early development, letters and numerals may be learned through meaningful social processes in which children were active participants.

Therefore, it is recommended that children be provided with rich materials that promote symbol use, caring adults that encourage children to discover symbols, and an environment where children may explore print. Gifford (1995) gives examples of themed play settings, such

as inside an aeroplane (e.g., seat numbers and dials with numbers on it), a post-office (e.g., post codes), and a grocery shop (e.g., price signs) that can expose the child to both numerals and letters and potentially foster their identification skills in the preschool years. In addition, ubiquitous environmental print that contains both letters and numerals (e.g., car number plates, grocery shop price signs, cereal box labels, and road signs) is a resource that can be used to help children develop their letter and numeral identification skills in the home and educational settings. Neumann, Hood, and Neumann (2009) discuss how parents, carers, and early childhood teachers could use environmental print to focus children's attention on letters embedded in words by pointing out and tracing their shapes with a finger and saying their names. This is likely to transfer readily to teaching numeral names and concepts. In order to facilitate children's differentiation of these symbol systems, discussions should occur about the specific function of letters versus numerals. For example, after pointing out the individual digits in the print "350 g" on the cereal box, the adult may say "That number, three-hundred and fifty, tells me how heavy the box is and that little letter g means grams so the box weighs three-hundred and fifty grams".

There is also some evidence that children from multilingual societies can increase their knowledge about print, through environmental print. Yannicopoulou (2006) examined Greek preschooler's ability to differentiate between Latin and Greek alphabet letters embedded in environmental print. Greek children are exposed to both Latin and Greek in their urban environment (e.g., logos, toy labels written in Latin e.g., McDonalds; and trading signs written in Greek e.g., ΕΠΑΥΛΙΣ) and are not formally taught letters in preschool. The children were able to differentiate between Latin and Greek letters indicating that preschool children in a non-English urban environment were sensitive to letters from different language systems. It is

possible that children who reside in multilingual settings may benefit from environmental print and use it to assist in the differentiation of their symbol systems.

Conclusions and suggestions for future research

Although research to date has been limited, there is some evidence to suggest that numeral and letter identification are related to each other (e.g., Aarnoutse et al. 2005; Durkin 1968) and to literacy and numeracy skills (e.g., Betts et al. 2009; Durkin 1968; Scanlon and Vellutino 1996). Fewer studies to date have examined the relationship between letter identification and numeracy skills; however, Betts et al. (2009) found that letter identification is related to number sense, patterning, and measurement. These findings are consistent with the notion that an understanding of both numerals and letters in the preschool years provides a solid basis for the development of more advanced math and reading skills (Scanlon and Vellutino 1996). Munn (1994) argued that fostering both literacy and numeracy in the preschool period through child-led open-ended joint numeracy and literacy activities would provide young children with that strong foundation. In addition, McMullen and Darling (1996) suggested that knowledge about one symbol system generalizes and facilitates the development of other symbol systems and, therefore, preschool-aged children should be provided with learning experiences from multiple symbol systems. Further research is required across written language systems and cultures to establish the effectiveness of teaching approaches that involve joint numeracy and literacy activities.

The main problem with the current evidence is that it largely consists of simple correlations between numeral identification and word reading. Although a causal relationship may exist, the relationship could also be accounted for by a third variable, in particular, by overlapping variance between numeral and letter identification, given letter identification is also

correlated with word reading. However, other third variables might also explain this relationship. A child's general cognitive ability (Betts et al. 2009), maturation, home environment, and external instruction are some of the possible variables that may increase both numeral and letter identification and literacy and numeracy skills and explain the overlapping variance. Further research is needed that controls for these potential alternative explanations. In addition, these relationships need to be explored with an experimental approach. For instance, if there is a causal relationship between numeral identification and literacy skills it would be predicted that children trained in numeral identification should subsequently show greater improvements in letter identification and other literacy skills than children not trained. An important implication of these outcomes would inform whether early childhood educators should treat numerals and letters as separate entities using a compartmentalized teaching approach or whether a more integrated approach should be used where activities include both numerals and letters. The research to date suggests that preschool children be provided with meaningful and contextual activities that foster both letter and numeral identification. This in turn may aid in the differentiation of these symbol systems and the acquisition of numeracy and literacy skills.

As the majority of studies in the present review were conducted with English speaking children from a Western socio-cultural context, it is not possible to generalize the findings and conclusions to other languages and writing systems. The emergence and development of print knowledge in multilingual settings where alphabetic and/or non-alphabetic systems are used requires further research. Finally, the learning of letters and numerals and the relationship between these and conventional literacy and numeracy skills across cultures is an area for future investigation. This research would help inform early childhood educators and policy makers on the best ways to foster emergent literacy and numeracy.

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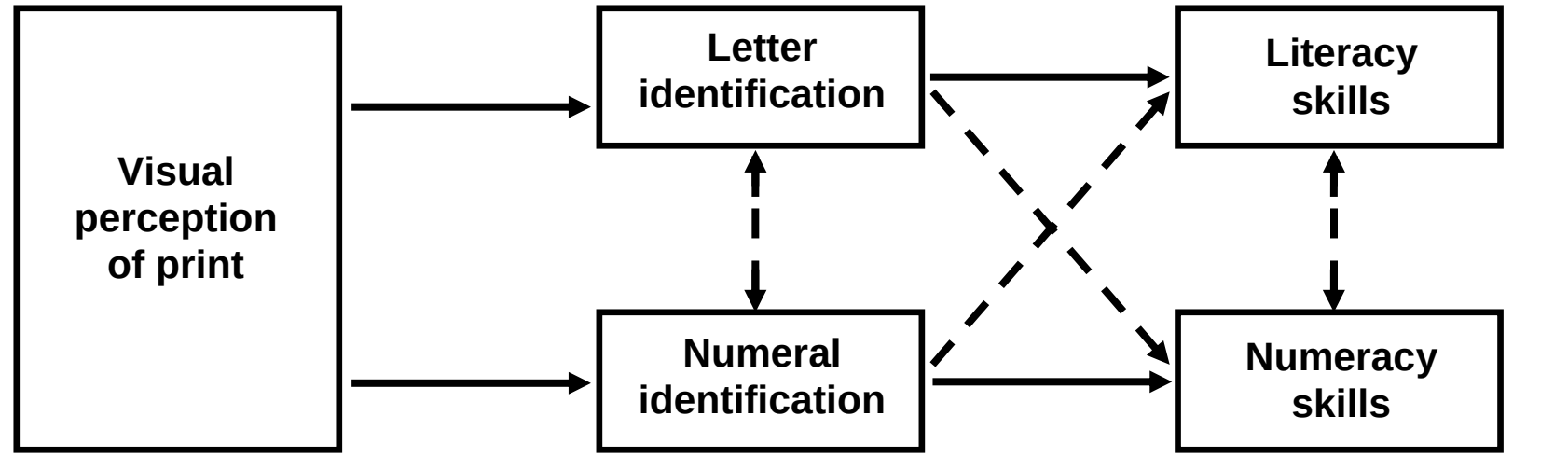

Figure 1: Emergence of print knowledge and proposed relationships between letter and numeral identification and literacy and numeracy skills.