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Letter names, letter sounds and phonological awareness: an examination of kindergarten children across letters and of letters across children

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Abstract. In this study 149 kindergarten children were assessed for knowledge of letter names and letter sounds, phonological awareness, and cognitive abilities. Through this it examined child and letter characteristics influencing the acquisition of alphabetic knowledge in a naturalistic context, the relationship between letter-sound knowledge and letter-name knowledge, and the prediction of Grade 1 phonological awareness and word identification from these variables. Knowledge of letter sounds was better for vowels and for letters with consonant–vowel names than for those with vowel–consonant names or names bearing little relationship to their sounds. However, there were anomalies within each category reflecting characteristics of the individual letters. Structural equation modelling showed that cognitive ability, comprising receptive vocabulary, non-verbal reasoning, rapid automatized naming of colours, and phonological memory significantly contributed to alphabetic knowledge and phonological awareness. In turn, letter-name knowledge but not phonological awareness predicted letter-sound knowledge and subsequent reading skill.

Key words: Alphabet, Kindergarten, Naming speed, Phonological awareness, Reading

Introduction

In North America, learning the alphabet is traditionally regarded as a quintessential academic task of kindergarten. Despite or perhaps because of this, relatively little research has been conducted on the acquisition of children's alphabetic knowledge and factors which may influence it. However there is a clear body of literature showing that letter-name knowledge is a strong predictor of beginning reading (Adams, 1990; Burgess & Lonigan, 1998; Byrne & Fielding-Barnsley, 1989; Calfee & Drum, 1979; Chall, 1967; Stevenson & Neuman, 1986; Stuart & Colheart, 1988; Wagner, Torgesen, & Rashotte, 1994), challenged only by letter-sound knowledge (e.g., Lomax & McGee, 1987; McBride-Chang, 1999; Pennington & Lefly, 2001), and phonemic awareness (see meta-analyses by Bus and van IJzendoorn (1999), Castles and Coltheart (2004), National Reading Panel (2000)).

While letter-name knowledge is completed earlier than letter-sound knowledge in a variety of countries (e.g., Blaiklock, 2004; de Abreu & Cardoso-Martins, 1998; Levin & Aram, 2004; Mason, 1980; Treiman, Tincoff, Rodriguez, Mouzaki, & Francis, 1998; Worden & Boettcher, 1990), letter-name and letter-sound knowledge in children are strongly correlated, in the order of .70 to .80 (Lomax & McGee, 1987; Richgels, 1986; Worden & Boettcher, 1990). The finding that letter-sound and letter-name knowledge intercorrelate and that knowledge of letter names so highly predicts reading has been interpreted in a variety of ways.

First, it has been suggested that knowing the names of letters makes them identifiable and familiar, allowing them to be processed more efficiently and rapidly when reading (Walsh, Price, & Gillingham, 1988) and allowing easy access to their sounds because many letter names contain the phoneme associated with that letter in either initial (e.g., *p, t*) or final (e.g., *f, s*) position. In support of this interpretation, Ehri (1983) and Treiman et al. (1998) found that children who could name given letters learned their associated sounds more readily than when they could not. Similarly, using regression analyses McBride-Chang (1999) found, through assessing children at four points in kindergarten and Grade 1, that letter-sound knowledge was predicted by letter name knowledge at an earlier time but the reverse was not true. Sound knowledge did not predict subsequent individual differences in letter-name knowledge. Thus letter-name knowledge appears to reinforce letter-sound learning, in a linkage that may help draw children's attention to the sounds of spoken language and provide a name and symbol to anchor this knowledge and break the code of alphabetic writing systems (Adams, 1990; Adams, Treiman, & Pressley, 1998; Barron, 1994).

Moreover, it appears that the position of the sound in the letter name may influence the ease with which letter-sound correspondences are learned. The sounds of consonant–vowel names, in which the sound is in the initial position, are known by a larger number of young children than those for vowel–consonant names in which the associated sound is at the end of the letter's name (McBride-Chang, 1999; Treiman, 1994; Treiman et al., 1998). Sounds for both types of letters are easier to learn than is the case for letters that do not contain their sounds (McBride-Chang, 1999; Share, 2004; Treiman et al., 1998). The status of vowels is less conclusive, perhaps because of different scoring systems. Long vowel sounds (e.g., /e/ for the letter *a*) are sometimes considered correct and sometimes discounted, and constitute the rationale for sometimes including vowels in the category of letter names with the sound at the beginning of the name, and sometimes not. (See Treiman et al., 1998 for these mixed categorizations).

While these generalizations have been reported, previous studies have not examined whether the letters grouped into the various categories, such as sound at the start of the name, sound at the end of the name, and sound not in the name, form coherent categories by showing similar correct response rates. Accordingly, the first set of purposes of the present study was to determine the extent to which the sounds for individual letters were known among a sample of kindergarten children, whether this was differentially associated with characteristics of the names, and whether sound knowledge for letters within letter-name categories was consistent across letters within categories. These categories were vowels (a, *e, i, o, u*), consonant–vowel names with the sound at the start of the name (*j, k, p, t, v, z, b, p, d*), vowel–consonant names with the sound at the end of the name (*f, l, m, n, r, x, s*), and a mixed category in which the letter name did not contain its sound or one of its sounds (*c, g, q, w, h, y*).

A second interpretation is that the relationship of letter-name and letter-sound knowledge to each other and the predictive value of letter-name knowledge to reading skill could be a function of other cognitive abilities that facilitate the acquisition of alphabetic knowledge, phonological awareness, and early reading skill. The influence of potential "third variables" such as age, general language ability, and intelligence, and the necessity of controlling for them was emphasized by Castles and Coltheart (2004). However research examining the relationship between letter-sound knowledge and letter-name knowledge has included such third variables to only a limited degree. Thus a second major purpose was to evaluate the predictive significance of letter-name knowledge to concurrent letter-sound knowledge after taking into account a range of cognitive abilities that might mediate the relationship.

The choice of these "third factors" was guided by previous research. At a general level, reviews by Stanovich (1992), Scarborough (1998), Swanson, Trainin, Necoechea, and Hammill (2003) showed a positive correlation between intelligence and reading, and/or between intelligence and phonological awareness, pointing to the importance of general ability or "*g*". This is reflected in Block Design and Vocabulary subtests of the Wechsler intelligence scales (Sattler, 2001). In addition, the strong relationship observed between receptive vocabulary and phonological awareness (Bowey, 1994; Burgess & Lonigan, 1998; Chaney, 1992; Lonigan, Burgess, Anthony,& Barker, 1998; Smith & Tager Flushberg, 1982; Tunmer, Herriman, & Nesdale, 1988; Wagner et al., 1994) has been interpreted as support for the theory that vocabulary acquisition contributes to phonological awareness via the increasingly fine discriminations and differentiations required among an increasing number of lexical items for efficient phonological representation (Metsala, 1999). Regardless of the interpretation, inclusion of receptive vocabulary would appear to be important in examining the relationship of phonological awareness to alphabetic knowledge and should reduce the association between the two. However, findings from previous research are inconsistent on this point. Bowey (1994) found that once oral language differences between children were controlled, no differences were observed in children's phonological awareness as a function of their letter-name knowledge. In contrast both Wagner et al. (1994) and Burgess and Lonigan (1998) found that individual differences in children's letter-name and letter-sound knowledge in kindergarten and Grade 1 significantly predicted phonological awareness a year later even after controlling for vocabulary knowledge. Both Block Design and a test of receptive vocabulary were included in the present study.

An additional "third variable" not considered in previous studies of the relationship of phonological awareness and alphabetic knowledge is rapid automatized naming (RAN). It is thought that this task reflects individual differences in rapid temporal processing necessary for analyzing stimuli, accessing lexical entries, and assembling units of behaviour (Wolf, 1997) for word reading. As such "letter reading," in other words, letter-name knowledge and/or letter-sound knowledge might be similarly influenced. RAN speed has been shown to be a significant predictor of reading skill in the early grades. (See Bowers & Swanson, 1991; Cronin & Carver, 1998; Parilla, Kirby, & McQuarrie, 2004; van den Bos, Zijlstra, & lutje Spelberg, 2002; Wagner et al., 1994; Wolf, 1991; Wolf, Bally, & Morris, 1986; Wolf & Bowers, 1999, and meta-analyses by Scarborough, 1998; Swanson et al., 2003.) For example, Parilla et al. (2004) found that naming speed for colours in kindergarten accounted for a large amount of unique variance in word identification and passage comprehension in Grades 1, 2 and 3. Thus a RAN task was included in the present study.

A fourth variable implicated in previous research is phonological or auditory short-term memory (Scarborough, 1998), although in several studies, its predictive variance is reduced when combined with other measures of phonological awareness (e.g., de Jong & van der Leij, 1999; Parilla et al., 2004; Wagner et al., 1994). A sentence repetition task was included here to tap this aspect of cognition.

Finally previous research has suggested that family income is associated with emergent literacy skill including alphabetic knowledge and phonological awareness (e.g., Bowey, 1995; Dickinson & Snow, 1987; Goldenberg & Gallimore, 1995) as well as academic achievement, and thus this variable was included in the present study.

In summary, each of these variables – socioeconomic status, verbal and non-verbal general intelligence, RAN, auditory short-term memory – was assessed in the present study to control for these factors in evaluating the concurrent relationship of letter-name knowledge to letter-sound knowledge, and the predictive value of letter-name knowledge to subsequent phonological awareness and reading skill.

A final interpretation is that the potential benefit of letter-name knowledge to reading development partially depends on the child's ability to isolate the sound in the letter's name (i.e., phonological awareness) to use letter names to help learn and solidify the correspondence between letters and sounds. A recent experimental study by Share (2004) suggests that this is the case, in that after controlling for receptive vocabulary, phonological awareness correlated with learning letter-sound correspondences when the names contained the sound. However additional evidence using a different sample and more than the single variable of receptive vocabulary as a common source of variance is needed. Thus another purpose of the study was to examine the extent to which phonological awareness would predict letter-sound knowledge when considered along with letter-name knowledge and all the aforementioned cognitive abilities. Finally we also extended our inquiry to Grade 1 to assess the predictive significance of cognitive ability, letter name knowledge, letter-sound knowledge and phonological awareness to word reading and phonological awareness in Grade 1.

In summary, this study examined kindergarten children's letter-name and letter-sound knowledge, the relationship between the two, the contribution of phonological awareness, letter-name knowledge and cognitive ability to letter-sound knowledge, and the predictive value of all for Grade 1 phonological awareness and word identification.

Method

Participants

A total of 149 5-year-olds, in two cohorts consisting of 79 boys and 70 girls, participated in the study which constituted the first year of a longitudinal study of reading development and parental coaching from kindergarten to Grade 2. Information regarding the project and consent forms were sent home with senior kindergarten children in 30 different senior or mixed junior/senior kindergarten classes in southwestern Ontario. Parents signed consent forms to return to the classroom teacher to indicate their and their child's consent to participate in the longitudinal study. Participants formed two cohorts with approximately half of the children in senior kindergarten in one school year and half in the subsequent school year. All spoke English as their first language. The two cohorts did not differ on any of the variables in the study and were collapsed to form one group.

Demographic data collected through telephone interviews with the parents indicated the following education levels: 7% of the fathers and 2% of the mothers had completed less than grade 12; 14% of fathers and 26% of mothers had completed grade 12 or 13; 35% of fathers and 32% of mothers a diploma course, 24% of fathers and 34% of mothers an undergraduate degree, and 10% of fathers and 7% of mothers a postgraduate degree. Family pretax incomes ranged from less than $16,000 Canadian per year (4% of sample) to over $100,000 (5% of sample). Between these ranges, 7% had incomes up to $26,000, 20% up to $40,000, 26% up to $55,000, 19% up to $70,000, 10% up to $85,000 and 10% up to $100, 000. This demographic sample was comparable to the profile of residents of Southern Ontario (Statistics Canada, 1996) and can be characterized as mostly middle class.

Telephone interviews with the teachers indicated that they had been teaching kindergarten for an average of 9 years (range 1–22 years). All teachers noted that their curriculum attempted to teach all the upper- and lowercase names, letter-sound correspondence, and phonological awareness for at least rhymes and beginning consonants. Some teachers explicitly noted that they followed a whole language curriculum in which letter names and sounds were taught within broader language arts activities and never as isolated activities. Some noted that they introduced a letter each week and organized activities to help children learn that letter. All indicated that they encouraged inventive spelling.

Procedure

After receiving parental consent, children were individually assessed in a separate room of the school in two testing sessions by graduate students and a professor trained in psychological assessment. This took place in April of the kindergarten year when the children were 5 years, 9 months old on average. At this time, tests of non-verbal reasoning, receptive vocabulary, short-term memory, RAN, alphabetic knowledge, reading and phonological awareness were administered. Ten months later in Grade 1, children's phonological awareness and reading skill were assessed in a single one-to-one assessment session.

Materials

Cognitive ability

Non-verbal reasoning and visual-perceptual ability was assessed by the Block Design subtest of the Wechsler Preschool and Primary Scale of Intelligence-Revised (Wechsler, 1989). This requires the child to create patterns with two or four (depending on the item) coloured flat blocks to match a given model. Jansky and de Hirsch (1972), Fletcher and Satz (1979), and Willows (1993) have argued that visual-processing deficits are a significant disadvantage in the early stages of reading when fine discriminations between letters must be noticed and remembered. Although the role of visual-perceptual deficits in reading disabilities has been strongly contested (e.g., Stanovich, 1985, Vellutino, Fletcher, Snowling, & Scanlon, 2004), the inclusion of Block Design is justified in that it is one of the best single correlates of the Performance IQ and measures of *g* on the WPPSI, and as such is a proxy measure for general intelligence. Split-half reliability for Block Design is .79 and .86 for children 5 and 6 years of age respectively. The maximum raw score is 40.

The Peabody Picture Vocabulary Test-Revised (Dunn & Dunn, 1981), primarily a test of vocabulary comprehension, was administered as both a test of vocabulary and a proxy measure for verbal IQ. Normed for ages 2–40, it presents four pictures in each item and requires the child to point to the one named by the examiner. Split half reliability is .74 and .85 for 5 and 6-year-old children respectively.

Children also completed the Memory for Sentences subtest from the Stanford Binet Scale of Intelligence-4 (Thorndike, Hagen, & Sattler, 1986). In it, children were asked to repeat verbatim increasingly longer and more syntactically complex sentences. As such, it taps both phonological short-term memory and receptive language ability. The test–retest reliability coefficient for children age 5 years is .78.

Finally a test of RAN was administered in which children were required to name as quickly as possible 50 dots of five colours, arranged randomly in five rows of 10 dots. Speed to name all 50 dots was timed as the dependent measure. Before their naming speeds were timed, children were asked to name each of the five colours in a pretest. All were able to do so. A parallel RAN task in which children named the letters *a, d, o, s*, and *p* was also given but discarded from use because several children did not know all of these letter names in the pretest. Similarly, Scarborough (1998) used object naming in studying second-grade poor readers, with the rationale that weak letter knowledge might hinder performance on a RAN task involving letters. Moreover, it has been suggested that rapid naming of letters and digits are "mere proxies of individual differences in early literacy and print exposure'' (p. 476, Neuhaus & Swank, 2002), and the question has been raised that ''rapid naming of letters is simply a reading fluency test at kindergarten:'' (Schatschneider, Fletcher, Francis, Carlson, & Foorman 2004, p. 280.) Thus, naming colours was used in the present study.

Alphabetic knowledge
Children were shown two cards having uppercase or lowercase letters, with each of the 26 letters of the alphabet randomly arranged in lines on a white, unlined background. They were asked to give the name of each letter. After intervening subtests, children were shown the card with lowercase letters a second time and asked what sound each letter makes. Lowercase letters were chosen for presentation given that text children might ''sound and blend'' or look at largely appears in lowercase form. In keeping with previous research, both ''hard'' (/k/, /g/) and ''soft'' (/s/, /dz/) phoneme responses for the letters *c* and *g* respectively, both /k/ and /kw/ for the letter *q*, and both long and short phonemes for the five vowels were counted as correct. For each of these tasks the maximum score was 26. Split-half reliability was .93 for knowledge of uppercase and .92 for knowledge of lowercase letters, and .96 for letter-sound knowledge.

Phonological awareness
The Test of Phonological Awareness (Torgesen & Bryant, 1994) was given in both kindergarten and Grade 1. Seven children were not available for testing in Grade 1. The kindergarten version consists of two parts. In the first part, the examiner names a pictured object and asks the child to mark which of three other named pictures starts with the same sound as the first picture. In the second part, the examiner names four pictures and asks the child to mark which one starts with a different sound from the other three. Ten items are in each part making for a maximum score of 20. The Grade 1 version follows a parallel format but requires the child to decide on ending sounds. Internal consistency is .90 and test–retest reliability .94.

Reading
In kindergarten the Test of Early Reading Ability-2 (Reid, Hresko & Hammill, 1989) was given. The test, normed for children ages 3–9, begins with items reflecting emergent literacy concepts such as page orientation, visual matching and discrimination, and progresses to letter matching, letter identification and word reading. A particular interest here was whether the children could correctly respond to any of the nine items in which words had to be read. In Grade 1, children completed the Word

Identification subtest of the Woodcock Reading Mastery Test-Revised (Woodcock, 1987). The manual reports a split-half reliability of .94 for this subtest.

Results

Analysis of letters across children

Table 1 provides the percentage of children able to name the letters correctly from no letter to all 26. Table 2 (first two columns) presents the percentage of children who gave a correct response to each of the 26 letters on the letter-name tasks (upper- and lowercase). By April, most children knew almost all of the uppercase letters, with the percentage of children answering correctly for the individual letters on average being near ceiling ($M = 89.1\%$ correct, $SD = 6.4$). Only the uppercase letters *v*, and *w* were named correctly by less than 80% of the children. Letter names for lowercase letters were less well known and more variable ($M = 74.9\%$ correct, $SD = 18.9$) with half of the children answering correctly on 21 items or fewer. All but one of the letters that changes identity when reversed on the vertical plane – *b, d, g*, and *q*, but not *p* – were named correctly by less that 56% of the children. In contrast, high scoring lowercase letters, known by a percentage of children greater than one standard deviation above the mean, were *i, o, s, x, and z*. Letters whose visual appearance in uppercase and lowercase is very similar (e.g., *c/C, k/K, o/O, p/P, s/S, m/M, w/W, y/Y, z/Z*) had a very similar percentage of children naming upper and lowercase forms correctly, the only exception being *u/U*. Finally, letter sounds were least well known with half of the children answering correctly for 16 letters or fewer.

Table 2 also presents two sets of figures for the letter-sound task administered in lowercase. In the third column data is presented for all children ($n = 149$), and in the fourth column for only those children who also knew the name for a given letter in its lowercase form. (Thus *n* varies and is indicated in parentheses). On average across all letters, 57.9% ($SD = 14.6$) of children responded with a correct letter sound, versus 69.9% ($SD = 14.5$) if only children knowing a given letter name are included. Letters scoring more than one standard deviation below the mean were *q, u, x, and y* for both columns, plus *b and h* when only children also knowing the lowercase letter name are considered.

Spearman intercorrelations were calculated between letter-name and letter-sound knowledge, the order in which the letter appears in the alphabet, and the frequency with which the letter appears in initial

Table 1. Frequencies of children knowing different numbers of letters.

Number known	Uppercase names		Lowercase names		Lowercase sounds	
	%	Cumulative %	%	Cumulative %	%	Cumulative %
0	0	0	0	0	5.4	5.4
1	0	0	0.7	0.7	2.0	7.4
2	0.7	0.7	1.3	2.0	0.7	8.1
3	0.7	1.3	0.0	2.0	3.4	11.4
4	0	1.3	0	2.0	3.4	14.8
5	0	1.3	0.7	2.7	4.7	19.5
6	0	1.3	0.0	2.7	1.3	20.8
7	1.3	2.7	2.0	4.7	4.0	24.8
8	0	2.7	4.0	8.7	2.7	27.5
9	0.7	3.4	1.3	10.1	2.7	30.2
10	0	3.4	4.0	14.1	0.7	30.9
11	0	3.4	2.0	16.1	2.0	32.9
12	2.0	5.4	0	0	2.0	34.9
13	1.3	6.7	2.0	18.1	2.7	37.6
14	1.3	8.1	2.7	20.8	2.7	40.3
15	0.7	8.7	1.3	22.1	4.7	45.0
16	3.4	12.1	5.4	27.7	5.4	50.3
17	0.7	12.8	3.4	30.9	2.0	52.3
18	1.3	14.1	2.0	32.9	2.7	55.0
19	2.0	16.1	2.0	34.9	2.7	57.7
20	4.0	20.1	5.4	40.3	6.7	63.8
21	4.0	24.2	10.1	50.3	6.7	70.5
22	3.4	27.5	6.7	57.0	8.1	78.5
23	2.7	30.2	10.7	67.8	6.0	84.6
24	6.7	36.9	12.8	80.5	8.7	93.3
25	13.3	50.3	7.4	87.9	2.7	96.0
26	49.3	100.0	12.1	100	4.0	100

position in three to seven-letter words according to data provided by Mayzner and Tresselt (1965). While the percentage of children knowing the name of a letter was significantly correlated with the percentage of children knowing the sound of a letter (r = .60), no relationship was observed between these two variables and the order in which the letter appears in the alphabet or the frequency with which a letter appears in

Table 2. Percentage of children giving correct response for names and sound for each alphabet letter.

Letter	Uppercase name	Lowercase name	Lowercase Sound	Lowercase sound if lowercase name
a	98.0	72.5	70.5	88.8 (of 108)
b	98.0	50.3	45.6	45.6 (of 75)
c	94.0	91.3	76.5	80.9 (of 136)
d	87.2	46.3	53.0	75.3 (of 69)
e	90.6	87.9	65.8	70.2 (of 132)
f	88.6	77.9	60.4	73.3 (of 106)
g	83.2	43.0	46.3	85.9 (of 64)
h	86.6	63.1	52.3	52.3 (of 94)
i	84.6	94.0	65.8	70.0 (of 140)
j	83.9	75.8	65.8	81.4 (of 113)
k	89.3	85.9	73.2	82.8 (of 128)
l	86.6	57.0	45.6	70.5 (of 85)
m	82.6	78.5	60.4	75.2 (of 117)
n	89.3	73.8	53.0	69.0 (of 107)
o	98.7	98.0	78.5	79.4 (of 136)
p	92.6	89.3	72.5	78.2 (of 133)
q	84.6	20.8	23.5	54.8 (of 31)
r	92.6	81.9	57.0	68.0 (of 122)
s	97.3	95.3	79.2	82.4 (of 142)
t	87.9	63.8	60.4	84.2 (of 95)
u	91.2	74.5	41.6	52.3 (of 111)
v	73.2	77.2	63.1	80.0 (of 115)
w	78.5	82.6	51.7	60.1 (of 115)
x	98.0	95.3	35.6	36.6 (of 142)
y	83.9	79.2	35.6	41.5 (of 118)
z	94.6	91.9	73.8	78.8 (of 137)

Note. $N = 149$ except for last column where number of cases varies from letter to letter.

first position in words. (See Table 3) This was also the case when the analysis was restricted to consonants alone.

Type of letter name

To determine the effect of the type of letter name on the percentage of children responding correctly on the letter-sound task, a repeated measures analysis of variance was conducted. It was predicted that sounds for

Table 3. Spearman intercorrelation of variables using letters as cases.

	Order	Freq	UpperCN	LowerCN	LowerCS
Order in alphabet	–	−.39	−.12	.34	−.18
Letter frequency		–	.08	−.19	.12
% children knowing uppercase name			–	.39*	.36
% children knowing lowercase name				–	.60**
% children knowing lowercase sound					–

Note. *$p < .05$, **$p < .01$.

vowels would be better known than sounds for the other three types, since the letter's name is the same as one of its sounds. It was also predicted that sounds for consonants in which the letter name started with the sound would be easier than those for consonants with names ending in the sound. Finally consonants having names not containing the sound or having more than one sound were hypothesized to be more difficult than all other categories. Column 4 of Table 4 presents descriptive statistics for

Table 4. Percentage of children giving correct response by letter category.

Letter type	Variable			
	UpperCN	LowerCN	LowerCS	LowerCS if lowerCN
Vowels (n = 5)				
M	92.6	85.3	64.4[a]	72.1
SD	(5.8)	(11.4)	(13.8)	(32.7)
Sound at start of name (n = 8)				
M	88.3	72.5	63.53[a]	75.8
SD	(7.6)	(17.4)	(10.2)	(34.1)
Sound at end of name (n = 7)				
M	90.7	80.0	55.9[b]	68.9
SD	(5.61)	(13.2)	(13.61)	(36.5)
Multi-sound/no sound in name (n = 6)				
M	85.1	63.3	47.6[c]	62.6
SD	(5.1)	(26.9)	(17.9)	(33.8)
All letters(n = 26)				
M	89.6	74.9	58.0	69.9
SD	(6.4)	(18.9)	(14.6)	(14.5)

Note. Different letters for different categories indicates that means differed when compared.

the percentage of children knowing the lowercase name who were also able to provide a correct sound for letters of each of the four letter types.

The one-way ANOVA, in which each of the four types of letter names was considered as a repeated measures factor, was significant: $F(3, 146) = 37.81, p < .001, \eta^2 = .45$. To determine which pairs of letter-name types were different, six one-way repeated measures ANOVA's were conducted setting alpha at .008 as a Bonferonni correction for the number of contrasts. The third column of numbers in Table 4 summarizes these comparisons. Mean scores for vowel names versus consonant names starting with the associated sound did not differ, but each was significantly higher than the remaining two categories. The score for vowels was higher than for letter names ending with their sound, $F(1, 148) = 11.00$, $p < .001$, and than letter names without their sound, $F(1, 148) = 56.85$, $p < .001$. Similarly, the score for letters whose name starts with the associated sound was higher than for those ending with their sound $F(1, 148) = 18.58$, $p < .001$; and those without their sound, $F(1, 148) = 101.44, p < .001$. Finally, the percentage of children giving correct sounds for letters ending with their sound was higher than for letter names without their sound, $F(1, 148) = 28.97, p < .001$.

To determine the coherence of the four categories, in particular whether letter-sound knowledge for each individual letter within a letter-name category was better or worse known by children than would be expected by chance, a series of binomial tests was conducted, one for each letter. For these tests the probability of knowing the letter sound was set at 69.9, which was the average sound correct score across all letters (column 4 of Table 4). The letters are arranged in Table 5 according to whether the binomial test showed a higher percentage of children knowing the letter sound than would be expected on average, lower than what would be expected on average, or not significantly different from that expected on average. Vowels did not form a coherent category, in that sounds for *a* and *o* were better known, *e* and *i* equally known, and *u* worse known than the average letter score. Letters whose sound is at the start of the name, or consonant-vowel names, formed a coherent category of being better known than the average with the exception of *b* and *d* which have scores equal to the average across letters. Similarly letters whose sound falls at the end of the letter name (vowel–consonant names) formed a coherent category of being known as well as the average of all letters, with the exception of *s* which was better known and *x* which was worse known. Finally, the mixed category did not hang coherently together, with the three of the six letters *q*, *w*, and *y*, having lower scores than the average value across letters and two letters, *c* and *g*, having higher than average

Table 5. Percentage of children knowing lowercase sound if knowing lowercase name.

	Percentage of children knowing sound > expected	Percentage of children knowing sound = to expected	Percentage of children knowing sound < expected
Vowels	A 88.9***	E 70.2	U 52.3 ***
	O 79.5**	I 70.0	
Sound at start	J 81.4**		
of name	K 82.8***	B 67.7	
	P 78.2*		
	T 84.2**	D 75.3	
	V 80.0*		
	Z 78.8***		
Sound at end	S 82.4***	F 73.3	
of name		L 70.6	X 36.6****
		M 75.2	
		N 69.1	
		R 68.0	
Multi-sound or	C 80.9**	H 72.3	Q 54.8*
No sound in name	G 85.9**		W 39.8***
			Y 41.5**

Note. Expected value was set at average observed value across all letters, i.e., 69.9; $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

values. These analyses show that while letter-name type does exert an effect, there are anomalies for individual letters within the categories.

Analysis of relationship between letter names, letter sounds and phonological awareness

The data was initially examined for normality and univariate outliers. One data point in each of nine cases was adjusted to fall 3 standard deviations from the mean. No skewness or kurtosis was apparent. Squared multiple correlations, condition indexes and Mahalanobis distances were also examined and no multicollineaity or multivariate outliers were detected.

Descriptive statistics for each of the tests administered and age at first testing in kindergarten are shown in Table 6. Table 7 shows the intercorrelations of the variables. Family income was modestly negatively

Table 6. Descriptive statistics for variables collapsed across children.

Variable	Mean	*SD*	Range
Uppercase names	23.05	4.90	2–26
Lowercase names	19.46	6.13	1–26
Lowercase sounds	15.07	8.07	0–26
TOPA-K	13.81	4.62	4–20
TOPA-1	13.86	4.47	4–20
Word ID-1	25.32	15.60	0–67
Block Design	24.26	6.22	9–42
Peabody PVT	75.24	16.24	43–112
Sentence memory	17.24	2.71	11–25
RAN colours	61.52	16.24	23–104
Age	70.99	3.59	64–81

correlated with scores for lowercase names and sounds, receptive vocabulary, and the test of phonological awareness. Gender was also modestly associated with these variables, as family incomes were lower among boys in this sample. Age modestly correlated with PPVT, Block Design, RAN and word identification scores. However all of these correlations were small ($r = .20$ or less), and these variables were not considered further.

All four cognitive variables were modestly correlated with each other, and modestly to moderately correlated with alphabetic knowledge and phonological awareness scores in kindergarten, and to phonological awareness and word identification scores in Grade 1. Correlations in Table 8 are those in which each cognitive variable is correlated with the literacy variables after partialling out the other three cognitive variables. The data show that each of the cognitive variables shared variance with between 2 and 4 of the five literacy variables that was not common to the other cognitive scores. Therefore, all four cognitive variables were retained in the analyses below.

Relationship of variables to concurrent letter-sound knowledge

To determine the relationship of each of the four cognitive abilities, phonological awareness and letter-name knowledge to concurrent letter-sound knowledge, structural equation modelling using AMOS (Arbuckle & Wothke, 1999) was completed. This technique allows one to determine whether cognitive ability, phonological awareness and letter-name knowledge have independent relationships to letter sound knowledge. The

Table 7. Intercorrelation of variables.

	LCN	LCS	TOPAK	TOPA1	WdID	BD	PPVT	RAN	SM	AGE	INC
Lower-case names	–	.									
Lower-case sounds	.86***	–									
TOPA-K	.55***	.63***	–								
TOPA-1	.37***	.42***	.53***	–							
Word ID-1	.68***	.62***	.56***	.53***	–						
Block Design	.26***	.27***	.40***	.33***	.34**	–					
Peabody PVT	.26***	.35***	.50***	.27***	.20*	.36***	–				
RAN colours	−.38**	−.43***	−.35***	−.20*	−.39***	−.29***	−.25***	–			
Sentence memory	.17*	.31***	.37***	.28***	.19*	.22**	.35***	−.24**	–		
Age	.06	.15	.17	−.04	.11	.17*	.23**	−.15*	.04	–	
Family income	.19*	.20*	.18*	.10	.03	−.09	.18*	.05	.00	−.07	
Gender	−.17*	−.22*	−.12	−.08	−.10	−.18*	.03	−.07	−.02	−.07	−.16

Note. $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$

Table 8. Correlation of each cognitive variable with each literacy variable after partialling out the remaining 3.

	Letter name	Letter sounds	TOPA-K	WordID	TOPA-1
PPVT	.11	.19*	.34***	.02	.10
Block Design	.11	.08	.22**	.24**	.23**
RAN Colours	−.30***	−.34***	−.20**	−.31***	−.07
Sentence Memory	.03	.17*	.19*	−.05	.17*

Note. $*p < .05$; $**p < .01$; $***p < .001$.

analysis was completed using maximum likelihood estimation with complete data. PPVT, Block Design, RAN Colours, and Memory for Sentences acted as observed variables for the latent variable cognitive ability, and the TOPA-K as the observed variable for the latent construct of phonological awareness. Letter-name and letter-sound knowledge were treated as observed variables. As noted earlier, scores for letter-names when letters were shown in uppercase form were near ceiling, but those for lowercase letters followed a normal distribution. Thus the latter set of scores was used in all analyses.

Figure 1 displays the model and standardized path coefficients in which $\chi^2 = 17.13$ (df = 11), $p = .11$. The root mean square error of approximation (RMSEA) = .06, the goodness of fit (GFI) index was .97 and the comparative fit index was (CFI) .98. Non-significant chi-square, CFI and GFI indices above .90 suggest model acceptance (Hoyle & Panter, 1995; Kline, 1998). RMSEA values below or at .05 indicate a close fit but values as high as .07 are acceptable (Browne & Cudeck, 1993). Thus, all indices indicated an acceptable fit of the model to the data.

It should be noted that regardless of the direction of the arrows between variables, the fit indices will remain the same, and the direction of relationships needs to be formulated in advance on the basis of theory and prior research. In this case, the model specification followed the general principle that children possess cognitive skill before learning letters, and that letter-name precedes other literacy skills as set out in the introduction. Thus the model specification was as follows. Numerals on the single headed arrows pointing from the latent construct of cognitive ability to the four cognitive scores are standardized factor loadings as in a confirmatory factor analysis, and are interpreted as correlations. All of these were statistically significant. Arrows pointing away from cognitive

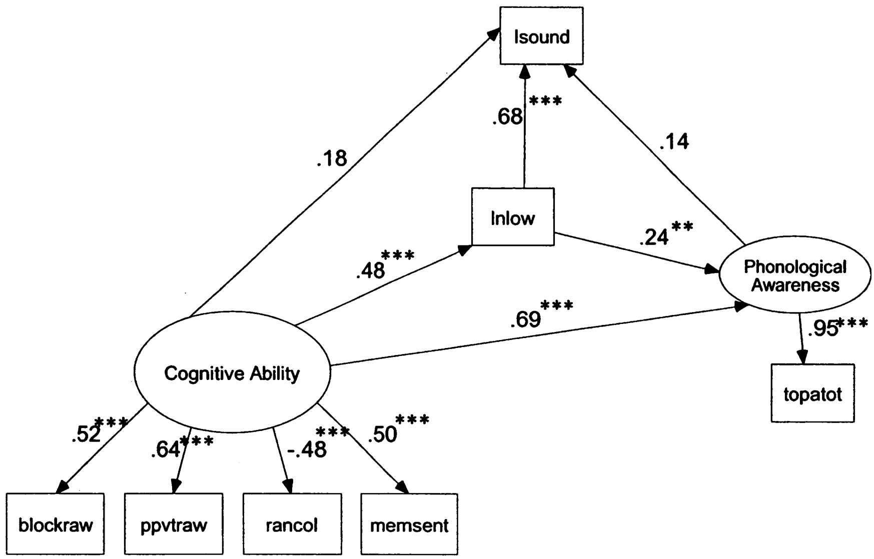

Figure 1. Model and standardized coefficients for relations among variables and letter-sound knowledge for all 26 letters. *Note.* blockraw = Block Design, ppvt-raw = Peabody Picture Vocabulary Test, rancol = RAN of Colours, mem-sent = Memory for Sentences, lnlow = letter names lowercase, sound = letter sounds, topatot = Test of Phonological Awareness; $^{*}p < .05$; $^{**}p < .01$; $^{***}p < .001$.

ability represent independent influence on the three emergent literacy variables – letter-sound knowledge, letter-name knowledge, and phonological awareness. The latter two also have paths in the model specification to letter-sound knowledge in keeping with the theory, as set out in the introduction, that each facilitates letter-sound knowledge. Finally a path was also specified from letter-name to phonological awareness, given previous research that phonological awareness, particularly at the phonemic level, is a least partly facilitated by letter knowledge (e.g., Burgess & Lonigan, 1998.) The standardized weights show that cognitive ability predicted both letter names ($\beta = .48, p < .001$) and phonological awareness ($\beta = .69, p < .001$) and that-letter-name knowledge in turn independently predicted both phonological awareness ($\beta = .24, p < .01$) and letter-sound knowledge ($\beta = .68$ $p < .001$). However neither the direct path from cognitive ability nor from phonological awareness to letter-sound knowledge gained a significant weight.

However as shown in the first half of the paper, only certain letter sounds are a part of the corresponding letter's name. Thus, the analysis was redone using the number of letter sounds for consonant–vowel letters and vowel–consonant letters having only one corresponding sound. Here the chi-square was reduced, $\chi 2 = 14.57$ (df = 11), $p > .20$. The GFI = .97, CFI = .99, and RMSEA = .05, all of these together indicating a slightly better fit than above. In this analysis both cognitive ability ($\beta = .28$, $p < .04$) and letter names ($\beta = .65$, $p < .001$) made independent contributions to letter-sound knowledge for letters whose name contain the sound. The contribution of phonological awareness was again negligible.

Supplementary analysis examining only non-readers
One potential criticism of these findings is that by the end of the kindergarten year some of the children were relatively sophisticated in their knowledge of letters, and some were likely reading. Therefore both of the above analyses were redone using a subset of 98 children who could read two words or fewer on the Test of Early Reading Ability-2. Within this group, 59% read no words successfully, 23% read one word, and 18% read two words. These children obtained lower scores than their peers on all the cognitive, alphabetic and phonological variables but did not differ from them in age, family income or the proportion of boys and girls. The purpose here was to determine whether any of the regression weights would substantially change when the analyses was restricted to non-readers. In both analyses (i.e., for all letters and only those containing their sound) all fit indices remained comparable. The path coefficients from phonological awareness to letter sounds increased by .08, and that to phonological awareness from letter-name knowledge increased by .06, while that from letter names to letter sounds slightly decreased. However the pattern of statistically significance remained unchanged.

Prediction to Grade 1

At the time of the Grade 1 testing, 139 children remained in the study. As noted earlier, preliminary analyses showed that child age, gender and family income were unrelated to TOPA or word identification scores in Grade 1. Thus, they were not considered further.

Word identification
Structural equation modelling was again completed to determine whether relations between cognitive ability, letter-name knowledge, letter-sound knowledge, and phonological awareness in kindergarten, and phonological awareness and word identification in Grade 1 were independent of each

other or redundant. To maintain a sample of 149 children, the missing data facility in AMOS was used. Because letter-name and letter-sound knowledge were highly correlated, two path analyses were completed, first with letter names as a variable and then with letter sounds.

When the variable letter-name knowledge was used, the results provided the following fit indices: $\chi^2 = 19.49$ (df = 11), $p < .05$, CFI = .97, and RMSEA = .07, together indicating an adequate fit. The standardized coefficients are displayed in Figure 2. Knowledge of letter names showed an independent causal influence on the ability to read words ($\beta = .51$, $p < .001$). Neither the direct path of cognitive ability nor of phonological awareness in kindergarten to word reading in Grade 1 was statistically significant. When letter sounds were substituted for letter names in the model, letter sounds independently contributed to the prediction of Grade 1 reading ($\beta = .41$, $p < .001$). The path from phonological awareness to word identification was again not statistically significant.

Again parallel path analyses using only non-readers in kindergarten was conducted. Fit indices remained comparable and indicated acceptable model fits. When the model included letter names, path coefficients changed only slightly and the only path to word reading with a significant

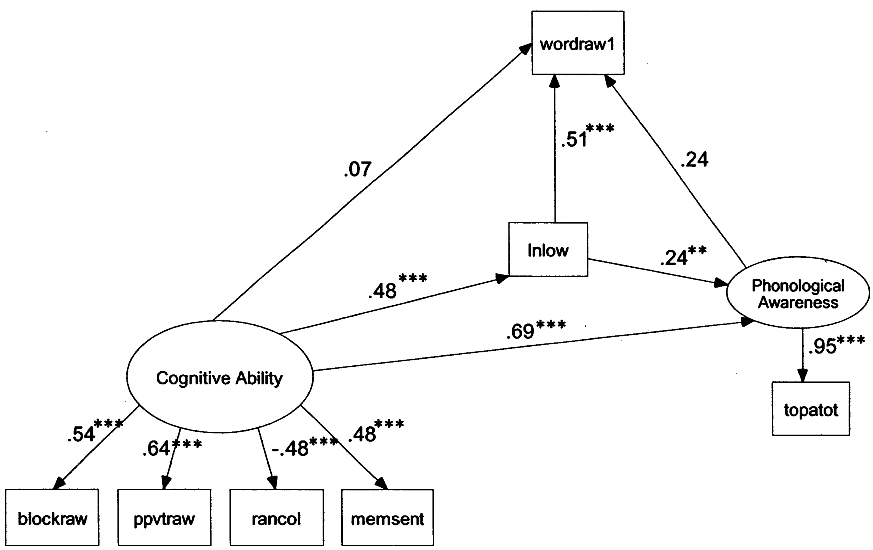

Figure 2. Model and standardized path coefficients using letter names or letter sounds and Grade 1 word identification. *Note.* Blockraw = Block Design, ppvtraw = Peabody Picture Vocabulary Test, rancol = RAN of Colours, memsent = Memory for Sentences, lnlow = letter names lowercase, lsound = letter sounds, topatot = Test of Phonological Awareness; *$p < .05$; **$p < .01$; ***$p < .001$.

beta weight was again letter names ($\beta = .45$. $p < .001$) . When the model included letter sounds rather than letter names, both the path from letter sounds ($\beta = .29$) and from phonological awareness ($\beta = .41$) to word identification were statistically significant ($p < .05$). Otherwise the pattern of statistically significance remained unchanged.

Phonological awareness

The same model and variables as above (letter-name knowledge, kindergarten phonological awareness and the four cognitive variables) were used to predict Grade 1 phonological awareness. The resulting statistics were as follows: $\chi^2 = 15.22$ (df = 11), $p < .17$, CFI = .98, and RMSEA = .05, together indicating an adequate fit. Here, in the presence of the other variables, kindergarten phonological awareness independently predicted Grade 1 phonological awareness ($\beta = .42$, $p < .03$) but path coefficients reflecting the influence of letter-name knowledge and cognitive ability were both negligible. When letter-sound knowledge was substituted for letter-name knowledge, its influence was also negligible ($\beta = .07$) and the other coefficients were basically unchanged. The same was true when these analyses were repeated with just the subset of non-readers.

Discussion

It is acknowledged at the outset that in this naturalistic study, we had no control over potential curricular effects. Nonetheless, the present study confirmed several previous findings and further showed that some letters were better known in their names and sounds than others within their letter-type category.

Learnability of individual letters

The findings here replicated that of previous research in showing that knowledge of uppercase letters precedes that of lowercase letters (Blaiklock, 2004; de Abreu & Cardoso-Martins, 1998; Levin & Aram, 2004; Mason, 1980; McCormik & Mason, 1981; Treiman et al., 1998; Worden & Boettcher, 1990). This may be due to differential curricular emphasis, the greater visual distinctiveness of uppercase letters, and the more prominent appearance in bold type in alphabet books and charts, titles and names, and the start of stories.

The unique properties of certain letters likely influences children's knowledge of them. Here lowercase letters with similar graphic forms in uppercase and lowercase form (*c/C, k/K, o/O, p/P, s/S, m/M, w/W, y/Y, and z/Z)* were known by a similar percentage of children. Treiman and Kessler (2003) have also shown that similarity of lowercase appearance to uppercase appearance predicted the extent to which letter names were known by 4-year-olds. However some letters have unique additional characteristics or "lives of their own" in not only representing sounds of spoken language but also meaning which may add to their ease of learning. The uppercase letters *A, B*, and *C* are frequently strung together as an acronym for the alphabet, especially for children (as in the nursery song "Now I know my ABC's"). Similarly *X* and *O* are used as the label for the game "X's and O's", and have long been known as among the first graphic forms that children produce in their drawings (Gesell & Amatruda, 1947) before attempting to print words. These five letters, in fact, were the five letters in the present study with the highest percentage of children knowing their names in uppercase form. Inspection of the appendices in Treiman et al. (1998) shows this also to be the case in the data from studies in Detroit and Houston. Finally, some letter sounds represent concepts or imitate sounds such as "*mmmm*" for delicious, "zzzzz" for buzzing (or snoring), and "sssss" for hissing which may aid learning letter-sound correspondence. In fact the letter S, having the shape of snake, is a natural mnemonic for its sound (Ehri, Deffner, & Wilce, 1984). In the present study, this letter sound was better known than all the other letters in the vowel–consonant name structure. Together, these special properties likely moderate the relationships observed in this and other studies between the percentage of children knowing a letter's name when presented in uppercase and lowercase font, and the effect of type of letter name on letter-sound acquisition. These findings also signal that not all letters may need to be taught with equal effort in kindergarten classrooms.

Special note of letter name knowledge should be taken for the lowercase letters typically used in RAN letter tasks – *a, d, o, s, p*. Here they were named correctly by 73%, 47%, 98%, 95%, and 89% of the children respectively. Worden and Boettcher (1990) found similar dispersion in these letters among 5-year-olds – 53%, 32%, 97%, 84%, and 76% respectively. For 6-year-olds the percentages were 95%, 72%, 100%, 95%, 88%. Children who identified all these letters accurately on the RAN pretest and proceeded with the test also better knew their other letter names and sounds than children who did not proceed with the test. Given that letter name knowledge increases across kindergarten, this may explain why the correlation between RAN for letters and alphabetic knowledge decreases across kindergarten as observed by Schatschneider et al. (2004).

As shown here and in previous research by Worden and Boettcher (1990) and Treiman and Kessler (2003), the order in which the letters appear in the alphabet and frequency of their appearance in words has little effect on children's acquisition of alphabetic knowledge. This result may seem at a variance with findings of Treiman, Kessler, and Bourassa (2001) in which kindergarten children were more likely to incorrectly insert letters into their spelling that are earlier in the alphabet and more frequent in words. However, their finding may have been confounded with the fact that children were also more likely to insert letters from their own names. *X* and *z*, two of the best known lowercase letter names here, are uncommon in children's given names and likely reduced the correlations found in the present study.

The effect of letter-name type

Nonetheless even with the individual quirks of particular letters, type of letter name exerted a significant effect on letter-sound knowledge, with knowledge of sounds best for vowels and for letters whose sound is at the beginning of the name. Letter-sound knowledge for both of these types of letters was higher than that for letters with the sound at the end of the name and for letters not containing their sound. These findings are in accordance with the naturalistic findings of Treiman et al. (1998) but present a clearer picture. Treiman et al. included sounds for vowels, sounds for the letters *c*, and *g*, and sounds *x*, and *y* – the last two letters being the least known letter-sounds – in the group of letters having multiple letter-to-sound mappings. The present study showed that sounds for *c* and *g* were in fact known by as many children, and in many instances by more children, than was the case for letters associated with a single sound, and that vowel sounds were relatively well learned. Thus, future research should treat vowels as a separate category.

McBride-Chang (1999) suggested that the ease with which children know the sounds of consonant–vowel letters may be due to children being "prewired to attend to initial sounds most closely" (p. 303). Phonemic awareness tasks also show position effects with initial phonemes easier than final phonemes, and segmentation at an onset-rime boundary easier than at other points in a word (Treiman, 1994; Treiman & Zukowski, 1996). However, similar position effects have not been found in other languages. For example a recent study by Share (2004) with Hebrew speaking children did not find any difference in the ease with which children learned the sounds of English letters with the sound in initial versus final position of the name. Moreover, in North American culture at least, letter sounds are taught via initial positions. For example, alphabet books and teaching interactions illustrating letter sounds take the form of "*p* is for pot" where the sound occurs at the start of the word, not " *p* is for top" where the sound is at the end. These observations suggest an experiential basis from alphabet books, parents, teachers, educational television and the spoken language in fostering speedier acquisition among English-speaking children for sounds of letters with consonant–vowel names than the reverse.

Relationships between kindergarten and grade one literacy

The second focus of this study was to examine the relationships between kindergarten literacy and Grade 1 reading. It included a variety of cognitive measures in its design that might be thought to influence emergent literacy: non-verbal reasoning (Block Design), receptive vocabulary (PPVT) RAN (for colours) and auditory memory (Sentence Memory). Each of these observed exogenous variables loaded significantly and roughly equally on the latent variable of cognitive ability. Each also correlated with at least some of the literacy measures in kindergarten and Grade 1 after partialling out each of the other cognitive scores. Of particular note was the finding that the speed with which children could serially name colours shared variance with all but one of the literacy measures after accounting for variance shared with the other cognitive variables. This suggests that the rapid retrieval of the names of non-alphabetic stimuli (in this case colours) involves processes not captured by the other tests that may be important in the performance of letter, word, and phonological awareness tasks across this age period. The results also suggest that relying on only one of these tests, such as a test of receptive vocabulary, may not be sufficient control for cognitive ability in evaluating the predictive significance of different aspects of emergent literacy such as letter-name, letter-sound knowledge and phonological awareness.

Structural equation modelling showed that cognitive ability predicted letter-name knowledge and phonological awareness in kindergarten. While cognitive ability has long been implicated in children's achievement, the present study revealed equally significant path coefficients to phonological awareness as assessed by the TOPA. This test consists of two parts. One part follows the sound categorization format of Bradley and Bryant (1985) in which the child picks which word starts (kindergarten version) or ends (Grade 1 version) with a different sound from the other three remaining words. The other part provides a target word and requires the child to select which of three other words starts (or ends) with the same sound. All words are pictured to reduce the load on memory. Consistent with previous research (e.g., Bowey, 1994; Wagner et al., 1994), in the present sample there was a relation between verbal ability and phonological processing (r^2 = .25). However, for all cognitive variables together, the squared multiple correlation was substantially higher at .37. It might be noted that McBride-Chang (1995) pointed out that intelligence assessed by four subtests of the Wechsler Intelligence Scale for Children, verbal memory, and speech perception all contributed unique variance to phonological awareness scores of children in third and fourth grades. The present study shows that a range of cognitive variables are an integral part of phonological awareness in younger children as measured by alliteration and oddity type tasks.

With the inclusion of paths from broadly assessed cognitive ability, only letter-name knowledge independently predicted knowledge of the sounds of all letters, and in a second analysis, knowledge of sounds for the subset of letters containing their sounds. In both analyses, phonological awareness did not. Treiman et al. (1998) have previously suggested that the superior learning of letter-sound correspondences in letters with the sound at the beginning of the letter's name is due children's phonological skills, allowing them to notice the letter's sound at the start of its name and hence learn it. Consistent with this, Share (2004) observed that phonological awareness made a modest contribution to the acquisition of names containing their sound but the only control variable used was verbal ability. The present results suggest that other cognitive skills may be fundamental to performance on phonological awareness tasks and the learning process. This is not to be interpreted as contrary to the merits of teaching phonological analysis, an abundant literature summarized, for example, by the National Reading Panel (2000). Rather the message here is that cognitive skills may play a significant role in predicting individual differences in the development of both phonological awareness and letter-name knowledge, and that in kindergarten, letter name knowledge, not phonological awareness demonstrates unique variance with knowledge of letter sounds. Cognitive ability directly predicted knowledge of the subset of letters containing their sounds but not all 26 letters considered together. The distinction between letter sounds in general and letter sounds for letters containing their sounds may be one that researchers will want to consider in future work.

When the path model was extended to Grade 1, neither kindergarten letter-name knowledge nor cognitive ability predicted additional unique variance in Grade 1 phonological awareness in combination with the autoregressor of kindergarten phonological awareness which exerted a strong effect. The difference between this and the 4% contributed by letter-name knowledge in the study by Wagner et al. (1994), who also used structural equation modelling, may be attributable the different samples and/or the different way that cognitive ability was measured.

With respect to reading, a 1 standard deviation change in the autoregressor of kindergarten letter-name knowledge predicted a 51% increase in word identification in Grade 1 holding phonological awareness and cognitive ability constant. In contrast, when letter-sound knowledge was used as the autoregressor, it predicted a 41% increase. In light of these results, individual differences in children's letter-name knowledge appears to have somewhat stronger predictive value than letter-sound knowledge over and above children's other abilities measured here and unmeasured variables such as home and curricular experiences. However the difference is small. (See also Schatschneider et al. 2004). The predictive value of both types of alphabetic knowledge adds to the claim (e.g., Bus & van IJzendoorn, 1999; National Reading Panel, 2000) that teaching phonological awareness should be in conjunction with teaching alphabetic knowledge for greater effects.

Finally it must be noted that these data are essentially correlational in nature. While path analysis allows for testing the fit of the model to the data, it does not prove the causal influence of one variable on another. This represents a limitation to be overcome through experimental designs.

Conclusion

This study has expanded upon previous research by examining the extent to which different letter names and sounds are known by kindergarten children. In addition by using a range of cognitive abilities and structural equation modelling, it examined the contribution of letter-name knowledge to phonological awareness and to letter-sound knowledge in kindergarten, and of these variables to reading and phonological awareness in Grade 1. All letters did not all behave similarly when categorized according to their type of name, or when compared in upper and lowercase forms. Specific attributes of letters appear to make them better or poorer known than other members of their letter-name category. In addition letter-name knowledge was a stronger variable than letter-sound knowledge in predicting Grade 1 word reading. Finally when a variety of cognitive skills that predict phonological awareness and achievement are included, in the normal course of development (i.e., not an intervention context) the contribution of phonological awareness to letter-sound knowledge and to word identification may be weaker than previously observed. In particular, cognitive skill when measured more broadly showed a large effect size on performance in a phonological awareness task. Given these findings attention should be given to earlier emerging orthographic knowledge and cognitive skills that may lay the foundations for alphabetic knowledge, and the kinds of experiences and instruction that are most effective in fostering it.

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