Journal of Research in Reading, ISSN 0141-0423 *DOI: 10.1111/j.1467-9817.2006.00329.x*
Volume 30, Issue 1, 2007, pp 7–22

Early reading in Kannada: the pace of acquisition of orthographic knowledge and phonemic awareness

Sonali Nag

The Promise Foundation

Acquisition of orthographic knowledge and phonemic sensitivity are processes that are central to early reading development in several languages. The language-specific characteristics of the alphasyllabaries (Bright, 1996), however, challenge the constructs of orthographic knowledge and phonemic sensitivity as discussed in the context of alphabetic scripts. This paper reports a study of 5–10-year-olds in Kannada, an alphasyllabary that represents print in units called *akshara*. It was hypothesised that in Kannada, when compared with the developmental pace reported in English early reading, (a) *akshara* knowledge acquisition would take longer and (b) phoneme awareness would be slower to emerge. The study found these hypotheses to hold true across grades and in both low-achieving and effective schools. The paper discusses the nature of the cognitive demands in *akshara* reading and the *akshara*-specific characteristics that set a pace of acquisition of orthographic knowledge and phonemic sensitivity that is quite at variance from what has been documented in the alphabetic scripts.

The state of reading research today, more than ever before, is bringing us closer to a universal account of the cognitive processes that underlie learning to read (Snowling & Hulme, 2005). One candidate element in such an account is the mapping between the spoken and the printed word. Current evidence indicates that irrespective of whether it is the matching of phonemes to letters (as in alphabetic orthographies like English and Spanish) or the linking of morphemes to characters (as in logographic orthographies like Chinese), reading acquisition depends on becoming skilled with sound and symbol mapping. However, the type of cognitive processes drawn upon when mapping phonemes to letters can be expected to subtly differ from the mapping processes for morphemes and characters. In character reading, for example, morphological knowledge may play a more crucial role when compared with letter reading (McBride-Chang, Shu, Zhou, Wat & Wagner, 2003). Further, the degree of consistency in the sound and symbol mapping facilitates or slows down reading acquisition. Children learning to read transparent, consistent alphabetic orthographies like Italian and Spanish, for example, acquire reading more rapidly than children learning to read in the more opaque, orthographically inconsistent languages like Portuguese and English (Seymour, Aro & Erskine, 2003). Thus, the type of mapping between spoken and printed words and the consistency of the mapping determine the nature of early reading development and also the nature of the

© United Kingdom Literacy Association 2007. Published by Blackwell Publishing, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main Street, Malden, MA 02148, USA

difficulties that children encounter when learning to read (Goulandris, 2003; Ziegler & Goswami, 2005).

Linguistic features of the alphasyllabaries suggest that sound-to-symbol mapping may be subtly different when compared with the alphabetic and logographic orthographies. The alphasyllabaries are a group of orthographies that represent sounds at the level of the syllable but have distinctive features to indicate sub-syllabic information (Bright, 1996). Kannada, a south Indian Dravidian language, is an alphasyllabary. Kannada represents print in units called *akshara*. In the *akshara* the consonant has a primary place, with the following vowels represented as diacritics (for example the consonant ಗ್/g/ seen with vowel diacritics ಗಿ/gi/, ಗು/gu/, ಗೈ/gai/).[1] An *akshara* with no vowel diacritics represents a consonant with an inherent vowel (schwa). Even though each *akshara* is organised at the level of the syllable, the *akshara* can also be deconstructed into its constituent phonemes. For CV syllables the vowel diacritics are distinguishable from the consonant (the vowel diacritic ಾ/ā/ as seen in ಗಾ/gā/, ಮಾ/mā/, ನಾ/nā/, ರಾ/rā/, ಲಾ/lā/). For the more complex CCV syllables the additional consonant shape also features as diacritics (/g/ in ಗ್ಗ/gga/ and /y/ in ಗ್ಯ/gya/).

Orthographic knowledge

Current evidence indicates that orthographic knowledge is a minimum skill for learning to read in all languages that have been studied. Letter knowledge is a predictor of reading success in alphabetic scripts (see Adams, 1990; Bowey, 2005; Seymour, 2005 for reviews). Similarly, *akshara* knowledge has been found to be low in poor readers and specific *akshara* knowledge training has been shown to improve reading levels in the alphasyllabaries (Nag-Arulmani, 2003).

It must be noted, however, that there are crucial differences in the construct of letter knowledge and *akshara* knowledge. Letters have a name quite different from the sound they stand for. Thus letter knowledge has been operationalised as knowledge of name and/or sound (e.g. Seymour et al., 2003). In Kannada, in contrast, there is no distinction between *akshara* name and *akshara* sound, and *akshara* knowledge requires the mastery of a single *akshara* name-sound.[2] *Akshara* knowledge also differs from letter knowledge because of differences in the visuo-spatial organisation of the orthographic units. While letters are linearised, the Kannada *akshara* uses a complex visuo-spatial arrangement to represent syllables. Post-consonantal vowels are placed either to the right, top or bottom of the initial consonant (thus the consonant ಕ್/k/ with vowel diacritics to the right: ಕಾ/kā/, top: ಕಿ/ki/, bottom: ಕೈ/kai/). In CCV clusters the second consonant is positioned at the bottom right of the first consonant (ಪ/p/ in ಪ್ಪ/ppa/). The right and top vowel diacritics are positioned relative to the first consonant (the vowel ಾ/ā/ is ligatured to ತ್/t/ in the CCV cluster ತ್ಯಾ/tyā/). The vowel-ligaturing rule therefore gives the written syllable of some CCV and CCCV clusters a visuo-spatial organisation that is not exactly in the sequence of the phonological syllable.

Akshara knowledge thus entails learning the rules of ligaturing which govern the large set of symbols in an *akshara* system, a dimension of learning not inherent in letter knowledge. While Kannada has several such specific ligaturing rules, it is important to note that all these rules are consistent. Points of irregularity are rare – for example, the nasalised consonant called *anuswara* and the *arka*, which refers to a specific /r/ in consonant clusters.

© United Kingdom Literacy Association 2007

The size of the orthographic register is yet another dimension of difference between the alphabet and *akshara* systems. Kannada has 476 CV *akshara*, and an additional repertoire of specific diacritics for additional consonants.

The cognitive demands of these *akshara*-specific characteristics when learning to read are not fully understood. However, one practical implication of gaining mastery of such complexities in orthographic knowledge is that we can expect to find differences in the pace of acquisition of orthographic knowledge. The closest parallel to orthographic knowledge required in *akshara* systems is perhaps the complexity that is seen with character knowledge in logographic scripts. Logographic reading acquisition requires greater interaction between morphological and orthographic knowledge for an exceptionally large number of characters. The phase for gaining mastery of orthographic knowledge is clearly drawn out and the acquisition of character knowledge spans more than 6 years. Thus, in mainland China, children are required to gain mastery of around 1,045 characters by the end of Grade 2, and of almost 2,570 characters by Grade 6 (Shu, Chen, Anderson, Wu & Xuan, 2003). The trend in letter knowledge acquisition is quite the reverse. Orthographic knowledge of letter name and letter sound in alphabetic languages like French, Italian and English is rarely reported to take any longer than Grade 1 (Seymour et al., 2003). In contrast to alphabetic scripts like English, French and Italian, but somewhat similar to Chinese, acquisition of *akshara* knowledge can be expected to be drawn out. This is because *akshara* knowledge acquisition would require the mastery of a large orthographic register and the ligaturing rules that govern this register.

Phonological sensitivity

Cross-linguistic evidence indicates that phonological awareness plays a central role in learning to read in all languages. In the alphabetic languages, the letters represent phonemes and probably because of this, the phoneme has emerged as the critical unit involved in reading development (Goswami & Bryant, 1990; Rack, Hulme & Snowling, 1993; Seymour et al., 2003). In Chinese, the functional linguistic unit in processing print is the morpheme. Chinese morphemes tend to be represented by a syllable and perhaps it is this salience that has set the syllable, rather than the phoneme, as a crucial phonological unit in logographic literacy development (see Hanley, 2005 for review). In alphasyllabaries, where print is represented at the syllable level but includes explicit phoneme markers, the unique phonology-to-orthography mapping in the early stages of literacy development favours larger sub-lexical units (Nag-Arulmani, 2003; Prakash, Rekha, Nigam & Karanth, 1993; Rickard Liow & Lee, 2004).

Kannada *akshara* have a consistent one-to-one mapping with phonological syllables. The syllable-*akshara* mapping is irrespective of the pattern of the phonological syllable (e.g. CV-CV in ಮರ/mara/[tree], V-CV-CV in ಇರುವೆ/iruve/[ant], CV-CCV-CV in ಕನ್ನಡ /kannada/[Kannada]). The language has predominantly bisyllabic words, followed by a high frequency of tri- and polysyllabic words. Word final syllables are typically open ended, and loan words are adapted to fit this rule ('rail' + 'u', 'bus' + 'u'). It is because of the consistency in syllable-*akshara* mapping and the salience of the syllable in spoken Kannada that we can expect the syllable to be the salient phonological unit in the early years of literacy development. However, an interesting question associated with the phonemic constituents of the *akshara* also needs exploration: what is the pace of

© United Kingdom Literacy Association 2007

acquisition of sensitivity to phonemes in Kannada? Understanding the acquisition of phonemic sensitivity is particularly interesting given the contrasting position of phoneme-level representation in the alphabetic and alphasyllabic orthographies.

Type of schools and pace of acquisition

The pace set for acquisition is closely linked with the opportunities made available for learning to read. Several social factors are known to impact on the emergence of early literacy (see Phillips & Lonigan, 2005 for review). Socioeconomic status (SES; Duncan & Seymour, 2000; Raz & Bryant, 1990), home literacy (Burgess, Hecht & Lonigan, 2002; Purcell-Gates, 1996) and instruction styles have all emerged as important variables that differentially impact on the pace of reading development.

Of particular concern to this study was the level of functioning of schools. In countries where schools span a wide range of effectiveness levels, from poorly resourced and irregular schools to schools that are rich in teaching/learning materials and planned instruction, school functioning emerges as an important intervening variable. The issue is particularly crucial when erratic school functioning and insufficient reading instruction are more often associated with schools that offer the local language under study. In such contexts, any discussion of the pace of acquisition of processes associated with early reading can remain ambiguous if school functioning as a variable is not accounted for.

In this study we tested phonological processing and Kannada *akshara* knowledge. We hypothesised that in Kannada, when compared with the developmental pace reported in English early reading, (a) *akshara* knowledge acquisition would take longer to master and (b) phoneme awareness would be slower to emerge. We were particularly interested to see the ways in which the phonology and orthography of Kannada would set the pace of acquisition of orthographic knowledge and phonological sensitivity.

Method

Design

This study is part of a larger 4-year-programme tracking a cohort of children in primary schools. The first two rounds of assessments are reported here. At the first assessment, children were in Grades 1, 2 and 3 (age range of 5–10 years). At the second assessment, 15 months later, children were at the end of the next grade (hence Grade 1 children were in Grade 2, Grade 2 in Grade 3 and Grade 3 in Grade 4). A within-subjects design was followed, with each child completing all the tests.

Participants

Eight children each were randomly chosen from Grades 1, 2 and 3, in eighteen schools in five educational blocks in Chamarajanagar district, Karnataka, South India. Of these schools 12 were rural, 3 semi-rural, 2 semi-urban and 1 urban school. All schools were multi-grade with five schools also having mono-grade classes. These schools were participants in a 5-year language development programme (LDP) being implemented in the district. The LDP had been conceived and developed by two external agencies and

© United Kingdom Literacy Association 2007

supported by the state department of education. The LDP offered in-service professional development to primary school teachers on language and literacy education and a school visits programme to support teachers in the implementation of alternative language and literacy pedagogies.

Participants were mainly from very low to middle SES categories. In two schools (called *Ashramashalas*) the children were from tribal families, many of whom were close to subsistence living and were supported by the fully subsidised education provisions from the tribal welfare department. Five schools catered to mixed SES families, with the rest of the eleven schools catering primarily to the lower SES families. A typical profile of a lower SES family would be low family literacy with a low-skill occupation like agricultural labouring. A lower-middle SES family would have educational levels up to high school and occupations such as small traders and semi-skilled workers. An example of a middle SES family would be education levels between high school and college, often with inherited, mid-sized family wealth, following occupations such as teachers and government mid-level officers. Approximately 2% of the families in the study were of upper-middle SES with college education in the family, often with substantial inherited family wealth, following priestly professions and occupations such as medicine and administrative positions in the higher cadres of the government services.

Three hundred and seventy-four primary school children participated in the study. At the time of the first assessment (*t1*) the children were in Grades 1, 2 and 3. One hundred and eighty-eight were girls (71, 60 and 57 in Grades 1, 2 and 3, respectively) and 186, boys (58, 60, 68 in Grades 1, 2 and 3, respectively). The children were in the age range of 5–10 years (mean age in Grade 1 was 6.1 [*SD* 0.5]; in Grade 2, 7.2 [*SD* 0.9] and Grade 3, 8.1 [*SD* 0.8]). Fifteen months later, the same children, who had now moved to the next grade, were assessed again (*t2*). The age range of the children was now between 6 and 11 years (mean age in Grade 2 was 7.5 [*SD* 0.7], in Grade 3, 8.6 [*SD* 0.8] and Grade 4, 9.5 [*SD* 0.9]).

At *t1* approximately 80% of the children had reported Kannada as their home language. However, as most children in the region were either bilingual or trilingual, all children were given a Kannada language proficiency test (details below). The other languages were Lambani, Soliga, Tamil, Telugu, Hindi and Urdu. The tribal languages of Lambani and Soliga use the Kannada script to represent the spoken word. Tamil, Telugu and Hindi are alphasyllabaries, while Urdu uses the Perso-Arabic Script. Telugu shares more than 75% of *akshara* with Kannada, while Tamil is a relatively more opaque alphasyllabary with a distinctly different visuo-spatial organisation. The Hindi *akshara*, similar to the Kannada *akshara*, has a large register of symbols with several consistent rules for ligaturing of vowels and consonants. However, the visuo-spatial organisation and phonology-to-orthography mapping is quite different from Kannada. It is important to note that the children in the study had not received formal reading instruction in any of these other languages.

Procedure

At the first assessment the Literacy Acquisition Battery (LAB, 2004) was administered. All children were assessed on a word and non-word reading subtest and a Kannada language proficiency subtest that required them to give a single-word answer to a variety of questions and statements. Children were also assessed for their *akshara* knowledge for a set of CV *akshara* with inherent vowels (CwIV), CV *akshara* with ligature rules for

© United Kingdom Literacy Association 2007

vowels (CVwL) and consonant clusters (CCV, CCCV).[3] In addition, all children were assessed for phonological processing of three sub-lexical units: the rhyme, syllable and phoneme. Sensitivity to rhymes was assessed though a rhyme recognition task, sensitivity to syllables through a syllable blending and segmentation task and sensitivity to the phoneme through a phoneme substitution task. Apart from these tests, the battery consisted of other tests (visual discrimination, word span, reading comprehension) that are not reported in this paper. Testing was carried out in the children's schools, in a relatively quiet area over one session of approximately 30 minutes. All tests were presented in a counterbalanced order. For each test, the items were presented in a fixed order. School functioning was assessed using the School Indicators Checklist (2004) and schools were classified as 'low achieving' or 'effective'.

A team of 20 field researchers were trained at the first round of assessment. All field researchers were either graduates or postgraduates, who had earlier experience with surveys, class observations and one-to-one testing of primary school children. Some field researchers had earlier been primary school teachers. The field researcher orientation programme was conducted over 2 days and comprised an introduction to the test battery, demonstrations of each test by this author, supervised practice sessions with primary school children and a review of administration details based on case studies. During the data collection phase, all field researchers were supported either through face-to-face meetings or email and telephonic discussions.

At the second assessment, field researchers returned to the 18 schools to administer the same subtests. Where necessary, repeated visits were made to assess children who were absent from school, but had been brought back through the efforts of school teachers. Field researchers also visited the village communities to track children who were absent from schools.

Materials

The subtests from the Literacy Acquisition Battery (LAB, 2004) reported in this paper are word and non-word reading, language proficiency, *akshara* knowledge and phonological processing.

Reading. This subtest consists of a set of 10 low and high-frequency words and 15 non-words. All words are chosen from primary school textbooks. The list comprises three bisyllabic words (ರಸ/rasa/, ಮೂರು/mūru/), six trisyllabic words (ಬಸವ/basava/, ಪ್ರಾರಂಭ/prārambha/) and one four-syllable word. In the non-word list, some non-words are created by changing one phoneme or syllable in a common word. Others use CCV blends that are not common in the native repertoire, but may be used with loan words (ಲತ್ಕೊ/latko/). The list comprises nine bisyllabic non-words (ಉರ/ūra/, ರಲ್ಪ/ralpa/), five trisyllabic non-words (ಔಪದಿ/aupadi/, ಗುದುರೆ/gudure/) and one four-syllable non-word. The word and non-word lists were given separately. Testing for each list was discontinued after five continuous failures.

Language proficiency. This test has been adapted from the Kannada Language Comprehension Test (Nag-Arulmani, 2000). The test comprises 40 questions, in 5 sub-sections. The child is required to give one-word answers to short questions about biographical details and general information about daily life, 'true/false' answers for statements about commonly known information, 'yes/no' answers to descriptive

© United Kingdom Literacy Association 2007

statements about a set of illustrations and answers to a set of common children's riddles. Scoring was based on the number of correct responses to the statements and questions. Testing was discontinued after continuous failure in two sub-sections.

Akshara knowledge. This subtest is an adaptation of the Syllabograph Recognition Test (LAB, 2003). The *Akshara* knowledge subtest consists of 20 Kannada *akshara*, presented randomly using flashcards. There are eight CV *akshara* with inherent vowels (ಕ/ka/, ಜ/ja/), five CV *akshara* with rules for vowel diacritics (ಭಿ/bhi/, ಲು/lu/) and six consonant clusters (ವ್ಯ/vya/, ಸ್ಥ/stha/). One *akshara* is a vowel in the primary form (ಇ/i/). Testing was discontinued after five continuous failures.

Short phonological processing battery. This is a battery of five subtests that have been adapted from the Cross-linguistic Phonological Battery (Nag-Arulmani, 2000; Nag-Arulmani, Reddy & Buckley, 2003). Words were used for the rhyme recognition and phoneme manipulation tasks, while for the syllable manipulation tasks nonsense words were used. All nonsense words were developed by replacing one syllable in a word. The rhyme recognition subtest consists of 15 word pairs (ಎಲೆ, ಅಲೆ/ele, ale/; ಮೂಗು, ಮೂರ/ mūgu, mūru/). Syllable processing is assessed through blending and segmentation tasks. Each syllable subtest consists of 10 items of 2 to 5 syllable units (ಇಕಿ/i - ki/; ವಾಯುಮಾನ/ vā-yu-mā-na/. Phoneme processing is assessed through phoneme substitution at the initial and the terminal positions. The phoneme /s/ was given for the initial phoneme substitution task for a set of 10 items (ಚಿಪ್ಪು → ಸಿಪ್ಪು/cippu → sippu/) and the phoneme /e/ for the terminal phoneme substitution task for another set of 10 items (ಲೋಕ → ಲೋಕೆ/lōka → lōke/). A consolidated score of the five subtests was computed as the phonological awareness score. For all the subtests two to four practice trials were given. Testing was discontinued after five continuous failures. A panel of linguists and primary school teachers reviewed all the above tests for appropriateness of word lists and texts for children from the district where the study was conducted.

School indicators checklist. This observation checklist covers indicators of school routines, work culture and teaching/learning processes. Each indicator is assessed on a 3-point scale by a field researcher every quarter, based on fortnightly school visits. The average scores on the indicators yield a classification of 'low achieving' or 'effective' schools.

Results

Table 1 reports the average scores of children from Grades 1, 2 and 3 across two times of testing on a reading measure (word and non-word reading subtests), a language proficiency measure (Kannada language proficiency subtest) and two associated early reading measures (*akshara* knowledge and phonological awareness subtests).

A series of two-way fixed effects analysis of variance was performed for the 374 children who were present at both times of testing. Time of testing was the within-subjects factor (*t1*, *t2*) and grade (Grade 1, 2, 3) was taken as the between-subjects factor, with reading, phonological awareness and *akshara* knowledge as the dependent variables. The analysis revealed a significant main effect of time of testing for reading, $F(1, 371) = 350.56$, $p < .001$; for *akshara* knowledge, $F(1, 371) = 562.70$, $p < .001$ and

© United Kingdom Literacy Association 2007

Table 1. Grade-wise mean scores (and standard deviations) across *t1* and *t2* for reading, language proficiency, *akshara* knowledge and phonological awareness.

Area (maximum score)	Grade 1 ($N = 129$)		Grade 2 ($N = 120$)		Grade 3 ($N = 125$)	
	t1	*t2*	*t1*	*t2*	*t1*	*t2*
Reading (25)	5.31 (4.72)	11.83 (5.96)	11.54 (6.31)	15.79 (6.05)	13.76 (6.41)	16.34 (6.57)
Language proficiency (40)	24.56 (6.06)	29.84 (6.10)	29.41 (5.91)	33.03 (4.99)	32.18 (5.77)	35.08 (5.66)
Associated early reading measures						
Akshara knowledge (20)	6.88 (3.68)	11.69 (4.12)	11.04 (3.89)	14.87 (4.08)	13.43 (4.61)	15.76 (4.56)
Phonological awareness (55)	15.57 (9.45)	28.04 (10.99)	25.18 (11.97)	36.30 (10.65)	31.58 (12.30)	38.69 (11.61)

for phonological awareness, $F(1, 371) = 358.32$, $p < .001$. The analysis also revealed a main effect of grade for reading, $F(2, 371) = 47.73$, $p < .001$, for *akshara* knowledge, $F(2, 371) = 62.09$, $p < .001$ and for phonological awareness, $F(2, 371) = 59.96$, $p < .001$. There was also a significant interaction between time of testing and grade for all measures: for reading, $F(2, 371) = 23.99$, $p < .001$; for *akshara* knowledge, $F(2, 371) = 23.36$, $p < .001$ and for phonological awareness, $F(2, 371) = 8.95$, $p < .001$, which reflected that within each of the grades there were differences in the changes over time.

Akshara knowledge acquisition

Results presented in Table 1 show that acquisition of *akshara* mastery continues well into elementary school. *Akshara* mastery level of the Grade 3 children at the time of the second assessment (when they were at Grade 4) was at around 80%. To understand the nature of the drawn-out process of *akshara* acquisition, we further looked at whether there were any specific *akshara* types that took longer to master. The *akshara* types that were analysed are consonants with an inherent vowel (CwIV), CVs with ligaturing rules for vowels (CVwL) and consonant clusters (CCV, CCCV). Table 2 gives the accuracy rates for identification of the *akshara* types across the three grades at *t1* and *t2*. The consonants with inherent vowels are mastered by the end of Grade 1. Partial mastery of the CVs with ligatures is seen around Grade 2. The consonant clusters show a similar trend of partial mastery beginning in Grade 2, with the rate of mastery a step behind CVwL. Unlike the CwIV, both CVwL and the CCV, CCCV *aksharas* require learning not only of the *akshara* name-sound, but also the orthographic rules of ligaturing. The phase of partial mastery of these *akshara* categories (CVwL, CCV, CCCV) continues well into Grade 4, with a substantial number of children showing less than 50% accuracy in *akshara* recognition (31% for CVwL and 56% for CCV, CCCV). These trends of time taken for Kannada *akshara* mastery are quite different from letter mastery seen in alphabetic languages. In the European languages, for example, the time taken is until the end of the first year of primary school, even when differences in age of school enrolment and age of introduction of literacy instruction have been accounted for (Seymour, 2005).

The associations between *akshara* knowledge and reading scores were explored next through correlational analyses. Table 3 gives the correlations between types of *akshara*

© United Kingdom Literacy Association 2007

Table 2. Grade-wise mean scores (and standard deviations) across *t1* and *t2* for types of *akshara* knowledge and phonological awareness.

Area (maximum score)	Grade 1		Grade 2		Grade 3	
	t1	*t2*	*t1*	*t2*	*t1*	*t2*
Akshara knowledge*						
CwIV	71.8 (35.26)	92.8 (19.81)	92.7 (7.27)	98.2 (9.07)	94.2 (17.99)	95.9 (15.29)
CVwL	4.9 (16.19)	42.9 (35.41)	33.6 (36.53)	65.5 (36.01)	53.6 (39.74)	72.5 (34.93)
CCV, CCCV	1.5 (11.35)	16.4 (25.55)	12.8 (23.59)	42.5 (38.24)	34.1 (34.74)	55.2 (38.97)
Phonological awareness						
Rhyme						
Rhyme recognition (15)	6.32 (3.89)	9.21 (4.11)	8.65 (4.08)	11.25 (3.67)	10.05 (3.66)	11.93 (3.53)
Syllable						
Blending (10)	4.12 (3.05)	6.29 (2.45)	6.23 (2.66)	7.26 (1.93)	6.85 (2.49)	7.26 (2.29)
Segmentation (10)	3.78 (3.32)	7.91 (2.32)	5.77 (3.37)	8.55 (1.66)	7.04 (2.55)	8.62 (2.02)
Consolidated syllable score (20)	7.89 (5.68)	14.19 (4.26)	12.00 (5.55)	15.81 (3.06)	13.89 (4.49)	15.89 (3.65)
Phoneme						
Initial substitution (10)	0.78 (1.58)	2.39 (2.84)	2.12 (2.68)	4.34 (3.27)	3.82 (3.38)	5.08 (3.33)
Terminal substitution (10)	0.58 (1.64)	2.25 (3.52)	2.42 (3.33)	4.90 (4.07)	3.80 (4.01)	5.80 (4.25)
Consolidated phoneme score (20)	1.36 (2.92)	4.64 (5.67)	4.53 (5.49)	9.24 (6.49)	7.63 (6.77)	10.88 (6.81)

Note: *% of correct responses.

Table 3. Concurrent correlations of Grade 1 at *t1* between reading scores, types of *akshara* knowledge and types of phonological awareness, with language proficiency partialled out.

	Reading	CwIV	CVwL	CCV, CCCV	Rhyme	Syllable	Phoneme
Reading	–	.651***	.464***	.225***	.200 (NS)	.429***	.396***
CwIV		–	.164 (NS)	.066 (NS)	.223 (.01)	.329	.250 (.004)
CVwL			–	.601***	.036 (NS)	.172 (NS)	.279 (.001)
CCV, CCCV				–	– .081 (NS)	.029 (NS)	.194 (NS)
Rhyme					–	.257 (.003)	.144 (NS)
Syllable						–	.374***
Phoneme						.	–

Note: *** $p = .000$.

knowledge and reading scores for Grade 1 and Grade 4 children. At the early stages of reading in Grade 1, the strongest associations are with the simplest *akshara* types: *akshara* with consonants that have inherent vowels (CwIV). The *akshara* with ligaturing rules (CVwL and CCV, CCCV) show weaker (0.2–0.4) but significant associations with beginning reading scores. The association of the complex *akshara* types with reading scores increases in the more advanced reading band in this analysis. With Grade 4 children, the associations were in the range of 0.7 (CVwL) – 0.8 (CCV, CCCV). Clearly, as would be expected, more words and non-words were decoded with increasing *akshara* knowledge about the more complex *akshara*.

© United Kingdom Literacy Association 2007

Phonological sensitivity

Table 1 and the preliminary analysis reported earlier (two-way ANOVA) indicate that there are significant changes in time in phonological awareness in all three grades under study. A further analysis was performed of each of the phonological units assessed (rhyme, syllable and phoneme). Table 2 gives the means and standard deviations of grades 1, 2 and 3 across the two rounds of assessment.

Phoneme awareness was an area of particular interest, given the reported spurt of phonemic sensitivity seen with increasing letter knowledge in alphabetic languages. Phoneme awareness in this sample is best understood in a comparison of the accuracy rates on the phoneme tasks with that on the rhyme and syllable tasks. As is evident from Table 2, phoneme accuracy rates are much lower when compared with rhyme and syllable accuracy rates.

To further understand phonological processing development, a comparison was made of the youngest group (Grade 1 at *t1*, average age 6.1 [*SD* 0.5]) and the oldest group (Grade 3 at *t2*, average age 9.5 [*SD* 0.90]) in the study (see Table 2). In studies with English-speaking samples, changes in scores with age have been reported in phoneme deletion tasks (a task somewhat close in task demand to the phoneme substitution task used in this study). Accuracy rates for children around age 5.6 are reported to be in the range of 30–50% (e.g. Hulme et al., 2002), and close to ceiling by age 9.5. In this sample, the youngest group performed almost at floor for both initial and terminal phoneme substitutions (8% and 5% accuracy, respectively). In comparison, the oldest group showed an average accuracy rate of 51% for initial substitution and 58% for terminal substitution. The older group was significantly better at terminal substitution than initial substitution ($t[124] = -2.34$, $p < .05$), a pattern reported with younger children in English reading samples (Hulme et al., 2002). These trends across two age bands indicate that phonemic sensitivity is slow to emerge in this Kannada sample when compared with English-speaking samples but shares the common pattern of development of phoneme awareness emerging earlier for terminal sounds than initial sounds.

The associations between the three phonological units and concurrent reading scores was also expected to yield information about phonological changes with increasing accuracy in word reading. We once again looked at the associations in Grade 1 at *t1* and Grade 3 at *t2* (now in Grade 4). The two groups may be seen to represent two discrete bands of reading attainment. Age was not significantly correlated with any of the measures. Language proficiency correlated significantly with all the measures (in Grade 1 between 0.2 and 0.5, Grade 3 all at 0.4) and was partialled out for the next step of analysis presented in Table 3. In both grades there are significant correlations between the phonological units and the reading scores. In Grade 1, where reading skills are still rudimentary, syllable awareness ($r = .429$) appears to have a stronger association with the reading scores than phoneme awareness ($r = .396$). The associations between rhyme awareness and reading scores at this early level of reading development are not significant. In Grade 3, where reading skills are more advanced, it is the phoneme measure ($r = .650$) that emerges with a slightly stronger association to reading scores than the syllable ($r = .561$). Rhyme emerges as significantly associated with reading scores at this stage of reading ($r = .538$).

In summary, the trends suggest that in this sample of Kannada children, phoneme awareness is slow to emerge, and gains in strength of association at the higher levels of

© United Kingdom Literacy Association 2007

Kannada reading (Grades 3–4). Syllable awareness however shows a consistently strong association with reading scores across both Grades 1–2 and Grades 3–4 level of reading.

Akshara knowledge and phonological sensitivity: interconnections

Understanding the ways in which the two developmental processes of *akshara* knowledge and phonological sensitivity interact with each other was the next step in our analysis. A correlational analysis between types of *akshara* knowledge and types of phonological sensitivity was carried out (see Tables 3 and 4). At the earliest phase of reading development (Grade 1 children) the association was clearly circumscribed to the CwIV *akshara* and the syllable. As other types of *akshara* knowledge were close to floor, associations with types of phonological sensitivity, not surprisingly, were not significant. By Grade 4, the associations across all types of phonological sensitivity with all types of *akshara* knowledge had emerged as significant. The consonant clusters (CCV, CCCV) are arguably the most explicit representation of the phonemic constituents in the *akshara* and by Grade 4 mastery of consonant clusters is well under way. It is of particular interest that across all the types of variables under study, the strongest association at Grade 4 was seen between phoneme sensitivity and *akshara* knowledge for consonant clusters ($r = .6$, $p = 0.000$).

We next conducted a series of multiple regression analyses to further understand the parallel development of *akshara* and phonological mastery in 6- to 11-year-olds. For these analyses the CVwL and CCV, CCCV scores were consolidated to derive a complex *akshara* score. In the first analysis, Grade and *t1* complex *akshara* score were entered, followed by language proficiency, *t1* syllable score and *t1* phoneme score, to analyse what explains the variance in *t2* complex *akshara* scores. *t1* complex *akshara* scores explained 49.6% of the variance in *t2* complex *akshara* scores. An additional 4.6% of variance in *t2* complex *akshara* scores was explained by *t1* syllable awareness scores. In a contrasting second analysis, Grade and *t1* phoneme awareness score were entered followed by language proficiency, *t1* consonant with inherent vowel (CwIV) score and *t1* complex *akshara* score, to analyse what explains the variance in *t2* phoneme awareness scores. *t1* complex *akshara* scores explained 35.3% of the variance in *t2* phoneme awareness scores. An additional 5.5% of variance was explained by *t1* phoneme awareness scores, another 3.7% by *t1* CwIV scores and another 8% by *t1* syllable awareness scores. The trends from these analyses suggest a reciprocal relationship between the growth of *akshara* knowledge about complex *akshara* and phoneme awareness.

Table 4. Concurrent correlations of Grade 3 at *t2* (Grade 4) between reading scores, types of *akshara* knowledge and types of phonological awareness, with language proficiency partialled out.

	Reading	CwIV	CVwL	CCV, CCCV	Rhyme	Syllable	Phoneme
Reading	–	.473***	.771***	.797***	.538***	.561***	.650***
CwIV		–	.423***	.201 (NS)	.458*	.514 ***	.246**
CVwL			–	.671***	.538***	.457***	.508***
CCV, CCCV				–	.472***	.368***	.600***
Rhyme					–	.285***	.488***
Syllable						–	.453***
Phoneme							–

Note: *$p = .004$; **$p = .006$; ***$p = .000$.

© United Kingdom Literacy Association 2007

Low achieving and effective schools

In this study schools were selected to represent administrative units (called educational blocks) and were at various levels of effective functioning. It may be argued that the drawn-out pace of development of *akshara* knowledge and phoneme awareness reported above are a reflection of inadequate teaching programmes in the poorly functioning schools participating in the study. The extended pace of learning could be an artefact of poor reading instruction and opportunity for practice of reading skills. To address this concern, a comparison was made of children studying in 'low achieving' schools and 'effective' schools. School classification was based on the School Indicators Checklist. The accuracy rates of the Grade 3 children at *t2* (Grade 4 children, now), is of particular interest, as their performance could give an indication of the extent of time to which *akshara* knowledge and phoneme awareness development is prolonged.

Accuracy rates on the a*kshara* knowledge test at *t2* for Grade 3 children indicated that the trends reported above persisted irrespective of type of school. In the group of low-achieving schools, the average *akshara* score is 15 (*SD* 4.57), while in the group of effective schools the average score is 17.40 (*SD* 3.13). Put differently, in the middle of Grade 4, the average mastery rate is 75% in low-achieving schools and 87% in effective schools.

A similar analysis with phoneme awareness scores also mirrored the trends reported earlier, irrespective of the school type. The average score in the low-achieving schools was 11.74 (*SD* 7.02) and in the effective schools was 13.60 (*SD* 5.21). The accuracy range of 58.7–68.7% is closer to the performance of younger children on an equivalent phoneme manipulation task in studies of early reading development in English (e.g. Hulme et al., 2002). Thus, while quality of school functioning clearly has an impact on orthographic knowledge and phonological sensitivity, the pace of development even in well-functioning schools is drawn out.

Discussion

We set out to review two key processes that underpin learning to read. Of particular interest was the pace of acquisition of orthographic knowledge and phonological sensitivity in the early stages of learning to read.

Akshara knowledge

The features of the *akshara* define the nature of orthographic knowledge in Kannada. One feature of *akshara* knowledge is the *akshara* sound-name. A second feature is the set of rules for ligaturing vowels and consonants to initial consonants. In theory, both these components are a necessary part of knowledge about all *aksharas*. However, *akshara* knowledge of consonants with inherent vowel (CwIV) precedes the mastery of the *akshara* with rules for ligaturing (the CVwL, CCV, CCCV *akshara*). While CwIV mastery is completed by the end of Grade 1/middle of Grade 2, the mastery of CVwL and CCV, CCCV *akshara* continues well into Grade 4. One explanation for the differential pace of mastery is that *akshara* knowledge needed for CwIV *akshara* is primarily the name-sound, with knowledge about ligaturing rules not needed. It is only when the other CV *akshara* and the CCV, CCCV *akshara* are being mastered that the additional component of learning about ligaturing rules begins to be required. Learning the rules has

© United Kingdom Literacy Association 2007

an important cognitive function. It helps to economise on memory demands, by giving a common set of principles to master the more than 400 symbols in the Kannada alphasyllabary. From this study, it is evident that the phase of complex *akshara* knowledge of name-sound plus ligaturing rules follows the phase of simple *akshara* knowledge of only name-sound.

Extensive and contained orthographies

Orthographic depth is an influential construct that has been used to explain the differences in cognitive demands when reading in different languages (Frost, 2005). Orthographies are seen on a continuum of varying degree of consistency between sound/letter and this in turn affects the pace of learning to read. Cross-linguistic data from the European orthographies, for example, confirms that the more inconsistent the sound/letter mappings, the longer the time needed to master reading (Seymour et al., 2003). One account for explaining the difference in the pace of development in the two orthographic clusters is a 'step up' of cognitive resources needed for the deep orthographies (Seymour, 2005).

Kannada is a shallow orthography but the pace of learning is not as would be predicted from a classification of orthographies along a transparent–opaque continuum. The pace of learning of Kannada orthographic knowledge is drawn out over at least 4 years. An additional dimension of orthographic complexity therefore becomes necessary to explain why the pace of learning is longer in orthographies such as Kannada. The size of orthography is a new dimension that can help account for the number of symbols available to represent sounds in different orthographies. We will refer to a large symbol inventory as an *extensive* orthography and a smaller symbol inventory as a *contained* orthography. Thus Chinese with more than 2,500 characters is an extensive orthography, while English with 26 letters is a contained orthography. The alphasyllabaries, including Kannada, are extensive orthographies.

The cognitive demands in learning to read extensive orthographies may be expected to be quite at variance from what has been documented to date in the more orthographically contained Roman scripts. Further, it may be theoretically expected that there will be differences between different extensive orthographies. The cognitive processing of orthographically extensive logographic systems, for example, can be expected to be quite different from the orthographically extensive *akshara* systems. We know for example that morphological knowledge is crucial in the early stages of character reading (McBride-Chang et al., 2003). This study shows the role of orthographic rule learning as important in the early stages of Kannada *akshara* reading.

Kannada orthography – phonology mapping

The time taken for orthographic rule learning in Kannada presents us with an extended period of influence of the orthographic domain on the phonological domain. Tracking changes in the phonological domain it becomes possible to tease out the ways in which the unstable sound unit – the phoneme – gains in salience.

Among the youngest group of Kannada readers, there is a greater sensitivity to the syllable when compared with the phoneme. One possible reason for the advanced syllable awareness in this group is the salience of this unit in the orthographic representations in Kannada. Phoneme awareness is slower to emerge. Kannada children in Grades 3–4 seem

© United Kingdom Literacy Association 2007

to reach a level of phoneme sensitivity that is equivalent to what is reported in younger English-speaking children (in Reception year and Grade 1).

The data from the present study further suggest a reciprocal relationship between *akshara* knowledge acquisition and the developmental patterns of phonological sensitivity seen in Kannada children. In the phase of acquiring the consonants with inherent vowel, the learner does not have a clear visuo-spatial distinction for the consonant–vowel components. This cluster of *akshara*, in effect, is perhaps simply processed as a representation of a syllable sound. It is only when *akshara* knowledge about CV and consonant clusters with ligaturing rules is acquired that the symbols become more clearly definable for their constituent parts. It is plausible that, for some children, it is at this phase of *akshara* knowledge acquisition that the psychological reality of the phoneme becomes represented in print for the first time. As *akshara* knowledge about orthographic rules increases, sensitivity to sub-syllabic structures also increases. More specifically, the complex *akshara* with their rules of ligaturing draw attention to phonemes in print and mediate in the development of greater phonemic awareness. Further, it is plausible that the increased phonemic awareness supports greater sensitivity to the sub-syllabic units within the *akshara. Akshara* knowledge shows a greater appreciation of the phoneme markers embedded within the *akshara*.

Practical implications

A persistent challenge in the evaluation of reading outcomes, particularly in resource-poor schools, is to understand the reason for delays in attainments (Nag, 2005). To disentangle the reasons for a slow pace of mastery it becomes necessary to tease out the role of poor reading instruction from the role of the nature of the script. Normative trends gleaned from this study suggest that the rate of acquisition of mastery remains drawn out over more than 4 years. Within this broader trend, the pace of attainments in low-functioning schools is approximately 1 year behind effectively functioning schools. A study about types of Kannada reading instruction is needed to further tease out the links between the rate of introducing the *akshara* between Grades 1 and 4 and the rate of acquisition of *akshara* knowledge and phonemic awareness.

The approach to reading instruction is another area of interest. The most common teaching practice for *akshara* learning is *akshara* recitation and simultaneous copy-writing. Such singsong recitation coupled with writing practice has been an indigenous teaching method for beginning readers for several centuries (see Dharampal, 1983 for 18th and 19th-century accounts). Further research is needed to understand what is the role of *akshara* recitation and simultaneous writing in promoting children's understanding of ligaturing rules and in turn, how such a strategy supports phonological sensitivity. Another associated question is about when *akshara* recitation and writing should be introduced. In a traditionally followed sequence, *akshara* learning is first completed before moving into reading (Dharampal, 1983) and some current psycholinguistic accounts of the *akshara* support this artificial compartmentalisation (Padakannaya & Mohanty, 2004). We propose that *akshara* practice needs to occur in parallel with reading practice, instead of being a precedent (Nag-Arulmani, 2003). Providing extensive opportunities for reading graded texts that have increasingly greater representation of words with complex *aksharas* (CVwL, CCV, CCCV) is a preferred method of Kannada instruction. Encountering complex *akshara* in varied contexts offers the opportunity for applying rule learning to recognise the *akshara*. The multiple contexts of *akshara*

© United Kingdom Literacy Association 2007

decoding would in turn have implications for speed of phonological recoding when reading novel words.

A logical next step in understanding developmental issues is to identify sensitive indices for predicting delays in reading development in Kannada. Some clues of aspects of orthographic knowledge and phonological sensitivity that may emerge as sensitive indices have been presented in this study.

Acknowledgements

This work was supported by grants from The Promise Foundation and Sir Ratan Tata Trust to the LDP, District Quality Education Programme (DQEP) which is a partnership between the National Institute for Advanced Studies and The Promise Foundation and is supported by Sarva Shiksha Abhiyan, Government of Karnataka. The author is grateful to the LDP team, field staff and the teachers and students of the participating schools for their cooperation.

Notes

1. The ISO 15919 transliteration scheme (2001) has been used throughout.
2. There are a few exceptions where the *akshara* name is different from the *akshara* sound. These include the *anuswara* and the *visarga*.
3. In Kannada the *akshara* with inherent vowels (CwIV) are called *sarala akshara*, the *akshara* with ligature rules for vowels (CVwL) are called *gunita akshara* and consonant clusters (CCV, CCCV) *ottakshara.*

References

Adams, M.J. (1990). *Beginning to read: Thinking and learning about print*. Cambridge, MA: MIT Press.

Bowey, J.A. (2005). Predicting individual differences in learning to read. In M.J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook*. (pp. 155–172). Oxford: Blackwell.

Bright, W. (1996). Kannada and Telugu writing. In P. Daniels & W. Bright (Eds.), *The world's writing systems*. (pp. 413–419). New York: Oxford University Press.

Burgess, S.R., Hecht, S.A. & Lonigan, C.J. (2002). Relations of home literacy environment to the development of reading-related abilities: A one-year longitudinal study. *Reading Research Quarterly*, 37, 408–426.

Dharampal (1983). *The beautiful tree: Indigenous Indian education in the eighteenth century* (Vol. III). Goa: Other India Press.

Duncan, L.G. & Seymour, P.H.K. (2000). Socio-economic differences in foundation-level literacy. *British Journal of Psychology*, 91, 145–166.

Frost, R. (2005). Orthographic systems and skilled word recognition processes in reading. In M.J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook*. (pp. 269–271). Oxford: Blackwell Publishing.

Goswami, U. & Bryant, P.E. (1990). *Phonological skills and learning to read*. Hove: Psychology Press.

Goulandris, N.K. (Ed.) (2003). *Dyslexia in different languages: Cross-linguistic comparisons*. London: Whurr.

Hanley, R.J. (2005). Learning to read in Chinese. In M.J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook*. (pp. 316–335). Oxford: Blackwell Publishing.

Hulme, C., Hatcher, P.J., Nation, K., Brown, A., Adams, J. & Stuart, G. (2002). Phoneme awareness is a better predictor of early reading skill than onset-rime awareness. *Journal of Experimental Child Psychology*, 82, 2–28.

ISO 15919. (2001). Information and documentation – transliteration of Devanagari and related Indic scripts into Latin characters. International Standards Organisation, 2001.

© United Kingdom Literacy Association 2007

Language Acquisition Battery (LAB) (2003). The Promise Foundation. Unpublished. Bangalore, India.
Language Acquisition Battery (LAB) (2004). The Promise Foundation–National Institute for Advanced Studies. Unpublished. Bangalore, India.
McBride-Chang, C., Shu, H., Zhou, A.B., Wat, C.P. & Wagner, R.K. (2003). Morphological knowledge uniquely predicts young children's Chinese character recognition. *Journal of Educational Psychology*, 95, 743–751.
Nag-Arulmani, S. (2000). Reading difficulties in a non-dominant language. Unpublished PhD Thesis. University of Portsmouth.
Nag-Arulmani, S. (2003). Reading difficulties in Indian languages. In N. Goulandris (Ed.), *Dyslexia in different languages: Cross-linguistic comparisons*. (pp. 235–254). London: Whurr.
Nag, S. (2005). Literacy for all: Chipping away at the ceilings. *NORRAG News*, 38.
Nag-Arulmani, S., Reddy, V. & Buckley, S. (2003). Targeting phonological representations can help in the early stages of reading in a non-dominant language. *Journal of Research in Reading*, 26(1), 49–68.
Padakannaya, P. & Mohanty, A.K. (2004). Indian orthography and teaching how to read: A psycholinguistic framework. *Psychological Studies*, 49(4), 262–271.
Phillips, B.M. & Lonigan, C.J. (2005). Social correlates of emergent literacy. In M.J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook*. (pp. 173–187). Oxford: Blackwell Publishing.
Prakash, P., Rekha, D., Nigam, R. & Karanth, P. (1993). Phonological awareness, orthography and literacy. In R.J. Scholes (Ed.), *Literacy and language analysis*. (pp. 55–70). Hillsdale, NJ: Lawrence Erlbaum Associates.
Purcell-Gates, V. (1996). Stories, coupons and the TV guide: Relationships between home literacy experiences and emergent literacy knowledge. *Reading Research Quarterly*, 31, 406–428.
Rack, J.P., Hulme, C. & Snowling, M.J. (1993). Learning to read: A theoretical synthesis. In H. Reese (Ed.), *Advances in child development and behaviour*. (pp. 100–132). San Diego, CA: Academic.
Raz, I.J. & Bryant, P. (1990). Social background, phonological awareness and children's reading. *British Journal of Developmental Psychology*, 8, 209–225.
Rickard Liow, S.J. & Lee, L.C. (2004). Meta-linguistic awareness and semi-syllabic scripts: Children's spelling errors in Malay. *Reading and Writing*, 17(1–2), 7–26.
School Indicators Checklist (2004). District Quality Education Programme, National Institute of Advanced Studies. Unpublished. Bangalore, India.
Seymour, P.H.K. (2005). Early reading development in European orthographies. In M.J. Snowling & C. Hulme (Eds.), *The science of reading: A handbook*. (pp. 296–315). Oxford: Blackwell Publishing.
Seymour, P.H.K., Aro, M. & Erskine, J.M. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology*, 94, 143–174.
Shu, H., Chen, X., Anderson, R.C., Wu, N. & Xuan, Y. (2003). Properties of school Chinese: Implications for learning to read. *Child Development*, 74(1), 27–47.
Snowling, M.J. & Hulme, C. (Eds.) (2005). *The science of reading: A handbook*. Oxford: Blackwell Publishing.
Ziegler, J. & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin*, 131(1), 3–29.

Received 22 May 2006; revised version received 7 September 2006.

Address for correspondence: Sonali Nag, The Promise Foundation, 346/2 1st A Main, Koramangala 8th Block, Bangalore 560 095, India. E-mail: *sonalinag@t-p-f.org*

© United Kingdom Literacy Association 2007