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Orthographic constraints on phonological awareness in biliteracy development

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This study examined how orthography-specific demands affect decoding development in 10–14-year-old multilingual students learning to read Kannada and English in India. Given that there is dual-level representation of the size of phonological information (syllable and phoneme) in alphasyllabic Kannada and single-level (phoneme) representation in alphabetic English, our study posed three questions: (1) Are there distinct phonological awareness (PA) levels corresponding to decoding development in Kannada as a first language of literacy vs. English as a second language of literacy?; (2) What is the relationship between phonological awareness in Kannada and that in English?; and (3) How does phonological awareness in Kannada contribute to decoding development in English? The results provided evidence for differences in the level at which phonological information is graphically encoded in each language. The findings further suggested that there are orthography-specific constraints on transfer of phonological awareness from alphasyllabic Kannada to alphabetic English.

Keywords: Biliteracy; Alphasyllabary; Kannada; Transfer; Phonological awareness.

This study examined how orthography-specific demands affect decoding development in children learning to read two languages—Kannada and English—written in alphasyllabic and alphabetic writing systems, respectively. Reading can be characterised as a process of translating print into spoken language. Its development requires making links between a spoken language and its script by uncovering how language elements are mapped onto graphic symbols. Reading acquisition thus relies heavily on decoding competence, the ability to extract lexical information from print. Such an ability develops as a result of continually accommodating the orthography-specific demands imposed by the writing system involved (Perfetti, 2003; Ziegler & Goswami, 2005, 2006). As such, one would expect that decoding development proceeds differently in languages with diverse rules for encoding their spoken language, and that distinct sets of sub-skills may be required for achieving the required mappings in each language.

In the case of biliterate readers, it is known that reading sub-skills transfer across languages (Geva, 2008; Koda, 2007, 2008). Thus, decoding sub-skills developed in one

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language differentially facilitate learning to read in another, with more facilitation expected when two scripts are structurally related, sharing similar orthographic properties. In light of this, it is of critical importance to identify possible sources of variances in learning to read both within and across learners, in various cases of biliteracy acquisition. In this study, we focused on how decoding development in biliteracy learners is orthographically constrained by the demands imposed by each writing system involved in Kannada and English. Consequently, the primary objectives were threefold: (1) to examine variations in the requisite sub-skills for decoding development in these two languages; (2) to determine cross-linguistic relationships in those sub-skills; and (3) to explore to what extent and how sub-skills developed in Kannada contribute to reading acquisition in English.

General mapping principle and orthography-specific mapping details

Reading has a set of universal properties. Understanding these properties is vital because they specify the prerequisites for literacy acquisition and the limits on possible variations in learning to read. According to the universal grammar of reading (Perfetti, 2003; Perfetti & Dunlap, 2008; Perfetti & Liu, 2005) reading is a dynamic pursuit embedded in two interrelated systems—a language and the writing system that encodes the language. As such, its acquisition requires making links between the two systems. In learning to read, therefore, children in all languages must first uncover which linguistic element is encoded in each graphic symbol (*the general mapping principle*), and then, figure out how spoken language elements are mapped onto units of graphic symbols (*the orthography-specific mapping details*).

For example, children learning to read English must first recognise that each letter represents a distinct sound—either a consonant or a vowel—and then gradually work out the details of the sound-symbol correspondences. Although the same realisation is required of children learning to read Korean, these readers must learn that consonants and vowels must be packaged into syllable blocks. In contrast, children learning to read Chinese must realise that each symbol (character) corresponds holistically to the meaning and the sound of an entire morpheme, and subsequently learn how single-unit characters are combined to form compound characters. Evidently, the linking requirement is universally mandated, but how it is accomplished varies across languages. In other words, learning to read entails systematically deducing how spoken language elements are graphically encoded in each particular language.

Predictably, such deductions are facilitated by metalinguistic awareness, the ability to analyse and manipulate language forms (Kuo & Anderson, 2008). The section that follows describes the specific contribution of one component of metalinguistic awareness, phonological awareness (PA), to reading acquisition.

ROLE OF PHONOLOGICAL AWARENESS IN LEARNING TO READ

The significance of phonological awareness for learning to decode lies in its capacity to enable children to analyse words into their sublexical phonological components (Fowler & Liberman, 1995; Goswami & Bryant, 1992; Kuo & Anderson, 2008; Nagy & Anderson, 1999). According to the Psycholinguistic Grain Size theory, children initially develop sensitivity to larger phonological units in speech and gradually fine-tune the sensitivity to distinguish smaller units (Ziegler & Goswami, 2005, 2006). Because spoken sounds are mapped onto graphemes differentially in diverse writing systems, the grain size optimal for achieving the required mappings varies from one

system to another. The desirable grain size is determined essentially by the amount of orthographic information required for decoding. In shallow orthographies, wherein sound-symbol correspondences are regular and consistent, decoding requires little orthographic information. The grain sizes used in shallow orthographies are small, usually at the phonemic level. In contrast, in deep, or opaque, orthographies, decoding demands far more orthographic information, involving larger grain sizes, such as rimes and syllables.

Systematic variations in PA across writing systems have been reported in studies involving children learning to read in diverse languages. Given that graphemes in alphabetic scripts encode phonemic-level information, it is evident that phonemic-level sensitivity is strongly related to (Byrne, 1998; Caravolas, Volín, & Hulme, 2005; Stahl & Murray, 1994; Torgesen, 2002; Wagner & Torgesen, 1987) and also causally affects (Wagner, Torgesen, & Rashotte, 1994) alphabetic decoding.

Alphasyllabic scripts, on the other hand, encode phonological information at both syllabic and sub-syllabic levels. The script is usually organised by space-separated syllable clusters, which consist of independent, identifiable graphemes that represent phonemes (Bright, 2000). This dual-level representation of phonological information requires sensitivity to both syllable-level and phoneme-level information for word reading across several alphasyllabaries, including Hindi (Vaid & Gupta, 2002), Kannada (Nag, 2007), Korean (Cho & McBride-Chang, 2005; Simpson & Kang, 2004), Telugu (Vasanta, 2004), and Thai (Winskel & Iemwanthong, 2009). Although both units are encoded, syllable information is visually more salient, rendering syllable-level awareness more important in alphasyllabic reading (Kim & Petscher, 2011). In the same vein, however, because syllable units are made up of decomposable phonemic units, phonemic awareness does emerge in alphasyllabary readers (Nag, 2007). Given its less salient position, however, phonemic awareness does not emerge until grade 3 or 4 (Cho & McBride-Chang, 2005; Nag, 2007), compared with around grade 1 or 2 in alphabetic readers (Liberman, Shankweiler, Fischer, & Carter, 1974). Thus, both shared and orthography-specific characteristics are included in the mapping details of alphabetic and alphasyllabic scripts, which leads to shared, as well as distinct, phonological awareness and decoding demands.

It is also evident that development of the various facets of PA is influenced by the phonological features of spoken language (Caravolas & Bruck, 1993; Cheung, Chen, Lai, Wong, & Hills, 2001; Cossu, Shankweiler, Liberman, Katz, & Tola, 1988). Beyond the initial sensitivity of phonological units that emerges as a consequence of spoken language development, phonological awareness becomes progressively more refined through cumulative experience of encoding and decoding phonological information in print and increased exposure to a particular orthography (Bowey & Francis, 1991; Perfetti, Beck, Bell, & Hughes, 1987; Vellutino & Scanlon, 1987). Studies have also compared literate and non-literate populations to indicate that advanced levels of phonemic awareness do not emerge without exposure to an alphabetic script (Bertelson, de Gelder, Tfouni, & Morais, 1989; Bertelson, de Gelder, & van Zon, 1997). Therefore, as exposure to print accumulates, the PA facets pertinent to that particular script are continually honed.

Taken together, the research indicates that both orthographic properties and spoken-language features jointly shape the initial formation of PA, and that in learning to read, PA and print experience (decoding practice, in particular) are reciprocally related, mutually enhancing their development. The corollary of this reciprocity is that the PA facets, directly related to learning to read, reflect the specific way in which phonological information is graphically encoded in a particular writing

system and thus vary systematically across languages. In order to master an alphabetic writing system, children must not only *recognise* that words can be divided into sequences of smaller sound units (e.g., syllable, onset, rime and phoneme), but also acquire *the ability to analyse* words into their sub-lexical and sub-syllabic phonological constituents.

PREVIOUS STUDIES OF PHONOLOGICAL AWARENESS IN BILITERACY DEVELOPMENT

In view of the strong contribution of PA in early reading development, a critical question for biliteracy development is how PA and decoding are related both within and across languages. Given that an understanding of the larger grain size of spoken words emerges prior to exposure to print (Bertelson et al., 1989), it can be argued that syllable awareness in bilingual children is initially language-neutral. Within the theoretical framework of the Transfer Facilitation Model (Koda, 2007, 2008), non-language specific aspects of phonological awareness, once developed in one language should be readily available in learning to read in another. As such, one would expect PA to be closely related between the two languages of bilingual readers. Moreover, the relationship between PA and decoding can be expected to vary in strength depending on the degree of similarity between the phonological encoding mechanisms in the languages involved.

A number of studies have investigated the hypothesised cross-linguistic relationships in PA and decoding in school-age biliteracy learners of two alphabetic languages. In a study with Spanish-dominant bilingual first grade students, Durgunoglu, Nagy, and Hancin (1993) determined that first language PA is a powerful predictor of subsequent decoding skills in both languages. Subsequent studies, which have examined biliteracy acquisition in learners of varying sets of alphabetic scripts, have found that first- and second-language PA are consistently closely related to each other, and that poor readers are uniformly weak in phonological skills in both languages (Abu-Rabia, 1995; August, Calderon, & Carlo, 2001; Comeau, Cormier, Grandmaison, & Lacroix, 1999; da Fontoura & Siegel, 1995; Gholamain & Geva, 1999; Verhoeven, 2000; Wade-Woolley & Geva, 2000). What remains to be determined is whether the reported cross-linguistic relationships also generalise to bilingual children learning to read in two typologically diverse writing systems.

A small, but growing, body of evidence examining Chinese-English biliteracy learners, suggests that various facets of PA in Chinese and English are differentially related across languages (Bialystok, McBride-Chang, & Luk, 2005; Lu, 2009; McBride-Chang, Cheung, Chow, & Choi, 2006; Wang, Perfetti, & Liu, 2005), presenting a more complex picture than has been shown in the biliteracy cases involving two alphabetic writing systems. There is also evidence of significant cross-linguistic relationships of PA and decoding from alphasyllabic Korean and alphabetic English biliteracy learners, but the facets of PA called upon are different from alphabetic biliteracy learners (Kim, 2009; Wang, Park, & Lee, 2006). In view of these complexities inherent in biliteracy, it is important to test the precise aspects of PA that may be responsible for cross-linguistic relationships, and in turn cross-linguistic contributions in the relatively unstudied case of Indic alphasyllabic and alphabetic biliteracy acquisition.

THE CASE OF BILITERACY DEVELOPMENT

Due to the complex multilingual milieu of the Indian subcontinent, a brief description of the linguistic situation is presented. India is home to more than 650 languages (Bhatia & Ritchie, 2004), with 47 used as medium of instruction, 87 in the press media, 71 in radio, 13 in cinema, and 18 in state-level administration (Annamalai, 2001). In addition to 18 official regional languages used at the state level, Hindi and English are the co-official languages of the nation. This widespread multilingualism is also encapsulated in the language-in-education policy, the Three Language Formula (TLF), which mandates that three languages be taught to students—one as the medium of education, one as a second language, and one as a third language—by the time they finish secondary school (Vaish, 2008). In most cases, the three languages are Hindi, English, and the regional language; or Hindi, English and a South Indian regional language, in states where Hindi is the regional language. The order in which these languages are introduced largely depends on the school, and the various possible combinations that have stemmed from this policy have extended beyond these two simple configurations (Annamalai, 2008).

Bangalore, where this study is undertaken, is located in the state of Karnataka. Kannada is the state's official regional language. According to the TLF, the three languages that school-going children are required to acquire in Bangalore are Kannada, English, and Hindi. Children from higher socio-economic brackets of the city generally attend private English-medium schools, and then receive a choice of learning either Hindi or Kannada as an L2 from Grade 3 and the other as an L3 from Grade 6. Government schools and some private schools from lower socio-economic brackets operate with Kannada as the medium of education and offer either Hindi or English as an L2 from Grade 3, and the other as an L3 from Grade 6.

Even at the local community level, multilingualism is widespread. Within Bangalore, Kannada and English are used as primary languages of wider communication. However, due to growing migration of peoples across state borders, several languages from across the nation are widely used in the city. One particular form of migration is the movement of peoples from rural areas to urban centres in search of better job prospects. As with other situations of migration within India, when these families move they bring their own regional language with them. Children born to these families speak, with varying degrees of self-reported proficiency, their mother tongue, each other's mother tongues, Kannada, English, and Hindi. Thus, the functional multilingualism, which is ubiquitous at all levels of society in India, is mirrored in the slum communities where this study of biliteracy acquisition takes place.

The instruction method employed by the private non-government funded school that these participants attended was phonics based for Kannada, wherein symbol-sound correspondence rules were explicitly taught. Given that this group of children was from high-poverty urban slum communities, they had seen very little print before the start of formal instruction; thus, the school also focused on familiarising children with print and print-related materials. English instruction methods at the time of data collection were not streamlined and volunteer teachers from a private English-medium school read short stories to the learners and helped them decode by pointing to words and reading with them. They also occasionally made use of phonics software.

ORTHOGRAPHIC AND PHONOLOGICAL FEATURES OF KANNADA

Kannada is a south Indian Dravidian language written in a Brahmi-derived alphasyllabic script. Its phonological system consists of mostly bi- or multi-syllabic

words suggesting that the syllable holds a primary position in the linguistic system. At the same time, most syllabic units are separable into identifiable consonant, vowel, and diphthong phonemes (Schiffman, 1979). Both syllabic and phonemic units are encoded in the orthographic system. The basic units of representation are called *akshara.* The base *akshara* script consists of 49 graphic symbols, 13 representing vowels, 34 representing consonants, and 2 representing a combination of vowels and consonants. In their primary form, all consonants are encoded with an inherent schwa vowel (/ə/) (Bright, 1996) and will thus be referred to as Cə. When vowels appear in the word initial position they are written in their primary form. When vowels other than the schwa appear post consonantally, they must be written as diacritics in their secondary form. The vowel diacritic is physically different in shape from the primary vowel and is attached to the primary consonant grapheme Cə, which remains physically dominant. The rules that dictate where the vowel diacritic should be placed (either to the right of, above, or below the Cə that it is being attached to) depend on which vowel it is. For example, short i /ɪ/ must always be placed above the Cə symbol.

It is also possible to have consonant clusters, such as CCV or CCCV syllables. In such cases, the second and third consonants are, as in the case of vowel diacritics, modified and attached to the preceding consonant (primary Cə symbol for the first consonant). Also similarly to the vowel diacritics, the placement of the consonant diacritic (at the bottom of, or to the bottom right of, the Cə) is dictated by rules specific to which consonant diacritic is being represented. Although CCV and CCCV clusters are written as a single graphic unit, there are three or four distinct phonemic components represented. In such clusters the word-final vowel is attached to the first consonant (Cə) in the cluster, leading to a spatial configuration that does not match the temporal sequence of the sounds. Given that vowels and consonants can be ligatured to form several legal combinations, a large number of syllable clusters can be formed (as many as 476 CV clusters, not counting consonant diacritics, according to Nag, 2007).

There are three main characteristics of the Kannada orthography that distinguish it from the English orthography. First, there is dual representation of syllabic and phonemic information. Each distinct symbol represents a syllable; however, these syllabographs can be easily segmented into its constituent phonemic units. Studies investigating word reading in Indian alphasyllabaries demonstrate that the facets of phonological awareness related to decoding reflect this dual representation of syllabic and phonemic information, with the former being more dominant (Karanth, 2002; Prakash, Rekha, Nigam, & Karanth, 1993; Vaid & Gupta, 2002) and the latter emerging later (Nag, 2007). Second, the numerous possible combinations of ligaturing of vowels and consonants make the number of symbol rules that need to be learned much higher in Kannada than in English. Third, the relatively greater consistency of the symbol-to-sound mappings in Kannada, despite its complex visuo-spatial representation of phonological units, makes it a transparent, or shallow, orthography.

HYPOTHESES

The primary objective of this study is to explore how orthography-specific demands affect decoding development in multilingual children learning to read two typologically diverse languages, alphasyllabic Kannada and alphabetic English. Rooted in the Transfer Facilitation Model (Koda, 2008) we formulated the following hypotheses regarding how the relationships in PA and decoding vary in this particular case of biliteracy development:

Hypothesis 1: Are there distinct aspects of phonological awareness contributing to decoding development in Kannada and English? We hypothesised that both syllable- and phoneme-level awareness contribute to Kannada decoding and that mainly phoneme-level awareness contributes to English decoding performance.

Hypothesis 2: Are there systematic relationships in PA between Kannada and English? We hypothesised that phoneme-level awareness will be more strongly related between the two languages; because syllable-level awareness is related to decoding only in Kannada, there is no orthography-based reason to postulate a close relationship in syllable-level PA between the two languages.

Hypothesis 3: To what extent and how does Kannada phonological awareness contribute to decoding development in English? Based on the dual-level representation of syllables and phonemes in Kannada, we hypothesised that both these levels of Kannada phonological awareness similarly contribute to English decoding.

METHOD

Participants

A total of 52 participants took part in this study. They ranged in age from 10–14 years ($M = 12.08$). Although this age range is high for a study of beginning reading and phonological awareness, these participants were exposed to little or no literacy resources in their homes and had received four years of Kannada instruction and one year of English instruction at the time of data collection. Exploratory analyses were conducted on the print exposure and experience patterns of the participants. In terms of oral language usage, the data revealed that their primary spoken language at home was Tamil (65.4% of the sample), Telugu (15.6%), or Urdu (15.6%), their second oral language and first literate language was Kannada, and their third (or possibly later acquired) oral language and second literate language was English. English was used minimally in the homes and slum communities, and although it is used widely in some parts of the city of Bangalore, the most experience that children had with English was in the school. This is in contrast with Kannada, which was used widely on a daily basis.

In the participants' homes there was very minimal print exposure, with only 21% of the homes having more than 10 books for children, and 8% having more than 10 books for adults in either English or Kannada. The books were mostly colouring books with no written language, or else siblings' textbooks, or religious texts. There were no books for children in the children's primary spoken language of the home. Neither the children nor their parents participated in any substantial reading activities at the home. The parents of the students were self-reported non-literates[1]. Despite this, "reading" religious texts on a daily basis by parents or other relatives occurred in 26.41% of the homes.[2]

All participants were recruited from one private school (with two campuses) which was part of a non-governmental organisation empowerment movement for slum

[1]There were two exceptions: one father who finished middle school, and another who finished high school

[2]This particular practice of "reading" entailed mostly memorisation. When the same words from the religious text were presented in isolation or reconfigured into a novel passage, even decoding was a struggle.

dwellers of Bangalore. The medium of education was Kannada, and all content courses were taught in it. As noted previously, Kannada had been taught for four years and English for one year (for two hours a week) at the time of testing. The print environment in the school was about 75% Kannada and 25% English. The spoken language in the school was primarily Kannada, although children spoke in their primary home languages during snack and lunch breaks.

Instruments

Receptive oral vocabulary knowledge

Receptive oral vocabulary knowledge (OVK) was measured to estimate relative language proficiency in Kannada and English using the Peabody Picture Vocabulary Test-Revised (PPVT-R) (Dunn & Dunn, 1981). The children were shown four pictures, and were asked to point to the picture that corresponded to the spoken word produced by the researcher. The same 60 words were tested in each language; items that were considered either culturally inappropriate or completely unfamiliar by the teachers and the NGO staff were not included in any language. The order of languages in which the tests were completed was counterbalanced. Testing was terminated after five consecutive errors.

Phonological awareness

Auditory discrimination

In English, an auditory discrimination task was constructed based on the Wepman Auditory Discrimination task (Wepman & Reynolds, 1987), in which the researcher said out loud a pair of monosyllabic words (e.g., /web/ and /wed/) and participants were to judge whether they were the same or different words by circling either "same" or "different" on an answer sheet. There were a total of 30 items (20 "different" and 10 "same") and five practice items. The phonemic contrast was located in word-initial, -medial, and -final positions. The items were randomly sequenced and presented to each participant in a fixed order. One point was given for each correct response.

In Kannada, a similar task was constructed following the same logic. As in English, following five practice trials there were 30 target items (20 "different" pairs), and all phonological contrasts were phonemic. Of the 20 target pairs, there were primary vowel phonemic contrasts, vowel diacritic phonemic contrasts, consonant diacritic phonemic contrasts, and Cə contrasts, and the position of the contrast was either word initial or medial. There were no phoneme-level contrasts in the word-final position due to the rarity of such words in Kannada.

All words in both languages appear in the school textbooks that the students were using. Some items for the Kannada task were selected from the cross-linguistic phonological battery created by Nag-Arulmani, Reddy, and Buckley (2003). After selection, two teachers were asked to judge the familiarity of the word, and only words that they both agreed would be familiar were included. This test was conducted as a group in a quiet room in the school.

Deletion

In English, participants were asked to delete syllables or phonemes from words that were said out loud by the researcher (based on Stahl & Murray, 1994). For instance, the participant was asked to say /batman/ without /bat/ (syllable-level deletion), or say

/bat/ without /b/ (phoneme-level deletion); the former included both morphological units (e.g., /bat/) and non-morphological units (e.g., /cri/ from /cricket/). There were six practice items (three syllable deletion tasks and three phoneme deletion tasks). There were 25 target items, including five syllable-level deletions and 20 phoneme-level deletions. Within each level there were items that were to be deleted from word-initial, word-medial, and word-final positions.

In Kannada, a parallel 30-item test was constructed, with 17 syllable-level and 13 phoneme-level deletion items. The syllable-level deletion tasks included consonants with vowel diacritics, CCV, and CVCV clusters, and the phoneme-level deletion task included the removal of Cə, vowels, vowel diacritics, and consonant diacritic phonological items. If the participant was able to accurately delete the target phonological unit, one point was given; otherwise, a score of zero was given.

In this task as well, all words had appeared in the textbooks used in school, and familiarity was judged by teachers in the same way as it was for the auditory discrimination task. The test was conducted individually by the researcher in a quiet classroom.

Decoding

Real and pseudoword decoding skills were assessed in Kannada and English. In English, there were 20 items in each test. For the real words only mono-morphemic words were used, chosen from the Word Identification subtest of the Woodcock Reading Mastery Test (Woodcock, 1987). The list was then compared with the school textbooks, and words that were not used in the textbooks were removed and replaced with words from the textbooks that were also mono-morphemic words of the same length as the words that were removed. After this process, teachers rated the students' familiarity with the words, and only words that both teachers agreed were familiar were utilised. All pseudowords ($N = 20$) were selected from the Woodcock Reading Mastery Test (Woodcock, 1987).

In designing the Kannada decoding tests, the same item selection procedure was followed. There were 15 real words, with Cə, consonant with diacritic, and CCV blends within the syllable clusters. All real words were selected from the school textbooks, and as in English, were screened by teachers for familiarity. There were 15 pseudowords, created by selecting words from the textbook and replacing one syllable cluster with another legal syllable cluster of the same type.

In both languages the words were typed on flashcards. They were presented to the participants one-by-one by the researcher in a random, but counterbalanced and fixed order. Participants were asked to pronounce the words in a clear, loud voice to the best of their capability. If the word was pronounced accurately (Indian English pronunciations were scored as correct for the English words), one point was given. There was no partial credit. This test was administered individually in a quiet classroom in the school.

Non-verbal intelligence

Raven's Standard Progressive Matrices (Raven, Raven, & Court, 2000) was used as a measure of non-verbal intelligence abilities. This was a paper-and-pencil test, and was conducted as a group.

Task administration

All tests, except the PPVT-R, were administered by the researcher in the school classrooms over a three-day period. The PPVT-R was administered by the teachers and a trained research assistant in the school. The PPVT-R data were collected two weeks after the other data were collected. Children and their families were given print-related materials as gifts for their participation after testing was completed.

RESULTS AND DISCUSSION

The preliminary analysis revealed that the scores from the auditory discrimination test in both Kannada and English were at ceiling (Kannada $M = 96.00$, $SD = 8.76$; English $M = 93.33$, $SD = 8.46$). Therefore, only the scores from the deletion test were used in the following analyses as an index of phonological awareness. All Kannada phonological awareness and decoding test items that were used in the analyses are provided in the Appendix. Means, standard deviations, and Cronbach's alpha reliability scores for the OVK, deletion, and decoding tasks in Kannada and English are presented in Table 1.

Paired sample *t*-tests revealed that all Kannada reading sub-skill scores were significantly higher than the corresponding scores in English, including OVK $t\ (51) = 22.81$, $p < .001$; PA-Syllable $t\ (51) = 4.77$, $p < .001$; PA-Phoneme $t\ (51) = 9.24$, $p < .001$; Total decoding $t\ (51) = 15.77$, $p < .001$; Real Word Decoding $t\ (51) = 14.73$, $p < .001$; and Pseudoword Decoding $t\ (51) = 14.25$, $p < .001$. Given that participants had received more years of schooling in Kannada and were clearly more proficient in it than in English and based on the Transfer Facilitation Model (Koda, 2008), we decided to analyse resource sharing only in one direction—from the stronger language, Kannada to the new language, English.

Further descriptive analyses on the relative performance of the PA tasks between the two languages demonstrated that syllabic manipulation skills were significantly stronger than phonemic manipulation skills in both Kannada $t\ (51) = 8.90$, $p < .001$ and in English $t\ (51) = 9.12$, $p < .001$. No significant difference was found between real

TABLE 1
Means, standard deviations, and reliability scores for all Kannada and English tasks

	Total points possible	*Min score*	*Max Score*	*Mean (%)*	*SD*	*Cronbach's Alpha*
Kan OVK	60	27	54	44 (73.33)	5.53	.80
Kan PA-Syll	17	12	17	15.38 (90.50)	1.59	.70
Kan PA-Ph	13	5	13	9.56 (73.52)	2.58	.75
Kan Dec-Total	30	4	30	23.63 (78.78)	5.63	.93
Kan Dec-RW	15	4	15	12.08 (80.51)	2.69	.76
Kan Dec-PsW	15	0	15	11.56 (77.05)	3.24	.84
Eng OVK	60	14	40	23.72 (39.53)	4.21	.83
Eng PA-Syll	5	1	5	3.84 (76.86)	1.08	.67
Eng PA-Ph	20	0	20	9.45 (47.25)	4.78	.87
Eng Dec-Total	40	1	35	12.23 (30.59)	9.82	.95
Eng Dec-RW	20	0	17	6.43 (32.16)	5.43	.92
Eng Dec-PsW	20	0	18	5.80 (29.02)	4.80	.88

Note. OVK=Oral Vocabulary Knowledge, PA-syll=syllable-level phonological awareness, PA-ph=phoneme-level phonological awareness, Dec-RW=Real Word Decoding, Dec-PsW=Pseudoword Decoding, Dec-Total=Total Decoding.

TABLE 2
Intercorrelations of OVK, PA sub-skills, and decoding in English and Kannada

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*
1. K OVK	–											
2. K PA-Syll	.22	–										
3. K PA-Ph	.27	.79***	–									
4. K Dec-Total	.31*	.63***	.50***	–								
5. K Dec-RW	.29*	.59***	.46**	.94***	–							
6. K Dec-PsW	.30*	.60***	.50***	.96***	.80***	–						
7. E OVK	.16	.10	.10	.12	.13	.11	–					
8. E PA-syll	.36*	.36*	.27	.22	.21	.21	.09	–				
9. E PA-Ph	.30*	.52***	.60***	.38**	.32*	.39**	.11	.49***	–			
10. E Dec- Total	.29*	.52***	.46**	.53***	.50***	.50***	.16	.22	.60***	–		
11. E Dec-RW	.27	.58***	.50***	.54***	.53***	.50***	.15	.22	.58***	.97***	–	
12. E Dec-PsW	.28	.42**	.38**	.47**	.42**	.46**	.16	.20	.57***	.96***	.84***	–

*p <. 05. **p<.01, ***p <.001.

Note. OVK = Oral Vocabulary Knowledge, PA-syll = syllable-level phonological awareness, PA-ph = phoneme-level phonological awareness, Dec-Total = Total Decoding (combined real word and pseudoword decoding scores), Dec-RW = Real Word Decoding, Dec-PsW = Pseudoword Decoding.

word and pseudoword decoding tasks in either language. Table 2 presents bi-variate correlations among all the English and Kannada measures.

Differential contribution of PA in decoding an alphasyllabary and an alphabet

The first research question we posed focused on the degree to which distinct PA facets contribute to decoding development in typologically different languages. We predicted that Kannada decoding skills would require both syllable- and phoneme-level awareness and that English would require only phoneme-level awareness, based on the encoding units in each language. As predicted, within Kannada the correlation analyses showed that both syllable-level ($r = .63$, $p < .001$) and phoneme-level ($r = .50$, $p < .001$) awareness were significantly related to decoding scores. However, in English only phoneme-level awareness was significantly related to decoding scores ($r = .60$, $p < .001$).

In order to determine the relative contributions of these two distinct levels of PA to decoding within each language separately, we ran hierarchical regression analyses predicting decoding in Kannada and English, shown in Tables 3 and 4 respectively. The entry order of the variables was Ravens and OVK as covariates, followed by the two facets of PA, in order to examine the additional contribution of each facet of PA over and above the one entered before it. In English, the order of entry was not reversed because there was no significant relationship between English syllable awareness and English decoding. Ravens non-verbal intelligence scores were used as a covariate instead of age or grade in this case, as age was not significantly related to language and literacy scores. This is most likely due to the fact that this school allowed students from the slum communities to enter their programs even if they were older at the time of joining, leading to slightly varied age groups within each grade level, a common phenomenon in various countries (Little, 2001). The regression analyses were also performed on real word and pseudoword decoding skills separately to probe the possibility of different levels of PA being employed for these two kinds of decoding, however, no significant differences were found in the pattern of contributions of PA skills, and thus only total decoding scores are reported as the outcome variable.

The findings demonstrate that both syllabic and phonemic awareness contribute to Kannada decoding when phoneme manipulation scores are entered before syllable manipulation scores. This suggests that there are unique contributions made by both levels of PA to Kannada decoding skills, and thus corroborates the idea that there is dual-level representation of phonemes and syllables in Kannada, and that each has a measurable impact on the nature of phonological awareness in its readers. This finding adds to the growing literature on alphasyllabary literacy acquisition, which underlines the fact that both syllabic and phonemic awareness are called upon for word reading due to the hybrid syllabic and phonemic nature of the orthography (e.g., Nag, 2007; Cho & McBride-Chang, 2005; Vaid & Gupta, 2002; Simpson & Kang, 2004).

The results also illustrated that when the entry order of the hierarchical regressions was reversed and syllabic awareness scores were entered before phonemic awareness scores, the latter did not explain any additional variance in Kannada decoding. This finding is also in line with orthography-specific properties of the alphasyllabic script. As indicated above, the base *akshara* script consists of vowels and consonants. Since every consonant is encoded with an inherent vowel (Cə), all consonants are syllabic in their primary form. When vowels and consonants are encoded in their secondary, diacritic form, they become phonemic units which are attached to the primary Cə

TABLE 3
Summary of regression analysis predicting Kannada decoding

	R^2	ΔR^2	ΔF
Ravens	.05	.05	2.69
K OVK	.12	.06	3.22
K PA-Syll	.44	.33	26.12***
K PA-Ph	.44	.02	.02
Ravens	.05	.05	2.69
K OVK	.12	.06	3.22
K PA-Ph	.28	.16	10.19**
K PA-Syll	.44	.16	12.72**

*p <. 05. **p<.01. ***p < .001.

syllable symbol creating more complex syllabographs (single graphemes representing syllables). In these cases where phonemic diacritics are used, they are proportionally much smaller visually than the primary Cə syllable unit to which they are attached underscoring the syllabic bias in the script. Hence, in alphasyllabic Kannada, there is evidence for the involvement of dual-level phonological awareness in decoding development, with a more dominant role being played by syllable-level awareness.

On the other hand, the within-language regression analyses predicting English decoding skills revealed that phonemic awareness was, as predicted, the only significant factor explaining English decoding scores. Syllable awareness was not even mildly correlated with English decoding (r = .28). This result also corroborates the well-established finding that for alphabetic English, phonemic-level awareness is one of the most important predictors of decoding success (e.g., Torgesen, 2002). Thus, as predicted the different facets of PA play out differently in Kannada and English. In the former, orthographic demands necessitate dual-level awareness of syllabic and phonemic constituents, whereas phonemic awareness occupies a primary position in English decoding development.

TABLE 4
Summary of regression analysis predicting English decoding

	R^2	ΔR^2	ΔF
Ravens	.14	.14	7.33*
E OVK	.15	.01	.78
E PA-Syll	.17	.02	.85
E PA-Ph	.39	.22	16.07***

*p <. 05. **p<.01. ***p < .001.
Note. OVK = Oral Vocabulary Knowledge, PA-ph = phoneme-level phonological awareness, PA-syll = syllable-level phonological awareness.

Cross-linguistic relationship in PA between an alphasyllabary and an alphabet

In order to trace a possible mechanism by which Kannada PA might contribute to English decoding we examined the relationship between the corresponding levels of PA in the two languages. Consistent with our hypothesis, the intercorrelations reported in Table 2 show a strong relationship in phoneme-level awareness (r = .60,

$p < .001$) and a weaker, but significant, relationship in syllable-level awareness ($r = .36$, $p < .01$) between the two languages. Moreover, Kannada syllable awareness is significantly related to English phoneme awareness ($r = .52$, $p < .001$). Within each language, phoneme awareness and syllable awareness are correlated more highly in Kannada ($r = .79$, $p < .001$) than in English ($r = .49$, $p < .001$).

These results demonstrate that the two levels of PA are differentially related between alphasyllabic Kannada and alphabetic English. The stronger relationship in phoneme awareness skills in Kannada and English suggests that phoneme awareness skills in the two languages may be more closely shared than the syllable awareness skills. Interestingly, Kannada syllable awareness was also significantly related to English phonemic awareness. Viewed collectively, these results suggest that cross-linguistic relationships in phonological awareness are more complex than have been suggested in studies involving typologically similar languages. Phonological awareness is not a single unitary construct and its multiple facets are differentially related to decoding development in diverse languages. Given that decoding development is constrained by orthography-specific demands, it can be argued that only the PA facet required in the mapping principle in both languages is selectively incorporated in learning to decode in a later acquired language. It is this functional selectivity that may explain the different patterns of relationships between the two levels of PA across the two languages.

Cross-linguistic contribution of phonological awareness from an alphasyllabary to an alphabet

The third research question builds on the first two, by examining how the cross-linguistic relationships between the PA levels might lead to cross-linguistic contributions of Kannada PA to English decoding development. Given the dual representation of syllable and phoneme awareness in Kannada, we expected both levels to contribute to English decoding scores, via their relationship with English phoneme awareness skill. To unravel the unique contributions of the levels of PA across languages, hierarchical regressions were run with the two levels of Kannada PA predicting English decoding. As was the case with the within-language hierarchical regressions, Ravens and OVK were entered first as covariates, and the steps of entry of the PA levels in both languages were alternated to test the additional variance that each PA level may explain when entered after each other. These results are presented in Table 5.

These findings reveal that English phonemic awareness is the strongest predictor of English decoding, above and beyond the variance accounted for by the combined syllable manipulation skills in both languages, pointing to the necessity for phoneme-level awareness for successful decoding in English. When the two levels of Kannada PA were entered before English phonemic awareness, both were found significant in predicting English decoding, confirming their contributions to English decoding. English syllable-level awareness, on the other hand, makes virtually no contribution to English decoding.

In order to trace the possible mediating role of English phonemic awareness in the contribution of both levels of Kannada PA to English decoding, we first ensured that there was a significant correlation between both Kannada phonemic awareness and English phonemic awareness ($r = .60$) and Kannada syllabic awareness and English phonemic awareness ($r = .52$), as well as that there was a significant correlation between English phonemic awareness and English decoding ($r = .60$). Next, as shown in Table 5, we confirmed that English phonemic awareness remains a significant

TABLE 5
Predicting English decoding using Kannada tasks

	R^2	ΔR^2	ΔF
Ravens	.14	.14	7.33**
E OVK	.15	.01	.78
E PA-syll	.17	.02	.85
K PA-syll	.29	.12	7.45**
E PA-ph	.44	.15	5.61**
K PA-ph	.45	.02	.27
Ravens	.14	.14	7.33**
E OVK	.15	.01	.78
K PA-syll	.29	.14	8.62**
E PA-syll	.29	.00	.00
K PA-ph	.29	.00	.07
E PA-ph	.45	.16	12.32**
Ravens	.14	.14	7.33**
E OVK	.15	.01	.78
E PA-ph	.38	.23	16.58***
K PA-ph	.38	.00	.29
E PA-syll	.39	.01	.66
K PA-syll	.45	.06	4.36*
Ravens	.14	.14	7.33**
E OVK	.15	.01	.78
K PA-ph	.24	.09	5.01*
E PA-ph	.38	.15	10.52**
K PA-syll	.42	.04	2.84
E PA-syll	.45	.03	2.15

*p<. 05. **p<.01.
Note. OVK = Oral Vocabulary Knowledge, PA-ph = phoneme-level phonological awareness, PA-syll = syllable-level phonological awareness.

predictor of English decoding even when entered after Kannada phonemic awareness and Kannada syllabic awareness. Finally, two simultaneous regressions—one using Kannada phonemic awareness and English phonemic awareness as predictors of English decoding, and another using Kannada syllabic awareness and English phonemic awareness as predictors of English decoding—were conducted. The results of this analysis indicated that the coefficient of the absolute relation between Kannada phonemic awareness and English decoding was larger (.46) than when both were entered simultaneously to predict English decoding (.16). This was also true for Kannada syllabic awareness, where the coefficients were .52 and .29 for the absolute relation and simultaneous relation, respectively. This analysis suggests that both levels of Kannada PA are related to English decoding but their contribution is likely to be indirect through English phonemic PA. In other words, both levels of Kannada PA relate to English phonemic awareness, which in turn is the sole unique predictor of English decoding.

Our intention in this research question was to bring to light the cross-linguistic resource sharing mechanisms in Kannada and English biliteracy development. The data extend the findings from previous studies of biliteracy learning by demonstrating contributions from Kannada PA to English PA, and then English PA to English decoding. Pertinent to the question of orthography-specific constraints on cross-linguistic resource sharing, this study revealed that Kannada PA provides dual-level

phonological support to English PA development, which in turn supports English decoding. In other words, across languages there is a similar contribution of syllable and phoneme awareness from Kannada to English PA, whereas there is only a single phoneme-level contribution from English PA to English decoding. Thus, the sensitivity to both syllabic and phonemic sub-lexical units that is honed from interacting with the dually represented Kannada orthography facilitates English reading development. This cross-linguistic facilitation is above and beyond what comes from English syllable-level awareness, but is brought about via English phonemic awareness. Essentially, the mechanism of resource sharing between an alphasyllabary and an alphabet is clearly reflective of the orthography-specific constraints in both languages.

SUMMARY AND CONCLUSION

The objective of this study was to examine how orthography-specific demands affect decoding development in biliteracy learning involving two typologically diverse writing systems, alphasyllabic Kannada and alphabetic English. Our findings showed that decoding skills are directly related to the particular way in which phonological information is graphically encoded in a particular script. Due to the dual-level representation of both syllables and phonemes in the Kannada orthography, Kannada decoding necessitates both syllable- and phoneme-level awareness. However, due to the single-level representation in the English orthography, the data indicated that English decoding demands primarily phoneme-level awareness. While these results corroborate the long line of research which has established the importance of phonemic awareness in English (e.g., Snow, Burns, & Griffin, 1998), the small number of items on our syllable awareness test does not allow us to rule out the possible contribution of syllable awareness to English decoding.

The results also demonstrated that in biliteracy development, strong cross-linguistic connections exist only in the facet of the focal construct (PA) that is similarly necessitated for the requisite symbol-to-sound mappings in both languages. More precisely, a stronger relationship was found between the phoneme-level awareness in the two languages than between the syllable-level awareness because phoneme awareness is commonly involved in decoding in both languages. Finally, our data also provide strong empirical support for cross-linguistic facilitation with Kannada PA contributing to English decoding. The cross-linguistic resource sharing can be traced from both PA levels in Kannada to English phonemic awareness to English decoding.

Our findings are generally in line with the current conceptualisation of cross-linguistic relationships, in which transfer is viewed as ability to learn new skills by drawing on previously acquired resources. Under this view of transfer, prior literacy experience is regarded as a reservoir of knowledge, skills, and abilities that is available to promote learning to read in a new language (August & Shanahan, 2006; Koda, 2008; Riches & Genesee, 2006). However, our results also suggest that the contributions of previously acquired competencies may be more localised, and thus restricted, than may have been assumed. This in turn suggests that facilitation benefits stemming from transfer may vary from one instance of biliteracy learning to another. In this regard, we underscore the importance of incorporating cross-linguistic variations in learning to read in predicting to what extent and how transferred sub-skills from one language facilitate reading development in another. We realise that examining transfer-induced facilitation, and variation therein, is extremely

challenging, but it is vitally needed, if we are to gain a clearer understanding of the precise nature of cross-linguistic resource sharing and facilitation brought about through such sharing in biliteracy development.

The study also offers some valuable pedagogical insights. If teachers recognise that metalinguistic resources from a previously learned language support decoding development in a later acquired language, they will find that they have a readily available repertoire of resources that bolsters literacy development within and across languages. Particularly in cases of alphasyllabic-alphabetic biliteracy development, teachers will serve students well by explicitly highlighting the differential sub-lexical components necessitated in both languages. Such classroom teaching will provide students with an analytic lens through which they can reflect on and sharpen their own metalinguistic insights in tune with the orthographies they are dealing with. This in turn will further support learning to read not only across the two languages, but also in learning to read any additional languages, such as Hindi, when required. These pedagogical suggestions are presumably even more critical in high-poverty settings such as this one because despite the fact that there is very limited literacy support from the context, there are identifiable, sharable cognitive resources, which can be harnessed for successful biliteracy development.

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APPENDIX

Items used in the Kannada phonological awareness deletion instrument.
Syllable deletion items (the phonological information that was to be deleted is in brackets)

1. ಶಾಲೆ /(shɑ:)lɛ/ [school]
2. ಹೆಚ್ಚು /(ɦe):tʃu/ [more]
3. ವಿಶಲ /(ʋɪ)ʃəla/ [wide]
4. ಅಪಘಾತ /(əpa)g^{h}aʈa/ [accident]
5. ವಿಜ್ಞಾನ/ʋigɲa:na/ [science]
6. ತ್ಯಾಗ /(ʈja:)ga/ [sacrifice]
7. ಕಾಡು /(ka:)ɖu/ [forest]
8. ಮನೆ /mə(ne)/ [house]
9. ಅಣ್ಣ /ə(ɳa)/ [elder brother]
10. ನಾಗರಿಕತೆ /nagərɪ(kaʈe)/ [civilisation]
11. ಅರಳಿದ /ərəlɪ(ɖa)/ [blossom]
12. ಚಕ್ರ /tʃə(kra)/ [wheel]
13. ದೂರದರ್ಶನ /ɖu:rəɖuərʃə(na)/ [television]
14. ಅಧಿಕಾರ /ə(ɖ^{h}ɪ)kara/ [in-charge]
15. ಸಮುದ್ರ /sə(mʊ)ɖra/ [ocean]
16. ಪ್ರತಿಕ್ರಿಯೆ /prə(ʈi)krɪje/ [reaction]
17. ಗಿರಿಜನ /gɪ(rɪ)dʒəna/ [forest dwellers]

Phoneme deletion items

1. ಆನಂದ /(ɑ:)nəŋda/ [happiness]
2. ಮಗ /(mə)ga/ [son]
3. ವಸತಿ /(ʋə)saʈi/ [home]
4. ರಸ್ತೆ /(rə)sʈe/ [road]
5. ಕುತಂತ್ರ /kʊʈə(ŋ)tra/ [cunning]
6. ಭಕ್ತಿ /b^{h}ək(ʈ)i/ [devotion]
7. ಅನುಕಂಪ /ənʊkəɲ(pa)/ [sympathy]
8. ನಗರ /nə(gə)ra/ [city]
9. ಬೆರಳು /be(rə)lu/ [finger]
10. ಪಂಡಿತ /pa(ŋ)ɖɪʈa/ [good at]
11. ಅಗೋ(ಚ)ರ /ago:(tʃə)ra/ [invisible]
12. ಸ್ಫೂರ್ತಿ /s(p)u:rʈi/ [inspiration]
13. ಮುಹೂರ್ತ /mʊhu:(r)ʈa/ [auspicious time for an event]

Kannada Real Word Decoding

1. ಆಗ / a:ga/ [at that time]
2. ತಿಳಿ /ʈɪli/ [understand]
3. ದಯೆ /ɖəje/ [sympathy]
4. ಉಪಾಯ /ʊpa:ja/ [clever plan]
5. ನಾಯಕ /na:jəka/ [leader]
6. ತರುಣ /ʈərʊna/ [young man]
7. ಗೊತ್ತು /goʈu/ [know]
8. ಸೈನಿಕ /sɛ:nɪka/ [soldier]
9. ಕಡಪಡಿಸು /kəɖəpəɖɪsu/ [impatient]
10. ವ್ಯವಸ್ಥೆ /vɛ:vəsʈ^{h}e/ [arrangement]
11. ಜೀವನೋಪಾಯ /dʒi:ʋəno:pa:ja/ [livelihood]
12. ವೃದ್ಧ /ʋrəɖ^{h}a/ [old man]
13. ಧೈರ್ಯಶಾಲಿ /ɖ^{h} ɛ:rjə ʃa:li/ [courageous man]
14. ಪಶ್ಚಾತ್ತಾಪ / pəʃtʃ:ʈa:pa/ [regret]
15. ಬೊಬ್ಬೆಯಿಡುತ್ತಾ /bo:bejeɖu:ʈa/ [cry out loud]

Kannada pseudoword decoding

1. ಉರ - /ʊra/
2. ಇಮೆಕೆ - /ɪmɛke/
3. ಚಿವಿ - /tʃɪʋi/
4. ರಾಕ - /ra:ka/
5. ಗುದುರೆ - /gʊɖʊre/
6. ಔಪದಿ - /ɔpəɖi/
7. ಗಾಬಗಿ - /ga:bəgi/
8. ಸುಂಗೆ - /sʊŋge/
9. ದಚ್ಚಿ - /ɖə:tʃi/
10. ಸಪ್ರೆ - /səpre/
11. ಸೆನ್ಸಿಲ್ - /sensɪl/
12. ಲತ್ಕೊ - /ləʈko/
13. ರಲ್ವಿ - /rəlʋi/
14. ಬರ್ವ - /bərʋa/
15. ಜುನ್ನಡೆಯುತ್ತ - /dʒʊ:nəɖejʊʈa/