

Title: Spelling development in Thai children

Short title: Spelling in Thai

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Abstract

Thai, a tonal language, has a distinctive alphabetic orthography. In the current study, spelling development in Thai children is examined. A number of predictions about spelling development and types of errors are made based on previous research on other orthographies in conjunction with the characteristics of Thai language and its orthography. Spelling of words was assessed in 60 Thai children ranging in age from 7 years to 9 years from Grade(s) 1, 2, and 3. After 4 months of school, Grade 1 children achieved 32% correct, Grade 2 children 85% correct, and Grade 3 children 87% correct for word spelling. Spelling performance rapidly increased between the youngest Grade 1 children and the older children with relatively few errors made by the older children. We found striking commonalities with other orthographies previously studied and also orthography-specific characteristics emerged. Homophonous consonants, consonant clusters, visually similar letters, vowel length, and other irregularities in the orthography posed significant challenges to young learners. As predicted the complex vowel combinations and tone system also proved problematic.

Keywords: development; error analysis; spelling; Thai

Introduction

The majority of research on literacy development has primarily been conducted on linearly arranged alphabetic orthographies, in particular Indo-European languages. Thai, a tonal language, forms an interesting comparison, as it has a distinctive alphabetic orthography with a non-linear arrangement of vowels that can be placed vertically above, or below, or to either side of the consonant, and that combine across the syllable to produce a large additional number of vowels or diphthongs. Thai orthography also has shared properties with syllabic scripts, as it has implicit vowels for some consonants. In order to gain greater insights into universal, typological, and orthography-specific developmental patterns and processes, it is essential to examine literacy development in diverse orthographies with markedly different characteristics. Moreover, literacy research has predominantly focused on reading rather than spelling development. In the current study, spelling development in Thai children is examined. First, I will discuss the important factors and features that have been found to affect spelling development in previously studied orthographies. Subsequently, I will review the characteristics of the Thai language and its orthography prior to outlining the research aims and predictions of the current study.

Important factors associated with spelling development

Consistency in phoneme-grapheme mapping

The relative consistency of the alphabetic orthography being learned affects spelling development. There are a few orthographies that are very consistent in terms of mapping between phonemes and graphemes, for example Turkish, Finish, Serbo-Croatian (Caravolas, 2005). However, the majority of languages deviate to some extent from this one-to-one mapping, and instead have many-to-one spelling-sound (feedforward), or many-to-one sound-spelling (feedback) correspondences, irregular, and/or opaque (silent letters) spellings. When

there are letters written that do not correspond to the spoken language (e.g. *wrist* or *knight*), children need to rote learn the orthographic information necessary for representing these spellings. The likelihood of children spelling a word correctly is related to its regularity (Romani, Olson, & Di Betta, 2005) and “the greater number of rules, exceptions, and sources of inconsistency, the more slow and difficult the learning process is likely to be” (Caravolas, 2005 p. 499).

Spoken language effects

Young children bring a wealth of knowledge and experience of their spoken language to the task of learning to read and write. In particular, in relation to learning to spell, it is important to consider what children know about the spoken language (Treiman & Kessler, 2005), as the phonological features of a child’s input language can affect their spelling (Alcock & Ngorosho, 2003; Bruck, Genesee, & Caravolas, 1997; Caravolas, Bruck, & Genesee, 2003; Caravolas, Hulme, & Snowling, 2001; Landerl & Wimmer, 2000). Furthermore, dialect differences also can have an effect on spelling (Jalil & Rickard Liow, 2008; Treiman, 1993; Treiman, Goswami, Tincoff, & Leavers, 1997).

It is important to consider to what extent the spoken and written systems correspond, as children have to learn to segment spoken language into units that correspond to the writing system. Research indicates that children find it more difficult to segment speech into the smaller units, phonemes than into syllables or onsets or rimes (Treiman & Zukowski, 1991). The segmentation of speech into phonemes is problematic for young spellers as illustrated by the spelling errors made by learners of alphabetic writing systems (Treiman & Kessler, 2005). A common error is to spell a consonant cluster with a single letter, for example children may write *pay* for *play* (Alcock & Ngorosho, 2003; Caravolas & Bruck, 1993; Treiman, 1993).

Visually similar letters

Learning to spell requires well-honed visual skills too. Children learning to read and spell need to be able to distinguish letters that are visually similar in their writing system, for example in English the letters *b* and *d* are often confused. These types of visually similar letters present problems for beginning learners and are a potential source of error and confusion.

Memory load and cognitive processing

In addition, memory load poses a significant challenge to young children. Memory load increases when children have to learn disjoint symbols such as French *é* and *ê* or when groups of letters can function as single units, such as *sh* as in English *ship* (Treiman & Kessler, 2005).

Suprasegmental features

Suprasegmental features, such as lexical tone and vowel length, appear to be psycholinguistically special (Liu et al., 2005; Treiman et al., 2005; Yip, 2002). Results from neurological studies are somewhat contradictory, but the consensus appears to be that there is a dissociation of neurological structure between suprasegmental and segmental units (Liu et al., 2005). Liu et al (2005) investigated tone and vowel production in Chinese and found greater activation of the right frontal gyrus for tones in comparison to vowels. Tone production was also less lateralised than vowel production. An underrepresentation of the suprasegmental features (stress, length, and tone) is apparent in the writing systems of the world's languages (Treiman & Kessler, 2005). When children are learning to spell words, suprasegmental features tend to be lost, and yet in contrast, segmental features are more readily retained, perceived, and written down. It has been suggested that one of the reasons this arises is that young writers tend to pronounce words slowly when they spell them, which causes these distinctions to be lost (Treiman & Kessler, 2005). Vowel length errors have been

found in Finnish, which has both long vowels spelled with a double letter (e.g. *aa*) and short vowels spelled with a single letter (e.g. *a*) (Lyytinen, Leinonen, Nikula, Aro, & Leiwon, 1995). Young Finnish children have a tendency to use a single letter for long vowels. In Hindi, it has also been found that children have difficulty in distinguishing and spelling short and long vowels (Gupta, 2004).

Error analysis

Spelling error analysis contributes to our understanding of the different cognitive processes and strategies that children utilize when learning to spell, and in particular how they acquire the idiosyncrasies of the orthography being learned (Abu-Rabia & Taha, 2004; Worthy, 1990). Spelling in particular is perceived as a “window of what an individual knows about words” (Gillis & Ravid, 2006 p. 623). It reveals more about a child’s phonological knowledge than reading, as a greater awareness of orthographic units is required in spelling than in the reading process (Alcock & Ngorosho, 2003; Lennox & Siegel, 1993). In order to spell proficiently, children need to be able to retrieve well developed orthographic lexical representations, in particular when there are irregularities in the orthography (Abu-Rabia & Taha, 2004).

Characteristics of Thai language and its orthography

Thai is a tonal language that has an alphabetic orthography with 44 basic consonants (plus 4 archaic consonants¹) that represent 21 consonant sounds (Thai consonants are listed in Appendix A). Thai is predominantly monosyllabic but it also has polysyllabic words, which have been borrowed mainly from Khmer, Pali, or Sanskrit. Syllable boundaries are clearly defined in spoken Thai and consist of the following syllable structures; V, VC, CV, CCV, CVC and CCVC (e.g. vowel (V), vowel-consonant (VC)) (Hudak, 1990). There are no spaces between words; instead, spaces in Thai text may indicate the end of a clause or sentence.

In general, there is a high degree of consistency in mapping between phonemes and graphemes in Thai, however there are multigrapheme to phoneme correspondences for some consonants (e.g. for /ph/, /th/, /kh/, /s/, /tʃh/) (refer to the consonants in Appendix A). In addition, there is a change in phoneme-grapheme correspondences of consonants when they occur in final position. Thai has only nine final consonant phonemes, /p/, /t/, /k/, /ʔ/, /m/, /n/, /ŋ/, /w/, /tʃh/ and other consonants occurring in final position have to take one of these sounds (e.g. อาหาร /a:ha:r/ *food* becomes /a:ha:n/).

There are 15 initial consonant clusters, which all start with a stop consonant and are followed by laterals, trills, or bilabials; กร /kr/, กล /kl/, กว /kw/, ขร /khr/, ขล /khl/, ขว /khw/, คร /khr/, คล /khl/, คว /khw/, ตร /tr/, พร /pr/, ปล /pl/, ผล or พล /phl/, พร /phr/. In addition, there are orthographic class-change clusters, in which the first consonant of the cluster, ห or อ is silent, and is used to change the class of consonant to a high or middle class expression with a corresponding change in tone, for example, นว /na:w0/ becomes หนว /na:w4²/ *cold* or ยาก /ja:k2/ becomes อยาก /ja:k1/ *want*. Thai does have additional irregularities, which include silent consonants and vowels that are not pronounced, for example the final consonant ‘ย’ *j* in อาทิตย์ /a:0tit3/ *week* is not expressed, which in this case is explicitly marked by the diacritic ̣.

Consonants occur in a linear sequence, however vowels can be placed vertically above, or below, or to either side of the consonant, and can combine to produce a large additional number of vowels (see Appendix B). Vowel length is linguistically significant and Thai has both short and long vowels. In addition, vowels are not always explicitly specified. Instead, inherent vowels can occur with the consonant, for example an *a* is usually found in words of Sanskrit, Pali, or Khmer origin, whereas an *o* is found in native Thai words.

Thai vowel expressions can be classified into the following categories based on the number of letters that combine to produce the vowel or diphthong: (1) single vowel

expressions, (2) simple vowel combinations that consist of two vowel letters, and (3) complex vowel combinations that result from the combination of three or more vowel-related letters (see Appendix B). In the simple and complex vowel combinations, the reader has to combine vowel orthographic units across the syllable to form a single vowel phoneme or diphthong. There are also five commonly used vowels (i.e. ๑ /e:/, ๒ /ɛ:/, ๓ /o:/, ๔ /aj/, ๕ /aj/) that precede the consonant and yet operate or combine across the syllable, as illustrated in Appendix B (i) Single vowel expressions. Thai vowels are complex graphemically in their expression, but have consistent phoneme to grapheme mapping.

Tone forms an integral element of the syllable in Thai, and serves an essential function in distinguishing meanings of syllables and words with identical phonological structure. There are five tones in Thai conceptualised as high, mid, falling, rising, and low, but only four tone markers; *maj3 e:k1* ¹, *maj3 tho:0* ², *maj3 tri:0* ³ and *maj3 tɕa1ta1wa:0* ⁴, which occur above the consonant. The tone determination of a syllable is complex, as it is influenced by a combination of the class of initial consonant, the type of syllable (open or closed), the tone marker, and the length of the vowel. In Appendix C, it can be seen that the different tone markers interact with the class of the consonant to produce particular tone realizations. We can see from this review that the expression of tone in Thai involves complex rules that can be inconsistent, and combine and operate at the syllable level.

The current study

Currently, little is known about spelling development and the particular challenges Thai orthography poses to young learners. The overall aim of the current study is to compare spelling development in Thai with other orthographies to identify common patterns in spelling development as well as orthography-specific patterns. Spelling of words was assessed in 60 Thai children ranging in age from 7 years to 9 years 8 months from Grade(s) 1, 2, and 3. A

number of predictions about spelling development and types of errors in Thai can be made based on previous research on other orthographies in conjunction with the characteristics of Thai orthography:

1. Consistency of phoneme-grapheme mapping

Thai vowels are complex graphemically in their expression, but have in general consistent phoneme to grapheme mapping. In contrast, Thai consonants are less consistent in their mapping as they are feedback inconsistent due to having homophonous consonants, which provide alternative spellings for the same phoneme, and hence constitute a potential source for spelling errors in Thai children (see Appendix A). In addition, there is a change in phoneme-grapheme correspondences of consonants when they occur in final position, which again we would expect to be potentially problematic for young language learners. There are other irregularities including silent final consonants (e.g. อาทิตย์ /a:0tit3/ *week*). When letters have no correspondence in speech, they produce opacity in the spelling system, which contributes to the relative difficulty children have in acquiring the system (Caravolas, 2005). Researchers are interested in tracking the developmental patterns exhibited by children learning these opaque alphabetic irregularities. Furthermore, we can predict that as consonants are relatively more inconsistent in their mapping in comparison with vowels, a greater number of consonant spelling errors will be produced than vowel errors.

2. Spoken language effects

Phonology of the spoken language plays an important role in spelling (Treiman, 1993; Joshi, Hoiem, Xiwu-Feng, Chengappa, Boulware-Gooden, 2005). In everyday spoken language, particularly in central Thai dialect, the /r/ is often spoken as /l/, e.g. ร้อน /rɔ:n/ ‘hot’

becomes /lɔ:n/. Hence, we can expect spelling errors that reflect this phonological confusion to emerge in the Thai children.

3. Segmentation problem

Based on prior research on other orthographies, we can also expect consonant clusters to be problematic to young learners (Sprenger-Charolles & Siegel, 1997; Stuart, 2005; Treiman & Weatherston, 1992). Specific to Thai, we can also expect the class-change clusters to be a challenge to young learners (e.g. นานา /na:w⁴/ *cold*).

4. Visually similar letters

Based on previous research, we can also expect that orthographically visually similar letters to be a source of confusion to young learners. It can be seen from Appendix A and B that there are many Thai letters, both consonants (e.g. ข /tɕh/ and ค /kh/) and vowels (e.g. อ /aj/ and โ /o:/) that are perceptually similar, and hence potentially problematic to young learners. Furthermore, some of the homophonous consonants are visually very similar (e.g. ฟ /f/ or พ /ph/). This is a particularly important distinction, as selection of the incorrect homophonous consonant may result in a change in tone of the syllable and the meaning of the word.

5. Memory load

According to Treiman and Kessler (2005), memory load increases when children have to learn disjoint symbols. Due to the complex graphemic representation of Thai vowels, which combine across the syllable, we can expect there to be difficulties associated with acquiring this complex system (refer to Appendix B). In Hindi, which also has vowels placed non-linearly above, below, and to the left or right of the consonant, it has been found that children have problems in spelling vowels (Gupta, 2004). We can expect this to be reflected in the number of correct responses made by children. Hence, we can predict that children will give more correct responses for single vowel expressions than simple vowel combinations,

and in turn more correct responses for simple vowel combinations than complex vowel combinations.

6. Suprasegmental features

Suprasegmental features, such as lexical tone and vowel length appear to be psycholinguistically special (Treiman & Kessler, 2005). Beginner writers tend to pronounce words slowly as they spell them and under these conditions suprasegmental features tend to be lost. Furthermore, the expression of tone for a syllable has a complex realisation in Thai, as it is determined by a combination of class of consonant, the type of syllable (open or closed), tone marker and length of the vowel. This includes the use of class-change consonants, e.g. ๓ in $\text{๓๓๓} /na:w4/$. An additional consideration is that the incorrect selection of homophonous consonant or tone marker can result in the incorrect tone realization. Hence, we can expect children to have difficulties spelling words with the correct tone forms.

7. Persistent errors

Furthermore, we are also interested in the persistent errors that exist in the older children, as this reveals more about the difficulty the particular orthography presents to children when learning to write or spell.

Method

Participants

A total of 60 Thai children ranging in age from 7 years to 9 years 8 months were recruited from a public school in a town located in the outskirts of Bangkok. Twenty children were recruited from each of the following grades: Grade 1, Grade 2, and Grade 3. Grade 1 children (9 boys and 11 girls) ranged in age from 7 years to 7 years 8 months with a mean age of 7 years 2 months ($SD = .20$); Grade 2 children (9 boys and 11 girls) ranged in age from 8

years to 8 years 10 months with a mean age of 8 years 3 months ($SD = .30$); Grade 3 children (12 boys and 8 girls) ranged in age from 8 years 10 months to 9 years 8 months with a mean age of 9 years 3 months ($SD = .30$). All children were native speakers of Thai and had no known reading or learning difficulties as evaluated by their teachers.

Typically, Thai children begin school in Grade 1 when they are 6 or 7 years of age. Prior to that, the majority of children attend Kindergarten where they are taught the letters of the alphabet; the consonants and single vowel letters are taught first. Initially, they are taught how to read real words or syllables composed of a consonant and simple vowel (e.g. มา /ma:0/ *come*) without final consonants, then easy words with final consonants are introduced. At the next stage, both monosyllabic and bisyllabic words are typically presented to the children. Gradually, children are taught to read words with more complex combinations of vowels (e.g. เข็ย or อ้าว). Simple sentences are subsequently introduced to the children. When children begin to learn to read Thai they are given spaced text, but then unspaced text is introduced in Grade 2 (around 7 or 8 years of age).

The school year starts in May in Thailand. As children in the current study were tested in September of the school year, they had been in their current grade for approximately 4 months. Parental permission was obtained, and standard ethical guidelines, both local and international, were adhered to.

Stimuli and procedure

The list of test stimuli consisted of 57 words to be written by the children (see Appendix C). Words were selected on the basis that they were common familiar words and also tested children's knowledge of the different vowel combinations and range of tone rules in Thai. The words also occurred in the children's school readers. Words were predominantly monosyllabic with one exception อาทิตย์ /a:0tit3/ 'week'. The word list included six words with

consonant clusters, eight words with class-change clusters in which the first consonant of the cluster, ห or อ is silent and is used to change the class of consonant to a high or middle class expression with a corresponding change in tone (e.g.หนาว /na:w4/ *cold*). In order to trace the developmental effects of opacity in the writing system one bisyllabic word อาทิตย์ /a:0tit3/ ‘week’ (a frequently encountered word) with a silent final consonant and one word with a final-change consonant ทาส /ta:s2/ spoken as /ta:t2/ *slave* were included in this selection. The other words consisted of representative words with initial consonant selected from each of the three consonant classes combined with an open or closed syllable, and either a tone marker or zero marked tone marker and short or long vowel.

Children were tested on the spelling task individually in a quiet room. They were asked to spell the words dictated by the experimenter. Children were all praised for their efforts, regardless of whether they gave the correct response or not.

Scoring of responses and error analysis

Children’s responses were initially scored as correct or incorrect. Subsequently the incorrect responses were analysed for the types of errors made. Errors that were unrelated to the word being spelled or that used the initial consonant in the word only were categorized into their respective categories as listed below. These types of errors occurred predominantly in the youngest Grade 1 children.

1. *Unrelated word*. This error response was when children made a word or nonword response that was completely unrelated to the target word (e.g. for เมือง /muang0/ *town* children produced เงิน /ng:n0/ *money*).

2. *Initial consonant only.* This error response was when a child either gave a word or nonword response but only used the initial consonant of the target word (e.g. for เปล่า /plaw1/ *empty* they produced ป่า /paj0/ *go*).

Subsequently, the remainder of the errors were categorised in terms of whether they were consonant, vowel, or tone errors, and whether the error was one of omission, addition or substitution, as listed below.

1. *Consonant errors.* The child substituted, omitted or added a consonant either in initial or final position in the syllable.

a. *Initial position in the syllable*

Unrelated initial consonant. Children substituted an unrelated initial consonant (e.g. for ฟาก /fa:k2/ *bank* they substituted มาก /ma:k2/ *very*).

Visually similar consonant. Children substituted a visually similar consonant (e.g. for ช้าง /kha:ŋ2/ *bank* they wrote ช้าง /tɕha:ŋ3/ *elephant*).

Homophonous consonant. Children substituted an incorrect homophonous consonant (e.g. for ฟาก /fa:k2/ *bank* children wrote ฟาก /fa:k1/ *deposit* or for ช้าง /kha:ŋ2/ *bank* children wrote ค้าง /kha:ŋ3/ *stuck*). This spelling error may result in a different tone realisation.

Consonant cluster. Children omitted the initial second consonant in the consonant cluster (e.g. for แปรง /pre:ŋ0/ *brush* they wrote แปง /pe:ŋ0/ or for เติร์ยม /triam0/ *try* they wrote เตียม /tiam0/).

Class-change cluster. Children omitted the initial class-change consonant (e.g. for ใหม่ /maj1/ *new* they wrote ไม่ /maj2/ *no*, or for หยอก /jɔ:k1/ wrote ยอก /jɔ:k2/ *prick*, or for เงา /ŋaw4/ wrote เงา /ŋaw0/ *shadow*).

b. *Final position in the syllable.* Children substituted, added, or omitted the final consonant (e.g. for เมือง they wrote เมืองค or เมือง).

Final-change consonant. Children either omitted the final consonant in ทาส /ta:s/ *slave* pronounced /ta:t/ (e.g. ทา /ta:/) or substituted the final consonant (e.g. ทาด /ta:t/ or ทาค /ta:k/).

Final silent consonant. For the word อาทิตย์ /a:0tit3/ *week* children either omitted the final silent consonant or substituted an incorrect one (e.g. อาทิต or อาทิตต์).

RL confusion error. Children confused the letters /r/ and /l/ (e.g. for เปลี่ยน /plian1/ *change* wrote เปลี่ยน /prian1/ or for รูป /ru:p2/ *picture* they wrote ลูปล /lu:p2/).

2. Vowel errors

Omissions. Children omitted a vowel (e.g. for เปล่า /plaw1/ *empty* children wrote ปลา /pla:0/ *fish*, or for เชื่อ /tçhuu2/ *believe* they wrote ชื่อ /tçhuu2/ *name*).

Substitutions. Children substituted an incorrect vowel (e.g. for น้ำ /na:m2/ *water* children substituted น้ำ /na:2/ *uncle* or in the older children for เปล่า /plaw1/ *empty* children wrote ปล่าว /pla:w1/). For the complex vowel combinations children made a mistake in one of the vowel components (e.g. for เกลือ /gluu0/ *salt* children produced เกลือ /glɤ:0/, or for เทียน *candle* children produced เทือน)

Vowel length errors. Children made a mistake in expressing the length of the vowel (e.g. for เงาะ /ŋɔ0/ *curly* children wrote เงา /ŋaw0/ *shadow* or for ฝู /phu/ *rotten* produced ฝุ /phu:/).

Visually similar vowels. Children substituted an incorrect visually similar vowel (e.g. instead of ไห /haj4/ *jar* children wrote โห /ho:4/).

3. Tone marker errors

Children omitted the tone marker (e.g. for ก่อน /kɔ:n1/ *before* children wrote กอน /kɔ:n0/), or children substituted a different tone marker (e.g. for ต้อง /tɔŋ2/ *must* children wrote ต้อง /tɔŋ1/).

In Thai there are many monosyllabic words that are very similar and vary in just one letter or in the tone of the syllable and hence are readily confused, in particular, when spelling.

Results

Developmental patterns in spelling

After 4 months of school, the Grade 1 children spelled 32% of the words correctly, Grade 2 children 85% correctly, and Grade 3 87% correctly. In order to compare performance on word spelling across the three different grades (Grade 1, Grade 2, Grade 3), a repeated measures analysis of variance (ANOVA) was conducted. There was a significant main effect of grade, $F(2, 57) = 104.68$, $p < .001$, $\eta_p^2 = .786$. Post-hoc comparisons conducted for grade using a Bonferroni adjusted α of .017 to avoid family-wise error (Howell, 2002) revealed that Grade 1 were significantly lower than Grade 2 responses, which in turn were lower than Grade 3 (refer to Figure 1). Thus, it can be seen that there was rapid development in spelling skills between Grade 1 and the older Grade 2 and 3 children.

. [Insert Figure 1 about here]

Error types

The unrelated and initial consonant only errors were predominantly found in Grade 1 children (28.95% of total responses) with only relatively few of these errors made in Grade 2 (1.31%) and Grade 3 (1.31%) children (refer to Table 1).

The remaining errors (Grade 1 = 39%, Grade 2 = 14%, Grade 3 = 11% of total error responses) were analysed in terms of the consonant, vowel, and tone-related error categories listed below and in Table 1 (errors are reported in terms of the percentage of error responses occurring in the particular grade). It can be seen that the majority of these errors were made by the Grade 1 children and only a relatively small number were made by the older Grade 2 and 3 children, as the older children were predominantly able to write the correct response.

[Insert Table 1 about here]

Consonant errors. In relation to initial position in the syllable consonant errors, Grade 1 children predominantly substituted an incorrect consonant (95%) and only infrequently added an additional consonant (5%). For final consonants, children tended to either substitute an incorrect consonant (66%), add a final consonant (6%), or omit the final consonant (27%). Final consonant position in the syllable (single consonants only excluding consonant clusters and class-change clusters), proved to be more problematic than initial consonant position for the Grade 1 children, ($t(39) = 4.17, p < .001$). There was no significant difference for the Grade 2 or 3 children.

Consonant cluster errors. As expected for the Grade 1 children, consonant clusters (71 errors 14.95% of total responses by Grade 1 children) and class-change clusters (51 errors 10.74%) were problematic for the Grade 1 children. These types of errors are much reduced in the Grade 2 and 3 children, however some errors still persist.

Final-change consonants. (The example used to examine this was ทาส /ta:s/ *slave* pronounced /ta:t/). If we examine the number of correct responses we can see that none of the Grade 1 children spelled this word correctly and 13 children from Grade 2 and 15 children from Grade 3 spelled it correctly. This indicates that this type of irregularity is still problematic to some extent even in the older children.

Final silent letter consonant errors. (The example used to examine this was อาทิตย์ /a:0tit3/ *week*). Only 4 out of the 20 Grade 1 children spelled this irregular spelling correctly, whereas 19 Grade 2 children and 18 Grade 3 children spelled it correctly. Hence, it was primarily problematic for the Grade 1 children, as the Grade 2 and 3 children appear to have largely learned this irregularity. However, it is important to note that it is a commonly used word in the classroom.

Spoken related RL error. Children did confuse the *r* and *l* spelling in Grade 1 (17 errors, 15 children), Grade 2 (10 errors, 5 children), and Grade 3 (5 errors, 2 children). This indicates the effect of the spoken language on spelling.

Comparison of number of consonant and vowel errors. It was predicted that there would be more consonant than vowel errors due to the less consistent phoneme to grapheme mapping of consonants than vowels. A comparison of the number of consonant errors (excluding consonant cluster and class-change cluster errors) in comparison to vowel errors from the three different grades (Grade 1, Grade 2, Grade 3) was analysed using a repeated measures analysis of variance (ANOVA). Letter error type (consonant, vowel) was a within-subjects factor and grade was a between-subjects factor. There was a significant main effect of letter error type, $F(2, 57) = 21.79$, $p < .001$, $\eta_p^2 = .277$ with more consonant than vowel errors made, and there was a significant effect of grade, $F(2, 57) = 35.29$, $p < .001$, $\eta_p^2 = .553$. There was a significant interaction effect between letter error type and grade, $F(2, 57) = 4.73$, $p < .05$, $\eta_p^2 = .142$. Post-hoc comparisons conducted for grade using a Bonferroni adjusted α of .017 to avoid family-wise error revealed that Grade 1 was significantly lower than Grade 2 and Grade 3 ($p < .001$). For Grade 1 the number of consonant errors was significantly higher than the number of vowel errors (Grade 1: $t(19) = 4.06$, $p < .01$), but there was no significant difference for the Grade 2 or 3 children.

Vowel errors

It can be seen from Table 1 that there was a tendency for the Grade 1 children to omit (24%) or substitute (41%) vowels. As predicted vowel length proved to be problematic to the youngest children (24 errors) and to some extent to the older children, Grade 2 (15 errors) and Grade 3 (13 errors) children. The similar vowels (i.e. $\text{๓๓} / \text{haj4}/$ and $\text{๓๓} / \text{ho:4}/$) were also often confused in the youngest children (23 errors, 17 children). Again these errors were largely overcome by Grade 2 and 3.

It was predicted that due to memory load the complex vowel combinations would be more difficult for children to acquire than single vowels. The effect of vowel type (single, simple combination, complex combination) on proportion of correct responses produced by

the children from the three different grades (Grade 1, Grade 2, Grade 3) was analysed using a repeated measures analysis of variance (ANOVA) (Table 2). Vowel type was a within-subjects factor and grade was a between-subjects factor. There was a significant main effect of vowel type, $F(2, 57) = 39.62$, $p < .001$, $\eta_p^2 = .410$, and a significant main effect of grade, $F(2, 57) = 123.62$, $p < .001$, $\eta_p^2 = .812$. Post-hoc comparisons conducted for grade using a Bonferroni adjusted α of .017 to avoid family-wise error revealed that Grade 1 was significantly lower than Grade 2, which in turn was lower than Grade 3 ($p < .001$). There was a significant interaction between vowel type and grade, $F(2, 57) = 7.51$, $p < .001$, $\eta_p^2 = .208$.

The proportion of single vowel responses were significantly higher than the simple vowel combinations ($t(59) = 4.06$, $p < .001$), which in turn were significantly higher than the complex vowel combinations ($t(59) = 4.09$, $p < .001$). For the Grade 1 children the proportion of single vowel responses were significantly higher than the simple vowel combinations ($t(19) = 2.20$, $p < .05$), which in turn were significantly higher than the complex vowel combinations ($t(19) = 4.97$, $p < .001$). For Grade 2 and Grade 3 only the single vowel responses were significantly higher than the simple vowel combinations ($t(19) = 2.74$, $p < .01$; $t(19) = 2.44$, $p < .05$), as the simple vowel and complex vowel combinations were not significantly different.

(Insert Table 2 about here)

3. *Tone marker errors*

The youngest children tended to omit or substitute the tone markers that occur above the word (37 errors), however the older children made relatively few of these error types.

Discussion

Developmental pathways in spelling in Thai children

In the current study, we examined the development of spelling of words in Thai children from Grade(s) 1, 2, and 3. We were interested in the particular challenges that this

distinctive orthography poses to children. After 4 months of school, the Grade 1 children achieved 32% correct for word spelling, in contrast Grade 2 children achieved 85% correct, and Grade 3 children 87% correct. It was noticeable that spelling performance rapidly increased between the youngest Grade 1 children, and the Grade 2 and 3 children, and that relatively few errors were made by the older children. The rapid increase in children's spelling performance in Grade 2 reflects children's developing orthographic skills and knowledge. It appears that difficulties associated with learning to spell the predominantly monosyllabic Thai words were to a large extent overcome by Grade 2.

An analysis of the spelling errors made by the children was conducted. The youngest children, the Grade 1 children, made a high proportion of unrelated and initial consonant errors. These types of errors are commonly found in learners of other orthographies and reflects the children's poorly developed phonological and orthographic skills, and inability at this stage to fully encode the words. Next, I will consider the spelling errors found in the Thai children in relation to the factors and features that have been found to influence spelling development in other orthographies. The aim is to delineate between what are common and orthography-specific errors.

Consistency of phoneme-grapheme mapping

The relative consistency of the orthography being learned affects spelling development. Thai vowels are complex graphemically in their expression, but are in general relatively consistent in phoneme to grapheme mapping. In contrast, consonants are less consistent in their mapping as they are feedback inconsistent due to having homophonous consonants, which provide alternative spellings for the same phoneme. In addition, there is a change in phoneme-grapheme correspondences of consonants when they occur in final position. We found support for the prediction that a greater number of consonant errors would be made than vowel errors. Young children also found the final consonants in the

syllable to be more problematic than initial consonants. The final change consonants (i.e. ทาส /ta:s/ *slave* pronounced /ta:t/) appear to be problematic for the Grade 1 children, as none of the Grade 1 children made a correct response to this type of consonant, and also some of the children in Grade 2 (7 children) and Grade 3 (5 children) children still made this error. There are other irregularities including silent final consonants (e.g. อาทิตย์ /a:0tit3/ *week*), which proved problematic to the youngest Grade 1 children. When letters have no correspondence in speech, they produce opacity in the spelling system, which contributes to the difficulty children have in acquiring the orthography (Caravolas, 2005). Due to frequent exposure in the classroom to this particular irregular word, children presumably acquired it relatively early.

Spoken language effects

Phonology of the spoken language plays an important role in spelling (Treiman, 1993; Joshi et al., 2005). In everyday spoken language, particularly in central Thai dialect, the /r/ is often spoken as /l/, e.g. ร้อน /rɔ:n/ ‘hot’ becomes /lɔ:n/. As predicted we found spelling errors that reflected this confusion in Thai children. This particular phonological error also occurs in Kiswahili (Alcock & Ngorosho, 2003). These spelling errors indicate an influence of the spoken language on children’s writing/spelling strategies.

Segmentation problem

Children have to learn to segment spoken language into units that correspond to the writing system. Segmentation of speech into phonemes has been shown to be problematic for children learning to spell in alphabetic writing systems (Treiman & Kessler, 2005). Similar to what occurs in other orthographies, a common error found in the Thai children was to spell a consonant cluster with a single letter (Alcock & Ngorosho, 2003; Caravolas & Bruck, 1993; Sprenger-Charolles & Siegel, 1997; Stuart, 2005; Treiman, 1993; Treiman & Weatherston,

1992). Thai children tended to drop the second consonant in the consonant cluster. Specific to Thai, the younger children had difficulty with the orthographic class-change clusters, in which the first consonant of the cluster, ๓ or ๔ is silent. Children often omitted these silent class-change consonants, which affects the tone realization of the word.

Visually similar letters

There was evidence that the Grade 1 children confused in particular the visually similar vowels (e.g. ๑ /aj/ and ๒ /o:/) and the visually similar homophonous consonants (e.g. ฝ /f/ or ผ /ph/). Learning to spell requires well-honed visual skills. Children learning to spell need to be able to distinguish letters that are visually similar in their writing system. In Thai there are many letters, both consonants (e.g. ช /tʃh/ and ข /kh/) including homophonous consonants (e.g. ฝ /f/ or ผ /ph/), and vowels (e.g. ๑ /aj/ and ๒ /o:/) that are perceptually similar, and hence potentially problematic to young learners.

Memory load

Memory load poses a significant challenge to young children when they have to learn the complex combinations of vowels. It was found that children acquired the single vowels prior to the simple vowel combinations, and the more complex vowel combinations were acquired later (as reflected by the number of correct responses). This illustrates that beginning readers do find the complex vowels challenging when learning to read and write Thai. In addition, children had difficulty, as reflected in the errors produced, with vowel length and visually similar vowels, which concurs with results found in Finnish and Hindi (Gupta, 2004; Lyytinen et al., 1995). However, by Grade 2, children had largely acquired the complex system of vowels and made relatively few vowel-related errors. The graphemic expression of Thai vowels is complex, but there is consistent mapping between phonemes and graphemes.

Suprasegmental features

As expected the complex rules associated with the expression of tone proved problematic for Thai children. Tone errors were still apparent in the older children, which were largely due to selection of the incorrect homophonous consonant, tone marker or omission of the class-change consonant, which all affect the tone realisation of the syllable. According to Treiman and Kessler (2005) when children are spelling words, suprasegmental features, such as vowel length and lexical tone tend to be lost partially due to young writers pronouncing the words slowly when they spell them. Moreover, the tone system in Thai is complex. Vowel length errors were also evident as children often confused these types of vowels.

Persistent errors

We were particularly interested in the errors that persist in the older children as this gives us additional clues about the specific challenges Thai orthography poses to the learner. The persistent errors found in the current study for Thai children predominantly involved the incorrect selection of homophonous consonants, omission of class-change clusters, and the incorrect expression of tone. The main persistent errors in the older children can be classified as *minus one errors*, as the correct monosyllabic response was made except for one error, either an incorrect consonant, vowel, or tone marker (e.g. instead of เขียว /khiaw4/ *green* children wrote เขียว /khiaw0/ or for เปล่า /plaw1/ *empty* wrote เปล่า /plaw0/), which is similar to the *minus one errors* found in other studies (Sprenger-Charolles et al., 1998; Fernandes, Ventura, Querido, & Morais, 2008).

Models of spelling

The dual-route model of spelling assumes that two procedures are relied upon when engaging in spelling: a lexical look-up procedure and a nonlexical procedure that uses phoneme–grapheme rules. It has been suggested that additional sublexical units other than phonemes, such as rimes and consonant–vowel clusters, are also important in spelling (Treiman, 1991; Treiman & Zukowski, 1988). Perry and Ziegler (2004) have proposed a model whereby the sublexical procedure is broken down into various grain sizes, including syllables, rimes, and phonemes. In order to test this model, Perry and Ziegler (2004) conducted several spelling experiments involving carefully selected words and nonwords with skilled readers. They concluded that in English, skilled spellers predominantly used phoneme–grapheme units when spelling, but also used larger units to some extent. In Thai, due to its distinctive characteristics and prominence of the syllable, larger syllabic units appear to play a prominent role in spelling as well as phoneme-grapheme units (Winskel, 2009; Winskel & Iemwanthong, in press).

Conclusion

In sum, we found striking commonalities in spelling development in Thai children with other orthographies previously studied. As vowels are relatively more consistent than consonants in terms of phoneme-grapheme mapping in Thai, less errors were made spelling vowels than consonants. As in other orthographies, we found that spoken language affected the spelling behaviour of children. In central Thai dialect, the /r/ is often spoken as /l/, which was reflected in the spelling errors made. Consonant clusters, visually similar letters, and vowel length were also problematic, as has been found in other orthographies (Alcock & Ngorosho, 2003; Caravolas & Bruck, 1993; Gupta, 2004; Lyytinen et al., 1995; Sprenger-Charolles & Siegel, 1997; Stuart, 2005; Treiman, 1993; Treiman & Weatherston, 1992). Particular to Thai, the complex vowel combinations posed significant challenges to young learners. Moreover, the tone system in Thai has a complex realisation, which includes

learning to use class-change consonants and tone markers appropriately, which is difficult for beginning spellers. Learning to spell Thai words with the correct tone realisation is essential, as lexical tone changes the meaning of the word and there are many syllables or lexemes that are phonologically the same apart from the assigned tone. Thai is predominantly a monosyllabic language with words with very similar spellings; often varying in just one letter or the tone of the syllable, which adds to the challenges of learning this particular orthography. This characteristic of Thai is also reflected in the children's error responses, as the most frequent errors in the older children were minus-one-errors, whereby the child produced the correct spelling apart from one error (an incorrect consonant, vowel, or tone marker).

In future, in order to gain greater insights into spelling development in Thai, we need to extend this preliminary study to include a larger variety of words, including multisyllabic words as well as spelling words in sentence contexts. It would also be interesting to see if older children make similar errors to the younger children when low frequency words are used.

APPENDIX A

Thai initial consonants (IPA symbols are in parenthesis).

Place of articulation		Bilabial	Labio-dental	Alveolar	Palatal	Velar	Glottal
Manner of articulation							
Stop	Voiceless aspirated	ผ พ ภ (ph)		ฐ ฑ ฒ ถ ท ฑ (th)	ฌ ฌ ฌ (tçh)	ข ฃ ฅ ฆ ฆ (kh)	
	Voiceless unaspirated	ป (p)		ต (t)	จ (tç)	ก (k)	อ (?)
	Voiced	บ (b)		ด (d)			
Nasal		ม (m)		ณ น (n)		ง (ŋ)	
Fricative			ฝ ฟ (f)	ซ ส ษ ส (s)			ห ฮ (h)
Lateral				ล พ (l)			
Trill				ร (r)			
Approximant		ว (w)			ญ ย (j)		

APPENDIX B

Thai vowel expressions classified in terms of vowel combinations (adapted from Schoknecht, 2000)

	Vowel expressions	Example
(1) Single vowel expressions		
(i) Preceding the consonant vowels:	เ /e:/, แ /ɛ:/, โ /o:/, ใ /aj/, ไ /aj/	แปรง /pre:ŋ/
(ii) Following the consonant vowels:	ะ /a/, ำ /a:/, อ /ɔ:/, า /am/	คอ /kɔ:/
(iii) Upper vowels occurring above the consonant:	ิ /i/, ี /i:/, ุ /u/, ู /u:/	สี /si:/
(iv) Vowels occurring below the consonant:	ุ /u/, ู /u:/	งู /ŋu:/
(2) Simple vowel combinations (combination of 2 vowel letters)		
(i) Preceding vowel plus following vowel:	เะ /e/, แะ /ɛ/, เอ /ɛ:/, โะ /o/, ไำ /aw/	โปะ /po/
(ii) Vowel above plus following vowel:	ัว /ua/	ัวัว /wua/
(3) Complex vowel combinations (combination of more than 2 vowel letters)		
(i) Preceding plus two following vowels:	เอะ /ɛ:/, เาะ /ɛ:/	เงาะ /ŋɔ:/
(ii) Preceding, upper plus following vowels	เีย /ia/, เือ /ua/	เรือ /rua/
(iii) Preceding, upper plus two following vowels:	เียะ /iaw/, เือะ /ua?/	เอี้ยะ /iaw/
(iv) Upper plus two following vowels:	ัวะ /ua?/	ลัวะ /lua?/

APPENDIX C

Lexical tone is determined by an interaction between tone markers, class of consonant and syllable ending (the irregular tone realizations are marked in bold).

Class of initial consonant			
	High class consonant	Mid class consonant	Low class consonant
Tone marker			
∅	rising	mid	mid
' –	low	low	falling
ʻ –	falling	falling	high
Ending			
Any ending except k, p, or t, or short vowel	rising	mid	mid
k, p, or t after a long vowel	low	low	falling
Short vowel, or k, p, or t after short vowel	low	low	high

APPENDIX D

The words for the spelling task

เรือ	สอง	รูป
boat	two	picture
เดือน	งาน	ทาส
month	work	slave
เก้า	ฟาก	รัก
nine	bank	love
เหนื่อย	หยอก	สิ่ง
tired	joke	thing
เชื่อ	ขวด	หนึ่ง
believe	bottle	one
เขียน	หก	ก่อน
write	six	before
แปรง	ผัด	เก่า
brush	fry	old
เปล่า	หยุด	ป้า
empty	stop	aunt
อาทิตย์	เหงา	อยู่
week	lonely	is
ใหม่	หนาว	วิ่ง
new	cold	run
เมือง	จิบ	ข้าง
town	taste	part
เทียน	เก็บ	หญ้า
candle	keep	grass
เชือก	อยาก	ต้อง
string	want	must
เกลือ	ม้า	บ้าน
salt	horse	house
เตรียม	น้ำ	จำ
try	water	remember
เงิน	โปะ	สุ
money	add	rotten
เปลี่ยน	เงาะ	งู
change	curly	snake
เขียว	ไห	อ้วะ
green	jar	bobbin
โค	ใย	เอี้ยะ
ox	web	lean

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Notes

1. There are 4 archaic letters; ฤ, ฤๅ, ฦ, ฦๅ, which are rarely used.
2. Tones are marked in the Thai examples cited in this paper as follows; 0=mid, 1=low, 2=falling, 3=high, 4=rising. This system is based on the system that was developed at the Linguistics Research Unit (LRU) of Chulalongkorn University (Luksaneeyanawin, 1993).
IPA transcription is used for the transcription of all other Thai text.

Table 1

Frequency of consonant, vowel and tone errors (percentages per grade level are in parentheses)

Error Type	GRADE 1	GRADE 2	GRADE 3
1. CONSONANT ERRORS			
a. Initial position in the syllable			
Substitutions			
Different	16	8	8
Visually similar	3	0	2
Homophonous	19	9	5
Total	38 (7.84)	17 (18.09)	15 (17.44)
Consonant cluster	71 (14.58)	9 (9.57)	12 (14.29)
Class-change cluster	51 (10.47)	7 (7.45)	8 (9.30)
b. Final position in the syllable			
Substitutions	93	12	13
Additions	9	3	4
Omissions	38	1	1
Total	140 (28.75)	16 (17.02)	18 (20.93)
Total consonant errors	300 (61.86)	49 (52.13)	53 (61.63)
Final-change consonant	13	6	5
Final silent letter error	16	1	2
Spoken related RL error	17	10	5
2. VOWEL ERRORS			
Omissions			
Vowel preceding consonant	30	1	0
Other vowel	24	1	3
Total	54	2	3
Substitutions	11	6	5
Vowel Length	24	15	13
Visually similar vowel	23	7	4
Total vowel errors	112 (23.00)	30 (31.91)	25 (29.07)
3. TONE	37	3	7

MARKER ERRORS	(7.60)	(3.19)	(8.14)
TOTAL	485	94	86

Table 2

The proportion of correct responses to the different vowel types

	Grade 1	Grade 2	Grade 3
Single vowel	0.48 (.12)	0.94 (.12)	0.93 (.09)
Simple vowel combination	0.37 (.23)	0.83 (.17)	0.88 (.15)
Complex vowel combination	0.11 (.16)	0.81 (.19)	0.81 (.21)