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The Causes of English Spelling Errors by Arabic Learners of English

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Abstract

This study investigates the possible cause(s) of English spelling errors by Arabic learners of English (ALEs). Studies show that ALEs make significantly more English spelling errors than other English second-language learner groups. Studies also show ALEs make more errors with vowels. The omission of short vowels in Arabic writing has been proposed to cause *vowel blindness* in English, resulting in the poorer spelling performance. This study evaluates this claim by comparing the distribution of short and long-vowel errors and vowel and consonant error types from handwritten texts by ALEs. While this study found more vowel than consonant errors, only the distribution of vowel graph-choice and insertion errors significantly differed from the number of consonant errors by subcategory. Graph-choice errors, not omission errors, were exceedingly the most common error type. Vowel length was not significantly associated with either vowel omission or graph-choice as expected under the vowel blindness hypothesis. The results, thus, did not indicate a missing vowel orthographic transfer effect as the primary reason for ALE orthographic production difficulty in English. Instead, this paper proposes an underdeveloped lexical-orthographic-representation hypothesis to account for both the degree and range of errors found. This study also found that low and high proficiency groups only significantly differed in consonant graph-choice and silent-graph error categories, with the advanced group performing better. These results suggest that ALE spelling skills are not markedly improving with the advancement of other writing skills and that ALEs may need explicit spelling instruction, especially to connect vowel phonemes with multiple graphemes.

Keywords: Arabic ESL; orthographic competence; orthographic transfer; spelling; vowel blindness

1. Introduction

1.1. Arabic orthographic difficulty in English

Orthographic difficulty by Arabic Learners of English (ALEs) is a topic of much discussion. ALEs reportedly have messier handwriting and poorer spelling skills than several other groups studying English as a second language (ESL) (Thompson-Panos & Thomas-Ruzic, 1983). Studies have found that ALEs perform significantly worse than other ESL groups on tests measuring spelling skill in terms of accurate graph

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recognition/attention (Hayes-Harb, 2006; Ryan & Meara, 1991) and production (Dunlap, 2012; Fender, 2008). Given this problem, several studies have investigated ALE spelling error types (Bowen, 2011; Dunlap, 2012; Haggan, 1991). Studies have also tested where spelling errors are more likely to occur (Fender, 2008) and be recognized (Saigh & Schmitt, 2012). When these studies have separated vowel errors from consonant ones, the results show that ALEs make more vowel errors.

Dunlap (2012) had 88 ESL participants, who spoke either Arabic, Spanish, Korean, or Chinese as their first language (L1), record an oral response from a computer prompted question and then transcribe their recorded message. Spelling errors were then categorized and counted from the transcriptions for each language group. The results showed that ALEs created more total errors than the other groups and more vowel errors than consonants.[†] Haggan's study (1991) tallied and compared spelling errors made by 1st and 4th year Arabic English majors on their end-of-the-semester handwritten examinations.[‡] The results showed that selecting an incorrect vowel graph (i.e., choosing the wrong letter for vowel graphs) to be a common problem (177 cases out of 405 total errors). Bowen (2011) surveyed ALE teachers to create an error database and found that 89% of the vowel letters as compared to 43% of the consonant letters were incorrect from 250 randomly selected misspelled words. Of these vowel errors, right-vowel wrong-place (i.e., vowel transposition or misordering errors) were more common than addition, deletion, or other vowel type errors (2011, p. 92). Haggan (1991), conversely, found few letter misordering errors for either vowel or consonants: only 12 cases, which was less than .03%. Instead, choosing the wrong letter for vowel graphs mapping to the vowel *schwa* (64 cases) and incorrectly selecting vowel graphs for other vowel phonemes (113 cases) were disproportional, frequent errors. It is difficult, however, to compare the results of these studies directly because each study categorized spelling errors differently. Nevertheless, these studies suggest that ALE orthographic difficulty centers on vowels.

To explain some of the orthographic difficulty that ALEs exhibit, Thompson-Panos and Thomas-Ruzic (1983) suggested that the omission of short vowels in the Arabic writing system results in the omission of vowels in English writing. Ryan and Meara (1991) coined the term *vowel blindness* to likewise describe why Arabic students were less likely to notice words with missing vowels in their study. Adopting this hypothesis, Hayes-Harb (2006, p. 335) concluded that the results of her study indicate that Arabic speakers attempt to visually process words in English much as they do in Arabic, creating a condition whereby vowel graphs are given less attention than consonant graphs. Subsequently, this vowel blindness hypothesis is often discussed as the cause for ALE spelling difficulty (see Alsadoon & Heift, 2015; Bowen, 2011; Dunlap, 2012; Saigh & Schmitt, 2012; Taylor, 2008), and it is cited as the reason why vowel errors are more common for ALEs (Bowen, 2011; Dunlap, 2012). Alsadoon and Heift (2015), for one, specifically target vowel blindness in their research designed to

[†] Dunlap does not give the frequency of more discrete vowel categories.
[‡] The exam papers were reported to be written "spontaneously" without the aid of dictionaries, and on a common topic (p.47).

improve ALE spelling ability, implying that vowel blindness is a major obstacle and prominent cause for ALE poor spelling skills.

The results of some studies have suggested that vowel blindness is a valid condition for literate Arabic (Hayes-Harb, 2006; Ryan & Meara, 1991; Saigh & Schmitt, 2012) and Hebrew speakers (Koriat, 1984). To examine the possible effects of vowel blindness on spelling recognition and production, Saigh and Schmitt (2012) tested if ALEs notice omitted or incorrect graphemes representing tense vowels more than lax vowels. Tense vowels such as [i] and [u] generally have a longer duration period than lax vowels, making these tense vowels more like non-omitted Arabic long vowels. They selected 40 frequent words with short vowels and another 40 words with long vowels and embedded them in sentences. Each vowel occurred in three conditions: a correct, incorrect, and omitted vowel condition. Incorrect vowels were represented by a different vowel grapheme. 24 native Arabic speaking participants were then instructed to mark each test sentence as either correct or to cross out and correct any encountered misspelled words. The results showed that the participants often failed to recognize incorrect or missing long vowels (i.e., about 1/3 of the errors were not noticed and another 1/3 were not accurately corrected), but the results also showed that the failure rate for short vowels was significantly greater (i.e., over 40% were not noticed and nearly 1/2 were not accurately corrected). While, this provides evidence that vowel quality affects ALE spelling accuracy, the ability of vowel blindness to explain the degree and range of spelling mistakes by ALEs is still largely unclear.

ALEs also struggle with capitalization (Thompson-Panos & Thomas-Ruzic, 1983) and choosing the correct consonant graphs in English (Bowen, 2011; Dunlap, 2012; Haggan, 1991). In Haggan's (1991) study, consonant doubling errors (54 cases) and other consonant errors (47 cases), were also relatively common. Silent <e>[§] misspellings were also problematic (36 cases). Furthermore, Saigh and Schmitt (2012) found that their ALE participants caught missing vowels significantly more often than incorrect vowels, suggesting that ALEs are aware of the importance of representing the vowel position. Saigh and Schmitt (2012) also found that neither the missing nor incorrect vowel-condition had a significant effect on a participant's ability to spell the target word correctly. While ALEs paid attention to vowel graphs, they had difficulty choosing the correct vowel graph in most cases. Additionally, ALEs underperformed in comparison to other ESL groups when spelling words containing both short and long vowels (see Fender, 2008).

Fender (2008) compared ALEs' ability to spell different word types with a group of non-Arabic ESL participants to gauge the acquisition of more complex spelling patterns. The study consisted of 37 ESL participants: 16 Arabic ESL students and 21 ESL students from Korea, China, and Japan. Three different spelling conditions were created to evaluate each group's acquisition of English spelling rules from simple to more complex words: a within word, syllable-juncture, and derivational spelling condition. Monosyllabic words that had short, long, or complex vowels (digraphs and

§ <> indicates orthographic units, // phonemes, [] phonetic units, {//} morphemes, and {} the target spelling.

or diphthongs) composed the within word condition (e.g., *cut*, *strange, cook, train*). Multisyllabic words consisting of doubled consonants, long vowels with open syllables, and short vowels with closed syllables composed the syllable juncture condition (e.g., *written*, *babies, kitchen*), and multisyllabic words with derivational affixes made up the derivational condition (e.g., *responsible, education*). The results showed that the non-ALE group performed significantly better in all three conditions. The results also showed that ALEs made more errors with multisyllabic words and words containing derivational affixes as opposed to monosyllabic words with both short and long vowels: "the problem [was] especially acute among the Arab ESL participants who seem[ed] to struggle with orthographic complexity" (p. 34). Inexplicable spellings are also frequently cited in the literature (e.g., "oniouns" for "audience" in Dunlap, 2012, p. 26). The problem, consequently, appears to be larger than a short-vowel omission transfer effect.

While it is possible that vowel quality contributes to some of the doubling errors in Haggan (1991) and Fender (2008) (i.e., the coda consonant in monosyllabic words with single-graph short vowels is doubled when suffixed with {-ing}, {-ed} etc… (e.g., hop → hopping), there is no known argument to the author's knowledge explaining how vowel blindness specifically causes many of the other frequent error types reported. Vowel blindness has simply been assumed to cause short-vowel errors, and thus its outcome has not been clearly articulated. It is unclear why vowel blindness would cause more graph-choice than graph-omission errors.

In addition to not fully understanding the cause of ALE orthographic difficulty, the extent that proficiency in written English addresses the cause(s) of the orthographic difficulty is not evident. When error types were compared between proficiency groups, Haggan (1991) found that advanced ALEs performed significantly better than ALE remedial students on consonant-doubling errors following an affix (e.g., swi<u>m</u>ing {swi<u>mm</u>ing}), and unnecessary silent <e> additions (e.g., with<u>e</u> {with}). Advanced ALEs, however, made more other consonant errors (39 cases) than the remedial group (only 8 cases), but the difference was not significant.** The results mainly showed insignificant improvement with both consonants and vowels.

The depth of the English orthographic system may play a substantial role in graph choice errors (cf. Fender, 2008; Taylor, 2008) and may cause vowel blindness to appear more significant than it actually is. That is, even if vowel blindness is a valid condition, it is possible that its effect is relatively minor when accounting for the overall spelling production problem. Thus, while it is clear that ALEs have orthographic problems in English, the cause or causes of this issue remain insufficiently described and demonstrated.

1.2. The depth of the English orthographic system and vowels

The English orthographic system consists of 26 individual graphs derived from the Roman alphabet. It reads from left to right, top to bottom. The system is deep because

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** Other comparisons did not reach significance or there were too many subcategories with zero counts for the chi-square analysis used.

the mapping of phonemes to graphemes is irregular (Frost, Katz, & Bentin, 1987), making it difficult for both native (Seymour, Aro, & Erskine, 2003) and non-native speakers (Haggan, 1991) to learn.

English graphemes create several difficulties for ESL learners to overcome: graphs link to many different phonemes (<y> ←→ any /i/, syllabus /ɪ/, shy /aɪ /, year /j/); some phonemes link only to a digraph (/ʃ/ ←→ <sh>; /θ/ ←→ <th>); some phonemes link to both a graph and digraph (/f/ ←→ <f>, <ph>, <gh>); some phonemic contrasts have no distinguishable graph or digraph contrast (/ð/, /θ/ ←→ <th>); some graphs or digraphs will be assigned no value (live <e>, height <gh>); some graphs or digraphs may systematically change their surface, phonetic value when obtaining a morphemic value (<s> as {/plural/} ←→ cats [s], dogs [z], boxes [z], <ed> as {/past/} ←→ tugged [d], trucked [t]). Stress placement, syntactic category, and the presence or absence of other non-local graphs can affect the value of a given graph (finite vs. infinite, live snails vs. to live, hop vs. hope). Furthermore, only 5 of the 26 letters are exclusively used to represent ~11 vowels and ~8 diphthongs.[††] In contrast, 21 letters represent English's ~24 consonants. Single vowel-graphs are used for long-vowels (to /u/, me /i/), diphthongs (bacon /eɪ/, bicycle /aɪ/), and short-vowels (put /ʊ/, mat /æ/). Digraphs are also used for long-vowels (spoon /u/, feet /i/), diphthongs (trail /aɪ/, pie /aɪ/), and short-vowels (certain /ɪ/, book /ʊ/). The English system is, thus, a deep system because of the number of digraphs and the variable mapping of phonemes to graphemes, especially for vowels.

The Arabic writing system consists of 28 primary graphs that are not derived from the Roman alphabet. It reads from right to left, top to bottom. The Arabic system is relatively shallow with more consistent grapheme to phoneme correspondences (GPCs).

The Arabic orthographic system is a consonantal script or Abjad. Its 28 graphs principally represent consonants: the short vowels /i/, /u/, and /a/ are not generally present in written Arabic. They do appear, however, in the Quran and in texts for language learners (Abu-Rabia, 1997; Fender, 2008). If present, short vowels are only indicated by a diacritic mark: the graph < ب >, which represents the sounds [b/p], is written as < بِ > for [bi], < بُ > for [bu] and < بَ > for [ba]. This means these short vowel sounds either have secondary status or are not indicated in writing. As Arabic learners become more proficient, though, they easily "fill in the missing vowels", as these short vowels often reflect grammatical information that can be gathered from the greater context (Hayes-Harb, 2006, p. 2). Thus, individually, written words usually do not display their full phonemic value.

A phonemic distinction exists between short and long vowels in Arabic. Unlike the short vowels, the long vowels are not omitted. The consonant letters 'alif <ا>, yā'<ي>, and wāw <و> are also used to represent the long vowels: /a:/, /i:/, and /u:/. Despite this and the letter tāʾ marbūṭa < ة > (which is a silent graph in modern Arabic), graphemes and phonemes in Arabic correspond very closely, almost 1:1 (cf. Saigh & Schmitt,

[††] ~ means approximately: the exact number of vowels and diphthongs naturally depends on the dialect of English.

2012; Watson, 2007). Accordingly, because Arabic is more consistent, ALEs may not be accustomed to matching variable graphemes with a particular phoneme as is required in English.

As discussed, ALEs appear to struggle with vowels more than consonants, but vowel-graph errors are also the most common error type for several other ESL groups (Bebout, 1985; Dunlap, 2012) and for L1 English children (cf. Mullock, 2012). The reason vowel errors are more common for most groups arguably results from the depth of the English orthographic system: GPCs vary greatly with vowels in English because of the small inventory of single graphs and the large number of vowel digraphs and pronunciation differences.

Since the depth of the English orthographic system also creates an obstacle for other ESL groups who use shallow orthographies, the difference in performance by ALEs should be the result of other factors. The question, then, is whether vowel blindness or something else coupled with the depth of the English orthographic system is the cause (or a primary reason) for ALE spelling difficulties in English.

1.3. Why English spelling may be particularly problematic for ALEs

The depth of the English orthographic system should be a nearly equal problem for several ESL groups. Spelling, however, was significantly less problematic for Spanish ESL students (i.e., Spanish like Arabic utilizes a shallow orthography) and Korean, Chinese, and Japanese ESL students, who do not use a Romanized script (see Dunlap, 2012, and Hayes-Harb, 2006). Other factors, such as phonological and morphological differences between English and Arabic and the state of L1 literacy and education in much of the Arabic world (cf. Taylor, 2008), may also contribute to the English spelling problem, making the depth of the English system more challenging for ALEs.

The morphology of Arabic may play a role in ALE spelling errors. Arabic roots are identified by a consonantal pattern. The script is mostly represented with different consonant clusters that compose a particular root pattern (eg., k-t-b = something to do with books/writing). This arguably creates a lot of repetition for Arabic readers by limiting the visual variance of a particular root. This perhaps allows Arabic readers to connect orthographic form to meaning more easily. Similarly, word length could contribute to spelling mistakes. Words in Arabic tend to be short: “less than six character long” (Randall & Meara, 1988, p. 135). This suggests the number of letters needed to be stored for accurate word recognition and production in Arabic is more limited than in English.

L1 literacy and education is another complicating factor that ought to be considered when accounting for ALE spelling errors and reading and writing difficulty in English. L1 literacy skills affect the quality of subsequent language learning (Carson, Carrell, Silberstein, Kroll, & Kuehn, 1990; Carrell, 1991; Saiegh-Haddad & Geva, 2010). Reading and writing education in much of the Arabic world has often lacked proper attention (cf. Taylor, 2008). Fender (2008) similarly suggested that many ALEs are also weaker readers in their L1. The situation of diglossia within the Arabic world contributes to this problem, because Arabic students must learn to read and write in a language that is different from the language spoken at home (Abu-Rabia, 2000). Accordingly, ALEs are not as skilled in reading and writing in Arabic. This suggests that ALEs lack practice with word recognition and practice connecting semantic/phonological forms to orthographic forms in writing.

One or a combination of these issues may be hindering ALEs' acquisition of GPCs in English. Without this skill, ALEs will subsequently be more susceptible to errors from orthographic depth and have weaker word recognition ability, resulting in spelling problems and slower and less accurate reading and writing ability.

1.4. The importance of orthographic competence for ALEs

In addition to poor spelling skills, ALEs have also exhibited poorer reading and writing skills than other ESL groups (cf. Fender, 2008; Randall & Meara, 1988; Taylor, 2008). ALEs, nevertheless, have performed nearly the same or better on listening and speaking tasks (Fender, 2008). Poor spelling skills likely contributed to the discrepancy between ALE reading and writing skill and listening and speaking skill.[‡‡]

While much ESL research on reading instruction has focused on top-down strategies, ESL learners who are weak readers in their L1 and or those who have different L1 orthographic systems may not have the ability to decode a text even after being given sufficient background information (Taylor, 2008, p. 31). Cultural gaps cause guesses and inferences to be less successful, greatly hindering comprehension: "the closer the match between their prior knowledge and the new knowledge, the more accurately [students] comprehend" (Wang, Martin, & Martin, 2002, p. 98). Clearly, there is a gap between the culture of the Arabic world and that of much of the English texts ALEs encounter. Framed as such, ALEs must utilize bottom-up reading comprehension strategies, and perhaps must do so more than other students.

Orthographic competence or awareness is a key component of writing speed and accuracy and reading speed and comprehension (cf. Fender, 2008; Perfetti, 1997; Perfetti & Hart, 2002; Saigh & Schmitt, 2012). The Lexical Quality Hypothesis (Perfetti, 1992; Perfetti & Hart, 2002) states that efficient word retrieval relies on "a fully specified orthographic representation (a spelling) and redundant phonological representations" (p.190). From a bottom-up perspective, it is believed that weak readers possess weak word recognition skills in both their L1 (Perfetti & Hart, 2002) and a second language (Fender, 2008; Nassaji, 2003; Randall, 2009). The ability to deconstruct words into phonemes and graphemes is limited. Consequently, poor spellers are likely to be slow readers and to have lower reading comprehension skills than better spellers.

Nassaji (2003) found that better graphophonic and word recognition skills (in addition to better semantic/lexical processing skill) accurately separated stronger ESL

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‡‡ Different processing strategies likely also play a role in ALE reading difficulty (see Randall and Meara, 1988).

readers from weaker ones. Fender (2008), noted that this and other research support the idea that "a single orthographic lexicon serves both English word recognition and spelling production", meaning those with poor orthographic representations have difficulty with both comprehension and production (p. 22). Accordingly, identifying the primary cause(s) for ALE orthographic difficulty may aid in the development of more effective corrective measures to improve ALE spelling skills, which may in turn improve ALE reading and writing skills.

1.5. Proposal and research design

This work argues that ALEs have a larger, more fundamental problem with orthographic competence in English than the vowel blindness hypothesis alone can explain. This general deficit may be the true cause or a contributing factor for many of the results attributed to vowel blindness because vowel graph errors should be more difficult for any learner who is weak with GPCs. Subsequently, it suggests that this problem is inherently linked with ALE reading and writing difficulty.

This study proposes an underdeveloped orthographic representation hypothesis (URH) which states that ALEs are mostly relying on phonological representations and a limited set of GPCs to spell words in English (see Fender, 2008, for a similar idea). ALEs comparatively lack orthographic representations for whole-word forms. This hypothesis places many ALEs near the partial alphabetic developmental stage of spelling described by Ehri (1997), whereby breaking words into phonemes and representing these with letters or the appropriate graph/digraph is difficult. The prediction is that ALEs will have problems with both consonants and vowels and that errors will increase as GPC and phonemic variation increases. Accordingly, graph choice errors will be the most common category overall but more common for vowels. This hypothesis does not exclude the possibility that ALEs are also less familiar with derivational spelling rules or that short-vowel omission has an effect, but claims insufficient whole word representation and GPCs are the core problem.

If vowel blindness is primarily responsible for ALE orthographic difficulty, then the following strong hypothesis may be made: pronounced vowel omission errors will be more frequent than extra vowel insertion errors, consonant omission errors, and silent <e> errors; short-vowel omission errors will be more frequent than long-vowel omission errors. Furthermore, as a weaker corollary, short-vowel graph choice errors are expected to be more frequent than long-vowel ones.

To evaluate these claims, errors were categorized into vowel and consonant graph/digraph error types and subtypes and tallied to see whether there were significant distribution differences. Pearson's chi-square tests, as used in Dunlap (2012) and Haggan (1991), were used to show significant differences between error categories and proficiency levels and between types of error categories. If vowel type errors attributable to vowel blindness constitute a larger percentage of the overall errors, this would suggest that addressing vowel blindness (as done in Alsadoon & Heift, 2015) is a priority when attempting to improve ALE spelling mistakes in

English. If vowel length does not appear to influence spelling error rates, this suggests an alternative cause such as insufficient knowledge of English GPCs.

2. Method

2.1. Error categorization

While there is no standard method for categorizing orthographic errors, as mentioned in the introduction, some previous studies (Bowen, 2011; Dunlap, 2012; Haggan, 1991) have examined types of spelling violations by ALEs.[§§] Bebout (1985) devised a discrete system which endeavors to universally categorize spelling error types by learners of English, but only Haggan (1991) attempts to directly use it to describe ALE spelling errors. All three studies categorized errors differently and Bebout did not design the system to investigate the cause of ALE errors: Bebout's system ignores vowel length as a variable.

This study proposes a way to categorize errors by ALEs to investigate vowels and vowel length on omission errors, and GPC accuracy. It borrows from Bebout's system, but the organization directly contrasts consonant and vowel type errors as done in Dunlap (2012). It also deviates from Bebout's system by not using several unattested error subcategories reported in Haggan (1991) and by focusing more on graphemes (i.e., graphs and or digraphs as a single unit) rather than letters. This study also eliminated several vague *other* categories, balancing error categories between vowel and consonant type errors to compare the frequency of each. This design was important under the premise that vowel blindness should effect the distribution of vowel errors differently than consonant ones, especially for omission type errors.

This study divided omission errors into silent and salient categories, unlike Bowen (2011) and Dunlap (2012). Silent omissions (e.g., <tim> {time} / hav {have}) are not the same as short-vowel omissions in Arabic, making their connection to vowel blindness less straightforward. Since silent graphs do not directly link to a phonemic value, their omission is arguably the result of incomplete orthographic, lexical knowledge.

Like other studies, this study also examined metathesis (transposition) errors to check whether writing direction in Arabic interferes with the order of graphs in English. This was to compare the effect of one orthographic variable with another: linear direction vs. omission. Unlike other studies, however, this study accounted for transpositions involving only vowel graphs, consonant graphs or a combination of two in order to examine if one type was more common.

This study also did not count *form* and *morphological/pattern/rule* type errors as done in Dunlap (2012) in order to separate punctuation, word use, and morpho-syntactic grammatical knowledge from word form and grapheme knowledge. The form <musics> would not be counted as an error because the derivation of this word is possible (e.g., *The musics of the world emotionally unite us.* 'types of music') and

[§§] Fender (2008) tested conditions where spelling errors were more likely to occur rather than types of spelling errors.

<deers> would not be counted as an error because this likely reflects morphosyntactic/lexical knowledge instead of spelling accuracy.

Vowel and consonant segment violations (graph/digraph errors) were divided into six major categories: graph choice, salient omission (a pronounced graph/digraph is missing), silent omission (an unpronounced graph/digraph is missing), insertion (a graph or digraph is inserted), and metathesis error categories. A single word could contain multiple graph errors of one or several categories (e.g., chouc_latte {chocolate} = 3 graph errors representing 3 different categories). The target word was determined by context (e.g., "when I was a small shild" {child}) and when the target word could not be clearly determined, the misspelling was not counted.[***]

Table 1. Examples of General Error Categories[†††]

Error Types	Vowel Error Examples	Consonant Error Examples
1. Graph/Digraph Choice:	seviral (several), pai (pie)	cources (courses),plak (black)
2. Salient Omission:	inter_sted (interested)	hear_ (heart)
3. Silent Omission:	leag_e (league),	hai_t (height)
4. Insertion:	prefefers (prefers)	driviting (driving)
5. Metathesis:	thier (their)	[ingore][‡‡‡] (ignore)
6. Metathesis CV:	starnge (strange)	

Table 1 line (1) demonstrates graph choice errors. These are errors where the student failed to pick the correct graph or digraph, choosing instead the wrong graph within the correct sequence. Line (2) type errors are ones where the student failed to produce a graph or digraph that satisfied all the sound segments of the target word. Line (3) type errors consisted of failing to produce a graph or digraph that has no associated phonological value. Line (4) type errors involved inserting an extra graph. With these errors, it is impossible to determine if the student intended for the graph to be pronounced or silent. In most cases, however, the addition would result in an additional syllable. Line (5) type errors are presumably the hardest to categorize because a variety of things are involved. Nevertheless, if the produced letters appeared out of order from the target form, these errors were counted as metathesis errors, regardless if the graph was silent, salient, or a digraph. Finally, Line (6) demonstrates metathesis CV errors. Since this error type involves both a vowel and a consonant, it was categorically both a vowel and consonant type error.

This design also better accounts for the use of digraphs. It interpreted errors involving a digraph as a single error rather than as two errors or as a transposition error as done in Bowen (2011). Accordingly, this study interpreted <pai> {pie} as applying <ai> for /aɪ/ as opposed to <a> for <i> and <i> for <e>: two potentially separate errors. Relatedly, <fainlly> {finally} is both a digraph error and a short-vowel omission error in this study, instead of 1 transposition error, where <a> is moved

[***] There were only a few cases where the target word could not be reasonably determined (e.g., adure, advistar {target unknown}).

[†††] All examples are ALE misspellings from this study except <ingore>. This example is from Haggan (1991) because no consonant metathesis errors were found in this study.

ahead of <i>, as done in Bowen (2011, p. 92). This approach is arguably better because the errors were generally accounted for with fewer assumptions (see Limitations section for more on this).

2.2. Error subcategorization

Vowel blindness only ostensibly explains short-vowel error types. Unlike previous studies that categorized produced spelling errors, this study divided omission errors into long /eɪ i aɪ oʊ u/[§§§] and short / ə ɪ ɛ æ ɒ ʌ ʊ / vowel errors. Another complicating factor is the different rate of vowel occurrence: short vowels are more frequent, creating more opportunity for errors. According to Cruttenden (2014), short vowels create roughly 67% of vowels found in texts in general British English (short vowels: /ə/ ~26%; /ɪ/ ~21%; / ɛ / ~ 7%; / æ / ~ 4%; /ɒ/ ~ 4%; /ʌ/ ~ 4%; /ʊ/ ~ 1.5 %), a figure which is similar to general American English (p. 158-159). This percentage was used to adjust the theoretical expected outcome when comparing long and short-vowel error counts with a chi-square test of goodness-of-fit. This study likewise divided graph choice errors into long and short subcategories to examine the possible weak effect of vowel blindness. If vowel length influences graph-choice errors, we would expect short-vowel errors to account for more than two thirds of the total errors because short vowels make up approximately two thirds of the vowels.

The study also checked silent <e> errors following a short or long vowel. Silent <e> errors may be GPC errors when they change the quality of the preceding vowel (e.g., cap vs. cape). They may also be a truly silent graph (e.g., have, some, one, because) for which correct use requires complete lexical knowledge rather than correct phonology and GPCs. Nevertheless, this study examined the frequency of silent <e> errors occurring after short and long vowels to see whether fewer omission errors occurred with long vowels.

Finally, to examine the possible effect of short vowels on a spelling rule, this study, like Haggan (1991), checked whether doubling errors (i.e., errors involving two adjacent identical graphs) occurred after the affixes {/-ing/}, {/-ed/} etc. This study also checked whether a doubling error occurred in a monosyllabic word with a single-graph short vowel (e.g., cut > cuting), digraph short-vowel (e.g., look > lookking), or long vowel / glide coda / complex coda (e.g., take > takking; say > sayying; talk > talkking). This was to see whether doubling errors were likely the product of GPC / word form errors, vowel blindness or incomplete knowledge of a derivational spelling rule. A large number of doubling errors after a short vowel could suggest a vowel blindness effect. On the other hand, if most mistakes were stem internal (e.g., ocur [occur]), this would suggest limited GPC / word form knowledge.

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‡‡‡ [] within a Table indicates an unattested example from this study.

§§§ Rhotic vowels were not simply categorized as long vowels but instead as a vowel and a consonant. The vowel could be short *fur* or long *here*.

Table 2. Examples of Vowel Error Subcategories

Vowel Error Subtypes	Examples
Graph Choice	
Short Graph Error	geless (jealous)
Long Graph Error	butiful (beautiful)
Omission	
Short Vowel	inter_sted (interested)
Long Vowel	unus_al (unusual),
Silent <e>, Morphological	happen_d (happened)
Silent <e>, Syllabic <l>	peopl_ (people)
Silent <e>, Short Vowel	som_ (some)
Silent <e>, Long Vowel	mistak_s (mistakes)
Vowel Insertion	
Silent <e>, Morphological	reasones (reasons)
Root Final <e>, Short Vowel	sectore (sector_)
Root Final <e>, Long Vowel	companye (company)

Table 3. Examples of Consonant Error Subcategories

Consonant Error Subtypes	Examples
Graph Choice	
1. Single for Single	televition (television)
2. Single for Digraph	preftionally (professionally)
3. Digraph for Digraph	mush (much)
4. Digraph for Single	toghothar (together)
Omission	
5. Silent Omission Other	gover_ment (government)
6. Doubled Stem Omission	eag (egg)[****]
7. D. O. - Affix, Multisyllabic Stem	financialy (financially)
8. D. O. - Affix, Monosyllabic, Single Graph, Short Vowel	[weding] (wedding)[††††]
9. D. O. - Affix, Monosyllabic, Digraph, Long Vowel	realy (really)
Insertion	
10. Insertion Other	teatchers (teachers)
11. Doubled Insertion	midell (middle)
12. Other Doubled Insertion at Affix	imottion (emotion)
13. D. I. - Affix, Monosyllabic, Single Graph, Other	[slowwing] (slowing)
14. D. I. - Affix, Monosyllabic, Digraph, Short Vowel	[bookking] (booking)
15. D. I. - Affix, Monosyllabic, Digraph, Long Vowel	[keepping] (keeping)

[****] These are counted as a type of doubling error under the premise that there is no phonological cue to differentiate between one consonant or a doubled consonant: *beg* and *egg*.
[††††] This was the closest example of this possible error type found. The actual spelling produced was *weedding* for *wedding*.

2.3. Research material selection

Assessment texts used to gauge ESL writing level proficiency at the end of a semester at the University of Florida English Language Institute were selected for this study's spelling error analysis. Each text was handwritten by one and only one student who had been given approximately one hour to write either a few paragraphs responding to the same, open ended prompts (e.g., describe a happy day in our life) or an essay on a similar, common prompt.

Two or more instructors at the University of Florida English Language Institute had independently rated each writing assessment on a proficiency scale of 1 (low) to 6 (high).[‡‡‡] Raters looked for writing structure, clarity, coherence, sentence complexity, grammar, vocabulary, and spelling to make their decisions. Students who had performed well on this task were placed into a higher level writing class. Since students were finishing coursework in one proficiency level, if they had performed well, they were placed into the next level or higher by this assessment. If they had not performed well, they had to repeat the previous level course.

From these assessments, 20 ALE texts were selected for this study.[§§§] Each text had been written by an adult (18 years or older) ALE from Saudi Arabia. Each author had completed at least four months of intensive English study in the U.S. Each text was between 200 and 450 words long. These texts were then subdivided into two groups based upon their proficiency level rating: 12 texts were rated low (10 at level 3 and 2 at level 2) and 8 texts were rated high (6 at level 5 and 2 at level 4). All level 2 and 3 texts were paragraph responses. Level 5 and 4 rated texts were essays responses except for one level 5 text, which was a paragraph response. The possibility that errors resulted from simple, careless typos was arguably reduced because the texts were handwritten.

3. Results

3.1. Main category error results

Table 4 divides the total graph/digraph vowel and consonant errors found from the 20 assessment texts by main category.

Table 4. Main Category Consonant and Vowel Errors

‡‡‡ A third rater had scored the assessment if there was a disagreement over level placement.

§§§ IRB-02 approval was issued via the University's review board as the assessments had been originally administered and gathered for educational purposes other than research.

Error Type Vowel	Error Number	Error Type Consonant	Error Number
1. Graph Choice	180	1. Graph Choice	42
2. Salient Omission	42	2. Salient Omission	17
3. Silent Omission	36	3. Silent Omission	19
4. Insertion	33	4. Insertion	25
5. Metathesis	5	5. Metathesis	0
Subtotal Vowels	**296**	Subtotal Consonants	**103**
6. Metathesis CV	12		
Total Errors	**411**		

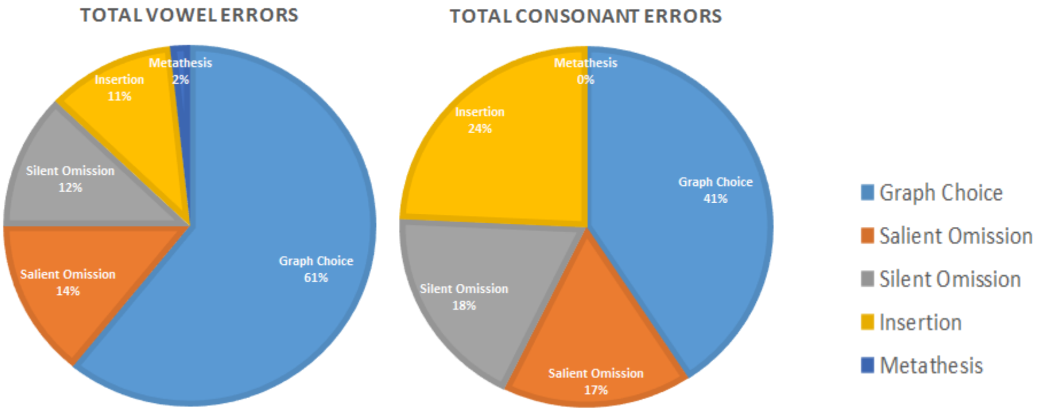

Figure 1. Proportion of Total Errors

A chi-square test of independence between vowels and consonants by error categories showed a significant difference, χ^2 (4, N = 399) = 18.771, p < .001. Cramer's V further indicated that this difference was strong (V = 0.217). The null hypothesis that vowel and consonant categories are independent can be rejected. Graph choice, χ^2 = 5.51, and insertion, χ^2 = 9.06, differences contributed most to this result as compared to salient omission, χ^2 = 0.28, silent omission, χ^2 = 2.19, and metathesis, χ^2 = 1.74.

The difference between vowels and consonants and graph choice and insertion errors was also found to be significant: p < .001, Fisher's exact test, two tailed. No significant difference, however, was found between consonant and vowel categories and silent and salient omission error types: p = .55, Fisher's exact test, two tailed. A chi-square test of goodness-of-fit test did not show a significant difference between salient vowel omission and vowel insertion errors with an expected even distribution, χ^2 (1, N = 75) = 0.86, p = .35 (corrected for continuity). *****

***** The value of all chi-square tests with 1 degree of freedom was corrected for continuity.

Table 5. Errors by Proficiency Group

	Low Level		High Level	
Error type	Vowel	Consonant	Vowel	Consonant
1. Graph Choice	113	34	67	8
2. Salient Omission	26	12	16	5
3. Silent Omission	17	17	19	2
4. Insertion	18	17	15	8
5. Metathesis	2	0	3	0

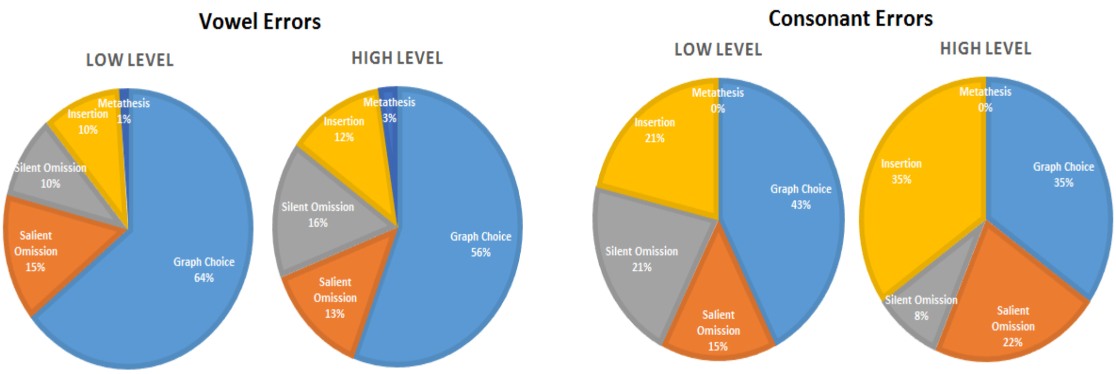

Figure 2. Vowel and Consonant Errors by Proficiency Group

A chi-square test of independence did not show a significant difference between low and high proficiency levels across vowel categories, χ^2 (4, N = 296) = 4.28, p = .36. Similarly, the results did not show a significant difference between low and high proficiency levels across consonant categories, χ^2 (3, N = 103) = 3.627, p = .3. A significant difference was, however, found using a chi-square test of goodness-of-fit between low and high levels for consonant silent-omission errors with an expected even frequency, χ^2 (1, N = 19) = 5.7, p < .02 and consonant graph-choice errors with an expected even frequency, χ^2 (1, N = 42) = 6.83, p < .01. No significant difference was found for addition or salient omission categories p > .05.

3.2. Results of subcategories

Table 6. Graph Choice Error Subtypes

Vowel Error Subtype	Number	Consonant Error Subtype	Number
Short Vowel	109	Single for Single	30
Long Vowel	71	Single for Digraph	9
		Digraph for Digraph	1
		Digraph for Single	2

A chi-square test of goodness-of-fit only showed a significant difference between short and long vowels with an expected even frequency, χ^2 (1, N = 180) = 7.6, p < .05. When the expected rate for short-vowel errors was increased to 60%, there was no significant difference, χ^2 (1, N = 180) = .023, p = .87, (χ^2 = 0, p = 1, when corrected for continuity). When it was increased to 67%, following the frequency from Cruttenden (2014), the difference was nearing significance, χ^2 (1, N = 180) = 3.09, $p \cong .08$, with more long and fewer short-vowel errors than expected, assuming a vowel blindness effect.

A chi-square test of goodness-of-fit between consonant single for digraph and digraph for single-graph errors was also found to be nearly significant with an expected even frequency, χ^2 (1, N = 11) = 3.28, p = .07.

Table 7. Salient Omission Subcategories

Vowel Error Subtype	Number	Consonant Error Subtype	Number
Short Vowel	33	Word Final	10
Long Vowel	9	Word Internal	7

A chi-square test of goodness-of-fit also showed a significant difference between observed and expected long and short-vowel salient-omission errors with an expected even frequency, χ^2 (1, N = 42) = 12.6, p < .001, but not at the proposed 67% rate, χ^2 (1, N = 42) = 2.05, p = .15. No difference was found between word final and internal consonant omission errors with an expected even frequency, χ^2 (1, N = 17) = 0.24, p = .62. Moreover, comparing salient and silent omissions found no significant difference with an expected even frequency, χ^2 (1, N = 78) = 0.32, p = .57.

Table 8. Silent Omission Error Subcategories

Vowel Error Subtype	Number	Consonant Error Subtype	Number
Other Vowel	2	Other Consonant	2
Short Vowel Silent <e>	13	Doubled Stem Internal	10
Long Vowel Silent <e>	16	Doubled, Affix, Multisyllabic	5
Morphological Silent <e>	2	Doubled, Affix, Monosyllabic, Short Vowel	1
Syllabic <l> Silent <e>	3	Doubled, Affix, Monosyllabic, Long Vowel	1

A chi-square test of goodness-of-fit between silent <e> omission and other vowel omission errors clearly showed a significant difference with an expected even frequency, χ^2 (1, N = 36) = 26.7, p < .001. No significant difference was found between silent <e> errors following short and long vowels with an expected even frequency, χ^2 (1, N = 29) = 0.14, p = .7.

A significant difference was found between doubled and other omission errors with an expected even frequency, χ^2 (1, N = 19) = 10.32, p = .001. No significant difference was found between stem-internal doubled omission errors and doubling errors following an affix with an expected even frequency, χ^2 (1, N = 17) = 0.24, p = .62.

Table 9. Insertion Subtype errors.

Vowel Error Subtype	Number	Consonant Error Subtype	Number
Insertion (Other)	12	Insertion (Other)	11
Short Vowel Final <e>	11	Doubled Stem Internal	12
Long Vowel Final <e>	5	Doubled, Affix Other	2
Morphological Silent <e>	5	Doubled, Affix, Monosyllabic	0

No significant difference was found between other vowel insertion and silent <e> insertion errors with an expected even frequency, χ^2 (1, N = 33) = 1.94, p = .16. Likewise, no significant difference was found between short and long silent <e> insertion errors with an expected even distribution, χ^2 (1, N = 16) = 1.56, p = .21. No significant difference was found between doubling and other insertion type errors with an expected even frequency, χ^2 (1, N = 25) = 0.16, $p \cong .69$. A significant difference was, however, found between stem internal and doubling after an affix insertion-errors with an expected even frequency, χ^2 (1, N = 14) = 5.78, $p < .02$.

4. Discussion

This paper aimed to answer whether vowel blindness or the proposed underdeveloped orthographic representation hypothesis better explains the types and frequency of ALE spelling errors and to answer whether vowel errors decrease with greater proficiency. Subsequently, it aimed to increase our understanding of which spelling error types improve with overall stronger writing skills and to describe prominent ALE spelling errors more discretely. This study found a significant difference between the distribution of vowel and consonant errors with vowel errors being more problematic than consonants (as similarly reported in other studies). This study, however, did not find a significant difference in the percentage of consonant and vowel omission errors or a clear association between vowel length and error rates, suggesting that vowel blindness is not the core reason for ALE orthographic difficulty. These results are valuable when considering appropriate pedagogical responses for the orthographic problem, a problem that likely contributes to ALE reading difficulty.

4.1. Lack of evidence for a specific vowel blindness effect

As articulated here, the strong version of the vowel blindness hypothesis not only predicts that vowels will be more problematic than consonants, but also that vowel omission errors will be more frequent than vowel insertion errors. This was not the case. Vowel omission errors were not found to be significantly different from vowel insertions errors. As in Haggan (1991), vowel graph-choice errors were the most common error type. Salient vowel omission errors only accounted for about 10% of the total errors found. There was also no significant difference between salient and silent omission errors. In addition, no significant difference was found between short and long-vowel omission errors when the expected frequency rate of errors was adjusted to reflect that short vowels occur more often. Likewise, no significant relationship was found between long and short-vowel graph-choice errors. It is unclear why a vowel omission effect was not detected. While these findings are technically only a failure to reject the null hypothesis, they also suggest that vowel length and error rates are independent. They indicate that ALEs are just as likely to insert an unnecessary vowel graph as they are to omit a necessary one, just as likely to omit long vowels as short vowels, and just as likely to choose the wrong graph for both short and long vowels when engaged in a writing task. Thus, these results do not support either the weak or strong version of the vowel blindness hypothesis discussed here.

The findings also failed to show that ALEs are significantly improving on the spelling of vowels. They, however, did show significant improvement with consonants on silent graphs and graph choice. The improvement on silent graphs and consonant doubling errors concurs with Haggan's (1991) findings while the improvement on graph choice is the opposite of what Haggan found. The lack of improvement with vowels coupled with some improvement with consonants could be taken as evidence that vowels are being treated categorically different. Nevertheless, while the differences were not significant, the high level ALEs did improve in every vowel category except for errors involving silent <e>. Because GPCs are more variable for vowels, this may have contributed to this result.

4.2. URH and GPCs

As introduced, the URH posits that ALEs are not acquiring lexical orthographic representations of a similar quality as compared to other groups. The URH predicts greater vowel errors while also explaining problems with consonant graphs. The greater GPC variance of vowels is argued to cause the disproportionate number of vowel errors and make learning vowels more problematic. A vowel-omission transfer effect may also exacerbate this problem, but much like the infrequency of metathesis errors in this study and in Haggan (1991), these kinds of orthographic differences appeared to cause few errors. The URH may then better explain why the short and long-vowel distinction did not affect the frequency of graph choice or omission errors.

If ALEs have poor orthographic representations, they likely build them from phonological ones. This is accomplished via GPCs, which appear limited (e.g., chiken {chicken}) or mismatched (e.g., <sh> for [tʃ] mush {much}). Accordingly, misspelling consonant digraphs with a single graph was more frequent than misspelling single graphs with digraphs and this difference was nearly significant. Single graph for single graph errors were the most common and often reflected using a graph incorrectly while preserving the correct pronunciation: consentrate (concentrate); televition (television); engoy (enjoy). This suggests that ALEs may resort to using simpler, more common GPCs that reflect accurate pronunciation while failing to notice incorrect word shapes, even in very common words/roots (e.g., vision, much, enjoy). GPC problems can also explain many of the other consonant graph errors. For instance, an English phoneme that does not exist in Arabic caused several of the graph choice errors (e.g., /b/ vs. /p/: proplem {problem}, berfect {perfect}).

English's deep orthography and Arabic's smaller inventory of phonemic vowels accounts for the prevalence of vowel graph choice errors. For example, the phoneme /aɪ/ can correspond with a single graph <i>, two non-local graphs <iCe>, a single consonant/vowel graph <y>[†††††], or a digraph <ai>, <ie>. If ALEs are building from the phonological level, they may rely on 1 or 2 common graphs/digraphs for this sound (i.e., this study found that <ai> was often mistakenly used for /aɪ/: maight {might}; taires {tires}; insaid {inside}; orgnaize {organize}. This contradicts the preference to use a single graph over a digraph. It may be that ALEs tend to use one graph for each sound: diphthongs perhaps are perceived as two units. There appeared to be some preference for using a single graph to represent short vowels: alredy {already}; geless {jealous} did {dead}; famus {famous}. Moreover, <i> was often used for the vowel [ɪ]/[i]: thim {them}; seviral {several}; thise {these}.

Ryan and Meara (1991) noted in their study that the position of the deleted segment within the word influenced the detection rate (i.e., deletions at word edges were detected more frequently). Similarly, in this study salient vowel omissions always occurred word internally and most often on unstressed vowels in multisyllabic words (e.g., dang_rous {dangerous}). In this position, the pronounced vowel is often reduced or deleted in speech. In addition, sonorant consonants often followed omitted vowels (e.g., sudd_nly {suddenly}), suggesting that the sonorant consonant is accounting for the nucleus of the syllable, making the omission of the vowel less obvious. Thus, while it is not clear why and how letter position would influence the effect of vowel blindness on short vowels, one may see how these results could emerge from deriving orthographic representations from phonological ones.

Poor lexical representations likely caused many of the omission/insertion silent <e> errors and omission/insertion doubled-consonant errors. The difference between silent <e> omission and other silent vowel omission errors was significant, which likely only means that silent <e> is a much more frequent silent graph. No significant difference was found between other vowel insertions and silent <e> insertion errors. Taken together, this may suggest that despite the prevalence of silent <e>, it is not part of the lexical representation. GPCs also did not seem to influence the distribution, as errors did not predictably follow vowel quality: no significant difference between insertion/omission of silent <e> and vowel length was found. Weak orthographic representations may, therefore, explain the frequency of these errors. In addition, the pronunciation of *schwa* after words like *as* and *child* might account for errors such as *ase* {as} and *childe* {child}.

If an orthographically doubled consonant is pronounced differently, the difference is not very salient (e.g., tomorrow vs. tummy). A significant difference was found between doubling and other omission errors with there being more doubling errors, but no significant difference was found between stem internal and doubling omission errors following an affix. This suggests that doubling is the primary reason for consonant omission errors, but that it is not associated with an affixation spelling rule. No significant difference, however, was found between doubling and other insertion type errors. A significant difference was found between insertion errors involving stem internal doubling and doubling after an affix with there being more

[†††††] One could make the argument that this graph is a vowel graph or a semivowel graph.

stem internal errors. In fact, this study did not find any cases of overapplying the doubling rule to digraphs, long vowels, glide codas, or complex codas. This suggests that doubling is not the primary reason for insertion errors and that when such errors do occur, they are not likely caused by the over-application of the spelling rule. These results are different from Haggan's (1991) because that study found most doubling insertion and omission errors to be at the affix/stem boundary.

4.3. Limitations and suggestions for future research

It was not possible to be completely confident about the categorization of every error. For instance, it is possible that some errors counted as silent omission errors were actually metathesis errors: does *achiev* result from *achive* or *achieve*? This study categorized this error as a silent <e> omission error given the evidence from clearer examples which signal a propensity to make this error type.

Sampling was dictated more by convenience than true randomness. Samples could only be taken from ALEs attending the English Language Institute who had completed the assessment. These problems, however, exist in the other studies on this topic as well.

The educational background (exact length of time studying English), L1 reading and writing proficiency, and knowledge of other languages was unknown for each author of the analyzed texts. Likewise, the other studies have not consistently reported or controlled these variables. One may wish to consider and control these variables in future research. Future study may want to examine typed errors and the use of spellcheckers. Such studies might also want to compare freely written ALEs errors with another group (such as Hebrew) whose L1 writing system also omits vowels.

5. Conclusions

The results of this study suggest that even if vowel blindness is a valid condition, it is not the core problem. The results show that both vowel and consonant errors are problematic across several categories but that vowel errors are much more frequent. While the distribution of vowel and consonant errors appeared to be significantly different, the cause of this difference was not omission errors as predicted by the strong version of the vowel blindness hypothesis. Instead, graph choice and insertion error frequencies were significantly different, suggesting that graph choice was especially problematic for vowels and that insertions were relatively problematic for consonants. Short vowel graph-choice and salient-omission errors were not significantly greater than long-vowel errors. Assuming vowel blindness more strongly affects short vowels, a larger percentage of short-vowel graph and omission type errors should have been found. Likewise, finding more salient omission than silent omission errors would more clearly indicate vowel blindness, but this study did not find a significant difference between these two error types. These findings, thus, suggest vowel blindness is not a useful hypothesis when attempting to explain the core cause of ALE spelling errors. Instead, spelling from a phonological representation may better explain the common distribution of consonant and vowel silent / salient omission errors. GPC errors may better explain the consonant graph-choice errors and the significantly higher number of vowel errors. GPC errors are more numerous for vowels because GPCs are more variable for vowels and ALEs may lack the literacy skills/learning habits to overcome this problem easily. If this conclusion is correct, teachers should explicitly teach both consonant and vowel GPCs to ALEs but focus more on the accurate production of different graphemes representing the same vowel sounds. Improving GPC awareness in ALEs will likely not only improve spelling accuracy but may also improve reading comprehension and speed. Accordingly, more research is needed to confirm this and to test effective means for improving GPCs for ALEs.

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