education sciences

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How a Phonics-Based Intervention, L1 Orthography, and Item Characteristics Impact Adult ESL Spelling Knowledge

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Abstract: Spelling ability is a key dimension of orthographic knowledge and a crucial component literacy skill that supports automatic word recognition and fluent reading. There has been substantial research on first language (child) English speakers' spelling ability, including the effectiveness of instruction interventions for improving spelling knowledge. However, there is relatively little research on spelling in adult learners of English as a second language, and even less examining instructional interventions for improving their spelling. The current study addressed this gap by implementing an adaptation of a phonics-based instructional intervention in a university-based intensive English reading class. Compared to two different control cohorts, the cohort receiving the intervention significantly improved their ability to accurately identify whether an English word was spelled correctly or not. Analyses also considered the influence of a variety of lexical characteristics as well as participants' L1 writing system. The results demonstrate the efficacy of this intervention in adult L2 English learners and also highlight the importance of considering word characteristics and participants' language background when examining spelling performance.

Keywords: L1 influence; ESL; spelling; phonics; interventions

Citation: Martin, K.I. How a Phonics-Based Intervention, L1 Orthography, and Item Characteristics Impact Adult ESL Spelling Knowledge. *Educ. Sci.* **2024**, *14*, 421. https://doi.org/10.3390/educsci14040421

Academic Editor: Sihui (Echo) Ke

Received: 31 December 2023
Revised: 2 April 2024
Accepted: 10 April 2024
Published: 17 April 2024

Orthographic knowledge is a crucial component of literacy [1,2]. Broadly defined, it is knowledge of and the ability to learn, store, and use information about the written forms of words and the conventions of writing and spelling [3,4]. Spelling skills are thus one important dimension of orthographic knowledge. Spelling also has strong ties to other literacy skills, including word recognition, phonological awareness, and both text comprehension and composition [5–7]. Spelling and its development have been widely studied in children, especially in a first language (L1) context, and the effectiveness of various instructional interventions for improving spelling (many of them based on phonological skills) has also been demonstrated [8–10]. However, comparatively little work has examined spelling in second language (L2) adult learners, particularly the effectiveness of instructional interventions for improving spelling knowledge. Therefore, the goal of the present research was to examine spelling knowledge in adult learners of English as a second language (ESL) and to demonstrate the effectiveness of a phonics-based instructional intervention for improving their English spelling knowledge.

1. Spelling Development

Orthographic knowledge is crucial for literacy development. During the early stages of literacy acquisition, children commonly use their knowledge of phonological forms, such as rhymes or shared first sounds, to learn about the structure of words [11]. Words with phonological overlap also often share parts of their spellings, thus providing a way for children to learn about whole spelling patterns rather than memorizing spellings letter by letter [12]. This familiarity can then be used as the basis for making analogies, helping children read or spell unfamiliar words that contain familiar spelling patterns [13,14].

Familiarity with the orthographic forms of words is also critical for the development of rapid, automatic word recognition, and thus reading fluency. Though phonological information is initially used for decoding words, increased exposure to print develops

readers' familiarity with orthographic sequences, facilitating their ability to rapidly extract lexical information from print [15–17]. This is a reciprocal process: as readers develop more automatic text processing, they begin to rely relatively more on orthographic information than grapheme-by-grapheme phonological decoding [18,19], ultimately linking together the sounds, spellings, and meanings of words in a process termed orthographic mapping [17]. This ability to recognize words as units, based on whole orthographic forms rather than by decoding a series of individual letters, is necessary for fluent reading because it frees up cognitive resources for higher-level text processing and comprehension [2,20–22].

Overall, greater orthographic knowledge is associated with better decoding skills, more accurate word reading, and greater reading comprehension [23–25], and it is important for supporting literacy cross-linguistically [26]. However, there is evidence that orthographic knowledge may be even more important for readers of non-alphabetic languages, such as Chinese, in which phonological information cannot be directly recovered from the written form, as well as readers of deeper alphabetic orthographies, such as English [27–29]. Thus, a thorough understanding of orthographic knowledge, its development, and how it can best be supported, is crucial for supporting literacy development.

It is important to recognize that the term 'orthographic knowledge' can be used to refer to a broad range of skills and types of knowledge, which can be grouped into sub-lexical and lexical orthographic knowledge [4,30,31]. At the lexical level, it is often used to refer to spelling ability, and it is this aspect of orthographic knowledge that is the focus of the current research. This spelling knowledge is crucial for general literacy acquisition because of its role in automatizing word recognition and serving as the basis for making analogies among different word forms. However, the value of spelling knowledge goes beyond this, as spelling ability also plays a critical role in social perceptions, with poor spelling often associated with poor education, carelessness, or even lower intelligence [32–34]. Even in an age of increasing acceptance of multiple language varieties, correct spelling is still critical and cannot be fully compensated for by tools such as spellcheck [35–37]. Spelling knowledge also directly translates to more applied skills, such as the ability to proofread one's writing and recognize orthographic errors [38,39].

Much of the research on spelling has focused on either documenting the development of spelling ability in children gaining L1 literacy or assessing the effectiveness of instructional techniques for improving L1 spelling (and other literacy skills). For example, studies have consistently found that phonics-based instruction is effective for improving spelling skills as well as reading ability, and that these effects can persist for years [8,40–42]. However, the vast majority of this research has focused specifically on children learning to spell in their L1, most commonly English. Compared to this extensive body of L1 spelling research, there is much less work on spelling development in an L2, in either children or adults [43,44]. Here, too, most of the research has concentrated on learners of English, although most studies comprise qualitative error documentation rather than examining the impact of instruction or L1 background on spelling ability. For example, Figueredo [43] provides a review of ESL spelling studies and reports that, of studies identified for the review, 59% (16 of 27) focused primarily on providing "descriptive analyses of ESL learners' English spelling errors" (p. 874) from a single L1 group, and only 11% (3 of 27) compared the spelling performance of learners from different L1 groups, making the generalizability of such findings unclear.

There has been even less work examining instructional interventions for L2 learners; indeed, most intervention studies and reviews, including the National Reading Panel [45], have specifically excluded learners of English as a second language (henceforth referred to as English learners or ELs) from their analyses. Thus, direct evidence of the efficacy of varying instructional interventions for L2 learners is limited, and as highlighted by Moore and Klingner [46], interventions that are effective for native English speakers cannot necessarily be assumed to be effective for ELs [47]. This is a critical issue to address, given that in the United States alone there are over 20 million individuals that speak English less

than "very well", over 11 million adults that are non-literate, and, of those who were or are adult English language learners, 39% are "below basic" in their prose literacy [48–51].

Despite this, a small number of studies do provide evidence for the effectiveness of interventions for L2 English spelling and suggest that similar instructional approaches are effective for EL children as well as L1 English-speaking children. Stuart [52,53] found that phoneme awareness and phonics training significantly improved 5-year-old ELs' reading, spelling, and general phonological awareness skills, and that these differences were maintained across multiple years of schooling. Similarly, Siegel and colleagues [54,55] have found that systematic phonological awareness activities and explicit instruction were effective for improving literacy outcomes (including spelling) and the rate at which children were classified as reading-disabled among ESL children in kindergarten and grades 1 and 2 (ages 5–7).

Similar results have been found with somewhat older learners. For example, Van Staden [56] found that explicit instruction on a range of reading skills, including word decoding, sight word recognition, and vocabulary knowledge, significantly improved word recognition, reading comprehension, and spelling outcomes for ELs in grades 4–6 (ages 10–14). Lovett et al. [57] examined the effectiveness of phonologically-based Response to Intervention (RtI) programs focusing on word decoding and identification for both ELs and L1 English speakers in grades 2–8 (ages 6–14) who were classified as reading-disabled. They found that such interventions were equally effective for improving outcomes for reading and related skills (e.g., phonological processing, word identification) in both groups. Among a small sample of adult learners, Massengill Shaw [58] found that learners who received Word Study [59] improved in their developmental spelling scores significantly more than control learners who received spelling tutoring focusing on traditional methods, such as sight word memorization.

Thus, there are some positive findings for the effectiveness of phonics-based, direct instruction for improving literacy skills in general, and spelling knowledge in particular, in ELs as well as L1 English speakers. This is therefore an area that needs increased attention in ESL literacy research, especially because to date such studies are limited in number, focus almost exclusively on younger children [60], and often examine individual or small-group supplemental instruction, rather than whole-classroom instruction [46,60]. Although this type of individualized instruction may be ideal, it is also resource-intensive and may not be feasible in all classroom environments, particularly with adult learners [61].

2. L1 Influences on Spelling Knowledge

Another factor that must be considered when examining ESL literacy skills is learners' L1 background. A growing amount of research demonstrates that L1, particularly the L1 writing system, influences the development of and reliance on literacy skills in text processing. For example, readers with an alphabetic L1 (in which each grapheme corresponds to a unit of spoken language), rely relatively more on phonological skills and information to read a text and spell words compared to readers from a non-alphabetic L1 background (in which there is a much less direct connection between written and spoken units of language) who rely relatively more on orthographic skills and information for the same tasks [27,29,62].

Most relevant to the current research, these L1 reading processes are often transferred to L2 literacy, so that L2 readers from an alphabetic L1 also rely more on phonological information and L2 readers from a non-alphabetic L1 rely more on orthographic information in their L2 for literacy tasks including vocabulary learning, word recognition, pseudoword decoding, phonological awareness, and spelling knowledge [63–68]. For example, Wang and Geva [69] compared spelling abilities in L1 Chinese-speaking children learning ESL and L1 English-speaking children. They found that the L1 Chinese speakers had lower performance than the L1 English speakers for spelling pseudowords to dictation, but that they had higher performance for a spelling task in which they had to rely on visual information over phonological information in order to perform accurately. Dixon, Zhao, and Joshi [70] compared bilingual children from Singapore with Chinese, Tamil (syllabic writing system),

or Malay (alphabetic writing system) as L1 and English as L2 on measures of English word reading and spelling. Their results also showed that the L1 Chinese speakers had the best spelling accuracy overall; however, their L1 Chinese speakers had relatively fewer misspellings that were phonologically plausible than their L1 Tamil or L1 Malay speakers. These findings are further supported by the work of Leong, Tan, Cheng, and Hau [71], who used regression, principle component analysis, and structural equation modeling to demonstrate stronger relationships in L1 Chinese (Cantonese) speakers between English word spelling and orthographic and lexical information, compared to phonological skills.

As these studies demonstrate, L1 background can help explain specific patterns of ESL spelling performance. This is notable given that, to date, most research on L2 literacy interventions have aggregated learners from different L1s, making it impossible to determine whether the effectiveness of instructional techniques varies by language background [46,60,72–74]. Thus, cross-linguistic research, including comparisons of students from different L1 types, is also needed to better understand L2 spelling development.

3. Lexical Influences on Spelling Knowledge

The impact of characteristics of the words to be spelled has also received attention in research on spelling and lexical processing. Lexical characteristics such as word frequency, length, concreteness or imageability, and bigram frequency (among many others) can strongly influence how quickly and easily words are processed [75–79]. Another strongly influential characteristic for lexical processing is spelling consistency, or the complexity of the mapping between written units (graphemes) and spoken units, such as phonemes or syllables (referred to as grapheme–phoneme correspondences or GPCs). In general, words with (more) consistent spellings are processed more quickly and accurately than words with (more) inconsistent spellings. This is true for a variety of tasks, including spelling, but also speeded reading aloud of isolated words (i.e., naming), word learning, auditory word recognition, and various types of lexical judgments [80–89].

Because of the strong influence of these lexical characteristics on lexical processing in general, and spelling in particular, it is crucial for these characteristics to either be controlled (for example, by equating items on these characteristics, or entering them into statistical analyses to account for their influence) or directly manipulated in language research. Given that there is relatively little research on how these factors influence L2 learners' language processing, though, it may be valuable to specifically study their impact on L2 spelling, thus further adding to the literature in this area.

4. The Current Study

Given the relative paucity of research on adult ESL spelling, particularly the impact of instruction on spelling knowledge in learners with varying L1 backgrounds, the current study addressed two goals. The first was to examine the effect of both item and participant characteristics on ESL spelling knowledge. To do this, at the beginning of an academic semester, three cohorts of participants completed an assessment of their English whole-word spelling knowledge that included items with varying lexical characteristics (monosyllabic and disyllabic consistent, inconsistent, and exception words). Accuracy on this pre-test spelling knowledge measure was examined in relation to these and other word characteristics as well as participants' L1 writing system type.

The second goal was to determine whether a phonics-based instructional intervention could improve ESL learners' knowledge of English spelling. To do this, two cohorts of participants received traditional ESL reading instruction only while the third additionally received a phonics-based instructional intervention. At the end of the semester, participants completed the same measure of their whole-word spelling knowledge a second time. Post-test performance was examined as a function of the type of instruction participants received after controlling for pre-test performance. The results of the current research therefore provide evidence regarding the lexical characteristics that influence ESL spelling knowledge as well as how L1 background may impact this spelling knowledge. Most importantly, the

research also demonstrates the effectiveness of an instructional intervention for supporting ESL learners' spelling knowledge.

5. Materials and Methods

5.1. Participants

Participants comprised students enrolled in a high-intermediate-level reading course in an intensive English program (IEP) at a large urban university in the United States. Data were collected in a group setting from a total of 177 participants across three academic semesters (forming three independent cohorts). Data were excluded from 18 participants who repeated enrollment in the course and thus contributed data across multiple semesters as well as the single participant from a Cyrillic L1 background, leaving a total of 158 participants whose data were analyzed (first control cohort n = 53, second control cohort n = 59, intervention cohort n = 46). Although standardized measures of proficiency were not available, all participants were recruited from the same intermediate course level at the language institute (roughly corresponding to a B1 level in the CEFR framework [90]) and had either advanced to that level through their coursework or been placed there on the basis of in-house diagnostic testing.

Participants were divided into five groups based on their type of L1 writing system. There were 17 Roman alphabet L1 participants (1 French, 1 German, 1 Italian, 3 Portuguese, 9 Spanish, 1 Turkish, 1 Vietnamese); 18 non-Roman alphabet L1 participants (Korean); 94 consonant-based L1 participants (abjad or abugida: 89 Arabic, 5 Thai); 10 syllabic L1 participants (Japanese); and 19 morphosyllabary L1 participants (Chinese). Comparison data were also collected from 17 undergraduate monolingual L1 English speakers from the same university, all of whom had not learned another language before the age of 12 or studied a language with a different writing system.

5.2. Materials

5.2.1. Spelling Knowledge

To measure their knowledge of English whole-word spellings, participants completed a spelling verification task in which they saw a list of single lexical items and had to decide whether each was a correctly spelled English word or not. Participants were encouraged to guess and to use what they knew about English words and English spelling to help them answer. There were three practice items (without feedback), followed by 120 test items.

All items were selected from a list of words the participants were expected to already be familiar with. These included all monomorphemic, monosyllabic, or disyllabic words from the General Service List [91]; the 2000 most frequent words of English [92]; words from the ESL textbook series *Words for Students of English* volumes 1–6 [93–98] and the ESL textbook series *Interchange* books 1–3 [99–101] which was used at the participants' IEP; the class vocabulary lists for students at or below the targeted level in the IEP; words that had been used productively in recorded activities by other students at or below the same level of the IEP; and words that occurred 100 or more times in an interim version of a corpus of texts produced by other students in the same language institute [102].

To examine the impact of item characteristics on participants' spelling judgments, items were chosen to cover a wide range of lexical characteristics. There were 70 monosyllabic and 50 disyllabic words, with half of each being high frequency and low frequency (determined using E-Lexicon) [103]. Words were also chosen based on the consistency of their grapheme–phoneme correspondences (GPCs); GPC consistency was determined using empirically derived consistency statistics, which use large databases to determine whether a spelling is always pronounced the same way or whether it is variable across words with that spelling [104,105]. The monosyllabic words comprised 24 items each of consistent (e.g., *came*), inconsistent (e.g., *child*), and exception (e.g., *chef*) GPCs. The disyllabic words comprised 24 consistent (e.g., *coffee*) and 24 inconsistent (e.g., *coupon*) items only; there were no disyllabic exception words because no database was available of disyllabic words that have been empirically categorized as 'exception'. Items were also matched as

closely as possible on length (in letters and phonemes), imageability, concreteness, age of acquisition, bigram frequency, and orthographic and phonological neighbors. Specifically, the high- and low-frequency consistent, inconsistent, and exception monosyllabic and disyllabic words were matched on imageability, concreteness, average L1 age of acquisition, bigram frequency, and number of morphemes. The monosyllabic items were additionally matched on number of letters, number of phonemes, number of phonological neighbors, and the frequency of those phonological neighbors. The only lexical characteristics on which monosyllabic words were not fully matched were the number and frequency of orthographic neighbors: the exception words had fewer and less frequent orthographic neighbors than the inconsistent words. The disyllabic items were matched on number of letters, number of phonemes, number of orthographic and phonological neighbors, and frequency of those orthographic and phonological neighbors.

Finally, participants saw three different types of spellings among the 120 test items. One third of each item type was correctly spelled, and participants therefore had to positively identify those items as correctly spelled English words. The remaining items were evenly divided between two types of misspellings. Pronunciation-changed (PC) items were those in which the misspelling altered the pronunciation of the original word (e.g., *heelth* for 'health'), and pronunciation-maintained (PM) items were those in which the misspelling preserved the pronunciation of the original word (e.g., *portch* for 'porch'). This manipulation was included because of previous evidence that phonological similarity to a real word influences the way that pseudowords or misspellings are processed [106–110]. The misspellings were developed following the same procedure outlined in Harris, Perfetti, and Rickles [109]. The final form of misspelled items was determined after pilot-testing with 6 monolingual L1 English speakers and norming with 43 L1 English speakers who spoke dialects of American English similar to the varieties of English taught at the participants' language institute and commonly heard in the local community. Although individual variations in pronunciations for the misspelled items (see Appendix A) are inevitable, this procedure was followed to establish as clearly as possible that the PC items actually differed in pronunciation from the original word, and that the PM items did not, in the varieties of English most familiar to the participants in this study. The same items were used in both the pre-test and post-test but were presented in a different pseudorandom order each time, with the constraint that no more than three items of the same type occurred in a row. All items are given in the Appendix A.

5.2.2. Standard Instruction

All participants were enrolled in a 14-week, high-intermediate-level intensive English reading course. As part of their normal course of study, all participants received approximately 3 ½ hours of direct reading and vocabulary instruction per week; classes met for 50 min on each of four different days. The standard curriculum for this course focused on academic vocabulary learning and reading skills such as skimming, scanning, and summarizing texts. All three cohorts of participants received this same curriculum, delivered by the same set of instructors. Two of the cohorts *only* received this standard instruction; they are referred to as Control-1 (n = 53) and Control-2 (n = 59).

5.2.3. Phonics-Based Intervention

In addition to the standard reading instruction, one cohort of participants (n = 46) also received a supplementary, phonics-based instructional intervention. This intervention comprised four lessons, each of which was approximately 30–40 min in length. These lessons were designed by the author in collaboration with the reading curriculum coordinator at the IEP and were delivered by the participants' normal instructor during class sessions. Participants also completed seven homework assignments that reinforced the lesson material and provided additional practice. In informal surveys, participants reported that these assignments typically required 30–45 min each to complete. Thus, in total, participants received approximately 5.5–8 h (330–480 min) of supplemental phonics-based

instruction and practice during the course of the study. This length of intervention falls at the lower end, but within the range, of intervention lengths identified in a recent review of reading-related instructional interventions for ELs by Richards-Tutor and colleagues [60].

The intervention was adapted from the PHAST (Phonological and Strategy Training) program developed by Lovett and colleagues [111,112]. This program was chosen as the basis for the current intervention because it has been used successfully with older adolescent and young adult learners up to age 20, in contrast with many other phonics-based interventions that specifically target children [9,113–116] and thus use activities and materials that are not visually or cognitively engaging for adults. The program combines direct instruction with extensive metacognitive training, which is more appropriate for older learners, and has materials that can be adapted for use with learners of varying ages. It was thus considered an appropriate starting point for the current intervention.

The original PHAST program teaches students five strategies for dealing with unfamiliar words: 'Sound It Out', which focuses on teaching grapheme–phoneme correspondences, spoken word segmentation, and blending skills; 'Rhyming', which teaches students to make analogies to other words with similar spelling patterns; 'Peeling Off', which focuses on awareness of affixes and separating words into their component morphemes to sound them out; 'Vowel Alert', which emphasizes the variability of vowel pronunciations and teaches students to try multiple pronunciations until they find one that sounds right; and 'I Spy', which teaches students to look for familiar components inside of longer, unfamiliar words and to blend them together. Along with these five strategies, students are also taught to talk themselves through the various strategies they can use when they encounter unfamiliar words, thus emphasizing problem solving and self-direction rather than memorization. As a result, the program follows the recommendation of Stahl, Duffy-Hester, and Stahl [117] of using analogy-based strategies in combination with direct instruction and an emphasis on using phonological cues and information to deal with unfamiliar words. For further details on the original intervention, see the work of Lovett and colleagues [111,112].

In the current adaptation of the intervention, these five strategies and their specific contents and activities were adapted and reorganized to fit the four available lessons. The list of keywords used for spelling analogies was also divided into four groups, with one group introduced to participants in each lesson; these groups were made such that most keywords were introduced as part of a lesson that focused on the most relevant spelling patterns. A brief overview of the focus of each lesson and homework assignment are provided below.

Lesson 1 focused on consonants and used direct instruction to review common consonant grapheme–phoneme correspondences (GPCs). These included the 'hard' and 'soft' pronunciations of <c> and <g> as well as ten consonant digraphs: <ck>, <ch>, <ph>, <sh>, <th>, <wr>, <qu>, <kn>, <ng>, and <wh>. Each digraph was presented on a slide along with how many pronunciations it has, what those pronunciation(s) are, example words containing the digraph, and any notes regarding their occurrence (e.g., that <ck> only occurs in the middle or at the end of a word, or that /tʃ/ is the most common pronunciation of <ch>). Participants were also introduced to the concept of keywords, or high-frequency words with common spelling patterns, which they could use as the basis for making analogies between unfamiliar and familiar words. For example, the keyword *rock* could be used to help decide the pronunciation of the unfamiliar word *shock*, and participants had the opportunity to practice with the keywords in a partner activity before the end of the lesson. The assigned homework asked participants to sort a list of words based on how their consonants were pronounced (specifically targeting hard vs. soft <c> and <g>) and to find examples of and analyze words from their assigned class reading that contained the digraphs covered in the lesson.

Lesson 2 focused on vowels and used direct instruction to review single vowel letters and their long and short pronunciations as well as the most common vowel digraphs (<ea>, <ei>/<ey>, <ie>, <oo>, <ou>/<ow>, <ue>, <ui>, <ai>/<ay>, <au>/<aw>, <ee>, <oa>, with the more variable digraphs covered first). The lesson also covered basic clues

to pronunciation that might be available from the spelling pattern of the whole word, for example, that the most common pronunciation of <a> is /æ/, but that it is often pronounced /ɔ/ before and <r> or <l>; see Figure 1 for an example slide from this lesson. Participants also reviewed the 'silent <e>' rule, in which vowels in a VCe pattern are often pronounced as long vowels with a silent <e> at the end, and practiced using keywords to help them sound out words with vowels as well as trying multiple pronunciations until they found one that sounded like a word they knew or had heard. Similar to Lesson 1, one of the homework assignments following Lesson 2 asked participants to sort a list of words based on how their vowels were pronounced; this assignment targeted the most variable diagraphs, <ea>, <oo>, <ou>, and <ei>. The second asked participants to catalog words from their assigned class reading that were difficult to pronounce and identify keywords that would be helpful for determining the correct pronunciation. The beginning of this assignment is illustrated in Figure 2.

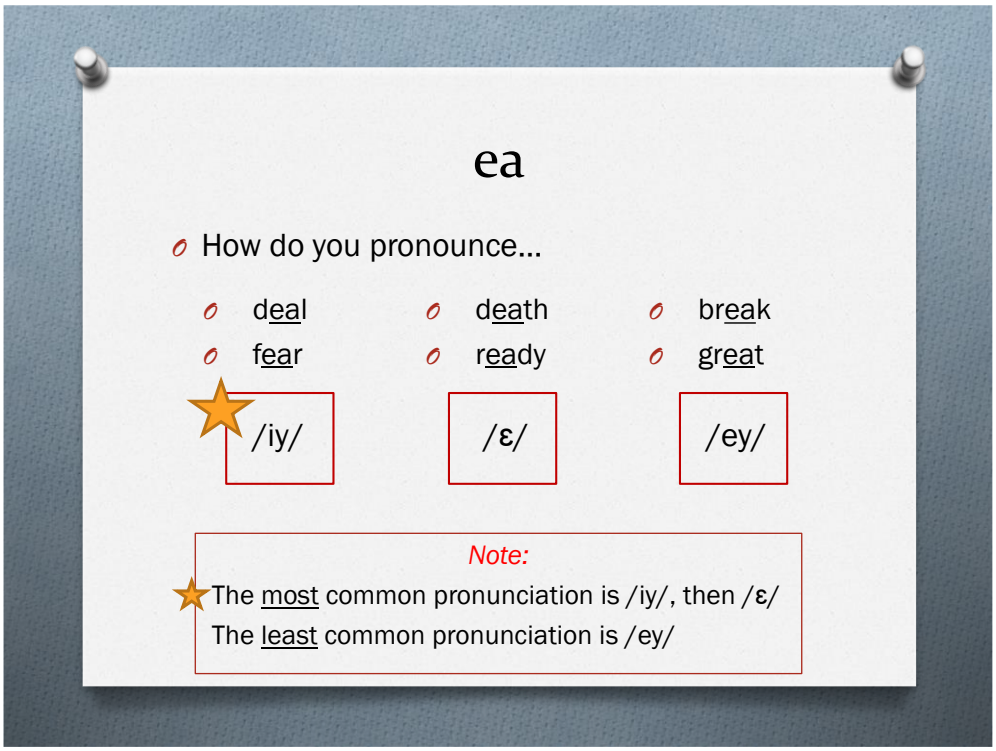

Figure 1. Example slide from Lesson 2.

Lesson 3 focused on introducing basic English morphology and the concepts of word roots and affixes. Participants reviewed common prefixes and suffixes and discussed their meanings and how they affected the pronunciation of the word root they attached to. The targeted affixes were <em->/<en->, <-ic>, <in->/<im->/<il->/<ir->, <-able>/<-ible>, <dis->, <-ion>/<-sion>/<-tion>, <-ive>, and <re->; these were chosen because they are among the more common higher-level affixes with spelling and pronunciation variations that may be challenging for L2 English learners [118]. Participants also practiced identifying affixes in words, separating them out in multimorphemic words, and using strategies they were already familiar with to decode the root. There were also two homework assignments following Lesson 3. The first asked participants to identify words with roots and affixes from their assigned class reading that were unfamiliar or difficult to pronounce and to choose keywords to help them read these words; the beginning of this assignment can be seen in Figure 3. The second provided participants with a paragraph from their assigned class reading that contained a number of words that could be correctly read with the help of the strategies participants had been practicing. Participants were asked to record

themselves reading this paragraph aloud and teachers provided general feedback on their pronunciation of the targeted words.

Directions:
First, choose four of the letter pairs from the box at the top. Write one on the line for each number below.
Then, find three words that contain each letter pair. These words should come from reading that you have done in English. You may use the reading for this class, the reading from any other class, or any reading that you do on your own outside of class.
Write down these words, along with the sentence that contains the word, and the source. Finally, write the pronunciation of the letter pair in that word.

Example:
Letter pair: __ch__
Word 1: challenges
Sentence: "An increasingly educated population poses daunting challenges for its leaders."
Source: New York Times Article, 1/16/13, "Next Made-in-China Boom: College Graduates"
Pronunciation: tʃ

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ng	th	wh
ck	sh	wr
ch	ph	kn
qu		

1. Letter pair: _____

   a. Word 1:
   Sentence:

   Source:

   Pronunciation:

   b. Word 2:
   Sentence:

   Source:

   Pronunciation:

Figure 2. Sample of an assignment following Lesson 2.

Lesson 4 served primarily as review and provided participants with an opportunity for additional practice with longer and more complex multimorphemic words. Participants reviewed the strategies they had already learned and built on them using a technique named 'SPY' or 'Seek the Part You know' (adapted from Lovett et al.'s [111,112] original 'I Spy'

strategy and also following the suggestion of other researchers [119]) that encouraged them to break apart long words and look for familiar chunks within them. Participants performed additional group work manipulating complex words (e.g., *ritualistic*, *contractually*), used the final group of keywords, and completed activities in which they worked with words sharing spelling patterns to emphasize the usefulness of analogies. The two homework assignments after this lesson asked participants to break long, complex words from their assigned class reading into smaller recognizable parts, identify useful keywords for pronouncing those parts, find examples of words from their assigned class reading with specific spelling patterns, and record themselves reading aloud a paragraph from these class texts.

Directions:
While you read in English, pay attention to words that are new, difficult, or unfamiliar. You should choose seven words that you found unfamiliar or difficult to pronounce. These words should come from reading that you have done in English, and they should have at least one prefix or suffix. You may choose words with prefixes and suffixes that we talked about in class, or others that you know. You may use the reading for this class, the reading from any other class, or any reading that you do on your own outside of class.
For each of the words, complete the information below. Include the word, the sentence where you found it, and the source. You should write the prefix(es) and/or suffix(es) from the word, plus the keywords (from Lessons 1, 2, and 3) that you can use to help pronounce it, and any other information or rules you can use to help you pronounce it.

Example:
Word: organic
Sentence: "The bacteria must depend on organic material that has drifted into the lake."
Source: New York Times Article, 2/6/13, "Bacteria Found Under Deep Sea Ice, Scientists Say, Opening New Antarctic World"
Prefix(es)/Suffix(es): -ic
Keyword(s), rule(s), pattern(s): 'or' – for; 'gan' – man

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1. Word:
   Sentence:

   Source:
   Prefix(es)/Suffix(es):

   Keyword(s), rule(s), pattern(s):

2. Word:
   Sentence:

   Source:
   Prefix(es)/Suffix(es):

   Keyword(s), rule(s), pattern(s):

Figure 3. Sample of an assignment following Lesson 3.

5.3. Procedures

Participants completed the spelling knowledge pre-test in class at the beginning of the third week of the term. All participants received standard reading instruction for four 50 min class periods throughout the 14-week academic term. The intervention cohort received lessons in weeks 4, 5, 7, and 9 and completed homework these weeks as well as weeks 6, 8, and 11 (see Table 1 for details). Finally, participants completed the spelling knowledge post-test in weeks 12 or 13 of the academic term (week 14 was reserved for final exams). The spelling knowledge pre-test and post-test were administered by the researcher and the instructor of record delivered the lessons and homework assignments. All instructors remained in contact with the researcher throughout the semester and the researcher attended each class for one intervention lesson to ensure adherence to the lesson plan.

Table 1. Study schedule.

Week	Tasks or Activities	Topic
3	Spelling knowledge pre-test	Pre-test
4	Lesson 1, Homework 1	Consonants, keywords
5	Lesson 2, Homework 2	Vowels, keywords
6	Homework 3	Keyword practice with multisyllabic words
7	Lesson 3, Homework 4	Roots and affixes, keywords
8	Homework 5	Reading aloud
9	Lesson 4, Homework 6	'SPY' strategy, multisyllabic words, spelling patterns, keywords
10	None—Spring break	-
11	Homework 7	Reading aloud, affixes, keywords
12–13	Spelling knowledge post-test	Post-test

5.4. Analyses

To account for the nested structure of the data, binomial generalized linear mixed-effects modeling was used to analyze the accuracy of the spelling knowledge tasks. The lme4 package in R was used for the main effects analyses. Overall main effects of variables with more than two levels were obtained via model comparison using the anova function and are reported using χ^2 values from these comparisons. The general linear hypothesis testing (glht) function available within the multcomp package was used for pairwise comparisons; the Tukey correction for multiple comparisons was also used. The threshold for significance was set at $\alpha = 0.05$; p-values between 0.05 and 0.10 are reported as marginally significant. Model building proceeded in an additive fashion: the first models estimated were baseline random intercepts models with random effects for item, participant, and class. Following this, variables were added to the model step by step in order of expected influence, beginning with the (expected) most influential variables. If a given variable was not significant when first added to the model, it was retained for one additional step of model building to examine whether the regression coefficient would change with the addition of other factors to the model [120]. If such variables were still not significant in the next step, they were removed from the model to maintain statistical power and model parsimony.

Two sets of analyses were performed. The first examined which L1 and item characteristics influenced participants' ability to discriminate correctly versus incorrectly spelled word forms. To do this, pre-test performance (correct/incorrect on each item) was examined as a function of participants' L1 orthography type as well as four item characteristics: word frequency (categorical: high, low; although using frequency as a continuous variable would provide greater statistical power, it was coded as categorical because continuous frequency estimates were not available on the same scale for all items), number of syllables (categorical: monosyllabic, disyllabic), spelling consistency (categorical: consistent,

inconsistent, exception), and answer type (categorical: correctly spelled, PC misspelling, PM misspelling).

The second set of analyses examined the effectiveness of the phonics-based instructional intervention for improving participants' English spelling knowledge. To do this, post-test performance (correct/incorrect on each item) was examined as a function of instruction type as well as L1 orthography type. For these post-test analyses, pre-test score was the first predictor entered into all models. This was done to control for any differences among classes or L1 groups that had existed at pre-test and also because the auto-regressive effect of a variable is often one of the best predictors of later performance [121].

6. Results

6.1. Pre-Test

Descriptive statistics for accuracy on the spelling knowledge pre-test and post-test are in Table 2, broken down by cohort (Control-1, Intervention, or Control-2) and participant L1. To analyze participants' accuracy on this task, frequency was the first factor added to the baseline random intercepts model and its effect was significant; high-frequency words were associated with a significant increase in the log odds of accuracy compared to low-frequency words, $\beta = 1.10$, $z = 4.78$, $p < 0.001$. The number of syllables was added next. Although its effect was not significant, $\beta = -0.23$, $z = -0.99$, $p = 0.32$, disyllabic words were numerically associated with a decrease in the log odds of accuracy compared to monosyllabic words. It was retained in the model at the next step, when spelling consistency was added as a predictor. The overall effect of consistency was significant, $\chi^2(df = 2) = 6.74$, $p = 0.03$. Pairwise comparisons among the three consistency types revealed that the log odds of accuracy for exception words was significantly lower than for consistent words, $\beta = -0.84$, $z = -2.54$, $p = 0.03$. In addition, the log odds of accuracy for exception words was marginally lower than for an inconsistent word, $\beta = 0.76$, $z = -2.30$, $p = 0.05$. Word frequency remained a significant predictor, $\beta = 1.10$, $z = 4.91$, $p < 0.001$, and in this model, number of syllables was also significant, $\beta = -0.50$, $z = -2.01$, $p = 0.04$, with lower accuracy on disyllabic compared to monosyllabic items. Thus, number of syllables was retained in the model going forward.

Table 2. Proportion correct on the spelling knowledge pre-test and post-test.

	Control 1		Intervention		Control 2	
	Pre-Test	**Post-Test**	**Pre-Test**	**Post-Test**	**Pre-Test**	**Post-Test**
L1 Roman alphabet	88.3% (32.1)	94.6% (22.7)	84.0% (36.7)	87.8% (32.8)	81.5% (30.6)	87.7% (32.9)
L1 non-Roman alphabet	88.0% (32.5)	88.8% (31.5)	88.3% (32.1)	90.8% (28.9)	90.2% (29.8)	90.2% (29.8)
L1 abjad/abugida	76.0% (42.7)	78.7% (40.9)	79.9% (40.1)	83.1% (37.4)	76.1% (42.7)	75.3% (43.1)
L1 syllabary	81.5% (38.9)	89.2% (31.1)	90.4% (29.5)	92.1% (27.1)	84.4% (36.3)	-- [b]
L1 morphosyllabary	78.4% (41.2)	77.5% (41.8)	68.6% (46.5)	87.9% (32.7)	77.8% (41.6)	87.0% (33.7)
L1 English [a]	98.1% (13.7)					

Note. Standard deviations are given in parentheses. [a] Data from L1 English speakers were collected at one time point only and are listed in the control cohort 1 pre-test column for convenience. [b] No post-test data from L1 syllabary students were available for this task during this cohort.

The last item characteristic, answer type, was added to the model next. The overall effect of answer type was not significant, $\chi^2(df = 2) = 0.73$, $p = 0.69$, thus no comparisons among the three answer types were made. As with number of syllables, answer type was retained in the model for one additional step to determine whether it would reach significance. However, it remained non-significant in the next model and was thus excluded as a predictor. Therefore, the three item characteristics retained in the final model were word frequency, number of syllables, and spelling consistency.

At the last step, L1 writing system type was added to the model. It was a coded as a categorical predictor with six levels: English L1, Roman alphabet L1, non-Roman alphabet L1, consonant-based L1, syllabary L1, and morphosyllabary L1 (see the Participants section for more details). The overall effect of L1 writing system type was significant, $\chi^2(df = 5) = 68.5$, $p < 0.001$. Pairwise comparisons revealed that all five non-native English speaker groups had a significantly lower log odds of responding correctly to a given item than the L1 English speakers. In addition, the non-Roman alphabet L1 and the Roman alphabet L1 groups each had a significantly higher log odds of responding to a given item correctly than the consonant-based L1 group, and the Roman alphabet L1 group had a significant higher log odds of accuracy than the morphosyllabary L1 group. All pairwise comparisons are given in Table 3 and the final model is summarized in Table 4.

Table 3. Pairwise comparisons among L1 writing system types on pre-test spelling knowledge accuracy.

Comparison	Coefficient	SE	*z*	*p*
L1 English vs. L1 Roman alphabet	2.32	0.34	6.83	<0.001
L1 English vs. L1 non-Roman alphabet	2.10	0.34	6.19	<0.001
L1 English vs. L1 abjad/abugida	3.23	0.29	11.22	<0.001
L1 English vs. L1 syllabary	2.66	0.38	7.06	<0.001
L1 English vs. L1 morphosyllabary	3.23	0.33	9.74	<0.001
L1 Roman alphabet vs. L1 non-Roman alphabet	−0.23	0.29	−0.79	0.97
L1 Roman alphabet vs. L1 abjad/abugida	0.91	0.22	4.09	<0.001
L1 Roman alphabet vs. L1 syllabary	0.34	0.33	1.04	0.90
L1 Roman alphabet vs. L1 morphosyllabary	0.91	0.28	3.28	0.01
L1 non-Roman alphabet vs. L1 abjad/abugida	1.13	0.22	5.15	<0.001
L1 non-Roman alphabet vs. L1 syllabary	0.57	0.33	1.73	0.50
L1 non-Roman alphabet vs. L1 morphosyllabary	1.13	0.27	4.15	<0.001
L1 abjad/abugida vs. L1 syllabary	−0.56	0.27	−2.05	0.30
L1 abjad/abugida vs. L1 morphosyllabary	0.002	0.21	0.01	>0.99
L1 syllabary vs. L1 morphosyllabary	0.57	0.32	1.76	0.47

Note. Reported significance values reflect correction for multiple comparisons using the Tukey procedure.

Table 4. Final model estimates of fixed effects and variance components predicting pre-test spelling knowledge accuracy.

Fixed Effect	Coefficient	SE	*z*	*p*
Intercept	4.73	0.36	12.98	<0.001
High frequency [a]	1.10	0.22	4.92	<0.001
Disyllabic [b]	−0.51	0.25	−2.02	0.04
Consistent spelling [c]	0.08	0.25	0.33	0.74
Exception spelling [c]	−0.76	0.33	−2.31	0.02
L1 Roman alphabet [d]	−2.32	0.34	−6.83	<0.001
L1 non-Roman alphabet [d]	−2.10	0.34	−6.19	<0.001
L1 abjad/abugida [d]	−3.23	0.29	−11.22	<0.001
L1 syllabary [d]	−2.66	0.38	−7.06	<0.001
L1 morphosyllabary [d]	−3.23	0.33	−9.74	<0.001
Random Effect	Variance Component	SD		
Item	1.41	1.19		
Participant	0.59	0.77		
Class	0.01	0.10		

Note. [a] Baseline is low-frequency words. [b] Baseline is monosyllabic words. [c] Baseline is inconsistent spelling words. [d] Baseline is L1 English speakers.

6.2. Post-Test

Descriptive statistics for accuracy on the spelling knowledge post-test are in Table 2, broken down by cohort (Control-1, Intervention, or Control-2) and participant L1. To analyze participants' accuracy on the post-test, the first model that was estimated was

again a baseline random intercepts model with random effects for item, participant, and class. The first predictor added to the model was individuals' pre-test accuracy score to control for any differences at pre-test. The effect of pre-test accuracy was significant, $\beta = 6.17$, $z = 10.50$, $p < 0.001$; participants who had higher accuracy on the pre-test also tended to have higher accuracy on the post-test.

As one of the major goals of this study was to determine whether a phonics-based intervention could improve ESL students' spelling knowledge, instruction type was added as the next predictor. There were three levels of this factor: Control-1, Control-2, and Intervention. The two control cohorts were analyzed separately rather than combined for two reasons: doing so allowed relatively equal sample sizes in each group to be maintained and comparing the intervention group against two independent control groups provided an additional check on the effectiveness of the instruction. The overall effect of cohort was marginally significant, $\chi^2(df = 2) = 5.51$, $p = 0.06$. Comparing the intervention group against each control cohort separately, participants in Control-1 had a marginally significant lower log odds of responding to a given item correctly, $\beta = -0.29$, $z = -1.76$, $p = 0.08$, and participants in Control-2 had a significantly lower log odds of responding to a given item correctly, $\beta = -0.46$, $z = -2.67$, $p = 0.02$. Thus, after controlling for differences at pre-test, the intervention group outperformed both independent control groups on the post-test.

Next, the L1 writing system type was added to the model. The overall effect of L1 was significant, $\chi^2(df = 4) = 10.57$, $p = 0.03$. Pairwise comparisons were examined, but with pre-test scores and instruction type already in the model, only one difference was significant: participants with a Roman alphabet L1 had a marginally higher log odds of responding to a given item correctly than participants with a consonant-based L1 (see Table 5 for all pairwise comparisons). The final model is summarized in Table 6.

Table 5. Pairwise comparisons among L1 writing system types on post-test spelling knowledge accuracy.

Comparison	Coefficient	SE	*z*	*p*
L1 Roman alphabet vs. L1 non-Roman alphabet	0.16	0.26	0.61	0.97
L1 Roman alphabet vs. L1 abjad/abugida	0.57	0.21	2.66	0.06
L1 Roman alphabet vs. L1 syllabary	−0.02	0.36	−0.06	>0.99
L1 Roman alphabet vs. L1 morphosyllabary	0.33	0.26	1.26	0.70
L1 non-Roman alphabet vs. L1 abjad/abugida	0.41	0.22	1.90	0.30
L1 non-Roman alphabet vs. L1 syllabary	−0.18	0.36	−0.51	0.99
L1 non-Roman alphabet vs. L1 morphosyllabary	0.17	0.25	0.66	0.96
L1 abjad/abugida vs. L1 syllabary	−0.59	0.32	−1.86	0.33
L1 abjad/abugida vs. L1 morphosyllabary	−0.24	0.18	−1.32	0.66
L1 syllabary vs. L1 morphosyllabary	0.35	0.35	1.00	0.85

Note. Reported significance values reflect correction for multiple comparisons using the Tukey procedure.

Table 6. Final model estimates of fixed effects and variance components predicting post-test spelling knowledge accuracy.

Fixed Effect	Coefficient	SE	*z*	*p*
Intercept	−1.40	0.59	−2.38	0.02
Spelling knowledge pre-test score	5.25	0.63	8.34	<0.001
Control cohort 1 [a]	−0.27	0.16	−1.72	0.08
Control cohort 2 [a]	−0.43	0.16	−2.64	0.01
L1 Non-Roman alphabet [b]	−0.16	0.26	−0.61	0.54
L1 abjad/abugida [b]	−0.57	0.21	−2.66	0.008
L1 syllabary [b]	0.02	0.36	0.06	0.96
L1 morphosyllabary [b]	−0.33	0.26	−1.26	0.21
Random Effect	Variance Component	*SD*		
Item	1.86	1.36		
Participant	0.32	0.57		
Class	0.001	0.03		

Note. [a] Baseline is intervention cohort. [b] Baseline is L1 Roman alphabet.

7. Discussion

The goal of the current research was to examine spelling knowledge in intermediate-level adult ESL learners and examine the impacts of word characteristics, learner L1 background, and a phonics-based instructional intervention on this spelling knowledge. The instructional intervention was adapted from the PHAST program by Lovett and colleagues [111,112]. The intervention in this study lasted 12 weeks and consisted of approximately 5.5–8 h of activities that were designed to improve participants' knowledge of GPCs and spelling patterns and provide them with strategies for dealing with unfamiliar words in a text. Spelling knowledge was evaluated using a spelling verification task, in which participants saw a list of single lexical items and for each had to indicate whether or not they thought it was a correctly spelled English word. These items varied on their word frequency, number of syllables (monosyllabic or disyllabic), spelling consistency (consistent, inconsistent, or exception), and their spelling (correct, misspelled but with preserved pronunciation, or misspelled with altered pronunciation).

The results from the spelling knowledge pre-test, administered at the beginning of the semester, revealed that word frequency, number of syllables, and spelling consistency were all significant predictors of accuracy: participants were more likely to accurately judge the correctness of an item's spelling if it was more frequent, monosyllabic rather than disyllabic, and had either a consistent or an inconsistent spelling pattern (rather than an exception spelling pattern). In addition, participants' L1 writing system type was also a significant predictor of spelling knowledge. Unsurprisingly, all ESL groups were less accurate than the L1 English speakers. In addition, the non-native English-speaker groups with an alphabetic L1 were more accurate than the groups with a consonant-based (abjad or abugida) L1, and the Roman alphabet L1 group was more accurate than the morphosyllabary L1 group.

A similar post-test was administered at the end of the semester to determine whether or how spelling knowledge had changed over the course of one semester of intensive English study. Compared to participants in the two cohorts that received only the standard IEP reading instruction, the participants in the cohort that received the phonics-based instruction intervention were more likely to accurately judge the correctness of an item's spelling. Further, after controlling for pre-existing differences at pre-test and instruction type, participants' L1 writing system type was still a significant predictor of accuracy. In particular, participants with a Roman alphabet L1 were more likely to respond to a given item correctly than participants with a consonant-based (abjad or abugida) L1.

The importance of these results are three-fold. First, and perhaps most critical, the results demonstrate the effectiveness of the instructional intervention for improving adult English learners' spelling knowledge. Although some previous studies have demonstrated the effectiveness of phonologically-based, direct-instruction teaching methods for improving ELs' literacy skills [52–58], there have been relatively few of these studies [46,60] and most of them have focused on elementary-age children rather than adults. Thus, the results of the current study both confirm the efficacy of phonics-based and direct-instruction methods for ELs and extend these findings to an under-studied population: adult learners. Given the large and growing number of adult ESL users with limited English proficiency and literacy skills, this will be a crucial area of focus for continued research.

Second, the significant impact of various lexical characteristics (word frequency, number of syllables, and spelling consistency) on participants' spelling knowledge is consistent with previous research that has focused on monolingual L1 speakers [122–125] and extends these findings to adult L2 English learners. This finding is notable because the source of these lexical effects is often thought to derive from experience with words and texts and may thus differ for non-native speakers who have different levels and types of language exposure. Thus, the finding of a similar set of effects in this study helps to establish that adult ELs with intermediate English proficiency have also experienced sufficient language exposure to be affected by such lexical variables, and it is therefore crucial to control them in studies with L2 speakers as well.

Third, literacy researchers have begun to recognize the diversity of ELs and the importance of the variations in their language experiences [46,60,74,126,127]. Despite this, relatively few studies have directly examined how these variable experiences actually impact learners' literacy skills. The current research therefore contributes to the growing body of literature demonstrating that learners with different L1 writing systems may have different levels of or strengths in their literacy skills [69,128–131]. Specifically, in the current study, learners with an alphabetic L1 generally had higher odds of accurately judging the correctness of an item's spelling than learners with a consonant-based or morphosyllabary L1. This suggests that the experiences these learners have had with their L1 alphabetic writing system have prepared them for a similar experience in their alphabetic L2, English. This finding of positive transfer of bottom-up literacy skills in learners with similar L1 writing systems is also consistent with previous research [132–135], which has demonstrated that L1 literacy facilitates the development of similar skills in a second language, especially one with a similar writing system.

Considering learners with a non-alphabetic L1, research has generally found that learners with a consonant-based L1 may have particular difficulty with L2 spelling in English [136–138]. On the other hand, studies with morphosyllabic L1 speakers have typically found that these learners have relatively stronger spelling skills than learners with an alphabetic L1 [69,139,140]. The finding from the current study that alphabetic L1 learners performed better on the spelling task is therefore somewhat inconsistent with previous research. Although it is not possible to definitively determine the reason for this, methodological considerations may play a role. Many of the studies that have found stronger spelling skills in speakers of a morphosyllabic L1 have used tasks that either required learners to actually write out words [69,139] or to compare multiple possible spellings [140], rather than respond to a single item (as in the current study). These different tasks may require the use of different dimensions of orthographic knowledge and thus result in differential advantages for learners with different types of L1 orthographic experiences; future research that investigates multiple dimensions of orthographic knowledge in the same samples of participants from different L1 backgrounds may help to illuminate this issue.

There are, of course, limitations to the current study. Given the importance of exploring the impact of diverse L1 backgrounds on ELs' spelling knowledge, and literacy skills in general, additional research would benefit from larger sample sizes of participants from each L1. This would provide crucial corroborating evidence of the patterns identified in this study and would also eliminate the need to group together learners from multiple L1s based on broader writing system types. This would be particularly useful given that even within writing system types (e.g., alphabets), there are wide ranges in the level of consistency [141,142]. Future research would also benefit from the use of multiple spelling measures. The ability to correctly identify misspelled words is useful in tasks such as proofreading [38,143,144], and does reflect underlying spelling ability, but is only a single way of operationalizing this knowledge. Finally, although the instructional intervention was found to be effective compared to two independent control groups, further replication would be beneficial to confirm this finding. Additional research looking at the efficacy of different components of the intervention, such as direction instruction of GPCs versus practice using keywords to make analogies to other words, would also be useful to refine and improve the intervention and identify which instructional components are most crucial [145].

To conclude, the current study demonstrated the effectiveness of a phonics-based instructional intervention for improving adult EL students' knowledge of English spelling. It also demonstrated that characteristics of both learners (their L1 background) and words (number of syllables, frequency, and spelling consistency) can impact learners' knowledge of English word spellings. Thus, this work extends to adults the findings from previous research regarding the usefulness of phonics-based activities and direct instruction on L2 spelling knowledge. This is a promising area for future research to more specifically identify the most crucial components of instruction for adult learners and refine instructional

approaches for ELs, as well as determine how various lexical characteristics impact literacy skills in these individuals.

Funding: This research was supported by a National Science Foundation Graduate Research Fellowship, National Science Foundation Doctoral Dissertation Research Improvement Grant BCS-1421354, a *Language Learning* Dissertation Grant, a Nationality Rooms and Intercultural Exchange Programs Israel Heritage Room Committee Scholarship from the University of Pittsburgh, and a Departmental Research Grant from the Department of Linguistics at the University of Pittsburgh. Funding for the publication costs came from the Office of the Dean, College of Liberal Arts and the Office of the Vice Chancellor for Research, Southern Illinois University Carbondale.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the IEP administration and the IRB at the host institution (PRO12080430).

Informed Consent Statement: All subjects gave their informed consent for inclusion before they participated in the study.

Data Availability Statement: The data presented in this study are available on request from the author. The data are not publicly available due to the IRB policies of the author's current institution, which requires opt-in consent from participants for data sharing.

Conflicts of Interest: The author declares no conflicts of interest. The funding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Appendix A. Items Used in the Spelling Knowledge Test

Base Word	Actual Stimulus	Syllables	Frequency	Grapheme–Phoneme Correspondence Consistency	Answer Type [a]
came	came	Monosyllabic	High	Consistent	Correct
hair	hair	Monosyllabic	High	Consistent	Correct
brain	brain	Monosyllabic	High	Consistent	Correct
life	life	Monosyllabic	High	Consistent	Correct
health	heelth	Monosyllabic	High	Consistent	Pron-Alt
real	ril	Monosyllabic	High	Consistent	Pron-Alt
flight	fleght	Monosyllabic	High	Consistent	Pron-Alt
church	chorch	Monosyllabic	High	Consistent	Pron-Alt
learn	lern	Monosyllabic	High	Consistent	Pron-Pres
fact	fakt	Monosyllabic	High	Consistent	Pron-Pres
fate	fait	Monosyllabic	High	Consistent	Pron-Pres
night	niight	Monosyllabic	High	Consistent	Pron-Pres
deed	deed	Monosyllabic	Low	Consistent	Correct
starve	starve	Monosyllabic	Low	Consistent	Correct
bean	bean	Monosyllabic	Low	Consistent	Correct
bold	bold	Monosyllabic	Low	Consistent	Correct
verb	veerb	Monosyllabic	Low	Consistent	Pron-Alt
melt	meelt	Monosyllabic	Low	Consistent	Pron-Alt
bride	brid	Monosyllabic	Low	Consistent	Pron-Alt
noon	noom	Monosyllabic	Low	Consistent	Pron-Alt
shook	shookk	Monosyllabic	Low	Consistent	Pron-Pres
porch	portch	Monosyllabic	Low	Consistent	Pron-Pres
lend	lennd	Monosyllabic	Low	Consistent	Pron-Pres
true	troo	Monosyllabic	Low	Consistent	Pron-Pres
tongue	tongue	Monosyllabic	High	Exception	Correct
heart	heart	Monosyllabic	High	Exception	Correct
poor	poor	Monosyllabic	High	Exception	Correct
truth	truth	Monosyllabic	High	Exception	Correct
huge	huj	Monosyllabic	High	Exception	Pron-Alt
depth	deepth	Monosyllabic	High	Exception	Pron-Alt
meant	mant	Monosyllabic	High	Exception	Pron-Alt
worse	worze	Monosyllabic	High	Exception	Pron-Alt
peace	peece	Monosyllabic	High	Exception	Pron-Pres
solve	solv	Monosyllabic	High	Exception	Pron-Pres
source	sorce	Monosyllabic	High	Exception	Pron-Pres

Base Word	Actual Stimulus	Syllables	Frequency	Grapheme–Phoneme Correspondence Consistency	Answer Type [a]
desk	desc	Monosyllabic	High	Exception	Pron-Pres
pier	pier	Monosyllabic	Low	Exception	Correct
soothe	soothe	Monosyllabic	Low	Exception	Correct
sauce	sauce	Monosyllabic	Low	Exception	Correct
bulb	bulb	Monosyllabic	Low	Exception	Correct
garb	garp	Monosyllabic	Low	Exception	Pron-Alt
false	folse	Monosyllabic	Low	Exception	Pron-Alt
tempt	timpt	Monosyllabic	Low	Exception	Pron-Alt
sparse	sperse	Monosyllabic	Low	Exception	Pron-Alt
mourn	morne	Monosyllabic	Low	Exception	Pron-Pres
chef	shef	Monosyllabic	Low	Exception	Pron-Pres
watt	wat	Monosyllabic	Low	Exception	Pron-Pres
realm	relm	Monosyllabic	Low	Exception	Pron-Pres
child	child	Monosyllabic	High	Inconsistent	Correct
rare	rare	Monosyllabic	High	Inconsistent	Correct
meat	meat	Monosyllabic	High	Inconsistent	Correct
choose	choose	Monosyllabic	High	Inconsistent	Correct
could	culd	Monosyllabic	High	Inconsistent	Pron-Alt
lose	loze	Monosyllabic	High	Inconsistent	Pron-Alt
gave	gav	Monosyllabic	High	Inconsistent	Pron-Alt
year	yer	Monosyllabic	High	Inconsistent	Pron-Alt
wood	wud	Monosyllabic	High	Inconsistent	Pron-Pres
bread	bredd	Monosyllabic	High	Inconsistent	Pron-Pres
height	hight	Monosyllabic	High	Inconsistent	Pron-Pres
death	deth	Monosyllabic	High	Inconsistent	Pron-Pres
nut	nut	Monosyllabic	Low	Inconsistent	Correct
tomb	tomb	Monosyllabic	Low	Inconsistent	Correct
scarce	scarce	Monosyllabic	Low	Inconsistent	Correct
cone	cone	Monosyllabic	Low	Inconsistent	Correct
stove	stov	Monosyllabic	Low	Inconsistent	Pron-Alt
gap	gep	Monosyllabic	Low	Inconsistent	Pron-Alt
warn	wern	Monosyllabic	Low	Inconsistent	Pron-Alt
drown	dron	Monosyllabic	Low	Inconsistent	Pron-Alt
mall	mawl	Monosyllabic	Low	Inconsistent	Pron-Pres
stool	stule	Monosyllabic	Low	Inconsistent	Pron-Pres
letter	letter	Disyllabic	High	Consistent	Correct
little	little	Disyllabic	High	Consistent	Correct
budget	budget	Disyllabic	High	Consistent	Correct
number	number	Disyllabic	High	Consistent	Correct
silent	selent	Disyllabic	High	Consistent	Pron-Alt
people	peoble	Disyllabic	High	Consistent	Pron-Alt
garden	gairden	Disyllabic	High	Consistent	Pron-Alt
market	mairket	Disyllabic	High	Consistent	Pron-Alt
pocket	pockit	Disyllabic	High	Consistent	Pron-Pres
coffee	cofee	Disyllabic	High	Consistent	Pron-Pres
silver	silvur	Disyllabic	High	Consistent	Pron-Pres
permit	purmit	Disyllabic	High	Consistent	Pron-Pres
burden	burden	Disyllabic	Low	Consistent	Correct
coffin	coffin	Disyllabic	Low	Consistent	Correct
beetle	beetle	Disyllabic	Low	Consistent	Correct
bitter	bitter	Disyllabic	Low	Consistent	Correct
toilet	tolet	Disyllabic	Low	Consistent	Pron-Alt
gentle	gintle	Disyllabic	Low	Consistent	Pron-Alt
tickle	tickile	Disyllabic	Low	Consistent	Pron-Alt
bucket	bocket	Disyllabic	Low	Consistent	Pron-Alt
helmet	helmit	Disyllabic	Low	Consistent	Pron-Pres
cherry	cherrie	Disyllabic	Low	Consistent	Pron-Pres
muffin	mufin	Disyllabic	Low	Consistent	Pron-Pres
bundle	bundel	Disyllabic	Low	Consistent	Pron-Pres
create	create	Disyllabic	High	Inconsistent	Correct
senior	senior	Disyllabic	High	Inconsistent	Correct
native	native	Disyllabic	High	Inconsistent	Correct
volume	volume	Disyllabic	High	Inconsistent	Correct
prison	preson	Disyllabic	High	Inconsistent	Pron-Alt
damage	demage	Disyllabic	High	Inconsistent	Pron-Alt

Base Word	Actual Stimulus	Syllables	Frequency	Grapheme–Phoneme Correspondence Consistency	Answer Type [a]
reason	rison	Disyllabic	High	Inconsistent	Pron-Alt
future	foture	Disyllabic	High	Inconsistent	Pron-Alt
window	windo	Disyllabic	High	Inconsistent	Pron-Pres
direct	direkt	Disyllabic	High	Inconsistent	Pron-Pres
column	colomn	Disyllabic	High	Inconsistent	Pron-Pres
person	purson	Disyllabic	High	Inconsistent	Pron-Pres
petrol	petrol	Disyllabic	Low	Inconsistent	Correct
borrow	borrow	Disyllabic	Low	Inconsistent	Correct
versus	versus	Disyllabic	Low	Inconsistent	Correct
coupon	coupon	Disyllabic	Low	Inconsistent	Correct
spiral	speiral	Disyllabic	Low	Inconsistent	Pron-Alt
chorus	cherus	Disyllabic	Low	Inconsistent	Pron-Alt
cousin	coasin	Disyllabic	Low	Inconsistent	Pron-Alt
garage	garege	Disyllabic	Low	Inconsistent	Pron-Alt
climax	climaks	Disyllabic	Low	Inconsistent	Pron-Pres
gallon	galon	Disyllabic	Low	Inconsistent	Pron-Pres
collar	kollar	Disyllabic	Low	Inconsistent	Pron-Pres
hazard	hasard	Disyllabic	Low	Inconsistent	Pron-Pres
letter	letter	Disyllabic	High	Consistent	Correct
little	little	Disyllabic	High	Consistent	Correct

Note. [a] Phon-Alt indicates items whose misspelled form was designed to change the pronunciation of the base word; Phon-Pres indicates items whose misspelled form was design to preserve the pronunciation of the base word.

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