**Adult Bilinguals' Orthographic Representations:
Cognates vs. Non-Cognates in Complex English Word Spelling**

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ABSTRACT

Spelling complex English words is more difficult than reading them, suggesting that spelling requires higher quality orthographic representations and a greater degree of word knowledge compared to reading. Without high-quality orthographic representations, spellers often rely on other information (e.g., phonological to orthographic encoding) to aid spelling. However, the quasi-regular nature of English orthography-to-phonology relations often render encoding strategies ineffective. This study examined whether alternative orthographic representations might facilitate the spelling of complex English words. Specifically, would English-Spanish bilingual university students benefit from orthographic similarities of English-Spanish cognates compared with non-cognates when spelling complex words?

Cognates are words that share similar spellings and meanings across languages; given the Spanish orthography's transparent nature, cognates might help inform English spelling. Bilingual students ($n = 77$) were asked to spell complex English words, half of which were Spanish cognates, with item-level spelling accuracy modeled using word-level (e.g., cognate status) and person-level (e.g., general reading ability) predictors. Results indicate that participants had a higher probability of spelling complex cognate words correctly compared to non-cognate words matched on other word features (e.g., frequency and word length). Findings from this study expand an interdisciplinary framework of understanding bilinguals' lexical access and strength of orthographic representations across languages.

INTRODUCTION

The orthographic transparency of a language refers to the pattern and likelihood of correspondence between graphemes (written letters) and their phonemes (spoken sounds), as detailed in Ziegler & Goswami's (2005) psycholinguistic grain size theory. For example, in English, the word "map" is orthographically transparent given that the correct pronunciation can be reached by sounding out the three individual letters; in the word "rough" however, the orthographic transparency is low since the "-ough" sound could not be decoded correctly by simply sounding out individual letter sounds if the reader did not already have familiarity with the irregular pronunciation of those letters when they appear in that particular order.

Examples of generally transparent orthographies include Spanish, Finnish, and Greek; if a reader already knows the letter sounds of each existing letter (which are significantly fewer for vowels as compared to the number of different sounds assigned to each English vowel), they can correctly read aloud the majority of the respective language's words, even if familiarity or semantic knowledge is limited (see Seymour, Aro, & Erskine, 2003). This concept is interesting in attempting to understand the complexity of reading and teaching different languages based on how accurately their words can be decoded with only basic letter knowledge to aid them, especially with languages that appear to be more orthographically opaque with a higher number of irregularities and "exception" words, such as English and French (Frost, Katz, & Bentin, 1987). English and French orthographies are considered "quasiregular" in that the relationship between orthography and phonology is systematic but admits many exceptions. Based on the need to understand the educational needs of a growing Spanish-English bilingual student population in the U.S. and the shared linguistic features already described, this study's design and hypotheses draw upon previous findings from students who are learning and being exposed to these specific languages (Gersten, Baker, Shanahan, Linan-Thompson, Collins, & Scarcella, 2007).

Reading & Other Learning Outcomes for Bilingual Students

One of the most interesting yet debated findings regarding the potential “bilingual advantage” is specific to successful reading development in multilingual children. A recent study from Kremin, Arredondo, Hsu, Satterfield, & Kovelman (2019) provides support for cross-linguistic transfer from Spanish phonological awareness to English word reading. Results also suggest that bilingual children demonstrate stronger associations between phonological and orthographic representations than monolingual students when reading English text. But how exactly does knowledge of Spanish potentially have an influence on the Spanish–English bilingual child’s sound-to-print associations in English? When considering the regularity and transparency of Spanish, it supports the quicker and more efficient mastery of sound-to-print associations than the irregularity and opacity of English does for monolinguals (Proctor, August, Snow, & Barr, 2010; Seymour, Aro, & Erskine, 2003).

Findings from a comparison between bilingual (Spanish–English or Italian–English) and English monolingual children have also demonstrated that bilingual students perform better on nonword reading tasks than English monolingual students (Bialystok, Luk, & Kwan, 2005). These findings suggest that being exposed to a phonologically transparent orthography, such as Spanish or Italian, can enable the transfer of linguistic skills to their phonologically more opaque language, such as English, which can create a “boosting” effect for bilingual students’ sensitivity to not only the individual sounds of the language, but also the ways in which the sounds map onto English language print.

However, evidence for a broader bilingual advantage is challenged by the 2013 NAEP (National Assessment of Educational Progress), which reports that only 5% of Hispanic/Latino ELL students in fourth grade demonstrated minimum reading proficiency in U.S. public schools. Even more disturbing is the fact that 71% of Hispanic/Latino ELL students scored at the “below basic” level in reading, demonstrating a major achievement gap for this group of students compared to their monolingual peers. Discrepancies between research findings and standardized testing outcomes suggest the need to further tease apart the relative contributions of bilingualism

in general learning processes when speaking, reading, and writing in any two languages and the contributions bilingualism makes to the narrower process of learning to read and spell in specific orthographies.

Why Do Cognates Matter?

Creating an awareness of the shared features between languages can be made possible through explicit instruction and, therefore, instruction could potentially be a mediating variable that facilitates cross-linguistic transfer (Proctor et al., 2006). What exactly in the shared features could be taught in a systematic way with observable patterns in words that monolingual and bilingual children may already have familiarity with? Cognates are defined as shared roots of words that contain the same meaning and similar spellings between languages; for example, the English word “island” shares the same meaning and similar spelling with the Spanish word “isla,” which is the root word of the direct English translation.

Based on some of the research that suggests support for a bilingual advantage in word reading, cognate words present a unique way of evaluating this advantage with the closest transfer between languages. One instance of this may appear in vocabulary development: for children who are bilingual in English and Spanish, which share similar alphabets and Latin roots, there are several words in English that are considered more complex in terms of regularity and frequency that are used often in Spanish vernacular, such as the word Spanish word “comenzar” for the English word “commence.” An example of a less frequent word in both languages is “panacea,” identical in spelling, but far more easily decodable in Spanish than in English. Cognates have been studied in relation to vocabulary development with some depth in the educational literature in light of instructors’ attempts to understand and improve teaching practices for ELL and DLL students (Bravo, et al., 2007). In addition, more recent research in pedagogy suggests that the use of the students’ primary language in the English instruction can be used effectively as a tool for developing English vocabulary and word consciousness (Ajayi, 2015).

An early study from Nagy, Durgunoğlu, and Hancin-Bhatt (1993) evaluated Spanish-English bilingual students' use of cognates in English expository reading tasks after explicitly teaching students the concept of cognates. The researchers confirmed the students' understanding of cognates by asking them to identify cognate words in the four passages they read. Results suggested that performance on the reading comprehension test was related to the students' ability to recognize cognate relationships. The relationship between Spanish vocabulary knowledge and English reading comprehension also relied on students' cognate recognition. This early finding demonstrates support for using children's Spanish background knowledge as a tool in English reading comprehension development, not merely immersing the child into English reading and leaving behind any connections that ELL/DLL students make to Spanish.

Skilled Spelling

While cognates have demonstrated great value in the realm of vocabulary instruction and have demonstrated that cross-linguistic knowledge can be a tool for broader reading outcomes, there still exists a gap in the literature for how cognate instruction can potentially aid spelling development. Spelling is one of the key skills that many students struggle with through schooling and into adulthood, especially within the broad population of students who learn English as a second language. Prior studies with children and adult participants across the range of spelling ability have explored different strategies for remembering word-specific spelling information, yielding support for strategies such as letter rehearsal, comparing misspellings to the correct spelling (Holmes & Malone, 2004; Ormrod & Jenkins, 1989), as well as the overpronunciation strategy that involves remembering a “novel” pronunciation of the word after translating the standard (correct) pronunciation to one that segments the word into syllables for optimal matches between letters and sounds (Holmes & Malone, 2004; Ocal & Ehri, 2017). Results from these training studies reveal that the most helpful strategies for skilled readers (and some poor readers) are the ones that encourage participants to reflect on the parts of words that are most difficult to remember correctly, such as the schwas that create ambiguity in which vowel letter forms the correct spelling. Focusing a speller's attention on these components of a word and observing

subsequent improvements in spelling accuracy suggest that the speller's lexical representation for a particular word is strengthened by a strategy that encourages the speller to consider multiple representations of that word, aligning with theories of how written words are stored in one's lexicon (Ehri, 1997; Share, 2008).

It is also important to consider that, according to the lexical quality hypothesis, spelling accuracy depends on a fully specified orthographic representation in an individual's orthographic lexicon (Perfetti, 1992; 1997), and therefore provides the best indicator of orthographic knowledge in assessment. According to Perfetti, a fully specified orthographic representation builds with more experience in reading and spelling over time. One component that contributes to a high-quality orthographic representation is precision, which refers to the specific letters that a reader's lexicon holds for a particular word. The orthographic representation's quality also depends on redundancy, or in other words, the grapheme-phoneme connections that are specific to each word. When a person can draw from generalized grapheme-phoneme correspondences and attach them to a specific letter string in the lexicon, the quality of that orthographic representation can strengthen the relationship between a printed word and its spoken form. Consequently, the quality of the representation depends highly on phonemic coding, which is supported by Share and Jorm's (1987) earlier work on the development of orthographic knowledge. In the absence of fully specified representations, individuals are often forced to rely on other sources of information (e.g., phonological to orthographic relationships) to aid in word spelling.

While Perfetti (1997) argues that only one set of grapheme-phoneme connections is required for building the orthographic representation of a word, two sets of these connections can serve as a "safety net" that boosts the probability of fluent word reading in various contexts (p. 29). Therefore, the lexical quality hypothesis, in combination with the linguistic interdependence hypothesis and prior work suggesting cross-linguistic transfer in phonological skills, would lend support to the idea that bilinguals may possess a strength in accurately forming multiple orthographic representations that support spelling complex or unfamiliar words.

The Current Study

A pilot study used an experimental design with Spanish-English bilingual undergraduates to examine individual differences in item-level English word spelling performance using word-level predictors including frequency and cognate status, and person-level predictors including decoding ability and oral vocabulary. The main focus was in examining whether bilingual participants would show higher spelling accuracy of complex English words that share cognates with Spanish compared to non-cognate words. Complex English words in this study were defined as low frequency, highly irregular words that students would have low exposure to prior to the study. These target words were chosen to observe the other strategies participants may use, such as calling upon explicit phonological-orthographic encoding or making cognate connections, in order to arrive at the accurate spellings.

The key outcome measure was an experimental spelling list comprised of complex English words ranging in difficulty and varying in cognate status, morphological complexity, word length, and frequency based on age-appropriate spelling difficulty and matched on number of phonemes, graphemes, and syllables. This task was used as a dependent measure to explore individual differences in complex English word spelling among bilingual speakers. A measure assessing Spanish familiarity was also given to ensure that these participants' fluency and vocabulary exposure was sufficient for the needs of the study.

I hypothesized that participants would be more likely to correctly spell English words that are Spanish cognates (compared to English non-cognate words) by presumably drawing upon the transparent spelling of the Spanish word to inform the spelling of the irregular English word. Based on the background literature and the design of this pilot study, the intention was to demonstrate how a word's categorization as a cognate and a participant's cross-linguistic word representations may potentially serve as valuable tools for correctly spelling complex English words, especially among bilingual students. The reported results will hopefully add a unique

perspective to the ongoing research on reading and language outcomes for bilingual students in the U.S. population.

PROCEDURES

Participants

Over the course of 9 months, data was collected from 77 bilingual (English and Spanish) undergraduate students from the psychology subject pool of a large public university in the Southeast region of the U.S. Prior to the study's initiation, ethical approval was obtained from the university's ethics committee for human subject research, in compliance with the U.S. Federal Policy for the Protection of Human Subjects. Individual consent was also obtained in person for each participant before the first study session began. Participating subjects completed two separate one-hour sessions, and they were compensated with extra credit for selected courses.

Demographic data for participants are presented in Table 1, and person-level descriptive statistics are displayed in Table 2. There was an intentional oversampling for Hispanic/Latino student populations in order to recruit more eligible Spanish-English bilingual participants. The study's population ranges in age from 18 years to 25 years based on the typical age of university students. Participants were determined to be bilingual via self-identification as fluent in both Spanish and English, but no other Romance languages (e.g., Italian, French, Creole). A small portion of the sample was fluent in other non-Romance languages, such as Russian or German, and were still permitted to take part in the study based on the assumption of little interference from these languages on the target spelling and reading tasks.

Materials

Participants were assessed on reading, spelling, word identification, oral vocabulary, and set for variability tasks. These tasks were assessed as a part of a larger battery of tests that lasted two 30-40 minutes sessions at each collection cycle. All tasks were adapted from pre-existing testing batteries, except for the set for variability task and the English and Spanish familiarity tests, which were adapted from measures used by Steacy et al. (2019) and Kearns et al. (2016).

Raw total scores were used for each measure, as well as standardized and scaled scores for measures from the Woodcock-Johnson III (Schrack, 2011), the Woodcock-Muñoz III (Muñoz-Sandoval et al., 2009), and the TOWRE (Torgesen, Wagner, & Rashotte, 2012).

Target Spelling (dependent measure). This task was adapted from the Woodcock-Johnson III (Schrack, 2011) standardized spelling task to measure participants' ability to spell the complex words of interest correctly (see Table 3). The cognate words were chosen from NTC's Dictionary of Spanish Cognates (Nash, 1993), and the non-cognate words were matched to the cognates for length, number of syllables, and frequency using the English Lexicon Project's database (Balota et al., 2007). The cognate and noncognate words' length ($p = 0.087$) and frequency ($p = 0.657$) were subsequently compared using a propensity score check, which determined no significant differences between cognate and non-cognate words beyond the categorization as a cognate. Participants heard each target word read aloud on a recording, the word used in a sentence, and then a repetition of the word before being asked to spell it on their activity sheets.

Person-level measures

Person-level descriptive statistics are displayed in Table 2, and zero-order correlations for person features are provided in Table 4.

English and Spanish Familiarity. This measure was adapted from a child-appropriate measure of polymorphemic words (Kearns et al. 2016) to include more complex English words, which match the complete list of target spelling words (see Table 3). Participants heard each target word and were asked to provide a yes/no response for whether the word sounded familiar or not (based on having heard or encountered the word in text prior to the testing sessions.) Following the same instructions, another list was presented to all participants with the direct Spanish translations of the English cognate words, serving as a proxy for bilingual participants' Spanish vocabulary.

Oral Vocabulary. The vocabulary subtest from the Woodcock-Johnson III (Schrack, 2011) was used to measure oral vocabulary. The test required participants to identify pictures with single word descriptions.

Reading Fluency. The reading fluency tasks were the phonemic decoding efficiency (for nonwords) and sight word efficiency (for real words) subtests from the TOWRE (Torgesen, Wagner, & Rashotte, 2012). Participants were asked to read a list of sight words and a list of nonwords as quickly and accurately as possible within the span of 45s for each list.

Set for Variability (SFV)– Listening Mispronunciation Task. Based on the work of Tunmer and Chapman (1998, 2012) and Steacy et al. (2019) with elementary-aged students, set for variability was evaluated by participants' ability to derive the correct pronunciation from spoken English words that are "mispronounced" based on regular decoding rules, as they might be if they were regular words or partially decoded (e.g., /brikfəst/ for /brɪkfəst/). This is an experimental measure aimed at capturing phonological flexibility and the strength of lexical representations in adult participants.

Standardized Spelling. The spelling subtest from the Woodcock-Johnson III (Schrack, 2011) was used to measure general spelling ability of increasingly difficult English words appropriate for the sample's specific age range.

Word Identification. The word identification subtests from the Woodcock-Johnson III (Schrack, 2011) and Woodcock-Muñoz (Muñoz-Sandoval, 2009) were used to measure the basic ability of identifying words across difficulty levels. Participants completed the Woodcock-Muñoz subtest to confirm that they had an appropriate minimum Spanish proficiency to be considered "bilingual" for this study. This subtest helped highlight a small group of students who had identified as bilingual based on some class experience with oral and written comprehension, but had very low reading proficiency. For those who did not reach a minimum proficiency on the test, the data was not included in the analyses as they could not be considered bilingual for this study's operationalization of bilingualism.

Word-level measures

Zero-order correlations for word features are provided in Table 4, and descriptive statistics representing length, frequency, and cognate status are also provided in Table 2.

Word length. This measures the number of letters in each word. The word length reported for the list of target words ranges from 6 to 13 letters.

Frequency. The standard frequency index (SFI) from the Educator's Word Frequency Guide was used as a measure of word frequency (Zeno, Ivens, Millard, & Duvvuri, 1995). The SFI is based on a corpus of more than 60,000 text samples from textbooks, fiction literature, and several other literary sources (Kearns et al., 2016). The SFI reported for the list of target words ranges from 22.1 to 49.1.

Cognate. The 40 English target words were split between 20 words that are Spanish cognates (e.g. "inseparable") and 20 words that do not present Spanish cognates (e.g. "behemoth") matched in other word features (see Table 3).

Data Analysis

Item-response based crossed random effects models were used to account for the roles of person-, word-, and person-by-word-level predictors of complex word spelling variance. These models allowed us to include person-, word-, and item-specific person-by-word level (interaction) predictors in the same model while retaining the ability to identify interactions between person- and word-level predictors. These cross-classified models were used to predict the participants' spelling of the specific word (e.g., "macabre") coded as a dichotomous response (correct or incorrect) using person-level (e.g., set for variability, vocabulary, decoding, spelling), word-level (e.g., frequency, number of letters, cognate status), and person-by-word predictors (i.e., item-specific performance on the set for variability mispronunciation task – correctly identifying "macabre" from /mækʌbɜ:/). Therefore, modeling these random person and item effects simultaneously decreases the probability of unbiased estimates of both, which may have been more problematic with separate analyses at either the person or item level due to "ignored dependencies" within the data (Gilbert et al., 2011).

Standardized spelling was included as a predictor in the models to control for general word spelling skill. The decision to include general word spelling as a predictor stems from the assumption that the undergraduate student sample may represent a wide spectrum of spelling ability, especially with the inclusion of participants who did not learn English as their first language. However, a model without this predictor was run separately to ensure that the results and interpretation are not misrepresentative of the study's outcomes. This analysis revealed that without standardized spelling in the model almost all of the person- and word-level predictors, including total score on set for variability, item-level performance on set for variability, English familiarity score, and word frequency remained significant predictors of target word spelling. However, phonemic decoding efficiency score also become a marginally significant person-level predictor of target spelling performance when standardized spelling was removed from the model ($\gamma = 0.02, z = 1.97, p = 0.049$). This analysis was conducted using a binomial distribution with a logit link, available through the `glmer` function (Bates & Maechler, 2009) in the `lme4` package from R programming (R Development Team, 2012)

RESULTS

Unconditional Model

A series of crossed random effects models (see Table 5) were run to separate the different sources of variance in word spelling for all participants. Given that the explanatory item response model uses list-wise deletion as a default solution to missing data, only participants with complete data were included in the models ($N = 77$). First, an unconditional model was created to determine how much variance in the target spelling responses was related to the word- and person-level variables. These variance estimates were used to identify how much variance was explained by the following interaction model. The intercept of the unconditional model, converted from a logit to a probability estimate, indicated that the average probability of a correct response across words and participants on the target spelling task was 0.63.

Individual Models

Next, a set of models estimated the contribution of each predictor alone in predicting the probability of a correct response (see Table 6). In the presence of no other word- or person-level predictors in each respective model, each of the main effects for all person-level variables were significant ($p < 0.001$) in predicting item-level target spelling accuracy. At the word-level, only word length and frequency were individually significant ($p < 0.001$) predictors of item-level target spelling accuracy. Word length and number of morphemes, however, were not significant predictors of target spelling accuracy in each of their respective models.

Main Effects Model

To examine the relationship between person- and word-level variables, a model was run with the full sample of bilingual participants ($N = 77$) to investigate the specific relationship between the participant's person-level features and a word's cognate status, among other word-level variables, in item-level target spelling performance (see Table 5). Interestingly, the significant main effect of cognate ($\gamma = 0.82, z = 2.04, p = 0.04$) indicates that overall, participants demonstrated a higher probability of accurate spelling across cognate words on the target spelling task, supporting the primary hypothesis.

As expected, the significant main effect of standardized spelling ($\gamma = 0.17, z = 7.04, p < 0.001$) can be interpreted as general spelling ability being a strong predictor of target spelling ability, where participants with higher scores on broad spelling ability had a slightly higher probability of accurate spelling across words on the target spelling task. The main effect of English familiarity ($\gamma = 0.87, z = 5.73, p < 0.001$) shows that a participant's familiarity with the target spelling words was a strong predictor of accurate spelling across those words. The significance of this particular main effect may help explain why oral vocabulary was one of the only non-significant person-level main effects in this model ($\gamma = 0.01, z = 0.57, p = 0.57$). English familiarity is a measure of the participants' knowledge or prior experience with the target spelling words, which are complex not only in lexical structure, but also in their frequency. As less frequent words that would be less likely to already be included in one's oral vocabulary

range, the variance that general oral vocabulary may normally account for in target spelling may have been absorbed by the familiarity measure that includes the exact target words as individual items, making the familiarity measure closer in proximity and more highly correlated to the target spelling task ($r = 0.37, p < 0.001$), than the items from the general oral vocabulary task, which is correlated more weakly with English familiarity scores at 0.18 ($p < 0.001$).

The only significant word predictors were cognate (in support of the primary hypothesis) and frequency as measured by SFI ($\gamma = 0.14, z = 4.64, p < 0.001$), which aligns with previous reading and spelling investigations (Brysbaert et al., 2011) and indicates that target spelling words with higher SFI were more likely to be spelled correctly across participants. One of the insignificant word-level main effects in this model is word length ($\gamma = 0.04, z = 0.35, p = 0.73$), which indicates that a target word's length (in the presence of other person- and word-level predictors) did not significantly predict target spelling accuracy across participants. The other insignificant word-level predictor, number of morphemes ($\gamma = -0.18, z = -0.65, p = 0.52$) also failed to uniquely account for a statistically significant amount of variance in target word spelling performance across participants.

A more novel finding is the main effect of set for variability (Sfv) total scores ($\gamma = 0.06, z = 3.13, p = 0.002$), which can be interpreted as another significant predictor of accurate spelling across words on the target spelling task. The main effect of set for variability (SfV) performance at the item-level was also significant ($\gamma = 0.52, z = 3.90, p < 0.001$) in this model, meaning that one's ability to correctly identify and pronounce a target word after being presented with its alternate pronunciation was a strong predictor of one's accurate spelling on that specific word in the target spelling task. These findings support recent work with elementary-aged children that reported significant effects of both the total scores on this task and performance on this task at the item-level (Steady et al., 2019). As an experimental task, the ability to correct a mispronunciation of the target spelling word serves as a proxy for estimating the strength of a participant's *phonological* representation of the target word, while the spelling is a proxy for the strength of a participant's *orthographic* representation instead. More specifically, these analyses

report initial evidence for SfV as an important person-level and item-level predictor of spelling performance among adults, a population that has not yet been explored in the emerging literature on set for variability. The significant contribution of this task at person level with total scores and item-level with individual words may explain why the main effect of phonemic decoding efficiency (PDE) was insignificant ($\gamma = 0.01$, $z = 1.54$, $p = 0.12$), indicating that nonword reading was *not* a strong predictor of target spelling ability in the presence of another task that tests the participant's phonological representations.

Exploratory Model

To expand on some of the factors that may contribute to total SfV performance, a dominance analysis was conducted using similar predictors to the main explanatory item-response model that predicted item-level spelling performance (see Figures 1 and 2). Dominance analysis is another method of determining which predictors are relatively important in accounting for the variance of scores in an outcome variable using a linear regression model (Budescu, 1993; Azen, 2013). In considering SfV as a measure of broader phonological flexibility that is highly correlated to the other person-level predictors from the main effects EIRM (see Table 4), dominance analysis is useful in delineating the importance of individual predictors that exhibit a high degree of multicollinearity. Using the *dominanceanalysis* R package (Bustos Navarrete & Coutinho Soares, 2020), estimates of the R^2 values of all possible combinations of the predictor variables were calculated for identifying levels of complete, conditional (i.e., across levels with differing numbers of predictors in each model), and general (i.e., across all models) types of dominance.

As shown in Figure 1, total score on cognate spelling words (maximum score of 20) contributed an average of 25.7% unique variance to SfV total performance, making it the variable with the greatest additional contribution across all models. In other words, total score on cognate spelling words demonstrated complete dominance over the other competing predictors, including non-cognate spelling total, English familiarity, oral vocabulary, PDE (nonword reading), and standardized spelling scores. Given that this predictor is completely dominant over

competing predictors in the model, it represents a predictor with both conditional and general dominance as well. Conditional levels of variance are provided in Figure 2, with each line representing how much unique variance each of the variables (on average) can account for with no other predictors in the model (level 0), only 1 other predictor present (level 1), and all possible combinations of the 5 separate predictor variables across levels 2-5 (i.e., how much additional variance in total SfV score a specific variable can account for in the presence of 2 predictors versus 3 predictors).

In comparison, only 15% unique variance was attributed to WJ-III oral vocabulary, the second highest average contribution. Total spelling scores of non-cognate words contributed a similar amount of average variance (13.7%) to SfV total performance, while WJ-III standardized spelling scores (11.8%), PDE (6.7%), and English familiarity (1.9%) contributed the lowest average amounts of variance across models. The rank order of relative importance from most important to least important predictor was cognate spelling score, WJ-III oral vocabulary, non-cognate spelling score, standardized spelling score, PDE, and English familiarity.

DISCUSSION

The purpose of this study was to explore the unique role of cognates and different reading skills in complex word spelling performance for bilingual participants. With a growing interest in bilingual student populations and a lack of understanding of the different word-level and person-level features that can contribute to adult spelling accuracy, this study aims to capture information relevant to both lines of investigation. For the primary analysis, standardized spelling, phonemic decoding efficiency, vocabulary scores, set for variability total scores, and English familiarity scores were included as predictors to represent general person-level language skills, along with set for variability as a separate item-level predictor. At the word level, the cognate status, word frequency, length, and number of morphemes were included as predictors to take into account different word features that may influence a participant's ability to reach correct spellings of each target word. All of these primary predictors were included in the models

to create a layered interpretation that captures the role of the specific spelling item, general person skills, and fixed word characteristics in accurate word spelling.

Based on the results of the main interaction model, the first hypothesis was supported: participants *did* show a higher probability of spelling cognate words correctly compared to non-cognate words (see Table 5). Based on prior work suggesting some bilingual transfer in elementary-aged students (e.g., Nagy et al., 1993; Ajayi, 2015), this finding demonstrates similar support for adults' ability to potentially draw on Spanish word representations as well. Importantly, this finding was supported in both models with standardized spelling excluded and when it was added to the predictors in a separate model, with cognate status remaining significant in both models (see Table 5). Given that general spelling ability should correlate with spelling on more complex and possibly unfamiliar words, the decision to run a separate model stemmed from the concern about a normal distribution of spelling ability being represented in the adult student sample.

Demographic data (from a self-report survey completed at the end of each participant's session; see Table 1) revealed that 23.68% of the participants designated Spanish as their primary language (i.e. the language they currently speak most frequently on a daily basis and feel most comfortable using), which further justified the need to examine whether standardized spelling could be accounting for too much of the variance in target word spelling. Despite this concern, the results from both models (i.e. the main effects model with standardized spelling included and the model without standardized spelling as a predictor) support a significant relationship that can be interpreted as a higher probability of bilinguals showing higher spelling accuracy on cognate words compared to noncognate words.

Additionally, set for variability (SfV) is an experimental task that was included as a test of phonological flexibility. Interestingly, overall performance on this task and at the item level were both uniquely significant predictors of target word spelling performance in the main model; the exploratory analysis expanded on the bidirectionality of this relationship by showing how cognate spelling accuracy was a dominant predictor (in the presence of other person-level

predictors) in overall performance on the SfV task. Prior work with emergent readers (Tunmer & Chapman, 2012; Steacy et al., 2019) has shown that performance on set for variability listening tasks is highly correlated with other reading tasks, and may even be a valuable predictor of reading performance for both typically developing children and those with reading difficulties. As this task and lexical flexibility continue to be studied in the context of reading intervention for at-risk student populations who struggle with encountering irregular words in text, the adult data here may contribute to our understanding of the many word features and reading/spelling strategies related to the creation and storage of high-quality polysyllabic irregular word representations.

Conclusion & Future Directions

This study explored both person- and word-level variables in the context of adult spelling to demonstrate how bilingual adults draw on multiple lexical representations when encountering complex cognate words. Given the multiple gaps in educational, linguistics, and psychological research literature regarding factors that contribute to adult bilinguals' spelling performance on difficult, unfamiliar words, and more specifically cognates, this study answered a string of questions that can inform many subfields of interest. Bilingual adults do show a higher probability of spelling cognate words correctly compared to non-cognate words, a finding that can be probed further in future empirical work by asking more nuanced questions about other person-level features, such as age of language acquisition and setting in which each language of proficiency was learned, and perhaps adding measures of written and oral fluency to create a more encompassing definition of a “bilingual” participant. Moving forward, more interdisciplinary work must be done to continue constructing our knowledge of how one's proficiency in each language morphs across stages of language and reading development. The use of explanatory item response modeling (as described in our analyses) and other regression-based modeling is also an important consideration for being able to capture individual differences across different profiles of language proficiency (van Hell & Tanner, 2012). By using

these tools and calling upon theories and empirical results from psychology, education, and linguistics fields, we can consider how our findings may be applied to the classroom, with cognates serving as a potentially valuable tool in improving instruction of understudied skills, like spelling, for underserved student populations, such as the growing number of Spanish-English bilinguals in the U.S.

APPENDIX
TABLES AND FIGURES

Table 1*Demographic Characteristics of Participants*

Variable	Partial sample (N=76)
Age (Years)	$M = 19.62$ $SD = 3.62$
Gender (%)	
Female	65.79
Male	34.21
Ethnicity (%)	
Hispanic/Latino	96.05
Non-Hispanic/Latino	3.95
Home Language (%)	
Spanish	68.42
English	18.42
Both	13.16
Primary Language (%)	
Spanish	23.68
English	75.00
Other	1.32
Race (%)	
American Indian/Alaskan Native	1.96
Asian	1.96
Black/African American	—
Caucasian	78.95
Multiracial	17.12

Note. Demographic data is based on 76 out of the total sample of 77 participants due to missing demographic data for 1 participant who had a complete dataset on the rest of study's testing battery.

Table 2*Descriptive Statistics of Person and Word-Level Variables*

Variable	Full sample (<i>N</i> =77)			
	<i>M</i>	<i>SD</i>		
Outcome variable				
Target spelling	22.65	6.74		
Person-Level variables				
Standardized Spelling	50.86	3.50		
Oral Vocabulary	29.26	5.40		
Decoding (PDE)	53.48	8.57		
Set for Variability (Total)	22.51	5.48		
English Familiarity	29.00	5.08		
Spanish Familiarity	15.14	2.54		
	Cognate (<i>N</i> =20)		Non-cognate (<i>N</i> =20)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Word-Level Variables				
Length	9.85	2.06	9.95	1.94
Phonemes	8.79	1.93	8.32	1.74
Syllables	3.68	0.94	3.00	0.89
Morphemes	2.11	0.76	2.53	1.10
Reaction Time (s)	819.89	100.16	775.22	85.43
Reading Accuracy	0.86	0.14	0.87	0.14
Frequency (SFI)	35.69	6.24	36.07	7.96

Note. PDE= phonemic decoding efficiency subtest from the TOWRE (Torgesen et al., 2012); SFI = standard frequency index (Zeno et al., 1995).

Table 3*List of Stimuli Presented to Full Sample*

Target English spelling words		Original Spanish words cognate words
admittedly	malign	ambidextro
ambidextrous	manifestation	dimensional
behemoth	marauders	dogmático
blithely	nausea	enigmático
chartreuse	neutralize	facilitar
commendable	nostrils	grandioso
dimensional	ostracism	inseparable
discouraging	overwhelmed	irrefutable
dogmatic	panacea	macabro
enigmatic	plunge	maligno
ensconced	primordial	manifestación
equivocal	promulgate	náusea
facilitate	rambunctious	neutralizar
forgiveness	reimbursement	ostracismo
grandiose	remembrance	panacea
hierarchical	reprisals	primordial
inseparable	sterilization	promulgar
irrefutable	superficial	esterilización
landowners	tumultuous	superficial
macabre	umbrage	tumulto

Note. All participants were presented with an audio randomized list of the target English spelling words for the English familiarity and target spelling tasks, as well as in their mispronounced forms for the set for variability task. All participants were also presented with an audio randomized list of the original Spanish cognate words for the Spanish familiarity task.

Table 4

Zero-Order Person-Level Correlations and Word-Level Correlations

Variables						
Person Variables	1	2	3	4	5	6
1. Standardized Spelling	–	–	–	–	–	–
2. Oral Vocabulary	.41	–	–	–	–	–
3. Decoding (PDE)	.39	.12	–	–	–	–
4. Set for Variability (Total)	.66	.61	.46	–	–	–
5. English Familiarity	.17	.18	.08	.21	–	–
6. Target Spelling	.28	.18	.16	.27	.37	–
Word Variables	1	2	3	4		
1. Cognate	–	–	–	–		
2. Length	-.04	–	–	–		
3. Frequency	-.03	.10	–	–		
4. Morphemes	-.18	.58	.28	–		

Note. Est.= parameter estimate; *SE* = standard error. All bolded values represent statistically significant correlations ($p < 0.05$)

Table 5*Fixed Effects and Variance Estimates Predicting Probability of Word Spelling Responses on Target Spelling Task*

Fixed effects	Unconditional model				Main effects model (N=77)			
	Est	SE	z	p	Est.	SE	z	p
Intercept	.53	.31	1.71	.09	-.82	.31	-2.65	.01
Person-by-Word								
Set for Variability (Item-Level)	—	—	—	—	.52	.13	3.90	<.001
Person factors								
Standardized Spelling	—	—	—	—	.17	.02	7.04	<.001
Oral Vocabulary	—	—	—	—	.01	.01	.57	.57
Decoding (PDE)	—	—	—	—	.01	.01	1.54	.12
Set for Variability (Total)	—	—	—	—	.06	.02	3.13	.002
English Familiarity	—	—	—	—	.87	.15	5.73	<.001
Word factors								
Cognate	—	—	—	—	.82	.40	2.04	.04
Length	—	—	—	—	.04	.13	.35	.73
Frequency	—	—	—	—	.14	.03	4.64	<.001
Morphemes	—	—	—	—	-.18	.28	-.65	.52
Intercepts	Variance				Variance			
Person	1.18				0.09			
Word	3.09				1.40			
					Variance Explained			
					92.37%			
					54.69%			

Note. Est.= parameter estimate; *SE* = standard error. Each of the predictors and the respective estimates represent the results from predicting probability of word spelling accuracy from all variables simultaneously (i.e., in the presence of all other word- and person-level predictors in the model).

Table 6*Individual Main Effects Predicting Probability of Word Spelling Responses on Target Spelling Task*

Single predictors	Individual models			
	Est.	SE	z	p
Person-by-Word				
Set for Variability (Item-Level)	.88	.13	6.80	<.001
Intercept	.02	.30	.06	.95
Person factors				
Standardized Spelling	.17	.01	12.05	<.001
Intercept	.31	.05	6.32	<.001
WJ-III Vocabulary	.11	.02	5.30	<.001
Intercept	.63	.30	2.05	.04
Decoding (PDE)	.04	.01	4.56	<.001
Intercept	.34	.08	4.47	<.001
Set for Variability (Total)	.17	.02	11.23	<.001
Intercept	.63	.29	2.13	.03
English Familiarity	1.84	.10	18.09	<.001
Intercept	-1.07	.11	-9.43	<.001
Word factors				
Cognate	.47	.06	7.44	<.001
Intercept	.14	.08	1.91	.06
Length	.17	.15	1.14	.25
Intercept	.53	.31	1.74	.08
Frequency	.16	.03	5.03	.04
Intercept	.53	.25	2.10	<.001
Morphemes	.25	.30	.83	.41
Intercept	.53	.31	1.72	.09

Note. Est.= parameter estimate; SE = standard error. Each of the predictors and the respective estimates represent the results from predicting probability of word spelling accuracy from one variable at a time, isolated from other word- and person-level predictors in the model.

Figure 1

Average contributions to set for variability total scores by variable

Note. PDE = phonemic decoding efficiency. WJ = Woodcock Johnson III.

Figure 2

Average contributions to set for variability total scores by level

Note. PDE = phonemic decoding efficiency. WJ = Woodcock Johnson III.

REFERENCES

- Ajayi, L. (2015). Vocabulary instruction and Mexican–American bilingual students: how two high school teachers integrate multiple strategies to build word consciousness in English language arts classrooms. *International Journal of Bilingual Education and Bilingualism*, 18(4), 463-484.
- Aro, M., & Wimmer, H. (2003). Learning to read: English in comparison to six more regular orthographies. *Applied psycholinguistics*, 24(4), 621-635.
- Azen, R. (2013). Using dominance analysis to estimate predictor importance in multiple regression. In *Applied Quantitative Analysis in Education and the Social Sciences* (pp. 46-76). Routledge.
- Balota, D. A., Yap, M. J., Hutchison, K. A., Cortese, M. J., Kessler, B., Loftis, B., & Treiman, R. (2007). The English lexicon project. *Behavior Research Methods*, 39(3), 445-459.
- Bates, D., & Maechler, M. (2009). The lme4: linear mixed-effects models using S4 classes. Retrieved from <http://lme4.r-forge.r-project.org/>
- Bialystok, E., Luk, G., & Kwan, E. (2005). Bilingualism, biliteracy, and learning to read: Interactions among languages and writing systems. *Scientific Studies of Reading*, 9(1), 43-61.
- Bravo, M. A., Hiebert, E. H., & Pearson, P. D. (2007). Tapping the linguistic resources of Spanish/English bilinguals: The role of cognates in science. *Vocabulary acquisition: Implications for reading comprehension*, 140-156.
- Brysbaert, M., Buchmeier, M., Conrad, M., Jacobs, A. M., Bölte, J., & Böhl, A. (2011). The word frequency effect. *Experimental psychology*.
- Budescu, D. V. (1993). Dominance analysis: a new approach to the problem of relative importance of predictors in multiple regression. *Psychological bulletin*, 114(3), 542.
- Bustos Navarrete, C., & Coutinho Soares, F. (2020). dominanceanalysis: Dominance Analysis. R package version 1.3.0. <https://CRAN.R-project.org/package=dominanceanalysis>
- Ehri, L. C., Perfetti, C. A., Rieben, L., & Fayol, M. (1997). Learning to spell: Research, theory, and practice across languages. *Learning to read and learning to spell are one and same, almost*, 237-270.
- Frost, R., Katz, L., & Bentin, S. (1987). Strategies for visual word recognition and orthographical depth: a multilingual comparison. *Journal of Experimental Psychology: Human Perception and Performance*, 13(1), 104.

- Gersten, R., Baker, S. K., Shanahan, T., Linan-Thompson, S., Collins, P., & Scarcella, R. (2007). Effective Literacy and English Language Instruction for English Learners in the Elementary Grades. IES Practice Guide. NCEE 2007-4011. *What Works Clearinghouse*.
- Gilbert, J. K., Compton, D. L., & Kearns, D. M. (2011). Word and person effects on decoding accuracy: A new look at an old question. *Journal of Educational Psychology*, 103(2), 489.
- Holmes, V. M., & Malone, N. (2004). Adult spelling strategies. *Reading and Writing*, 17(6), 537-566.
- IES NCES, (2018, April). English Language Learners in Public Schools. Retrieved April 28, 2019, from https://nces.ed.gov/programs/coe/indicator_cgf.asp#f2
- Kearns, D. M., Steacy, L. M., Compton, D. L., Gilbert, J. K., Goodwin, A. P., Cho, E., & Collins, A. (2016). Modeling polymorphemic word recognition: Exploring differences among children with early-emerging and late-emerging word reading difficulty. *Journal of learning disabilities*, 49(4), 368-394.
- Kremin, L. V., Arredondo, M. M., Hsu, L. S. J., Satterfield, T., & Kovelman, I. (2019). The effects of Spanish heritage language literacy on English reading for Spanish-English bilingual children in the US. *International journal of bilingual education and bilingualism*, 22(2), 192-206.
- Muñoz-Sandoval, A. F., Woodcock, R. W., McGrew, K. S., Mather, N., & Ardoino, G. (2009). Batería III Woodcock-Muñoz. *Ciencias Psicológicas*, 3(2), 245-246.
- Nagy, W. E., García, G. E., Durgunoğlu, A. Y., & Hancin-Bhatt, B. (1993). Spanish-English bilingual students' use of cognates in English reading. *Journal of Reading Behavior*, 25(3), 241-259.
- National Assessment of Educational Progress. (2013). *NAEP data explorer*. Retrieved from <http://nces.ed.gov/nationsreportcard/naepdata/>.
- Ocal, T., & Ehri, L. C. (2017). Spelling pronunciations help college students remember how to spell difficult words. *Reading and Writing*, 30(5), 947-967.
- Ormrod, J. E., & Jenkins, L. (1989). Study strategies for learning spelling: Correlations with achievement and developmental changes. *Perceptual and Motor Skills*, 68, 643-650.
- Perfetti, C. A. (1992). The representation problem in reading acquisition. In P. B. Gough, L. C. Ehri, & R. Treiman (Eds.), *Reading acquisition* (pp. 145-174). Hillsdale, NJ: Erlbaum.
- Perfetti, C. A. (1997). The psycholinguistics of spelling and reading. In C. A. Perfetti, L. Rieben & M. Fayol (Eds.), *Learning to spell: Research, theory, and practice across languages*;

- learning to spell: Research, theory, and practice across languages* (pp. 21-38). Hillsdale, NJ: Erlbaum.
- Proctor, C. P., August, D., Carlo, M. S., & Snow, C. (2006). The intriguing role of Spanish language vocabulary knowledge in predicting English reading comprehension. *Journal of Educational Psychology*, 98(1), 159.
- Proctor, C. P., August, D., Snow, C., & Barr, C. D. (2010). The interdependence continuum: A perspective on the nature of Spanish–English bilingual reading comprehension. *Bilingual Research Journal*, 33(1), 5-20.
- R Development Core Team (2012). R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org/>.
- Schrank, F. A. (2011). Woodcock-Johnson III Tests of Cognitive Abilities.
- Seymour, P. H., Aro, M., & Erskine, J. M. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology*, 94(2), 143–174.
- Share, D. L. (2008). Orthographic learning, phonological recoding, and self-teaching. In R. Kail (Ed.), *Advances in child development and behavior* (Vol. 36, pp. 31– 82). Amsterdam: Elsevier.
- Share, D. L., & Jorm, A. F. (1987). Segmental analysis: Co-requisite to reading, vital for self-teaching, requiring phonological memory.
- Steady, L. M., Wade-Woolley, L., Rueckl, J. G., Pugh, K. R., Elliott, J. D., & Compton, D. L. (2019). The role of set for variability in irregular word reading: Word and child predictors in typically developing readers and students at-risk for reading disabilities. *Scientific Studies of Reading*, 1-10.
- Torgesen, J. K., Wagner, R., & Rashotte, C. (2012). *Test of Word Reading Efficiency: (TOWRE-2)*. Pearson Clinical Assessment.
- Torgesen, J. K., Wagner, R. K., Rashotte, C. A., Burgess, S., & Hecht, S. (1997). Contributions of phonological awareness and rapid automatic naming ability to the growth of word-reading skills in second-to fifth-grade children. *Scientific studies of reading*, 1(2), 161-185.
- Tunmer, W. E., & Chapman, J. W. (1998). Implicit and explicit processes in reading acquisition. In K. Kirsner, C. Spelman, M. Maybery, A. O'Brien-Malone, M. Anderson, & C. MacLeod (Eds.), *Implicit and explicit mental processes* (pp. 357–370). Mahwah, NJ: Erlbaum.

- Tunmer, W. E., & Chapman, J. W. (2012). The simple view of reading redux: Vocabulary knowledge and the independent components hypothesis. *Journal of learning disabilities*, 45(5), 453-466.
- Van Hell, J. G., & Tanner, D. (2012). Second language proficiency and cross-language lexical activation. *Language Learning*, 62, 148-171.
- Ziegler, J. C., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: a psycholinguistic grain size theory. *Psychological bulletin*, 131(1), 3.