THE INFLUENCE OF NOVEL ORTHOGRAPHIC INFORMATION ON SECOND LANGUAGE WORD LEARNING: THE CASE OF NATIVE ENGLISH SPEAKERS LEARNING ARABIC

by

Catherine E. Showalter

A thesis submitted to the faculty of
The University of Utah
in partial fulfillment of the requirements for the degree of

Master of Arts

Department of Linguistics

The University of Utah

August 2012

The University of Utah Graduate School

STATEMENT OF THESIS APPROVAL

The following faculty members served as the supervisory committee chair and members for the thesis of Catherine E. Showalter.

Dates at right indicate the members' approval of the thesis.

Rachel Hayes-Harb	, Chair	4/30/12 Date Approved
Jane Hacking	, Member	4/30/12 Date Approved
Aaron Kaplan	, Member	4/30/12 Date Approved

The thesis has also been approved by Edward Rubin

Chair of the Department of Linguistics

and by Charles A. Wight, Dean of The Graduate School.

ABSTRACT

Recent research indicates that knowledge of words' spellings can influence memory of phonological forms of second language (L2) words. For example, L2 learners whose first language uses the Roman alphabet remember newly-learned words more accurately when provided spelled forms in Roman orthography than when spelled forms are unavailable. Research also indicates that learners exposed to novel suprasegmental tone marks are more likely to remember tones associated with novel words and create tone-tone mark correspondences than learners not exposed to tone marks. However, while learners can use familiar letters and novel suprasegmental marks to make inferences about phonological forms, it is unknown whether learners can use *entirely* unfamiliar orthographic symbols. I therefore asked: Can learners use their knowledge of the alphabetic principle to infer phonological forms of new words when presented an unfamiliar L2 orthography? (Experiment 1). Did learners create grapheme-phoneme correspondences given orthographic representations? (Experiment 2).

Native English speakers (no Arabic experience) were randomly assigned to Orthography or Control word learning groups. Six nonword minimal pairs contrasting Arabic velar-uvular contrasts (i.e., [k] and [q]) were randomly assigned picture "meanings". During a word learning phase, subjects saw pictures and spelled forms (either the word spelled in Arabic script—Orthography condition, or a meaningless sequence of Arabic letters—Control condition), and heard auditory forms. In Experiment 1, subjects determined whether a picture associated with, e.g., [kaʃu], matched an auditory form [qaʃu]. There was a significant effect of item type ($p<.005$), with matched items being easier, but no significant effect for subject group ($p=.661$) and no significant interaction of item type and subject group ($p=.867$). In Experiment 2, subjects determined whether orthographic representations and auditory words matched. Neither group performed significantly above chance on test items (Orthography mean = .513; Control mean = .539).

Results suggest there are conditions under which novel scripts may not aid in learning L2 contrasts. However, it is unclear whether the lack of positive impact of orthographic representations results from difficulty associated with the Arabic script and/or perception of the target contrast.

TABLE OF CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Second language acquisition researchers have recently become increasingly interested in the possible interaction of phonological and orthographic representations in second language learners. Simon and Van Herreweghe (2010), in the introduction to a 2011 issue of *Language and Speech* devoted to this topic, note that while research has revealed a connection between phonological forms and orthography, (where orthography influences phonology) many of these studies are concerned with first language (L1) acquisition (e.g., Cutler, Treiman, & van Ooijen, 2010; Erdener & Burnham, 2005; Grainger & Ferrand, 1994; Kim, Taft, & Davis, 2004; Lee & Turvey, 2003; Pattamadilok, Kolinsky, Ventura, Radeau, & Morais, 2007; Tyler & Burnham, 2006; Ventura, Kolinsky, Brito-Mendes, & Morais, 2001; Ziegler, Ferrand, & Montant, 2004), and more research is needed on the relationship between phonological and orthographic forms in second language (L2) acquisition. Several studies have provided evidence for an interaction between phonological and orthographic representations in a second language (e.g., Arab-Moghaddam & Senechal, 2001; Bassetti, 2009; Bassetti, 2007, Bassetti, 2005; Detey & Nespoulous, 2008; Dijkstra, Frauenfelder, & Schreuder, 1993; Georgiou, Parrila, & Papadopoulos, 2008; Kaushanskaya & Marian, 2008;

Mayer, Crowley, & Kaminska, 2007; Ota, Hartsuiker, & Haywood, 2010; Ota, Hartsuiker, & Haywood, 2009; Schwartz, Kroll, & Diaz, 2007; Slowiaczek, Soltano, Wieting, & Bishop, 2003; Taft, 2006; Vendelin & Peperkamp, 2006; Weber & Cutler, 2004). Simon, Chambless, and Alves (2010) found orthographic representations to be neither a help nor hindrance to learners. In many cases, the availability of orthographic representations appears to facilitate second language learners' performance on word learning and phonemic awareness tasks (e.g., Escudero, Hayes-Harb, & Mitterer, 2008; Escudero & Wanrooij, 2010; Ziegler, Muneaux, & Grainger, 2003). However, in some cases, the availability of orthographic representations may interfere with the acquisition of novel second language words (e.g., Bassetti, 2006; Halle, Chereau, & Sequi, 2000; Hayes-Harb, Nicol, & Barker, 2010).

The L2 studies cited above have all investigated the interaction of phonological and orthographic representations when the first and second languages use the same orthography (e.g., the Roman alphabet). However, Showalter and Hayes-Harb (2011) investigated the influence of novel orthographic symbols on learners' ability to memorize the phonological forms of novel second language words. Showalter and Hayes-Harb taught native English speakers with no previous Mandarin language experience a set of Mandarin nonword minimal quadruplets differentiated only by tone. One half of their subjects saw written forms of the words that included tone marks (e.g., <fián>), while the other half saw forms without tone marks (e.g., <fian>). They found that subjects who saw tone marks during the word learning phase were better able to match the auditory words to pictures representing their meanings than were the subjects who did not receive orthographic tone marks. Showalter and Hayes-Harb conclude that even unfamiliar orthographic symbols can help learners acquire the phonological forms of novel second language words.

In the present study, building on the findings of Showalter and Hayes-Harb (2011), it is asked whether the learners are similarly aided by using entirely novel orthographic forms (in this case, native English-speaking learners of Arabic, which uses the Arabic script). A second aim of the present study is to determine to what degree learners actually learn the specific mappings between orthographic representations and sounds. In a follow-up to Showalter and Hayes-Harb (2011), Showalter and Hayes-Harb (submitted) asked whether subjects who saw orthographic tone marks during the word learning phase actually learned the association between each tone mark and the tone they heard, or whether the presence of tone marks simply cued the learners to pay more careful attention to the auditory signal, resulting in their noticing and remembering the tones associated with each word. Results from Showalter and Hayes-Harb revealed that learners who received tone marks during the word learning phase were able to create tone mark-phoneme correspondences. These learners were able to create a connection between the tone mark in a novel word and the phonological representation more accurately and consistently than learners who did not receive tone marks during the word learning phase.

Thus the present study involves two experiments: Experiment 1 investigates native English speakers' ability to learn Arabic words differentiated by a novel phonemic contrast (i.e., Arabic velar-uvular stop contrasts) presented with or without their spelled forms in the Arabic script, and Experiment 2 investigates whether native English speakers who are exposed to the Arabic written forms during the word learning phase actually learn the grapheme-phoneme correspondences of Arabic exemplified in the stimuli. The present study will therefore investigate the interaction of phonology and orthography, specifically how this interaction presents itself in learners when given an entirely unfamiliar L2 script.

CHAPTER 2

LITERATURE REVIEW/BACKGROUND

Orthographic representations have been found to interact in various ways with phonological representations in both word learning and phonological processing. Knowledge of how words sound (i.e., words' phonological forms) can be influenced by the grapheme-phoneme correspondences associated with the word's spelling.

2.1 Studies of the interaction of phonological and orthographic representations in the L1

Halle, Chereau and Sequi (2000) investigated whether orthographic knowledge influences phonology. Specifically, they asked if listeners were more likely to perceive what is auditorily presented to them or if they perceived what they believed they "should" perceive based on a preconceived notion garnered from outside factors, such as orthography. French /p/ and /b/ exhibit voicing assimilation, where /b/ is devoiced when followed by a voiceless obstruent and /p/ is voiced prior to a voiced obstruent. French has a deep orthography, which means that there is not a one-to-one grapheme-phoneme correspondence, and this can create difficulty for listeners. Halle et al. inquired as to whether listeners perceived [p] or [b] in the environments where voicing assimilation occurs, and whether the presence of orthographic representations of the auditory words altered the listeners' perceptions. That is, they were interested in whether listeners perceived [p] or [b] when given an orthographic representation that differed from the auditory representation (i.e., see <b>, auditory [p]).

Halle, Chereau, and Sequi (2000) used words with sound sequences of <bs> and <bt> in their experiments as perceptually confusable sequences, and then had words having a clear /b/, /p/ distinction (i.e., sequences of /bʒ/ or /bd/ with no assimilation). In the first experiment, listeners heard only portions of words and were asked to determine which of the two consonants they heard. In other words, listeners underwent a phonemic gating task, where the initial portion of the words was removed leaving the bilabial information and the subsequent environments (e.g., [psyrd] for *absurde*), but presented at different durations (i.e., 40 ms or 250 ms after the bilabial stop release burst). Listeners wrote down whether they heard 'b' or 'p'. Without the lexical context provided by the initial vowel [a], subjects perceived [p] more often than [b] in this devoicing environment.

In the second experiment, in addition to hearing the gated auditory stimuli, subjects saw spelled forms of the words from which the auditory forms were extracted, with some participants seeing incongruent spellings and some congruent spellings. In the incongruently-spelled items, the orthographic representation of the bilabial stop consonant had the opposite voicing of the surface consonant (e.g., the devoiced auditory form [apsyrd] is spelled as <absurde> and listeners heard [apsyrd]). In the congruently-spelled items, the orthographic and auditory representations match (e.g., <capsule> and [kapsyl]). The subjects were explicitly told not to focus on the spelled forms in making their sound judgments. It was hypothesized that if participants focused on spelling, a greater number of [b]s would be perceived on items spelled with <b>, and if listeners solely based their perceptions on the auditory representation, more [p]s would be perceived. That is, for auditory [p] and orthographic <p>, more [p]s should be perceived. However, for auditory [p] with orthographic <b>, more [b]s would be perceived. As a whole, more [b]s were detected and reaction times were longer in the [p], <b> condition. Halle, Chereau, and Sequi (2000) concluded that orthography biased perceptions.

The third experiment consisted of a phonemic gating task (each gate being at 40ms) in which the longest forms were the full auditory words. Words containing <bs>, <bt> and <bʒ>, <bd> were used once again, but words with <ps> were added for controls. More [b]s were perceived until words were given in full or when they were closer to their "uniqueness point", the point at which they become distinguishable from other words. When given the full auditory word or given a word past the uniqueness point, more [p]s were heard, because listeners no longer relied on the orthographic representation to give clues in creating a perception of the auditory word. Finally, Halle et al. (2000) conducted an experiment with nonwords to make sure that more frequently encountered words and grapheme-phoneme correspondences were not substantially influencing listeners' perceptions. However, it was still found that more [b]s were heard than [p]s in words where [b] was the assimilated auditory representation.

The experiments of Halle et al. (2000) demonstrated that orthographic representations have a strong influence on phonological processing. The purpose of the study was to demonstrate that the presence of orthographic forms can negatively influence a listener. That is, when words are pronounced in way X, knowing their orthographic correlate may convince readers that they are hearing words pronounced in way Z. Therefore, Halle et al. found an interaction that may cause listeners to alter their perception of phonological representations.

Tyler and Burnham (2006) investigated the effects of orthography on phonology, and found that orthographic representations affect performance on phonological tasks, even when learners are explicitly told not to focus on orthography or have no instruction about using orthography. Tyler and Burnham also deduced that learners who are literate perform better on phoneme awareness tasks because they have learned about the sounds and phonetics of their language via their exposure to orthography, as “graphemes are visual sounds” (Tyler & Burnham, 2006, p. 2011). In one experiment, Tyler and Burnham (2006) instructed subjects to remove the first sound of a word, and this was done by telling subjects to “remove the sound __ from __” to create another possible English word. Some words in the experiment were classified as incongruent, where after the deletion of the word-initial letter, the remaining letters did not spell the word that would result from deleting the word-initial phoneme (e.g., ‘worth’ becomes ‘earth’ but spelled <orth>). The other words in the experiment were congruent, where deletion of the first sound resulted in the same spelling as the phonological representation (e.g., ‘wage’ becomes ‘age’). On congruent items, graphemes could be used to obtain the correct answers (‘w/age’ → ‘age’), but on mismatched items graphemes would lead to an incorrect or indiscernible answer (‘w/orth’ → ‘orth’, ‘w/orth’ → ‘earth’). Tyler and Burnham found that subjects were less accurate at pronouncing the sound-removed words when their letter-removed spelled forms did not match the expected auditory-spelled correspondence. Incongruent item error rates were much higher and responses took longer than the congruent items. Therefore, Tyler and Burnham posited that orthography was used for phoneme deletion tasks.

Tyler and Burnham (2006) conducted a second experiment where subjects were explicitly told not to focus on orthography, as this would give them wrong answers on the experiment. Items in the practice phase were made incongruent to demonstrate the wrong answers and deter subjects from focusing on their orthographic knowledge. It was hypothesized that if phonemic awareness and orthographic knowledge are two separate entities, then orthography would not have an effect on the phoneme deletion. Reaction times for the incongruent items were longer than for their congruent counterparts, and subjects still exhibited orthographic effects after being instructed not to focus on orthography. Words that contained initial consonant clusters, proved especially difficult when instruction was given. Subjects had difficulty deleting a single phoneme versus the orthographic cluster that would be analogous to an initial sound (i.e., [s] from 'scarf', but subjects removed [sk] to become 'arf'). Tyler and Burnham deduced that orthographic awareness is automatic and cannot be inhibited.

In a third experiment, Tyler and Burnham (2006) gave directions to half of the subjects about using orthography while the other half did not receive these directions. None of the subjects received carrier sentences as in the first two experiments, but were instead given a single written word. In this experiment subjects would see <street>, without the sounds to be removed already deleted (e.g., they saw <street> not <treat>). The carrier sentence in the first two experiments told participants which sound to remove, which was not done in this experiment. Subjects who received instructions about ignoring spelling performed better at task than those who did not, and incongruent items created longer reaction times.

The final experiment built upon results found in the first three experiments, while Tyler and Burnham (2006) used word initial clusters to investigate whether they were more difficult for subjects because of spelling than simple onsets (*i.e.*, for ‘grief’, whether learners would delete [g] and get ‘reef’ or delete [gr] and get ‘ief’). Learners were once again instructed not to use orthography, but findings demonstrated that learners performed worse on word initial clusters due to spelling ambiguity and difficulty.

Tyler and Burnham (2006) thus found that learners have difficulty determining which portion of a word should be deleted to form a new word when the word has an incongruent orthographic representation. Spellings that demonstrate complexity or complex phonological sequences will contribute more difficulty to a task. They thus concluded that learners will always use orthographic knowledge to support their phonological abilities when orthography is present, especially in their L1, as learners are accustomed to how the correspondences work.

The two studies discussed above demonstrate the interaction of orthographic representations and phonology. It is concluded that there is indeed a relationship between the two; however, these studies only show this interaction in an L1.

2.2 Studies of the interaction of phonological and orthographic representations in an L2 when L2 orthography is familiar to learners

Many studies have investigated how knowledge of L1 grapheme-phoneme correspondences influence phonological representations in an L2, and many studies have investigated this by using languages with the same or similar script or by using speakers with knowledge of the script being used (Bassetti, 2006; Cutler, Weber, & Otake, 2006; Detey & Nespoulous, 2008; Escudero, Hayes-Harb, & Mitterer, 2008; Ota, Hartsuiker, & Haywood, 2010; Ota, Hartsuiker, & Haywood, 2009; Simon & van Herreweghe, 2010; Weber & Cutler, 2004; Ziegler, Muneaux, & Grainger, 2003). It has been found that, in L2s, learners may find orthographic representations to be either helpful or to be a hindrance when perceiving phonological contrasts.

Erdener and Burnham (2005) investigated the effects of orthographic depth on learners in production tasks and tasks involving written responses. They posited that a transparent language, a language with a one-to-one correspondence of graphemes and phonemes, would be more beneficial for learners at task. Erdener and Burnham hypothesized that learners who have knowledge of grapheme-phoneme correspondences have better awareness of nonnative contrasts, and thus employing the use of these correspondences would enhance performance on tasks.

Irish was used as the stimulus language with opaque, many-to-one grapheme-phoneme correspondences, and Spanish was used as the transparent language. Participants were native speakers of Turkish, which employs a transparent orthography, and Australian English speakers, who are familiar with an opaque orthography.

Participants silently read stimuli (CVC and CVCV words; e.g., 'yur' [jʊːr] and 'bema' [bɛma] for Spanish and 'meib' [mɛb] and 'reibe' [rɛb'ɛ] for Irish), then produced the stimuli, and finally underwent a writing task with phoneme errors (deletion, insertion, etc.) as measures of ability utilizing the correspondences of each orthography. Each of these two tasks were completed separately and conditions between the two included an auditory only condition, auditory-visual condition, auditory-orthography, and auditory-visual-orthography condition. In the auditory conditions, subjects were instructed to produce the stimulus. In the orthographic conditions, subjects were instructed to write the stimulus.

It was found that the Turkish speakers significantly outperformed the Australian English speakers on the Spanish stimuli, but both participant groups had low performance scores on Irish. Transparent Turkish orthography benefitted Turkish speakers with learning the transparent Spanish stimuli, but was of no help with the opaque Irish stimuli. In all conditions with orthography, participants' performance was enhanced, but when orthography was opaque, error rates were higher because of the inconsistency, and therefore relative unpredictability, of grapheme-phoneme correspondences. In the writing conditions participants displayed fewer errors in Spanish because of the predictable grapheme-phoneme correspondences.

Therefore, Erdener and Burnham (2005) found that benefits of orthographic knowledge are dependent on one's native language's orthographic depth as well as the second language's depth. That is, learners of a language with a transparent orthographic depth will perform more accurately when their native language's depth is transparent, and they will not benefit in an opaque language learning situation. Finally, the use of orthography as a visual cue for learners greatly enhances performance and reduces errors.

Escudero et al. (2008) investigated the issue of perception and lexicalization in novel L2 segments and followed up on a finding by Weber and Cutler (2004). Each of these studies investigated the lexicalization of novel phonemes, and whether availability of orthographic representations can affect the encoding of these lexicalizations.

Escudero et al. (2008) asked whether knowledge of orthographic forms may play a role in lexicalizing novel L2 contrasts. They hypothesized that Weber and Cutler's (2004) findings of an asymmetry in lexical activation, where native Dutch speakers listening to L2 English appeared to activate /ɛ/ lexical items whether [æ] or [ɛ] was present in the auditory signal, may result from a combination of their difficulty perceptually distinguishing auditory [æ] and [ɛ] and their knowledge of the word's spelled forms. If native Dutch speakers could not perceive the English [æ]-[ɛ] distinction, it might be expected that [ɛ] words (e.g., pencil) and [æ] words (e.g., panda) would activate each other symmetrically. However, if native Dutch speakers neutralized English [æ] and [ɛ] to their closest Dutch counterpart /ɛ/, they may have initially perceived all [æ]- and [ɛ]- words as [ɛ]-words. Given that 'pencil' is spelled with the letter 'e' (which also maps to /ɛ / in Dutch), the asymmetry in the direction of 'e'-words is not surprising. However, if this was the case, the asymmetry should have been found only in cases where the native Dutch speakers know the spellings of the English words.

Escudero et al. (2008) taught nonwords ([tɛnzə] and [tændək]) and nonobjects to native Dutch speaker participants. This research study consisted of a word learning phase and a testing phase. In the word learning phase of the study, one group received only a sound and picture stimulus, while another group received a sound, picture, and spelled form. Participants had to choose the correct picture on a grid displaying the target and distracters, receiving feedback as to whether the word they chose was correct. In the testing phase participants used an eye-tracking device to complete tasks similar to the word learning phase.

Results demonstrated that learners who received orthographic representations with the auditory stimulus in the word learning phase were able to create contrastive lexical representations. The auditory only group had symmetric glances toward /ɛ/ and /æ/. The auditory and orthography group had more fixation and glances toward /ɛ/ when <e> was presented, with fewer glances to /æ/ stimuli. Escudero et al. (2008) found that learners lexically represent novel contrasts if they have orthographic representations available to them, but this ability is less accurate when orthographic representations are not available to demonstrate a contrast.

The knowledge of orthographic forms of novel words can also be a hindrance to second language learners (Georgiou, Parilla, & Papadopoulos, 2008; Hayes-Harb, Nicol, & Barker, 2010; Mayer, Crowley, & Kaminska, 2007; Vendelin & Peperkamp, 2006). Bassetti (2006) found first language (L1) orthography influences how L2 orthographic and phonological correspondences are interpreted. Bassetti studied learners of Chinese and the influence of *Pinyin*, the Romanized version of Mandarin that utilizes a shallow orthography, on phonological representations in learners of Chinese as a foreign language (CFL). *Pinyin* was interpreted in accordance with the learners' native language grapheme-phoneme correspondence rules. Bassetti posited that orthographic representations will interact with phonology as learners try to create mental representations of lexical items in the L2.

Bassetti (2006) used Chinese rimes with diphthongs and triphthongs. Learners produced [iou], [uei], and [uən] in both a phoneme counting and phoneme segmentation task. It was hypothesized that English CFL learners would count fewer vowels in a syllable when the orthography of a syllable did not contain a main vowel (e.g., <tui> ([duei]) counted with one vowel, but <wei> ([uei]) counted with two even though both have two vowels present). Similarly, it was hypothesized that CFL learners would not pronounce the main vowel separately, in the phoneme segmentation task, when the orthography did not contain it. That is, a word written as <gui> is pronounced [gui] by an English speaker although the Mandarin pronunciation is [guei], where the main vowel [e] is not included in the orthographic representation. However, when a word is written with <e> included, such as <wei>, English speakers will interpret and pronounce the [e].

The first experiment included first year CFL learners with native languages that also used the Roman alphabet. All learners had studied *Pinyin* to transcribe Chinese. Bassetti gave participants a list of Hanzi characters, Chinese logograms, with no transcriptions, with phonologically and orthographically inconsistent and consistent items in regards to syllables. Learners counted more phonemes in rimes with the *Pinyin* representations including the main vowel.

The next experiment used a new set of subjects who saw the Hanzi character, read the word, and then read the word again by pronouncing each phone individually. Three of the stimuli had syllables with the main vowel spelled, while two spelled the item without the main vowel. For most of the learners, rimes were phonemically segmented the same way a word was orthographically constructed.

Bassetti (2006) found *Pinyin* orthography to influence phonological representations in learners, and that first language grapheme-phoneme rules determined how orthographic representations were interpreted. Bassetti gave other explanations as to what could cause the outcomes she had obtained in the study, but none were as strong as orthography being the influencing factor on L2 phonological representations. Bassetti also mentioned that L2 graphemes are normally interpreted by learners the same way they are interpreted in the learner's L1. Therefore, she concluded that knowledge of L1 orthography transfers to and influences the L2.

Ota, Hartsuiker, and Haywood (2009) investigated L1 phonological transfer on L2 lexical representations. In the study, they used English minimal pairs that might be perceived as homophones by subjects whose native languages lack the relevant contrasts (e.g., ROCK-LOCK, PEACH-BEACH). Ota et al. argued that using auditory only tests makes it difficult to study why learners are not creating mental lexical representations for novel L2 contrasts, as there are no concrete visuals to support how learners are forming what they think is correct. However, Ota et al. described that by giving learners orthographic representations of words, learners automatically create phonological representations and these representations will have correspondences to the visual information that was given.

Participants included Japanese, Arabic, and native English speakers. Native Japanese and Arabic speakers do not use the Roman alphabet, and therefore Ota et al. could control for L1 orthographic interference, as the participants could not use L1 grapheme-phoneme correspondences to formulate their answers. Participants had to pass a phoneme identification task with the contrasts used in the study before being included. Contrasts used in the study included /l/-/r/ and /p/-/b/, where the /l/-/r/ contrast was expected to be difficult for Japanese speakers and the /p/-/b/ contrast difficult for Arabic speakers because the contrasts are not present in the L1 of these speakers.

Ota et al. (2009) included 20 homophone pairs and 20 minimal pairs with the /l/-/r/ and /p/-/b/ contrasts, as well as filler pairs, and participants saw one member of the pairs with the spelling control. Some pairs were formed as BRAKE-BREAK (homophonous pair), some as ROCK-LOCK (minimal pair), while others were formed as LOCK-SOCK (spelling control). Participants indicated whether the pairs shown were semantically related (e.g., KEY-LOCK are semantically related, but KEY-ROCK are not), and whether the pairs were considered homophones.

Ota et al. (2009) found more errors occurred and slower reaction times happened in the pairs that were homophones than for the spelling controls, while participants did not have access to a salient differentiation. It was also found that Japanese speakers showed more problems with /l/-/r/ contrasts and Arabic speakers demonstrated more errors with /p/-/b/ contrasts, which supports the hypothesis that L1 representations affect deciphering L2 contrasts. Ota et al. found L1 representations transfer to L2 lexical coding, even with orthographic information that may not be available in an L1. That is, Ota et al. found that learners are unable to create representations consistently in both written and spoken forms. An interaction can be seen between L1 and L2 phonological and orthographic representations, even in instances where nonnative or new information is processed, such as in the Japanese /l/-/r/ and Arabic /p/-/b/ contrast.

Hayes-Harb, Nicol, and Barker (2010) found that orthographic representations may not necessarily be helpful to learners, and can, in some cases, actually hinder learners in learning the phonological forms of novel words. It is difficult for a learner to perform in a task where the writing system is the same or similar to their L1, but grapheme-phoneme correspondences do not match in the L2 as they do in the speaker's L1. Hayes-Harb et al. (2010) wanted to know if there was an effect on novel lexicalization using orthographic representations and phonology. Specifically, this study investigated how incongruencies in grapheme-phoneme correspondences within a familiar script would affect word learning, and if congruent orthographic representations aided learners in remembering novel words.

Monolingual speakers of English underwent a word learning phase and testing phase. In the learning phase all groups were given a drawing associated with the auditory stimulus, where stimuli were bisyllabic English nonwords that contained phonemes available in an English speaker's lexicon and followed English phonotactics. There were three different word learning groups. One group was shown a picture, the auditory word, and the visual sequence 'XXXX', while the other two groups were exposed to orthographic representations in addition to the picture and auditory representations. One of the groups saw congruent spellings of the auditory stimuli, while the other saw incongruent spellings (i.e., a wrong or extra letter).The testing phase consisted of participants saying whether the auditory token matched the picture given.

At test, the matched items, orthographic representation and auditory representation (i.e., <togeg> and [togeg] in stimuli), were equally easy for all participants. Participants in the auditory and congruent/incongruent group performed the least accurately (i.e., <thogeg> and [togeg] in the stimuli). Wrong letter incongruencies (i.e., <faza>, [faʃa], <fasha>, where <z> is incongruent) proved to be difficult, while learners expected a grapheme-phoneme correspondence that was not available, but incongruent silent letters (i.e., <n> in *column*) had no significant effect, most likely due to English speakers encountering this spelling incongruency often. Therefore, it can be seen that when orthography was given with incongruent letters, effects were detrimental in remembering the new phonological forms.

2.3 Studies of the interaction of phonological and orthographic representations with unfamiliar orthographic marks

To this point, studies have provided information that L2 learners are helped or hindered by transferring L1 grapheme-phoneme correspondences (Escudero, Hayes-Harb, & Mitterer, 2008; Escudero & Wanrooij, 2010) to the L2 in a given study. We also know that orthography can aid a learner with novel forms in an L2, even when there is a novel orthographic mark they must observe as found in Showalter and Hayes-Harb (2011). Showalter and Hayes-Harb investigated how learners use novel orthographic marks when learning new L2 words. They hypothesized that even novel orthographic marks, in this case tone marks, would be beneficial to learners. Subjects with no prior experience of Chinese (or other tonal language) participated in a word learning phase, a criterion test, and a final test. In the word learning phase, subjects heard a word and saw a picture (e.g., heard [gí] and a nonobject picture corresponding to [gí]). One group of subjects saw orthographic representations with no markers for tone, while the other group saw orthographic representations with the tone marks (i.e., <fian> versus <fián>). Showalter and Hayes-Harb (2011) administered a criterion test wherein learners were asked to determine whether the picture and auditory representation matched. This portion of the experiment did not test for tone, but only tested whether learners could determine if [fian] auditory representations were matched with [fian] pictures and [gi] representations matched with [gi] pictures.

Showalter and Hayes-Harb (2011) then had learners undergo a testing phase. In this phase items crucially tested subjects' knowledge of the tones associated with each picture. Learners answered whether auditory representations matched the pictures based on which tone was heard and if this was correct. For example, a learner may hear [fian (tone1)] and see a picture for [fian (tone1)] (matched) or [fian (tone 3)] (mismatched). On the mismatched items, Showalter and Hayes-Harb (2011) found a significant difference between learners with and without the tone marks in the word learning phase. The use of orthography when learning novel words, even with novel orthographic marks to distinguish words, was beneficial to learners in this study. Because this study resulted in robust outcomes, the present study will use the same methodology including presentation, use of pictures, and number and types of phases, but use an unfamiliar script.

Showalter and Hayes-Harb (submitted) investigated whether learners created grapheme-correspondences with the novel words and orthographic marks in Showalter and Hayes-Harb (2011). Showalter and Hayes-Harb (submitted) was structured in the same manner as Showalter and Hayes-Harb (2011). However, at test learners saw the orthographic forms of words (*i.e.*, <fián>) and heard the auditory representations. All learners performed more accurately on the matched items than the mismatched items. The group who received tone marks performed more accurately than the group who did not receive tone marks. The group who received tone marks created grapheme-phoneme correspondences, but they were not robustly able to create the correspondences (65% accuracy), while the group who did not receive tone marks did not differ from chance. Based on these findings, that the tone marks group outperformed the no tone marks group, if an interaction is found in Experiment 1 of the current study, it is expected that a similar finding will occur in Experiment 2 as it did in Showalter and Hayes-Harb (submitted).

Showalter and Hayes-Harb (submitted) also investigated whether the tone marks affected learners positively because of the iconicity (that could be) associated with them. That is, whether the tone mark for <fiān> is easy for learners to remember because it is flat, and therefore learners deduced that the “flat” phonological representation is paired with the flat tone mark in the orthographic representation without actually learning the grapheme-phoneme correspondence. Results indicate that some of the tone marks were indeed easier for learners to remember than others. That is, there was a significant effect of tone. The current study will help determine whether this iconicity was helpful in learners creating the grapheme-phoneme correspondences or whether learners can create grapheme-phoneme correspondence even in the event that there are no iconicity judgments available. This will also allow for determining whether learners see the novel script as merely a picture, a whole entity, or whether learners recognize that grapheme-phoneme correspondences can be created.

2.4 Arabic as a second language

Relatively few studies describe perception and phonemic learning in Arabic; however, researchers who have investigated English speakers learning Arabic demonstrate that learning Arabic contrasts is difficult for learners. Zaba, Bolewicz, and Hayes-Harb (submitted) investigated how consonants in Arabic are perceived by native speakers of English. Zaba et al. examined pharyngealized and nonpharyngealized consonants in different vowel contexts. That is, the difference between /t/ and /tˤ/ (also /d/ and /dˤ/) with a succeeding vowel, either /a/, /i/ or /u/, and in some words /k/ was added (some words CV and some CVC). Based on the acoustic patterns of vowels, Zaba et al. hypothesized that learners would be able to use their knowledge of these patterns to create inferences about whether the consonant in question was pharyngealized or nonpharyngealized.

Zaba et al. (in prep) included two tasks; one was a vowel identification task and the other an AXB task. In the identification task learners received words such as [dik] and [dˤik], and then determined which vowel they perceived. Learners identified /i/ with the greatest accuracy, but /a/ and /u/ had more varied accuracy.

In the AXB task, Zaba et al. instructed learners to determine which sounds in a set of three were similar to each other (e.g., learners heard [tik]— [tˤik]—[tˤik] and said B, the last form, was the correct answer). There was a main effect of vowel and consonant in this task, with /a/ being the vowel with the most accurate responses. There was also a significant interaction of consonant, meaning /d/, /d ˤ/ was easier for learners to discriminate than /t/ and /tˤ/.

The results of Zaba et al. (in prep) support the hypothesis that learners utilize vowel contexts to identify novel consonant contrasts. This study shows that learners need to be aided in discriminating and identifying contrasts in Arabic. Arabic is a difficult language for native English speakers to learn because of its novel contrasts and novel writing system. Most studies done on English learners of Arabic have used the pharyngealized versus nonpharyngealized contrast, however the present study will use a velar-uvular contrast, as this may be an easier contrast for English speakers because at least one of the sounds is familiar to them (e.g., [k] and [g] are velar sounds in English). Zaba et al. only gave auditory representations to learners, but in the present study with the added difficulty of the orthographic representations being present, a more familiar, even if only slightly more familiar contrast, may prove to be beneficial at task.

Several of the studies discussed thus far have demonstrated that L2 learners can make inferences about the phonological forms of L2 words from orthographic forms that are familiar to the learners (e.g., the Roman orthography such as in Arab-Moghaddam & Senechal, 2001; Bassetti, 2009; Bassetti, 2007; Bassetti, 2005; Cutler, Treiman, & van Ooijen, 2010; Cutler, Weber, & Otake, 2006; Detey & Nespoulous, 2008; Dijkstra, Frauenfelder, & Schreuder, 1993; Erdener & Burnham, 2005; Ferrand, & Montant, 2004; Georgiou, Parrila, & Papadopoulos, 2008; Grainger & Ferrand, 1994; Kim, Taft, & Davis, 2004; Kaushanskaya & Marian, 2008; Lee & Turvey, 2003; Mayer, Crowley, & Kaminska, 2007; Ota, Hartsuiker, & Haywood, 2010; Ota, Hartsuiker, & Haywood, 2009; Pattamadilok, Kolinsky, Tyler & Burnham, 2006; Schwartz, Kroll, & Diaz, 2007; Simon, Chambless, & Alves, 2010; Slowiaczek, Soltano, Wieting, & Bishop, 2003; Taft, 2006; Vendelin & Peperkamp, 2006; Ventura, Radeau, & Morais, 2007; Ventura, Kolinsky, Brito-Mendes, & Morais, 2001; and Weber & Cutler, 2004), and even when the orthographic forms contain unfamiliar marks (as in Showalter and Hayes-Harb, 2011, submitted). However, it is not yet known whether learners benefit similarly from the availability of orthographic representations when they are presented in an entirely unfamiliar script. In the current study the influence of the availability of entirely unfamiliar orthographic forms on native English speakers' ability to remember the phonological forms of novel words is investigated. In this case, the orthographic forms are presented in the Arabic writing system, which is a transparent orthography, but is entirely unfamiliar to the learners. It is then examined whether learners are simply noticing that consonant contrasts are different than their native language, or if they are learning specific grapheme-phoneme correspondences in the new language. The research questions are:

- Can learners use their knowledge of the alphabetic principle (i.e., that letters represent sounds) to infer the phonological forms of new L2 words even when the orthography is unfamiliar? (Experiment 1)
- Do learners have to learn specific grapheme-phoneme correspondences to benefit from orthographic representations? (Experiment 2)

The dependent variable in Experiment 1 is proportion correct at matching pictures and auditory forms; the dependent variable in Experiment 2 is proportion correct at matching written forms and auditory forms. The independent variable in both experiments is the availability of orthographic representations during the word learning phase. If subjects who see orthographic forms perform more accurately in Experiment 1 than subjects who do not see orthographic forms, it can be concluded that orthographic representations, even when in a novel script, are beneficial to learners' ability to remember the phonological forms of novel L2 words. In Experiment 2, if subjects who are exposed to orthographic forms during the word learning task perform above chance on a task where they are asked to match orthographic and auditory forms, it can be concluded that they have, to some extent, learned the novel grapheme-phoneme correspondences.

.

CHAPTER 3

METHODS/RESULTS

<u>3.1 Experiment 1: Lexical form task</u>

3.1.1 Subjects

Native English speakers without knowledge of Arabic were the tested population. Subjects excluded from the study included persons with a reported hearing, language processing, speech, or neurological disorder. Subjects were recruited from the University of Utah campus, and received class credit for participating. Subjects were between 18 and 58 years old. Following Showalter and Hayes-Harb (2011, submitted), a total of 30 subjects were randomly assigned to one of two word learning conditions, an Orthography group and a Control group, described below. There were 5 males and 10 females in the Orthography group, and 3 males and 12 females in the Control group.

3.1.2 Stimuli

The stimuli for Experiment 1 were six nonword minimal pairs contrasting Arabic velar-uvular contrasts (i.e., /k/ and /q/) in a CVCV structure. All words used in the study were Arabic nonwords to ensure consistent word structure and eliminate any possibility that a word may be recognized. There were a total of 12 words, with six pairs of words differing only in the /k/-/q/ contrast. Three pairs were created in a CV_1CV_2 structure (e.g., [qita]), and three pairs were created in a CV_1CV_1 structure (e.g., [qini]). The nonwords were produced by two male native speakers of Arabic. The speakers were recruited from the University of Utah community. Talker 1 is from Jordan (Jordanian dialect) and is 30 years old, with 13 years of English language experience, and has lived in the United States for 2 years. Talker 2 is from Jordan (Jordanian dialect) and is 21 years old, with 9 years of English language experience, and has lived in the United States for 2 ½ years. Each talker was asked to read the list of 12 Arabic nonwords, which were written in Arabic script without 'pointing' indicating short vowels, three times in different random orders each time. Filler Arabic nonwords were placed at the beginning and end of each list to avoid list intonation effects in their pronunciations. The second token of each of the 12 target nonwords was selected for presentation in the experiment, resulting in two auditory versions of each nonword: one produced by each of the two talkers.

Each of the 12 Arabic nonwords was randomly assigned to a picture retrieved from the Bank of Standardized Stimuli (Brodeur, Dionne-Dostie, Montreuil, & Lepage, 2010; Creative Commons, n.d.). Because the subjects had no prior exposure to Arabic, they were unaware of the meanings associated with the words, or more specifically, that the words were nonwords, and therefore any picture could accompany the auditory and orthographic representations. The auditory and visual stimulus elements are thus as exemplified in Figure 1. The full set of auditory and visual stimuli can be found in Table 1.

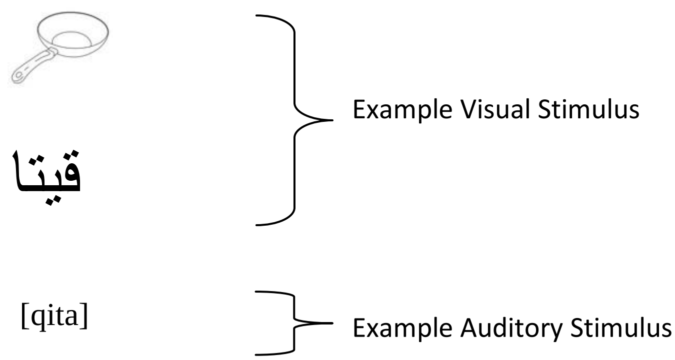

Figure 1. Example auditory and visual stimuli used in Experiment 1

Table 1. Stimuli

Orthographic Form (Arabic Script)	Object Picture	Auditory Form	Orthographic Form (Arabic Script)	Object Picture	Auditory Form
كاشو		[kaʃu]	قاشو		[qaʃu]
كيتا		[kita]	قيتا		[qita]
كوثي		[kuΘi]	قوثي		[quΘi]
كاسا		[kasa]	قاسا		[qasa]
كيني		[kini]	قيني		[qini]
كوبو		[kubu]	قوبو		[qubu]

3.1.3 Procedure

Experiment 1 involved a word learning phase and a testing phase. Both phases were presented via DMDX (Forster & Forster, 2003). In the word learning phase, subjects heard an auditory form and saw a picture (indicating the “meaning” of the nonword) and a written form. In the Orthography condition, the written form was the spelled form of the auditory nonword; in the Control condition, the written form was the unpronounceable and meaningless Arabic letter sequence <ط ط ط ط> (a rough Arabic equivalent of English <XXXX>, included so that subjects in both conditions saw visual forms of nearly equivalent complexity and novelty). Figure 2 presents what subjects heard and saw in the two conditions of the word learning phase.

Subjects in both word learning conditions were instructed to learn the words and their meanings as well as possible. Following Showalter and Hayes-Harb (2011) the 12 items were presented once per block, and the block was presented four times for a total of 96 presentations. Word learning stimuli were presented in a different random order

a. Orthography Condition b. Control Condition

قاشو ط ط ط ط

[qaʃu] [qaʃu]

Figure 2. Example presentation in the word learning phase in each word learning condition

for block for each subject and each word learning cycle.

After the first word learning cycle, subjects completed a criterion test. In this test, subjects were asked whether, for example, the picture of the baseball (which they learned was a [qaʃu]) matched the auditory form [kuΘi] (which they learned was associated with the picture of a paperclip). Figure 3 presents an example of a 'matched' and 'mismatched' criterion test item.

Crucially, in the criterion test, subjects were not tested on their ability to distinguish the uvular-velar minimal pairs (e.g., the picture of a baseball with the incorrectly-matched auditory form [kaʃu]). That is, the criterion test measured whether subjects had learned the auditory and picture pairings of very different words, not whether they could distinguish between words containing uvular and velar consonants. Each word was presented once in the matched condition and once in the mismatched condition, for a total of 24 criterion test items.

The 24 criterion test items were presented in a different random order for each subject. Subjects registered their responses by pressing 'yes' or 'no' keys on a computer keyboard. Subjects had three seconds to respond before the test considered their answers incorrect and moved on to the next item. Each subject completed the word

[qaʃu] [kuΘi]

matched mismatched

Figure 3. Example presentation in the criterion test for each item condition

learning-criterion test sequence as many times as need to reach 90% accuracy on the criterion test.

Upon passing the criterion test with 90% accuracy, subjects proceeded to the final test, where they were tested on their ability to discriminate the uvular-velar minimal pairs. The final test was identical to the criterion test, in that each trial consisted of the presentation of a picture and an auditory word, and that one half of the 24 items were matched and one half mismatched. However, in the final test, mismatched items involved the visual representation of a picture and the auditory presentation of the *minimal pair counterpart* of the picture's name (e.g., the picture of a baseball (which they learned was a [qaʃu]) with the incorrectly-matched auditory form [kaʃu]). Again, subjects answered by pressing "yes" and "no" buttons on a computer keyboard and were given a three-second time limit to respond. Figure 4 presents example final test stimuli.

[qaʃu] [kaʃu]

matched mismatched

Figure 4. Example presentations in the final test for Experiment 1 in each item condition

3.1.4 Results

The Orthography group had a mean of 3.66 (range 1-8) word learning-criterion cycles to reach 90%. The mean number of cycles for the Control group was 3 (range 1-6). Group differences on the number of word learning-criterion cycles were not significant ($F(1,28)=1.00$, $p=.326$).

Averaged across all items, the Orthography group had a mean proportion correct of .66 (SD=.23) and the Control group had a mean proportion correct of .68 (SD=.23). Overall, matched items were easier for both groups, with a mean proportion correct of .86 (SD=.07) for the two groups together (Orthography=.85, Control=.87), than mismatched items, where the mean proportion correct for the two groups together was .48 (SD=316; Orthography=.47, Control=.48). An ANOVA with subject group as a between-subjects variable (two levels: Orthography and Control) and item type as a within-subjects variable (two levels: Matched and Mismatched) revealed a significant effect of item type ($F(1,28)=136.656$, $p<.005$, partial eta squared=.830), with higher accuracy on matched than on mismatched items, which was expected. There was not a significant main effect of subject group ($F(1,28)=.196$, $p=.661$, partial eta squared=.007). The interaction of item type and subject group was not significant ($F(1,28)=.029$, $p=.867$, partial eta squared=.001). Figure 5 provides the results of item type mean proportion correct by each group.

Of interest is the fact that the Orthography group appears to have lower mean proportion correct scores on all items, as well as the fact that the Orthography group required, on average, more word learning-criterion cycles. This may be the result of the novel script being too much new information for learners to store to be able to process.

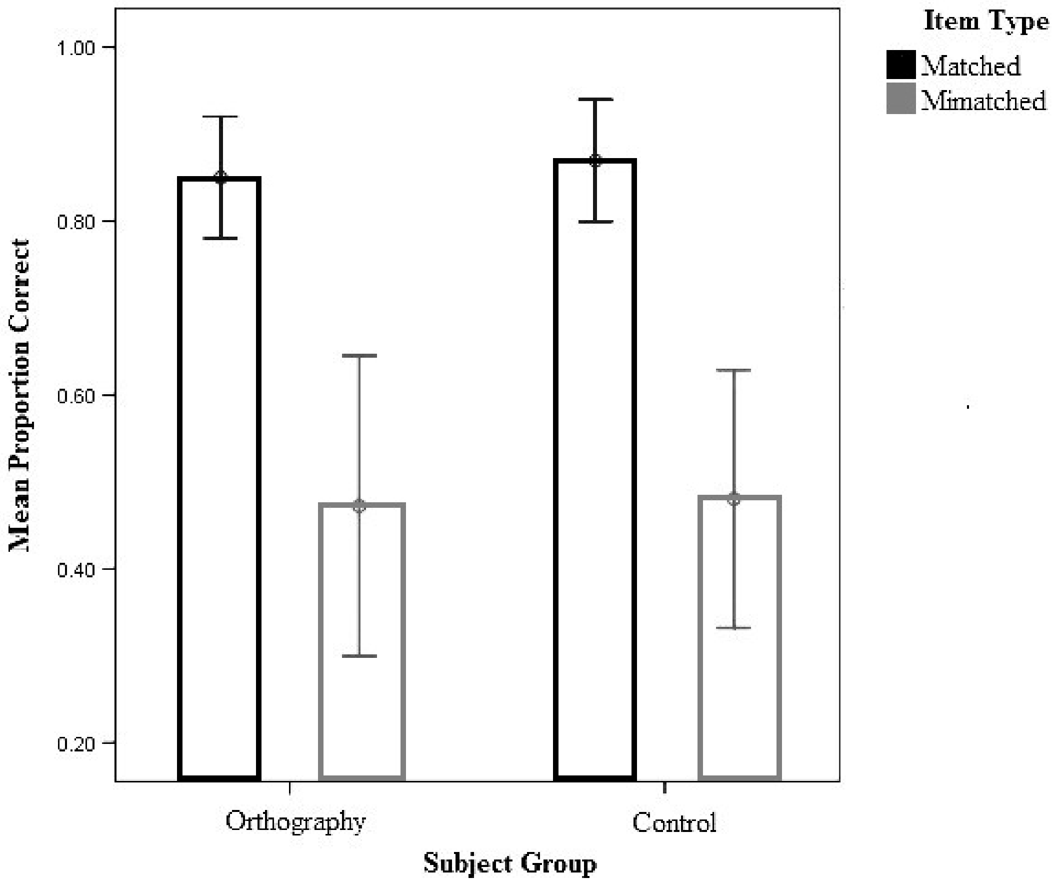

Figure 5. Proportion correct on matched and mismatched items by both groups; bars represent +/- 1 standard deviation

This will be described in more detail in the Discussion section. Results indicate that there is not a difference between the subjects who received orthography and those who did not receive orthography.

3.2 Orthographic knowledge task

3.2.1 Subjects

Native English speakers without knowledge of Arabic were the tested population. Subjects excluded from the study included persons with a reported hearing, language processing, speech, or neurological disorder. Subjects were recruited from the University of Utah campus, and received class credit for participating. Subjects were between 18 and 25 years old. Because no significant interactions or effects of the availability of orthographic representations were found in Experiment 1, Experiment 2 was not expected to have significant results. Therefore, only a total of 16 subjects were randomly assigned to one of two word learning conditions. There were 4 males and 4 females in the Orthography group, and 5 males and 3 females in the Control group. New subjects were used in Experiment 2 in order to minimize testing effects such as boredom or memorization of the test stimuli.

3.2.2 Stimuli

The stimuli for Experiment 2 were the same as in Experiment 1. That is, six minimal pair nonwords contrasting Arabic velar-uvular contrasts (i.e., /k/ and /q/) in a CVCV structure. As in Experiment 1, three pairs were in a CV_1CV_2 structure (e.g., [qita]), and three pairs were in a CV_1CV_1 structure (e.g., [qini]). The same productions from the same speakers of the nonwords were used. Experiment 1 and Experiment 2 also used the same pictures and orthographic representation that were assigned to the nonwords.

3.2.3 Procedure

The first two phases, the word learning phase and criterion test, were the same as Experiment 1, using the same orthographic and auditory representations. The final phase in Experiment 2 was the orthographic knowledge task. Upon passing the criterion test with 90% accuracy, subjects proceeded to the final test, where they were tested on their ability to discriminate the uvular-velar minimal pairs. The final test was identical to the criterion test, in that each trial consisted of the presentation of a picture and an auditory word, and that one half of the 24 items were matched and one half mismatched. Again, subjects answered by pressing “yes” and “no” buttons on a computer keyboard and were given a three-second time limit to respond. However, subjects did not see the nonobject pictures. Test stimuli in this task included the auditory representation and the orthographic representation. Mismatched items involved the visual representation of the orthographic form and the auditory presentation of the minimal pair counterpart of the orthographic form (e.g., the form كيني which they learned was [kini]) with the incorrectly-matched auditory form [qini]). Figure 6 presents example final test stimuli in Experiment 2.

قاشو قاشو

[qaʃu] [kaʃu]

matched mismatched

Figure 6. Example presentations in the final test for Experiment 2 in each item condition

3.2.4 Results

Because none of the Experiment 1 subjects appeared to have learned the lexical /k/-/q/ contrast, it was not expected that they learned the grapheme-phoneme correspondences. The mean number of word learning-criterion cycles to reach 90% for the Orthography group was 2 (range 1-3). The mean number of cycles for the Control group was 2.13 (range 2-3). Group differences on the number of word learning-criterion cycles were not significant ($F(1,15)=.179$, $p=.678$).

Mean proportion correct averaged across all test items for the Orthography group was .513 and for the Control group was .539. As in Experiment 1, both groups performed more accurately on matched items than mismatched items. Mean proportion correct for both groups on matched items was .63 (SD=.09) and .42 (SD=.14) for mismatched items. Mean proportion correct for matched items by the Orthography group was .65 (SD=.10) and .61 (SD=.08) for the Control group, and mean proportion correct for the Orthography group on mismatched items was .38 (SD= .13) and .47 (SD=.14) for the Control group. Figure 7 shows the results for mean proportion correct on matched and mismatched items between groups. An ANOVA with subject group as a between-subjects variable (two levels: Orthography and Control) and item type as a within-subjects variable (two levels: Matched and Mismatched) revealed a significant effect of item type ($F(1,14)=17.849$, $p<.005$, partial eta squared=.560), with higher accuracy on matched than on mismatched items. There was not a significant main effect of subject group ($F(1,14)=.776$, $p=.393$, partial eta squared=.053). The interaction of item type and subject group was not significant ($F(1,14)=1.885$, $p=.191$, partial eta squared=.119).

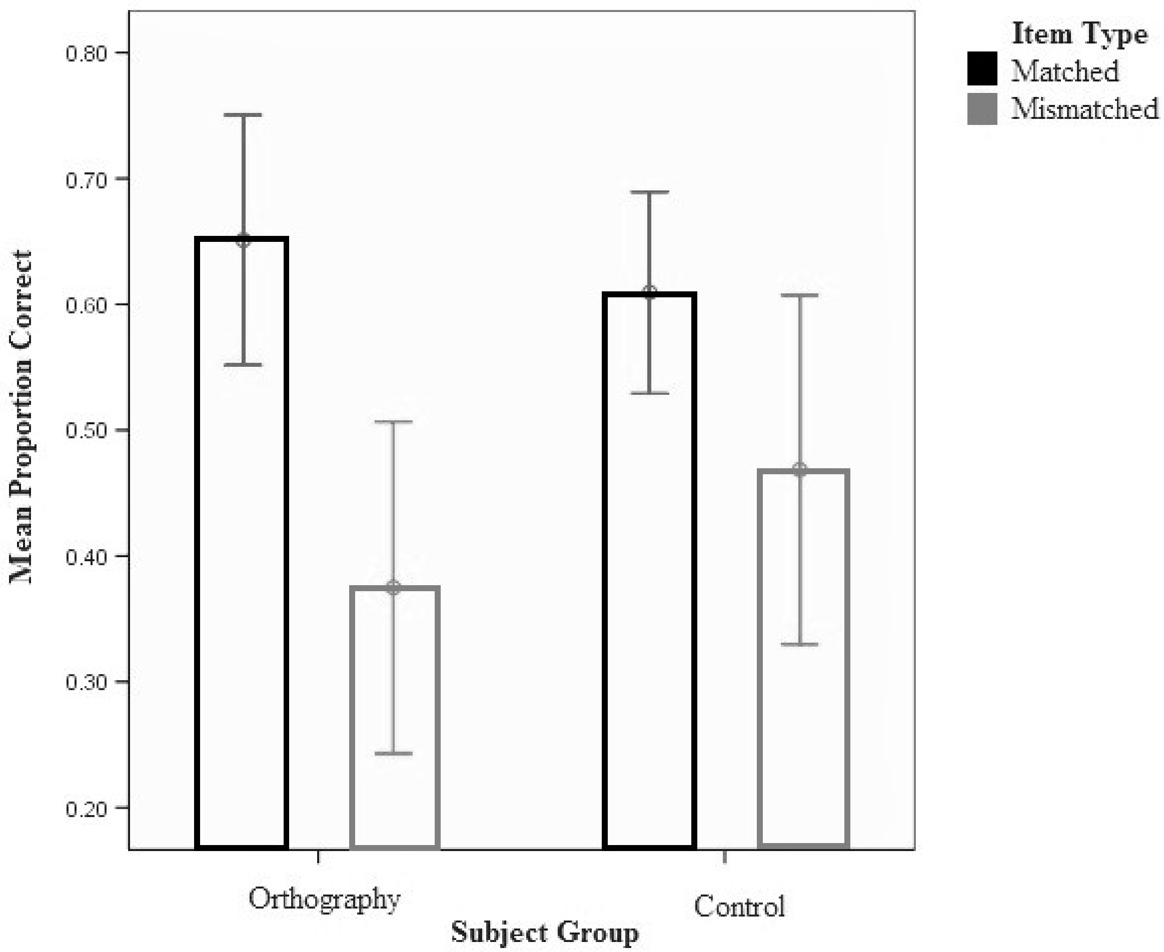

Figure 7. Proportion correct on matched and mismatched items by both groups; bars represent +/- 1 standard deviation

To establish whether subjects had learned the grapheme-phoneme correspondences or whether they simply guessed during the testing phase, the proportion correct score averaged across all items were examined to determine if the scores were above chance (above chance meaning the subjects had learned the grapheme-phoneme correspondences to some extent). Neither group performed significantly or robustly above chance on all items. The Control group had a higher mean at .539 ($t(7)=2.195$; $p=.064$) than the Orthography group at .513 ($t(7)=.552$; $p=.598$) This *suggests* that neither group was able to consistently create grapheme-phoneme correspondences. It is interesting to note that the Control group had a higher mean and was marginally significant. Although it is difficult to determine, this discrepancy between the Orthography and Control group may be due to a similar reason to that mentioned above about the world learning-criterion cycles. That is, the Orthography group may have required too many resources to learn the orthographic representations during the word learning phase to perform adequately during testing.

CHAPTER 4

DISCUSSION

Results from Experiment 1 are not consistent with findings from previous studies, which is that the availability of orthographic information can be beneficial to learners (Escudero, Hayes-Harb, & Mitterer, 2008; Escudero & Wanrooij, 2010; Showalter & Hayes-Harb, 2011; Ziegler, Muneaux, & Grainger, 2003). Both groups, subjects who received orthography and those who did not receive orthography, performed almost equivalently with each other. No significant effects or interactions were found in Experiment 1, suggesting that orthographic representations, when given as a novel script, are of no help to learners. This may not be true of all Arabic contrasts, instead the /k/-/q/ contrast in the present study may be difficult for learners even without the added difficulty of the novel script or even without orthographic representations to provide clues about the phonological forms of novel words. The fact that the Control group performed, albeit slightly, more accurately than the Orthography group may be a result of the Orthography group needing to utilize more resources for learning the associations of the orthographic representations to the other information they were learning. That is, the Control group received only pictures and auditory representations, where it can be assumed that the visual stimulus was ignored by some members of the group, since it did not change from word to word. However, the Orthography group had more information to learn—picture, auditory, *and* orthographic information.

The difficulty may stem from the novel script being too taxing when learning a new language. Unlike Showalter and Hayes-Harb (2011, submitted) where subjects were familiar with the Roman alphabet used, and therefore needed only to pay attention to the diacritic tone marks to make inferences about the phonological forms of words, subjects in the current study needed to understand that the novel script contained grapheme-phoneme correspondences *and* that the script read from right to left. Therefore, expecting the script to be read in the same manner as English would result in the subjects creating nontarget-like grapheme-phoneme correspondences. Hayes-Harb, Nicol, and Barker (2010) found that unfamiliar grapheme-phoneme correspondences (i.e., extra letters) were a hindrance to learners who were exposed to novel words. These nonwords were written in the Roman alphabet. If this change within a familiar script caused learners to misinterpret or misremember the phonological forms novel words, then an entirely unfamiliar script may be similarly hindering learners. Learning unfamiliar grapheme-phoneme correspondences may be analogous to learning novel scripts, and therefore creating grapheme-phoneme correspondences with a novel script may require learners to receive more help in word-learning phases.

Another issue learners may have encountered is that instead of creating grapheme-phoneme correspondences, subjects in the Orthography group may have been treating the orthographic representation as a picture analogous to the object picture received. If this is indeed the case, this would explain why subjects in the Orthography group had difficulty making consistent judgments about the contrasts in the test phase. The Control group did not have the extra orthographic representations on which to focus, but they did not have any indication about how the contrasts may differ and had to rely on auditory representations and pictures alone. Therefore, this group performed at expectation with findings from previous studies and the hypothesis, which was that the Control group would be unable to create grapheme-phoneme correspondences.

One consideration in interpreting results is the number of speakers in the study. In Showalter and Hayes-Harb (2011, submitted), only one speaker's auditory representations were used after it was found that two speakers made the task too difficult for learners. The results from Showalter and Hayes-Harb may have been as robust as they were because of this fact. Learners needed only to focus on the novel diacritics and the auditory representations. However, in the present study, two speakers were used. Therefore, subjects needed to focus on the novel script, auditory representations, and the phonemic contrasts as said by both speakers. The added difficulty of two speaker voices may have contributed to the lower proportion of correct scores in the present study's results.

The results from the study do provide valuable information about grapheme-phoneme correspondences in second language learning. Although the results did not provide robust information about the creation of correspondences when given a novel script, the results do provide information about where orthographic representations become a hindrance to learners, or where orthographic representations cannot be utilized by learners to make inferences about the phonological forms of words. The question becomes, at what point does the availability of orthographic representations become a hindrance to learners?

In the study completed by Showalter and Hayes-Harb (2011, submitted), novel diacritic marks were beneficial to learners when creating lexical representations. If learners were able to take advantage of novel orthographic marks, then they may be able to, even if to a lesser extent, use a novel script to create lexical representations. This hypothesis was tested in the lexical form task where learners exposed to orthographic representations performed more accurately than those who did not receive the orthographic representations. In the present study, the novel script was too much for learners to be taught and remember. The exposure to orthographic representations did not robustly improve learners' performances of discriminating the /k/-/q/ contrast, and, in fact, the group not exposed to orthographic representations performed more accurately.

Experiment 2 took information from previous studies and the results from the lexical form task one step further. This task was designed to test whether learners created grapheme-phoneme correspondences between the orthographic representations and auditory representations when learning the novel words in the study, or if learners simply recognized that the auditory representations were different from one another, suggesting that the corresponding orthographic forms may also differ from one another. The latter would suggest that learners would not create grapheme-phoneme correspondences if they were unaware what was specifically different in the representations to which they were exposed. Because no significant differences between subject groups were found in Experiment 1, no significant results were expected in Experiment 2 task and this was indeed the case. It can therefore be concluded that no consistent correspondences were made.

CHAPTER 5

CONCLUSION

The current study investigated the effect of novel orthographic representations using a novel script on learners in a lexical form task and an orthographic knowledge task. It was hypothesized that if subjects were able to accurately perform on the lexical form test, then orthographic representations, even in a novel script, are beneficial to learners. It was also hypothesized that if subjects could perform above chance on the orthographic knowledge task, then learners are able to encode novel orthographic representations. Results from the two experiments do not support the hypotheses.

Subjects in Experiment 1, even when given orthographic representations, appear to have been unable to use the orthographic representations to help encode the /k/-/q/ contrast. The fact that the novel script is comprised of different segments, and written in a different direction from the Roman alphabet, may have been too much information for a learner to utilize. Both groups in the lexical form task were able to distinguish the contrasts, but were unable to do so consistently and with high accuracy. Because no significant results were found in the lexical form task, the orthographic task was not expected to have significant results. Learners were unable to consistently form grapheme-phoneme correspondences in Experiment 2.

The current study suggests that giving learners a novel script is too much input to have orthographic representations be helpful in making inferences about the phonological forms of new words. Novel orthographic marks in Showalter and Hayes-Harb (2011, submitted) were found to be a help to learners when the orthography was in the Roman alphabet. However, in the present study a novel script was a hindrance to learners. Therefore, the current study represents where orthographic representations no longer help learners in making inferences about new words, and more studies should be conducted to see where, between novel orthographic marks and novel scripts, the novelty of orthography still helps learners in discriminating word forms and creating grapheme-phoneme correspondences.

CHAPTER 6

LIMITATIONS AND FUTURE DIRECTIONS

Although the current study was created with a very common Arabic contrast, the contrasts may have been more difficult for learners because it is not as salient as, for example, an emphatic consonant in Arabic. Also, even though the orthographic representations of the contrasts in the current study are different from one another, the difference may have been too subtle to adequately examine whether orthographic representations did indeed influence the phonological inferences made by the subjects. Fewer stimuli could capture this assumption more accurately. In addition to fewer stimuli, adding more consonant contrasts could have produced more robust results in regards to demonstrating how subjects made inferences or whether they even made a conclusion that the orthography represented the contrasts. By adding more contrasts, subjects may have been able to more readily notice differences between orthographic representations, aiding them in determining what the grapheme-phoneme correspondences were and in what direction the words were to be read. Another solution to the issues noted could be to reduce the auditory representations to only be from one of the speakers. It might be the case that listening to two different speakers, given that the speakers may have produced the tokens differently, even slightly, may have been too much information given to the subjects. Yet another solution to the issues would be to teach learners how to read the novel script and other pertinent information about the script they are given in a study.

A follow-up study was conducted that gave learners an introduction to the Arabic script to observe whether learners can be aided by orthography if they are aware of the structure of the orthographic representations they receive. The follow-up was designed identically to the current study; however, learners were given instructions about the orthographic representations before they entered the word learning phase. Learners were told that the Arabic script is read from right to left, and not left to right like English. The learners were also shown images that demonstrate where specific letters appear in an orthographic representation. Learners did not know that the letters in the orthography training were the letters that would appear in the experiment and at test. Figure 8 gives an example.

The purpose of this follow-up was to understand where orthographic representations are no longer a help to learners. Showalter and Hayes-Harb (2011) demonstrated that novel tone marks written in the Roman alphabet aid learners in creating inferences about phonological forms, but Experiments 1 and 2 demonstrated that

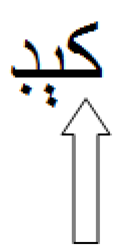

Figure 8. Example of orthography training.

learners are unable to consistently use a novel script to create inferences. If learners were able to use the knowledge they received from training in the follow-up, we can conclude that learners are able to use novel scripts in creating inferences, but they need some knowledge of the how the script works. That is, the learners know nothing of the grapheme-phoneme correspondences, but need to understand how the script is read to create new grapheme-phoneme correspondences.

At this time, results indicate that the extra instructions together with the orthographic representations do not allow learners to perform more accurately in regards to discriminating the /k/-/q/ contrast. The mean for the matched items was .899 and the mean for mismatched items was .419. When compared to the means of both groups in Experiment 1, the means in the follow-up experiment suggest only that performance was slightly more accurate on mismatched items, but this could be the result of a bias to saying items were matched. It could be the case that giving subjects instructions simply added more information for the subjects to process with the orthographic representations, auditory representations, pictures, and the contrast.

One more follow-up experiment was conducted to attempt to find more definitive results. In this experiment, subjects received orthographic representations in the Roman alphabet, but otherwise Experiment 4 was identical to Experiment 1. The purpose of designing the experiment in this manner was to determine whether it is the Arabic script that is difficult for subjects, or whether the subjects simply have trouble with the /k/-/q/ contrast. The mean for matched items by subjects in this experiment was .839 and the mean for mismatched items was .260.

To determine how subjects performed on this experiment, their performance needs to be compared to the performance by subjects in the other experiments. A dprime analysis was conducted and dprime scores for subjects in Experiment 1 was .996, Experiment 3 was .992, and Experiment 4 was .329. It can be concluded that the subjects were not perceiving the /k/-/q/ contrast, and it was therefore not the novel orthography that was hindering the learners but rather the contrast. After this study, no conclusions can be made about the novel script either being a hindrance or a help. Another follow-up study will be conducted in the future with a perceptually easier contrast to determine how a novel orthography influences phonological inferences.

REFERENCES

Arab-Moghaddam, N., & Senechal, M. (2001). Orthographic and phonological processing skills in reading and spelling in Persian/English bilinguals. *International Journal of Behavioral Development*, *25*(2), 140-147.

Bassetti, B. (2008). Orthographic input and second language phonology. In T. Piske and M. Young-Scholten (Eds.), *Input matters in SLA* (pp.191-206*)*. Clevedon, UK: Multilingual Matters.

Bassetti, B. (2007). Effects of Hanyu *pinyin* on pronunciation in learners of Chinese as a foreign language. Retrieved November 2, 2011 from http://eprints.bbk.ac.uk/528

Bassetti, B. (2006). Orthographic input and phonological representations in learners of Chinese as a foreign language. *Written Language and Literacy*, *9*(1), 95-114.

Bassetti, B. (2005). Effects of writing systems on second language awareness: Word awareness in English learners of Chinese as a Foreign Language. In V. Cook and B. Bassetti (eds.), *Second language writing systems* (pp. 335-356). Clevedon, UK: Multilingual Matters.

Brodeur, M.B., Dionne-Dostie, E., Montreuil, T., & Lepage, M. (2010). The Bank of Standardized Stimuli (BOSS), a new set of 480 normative photos of objects to be used as visual stimuli in cognitive research. *PLoS ONE, 5, e10773.*

Creative Commons. (n.d.). Retrieved January 30, 2012 from http://creativecommons.org /licenses/by-sa/3.0/

Cutler, A., Treiman, R., & van Ooijen, B. (2010). Strategic deployment of orthographic knowledge in phoneme detection. *Language and Speech*, *53*(3), 307-320.

Cutler, A., Weber, A., & Otake, T. (2006). Asymmetric mapping from phonetic to lexical representations in second-language listening. *Journal of Phonetics*, *34*, 269-284.

Detey, S., & Nespoulous, J. (2008). Can orthography influence second language syllabic segmentation? Japanese epenthetic vowels and French consonantal clusters. *Lingua*, *118*(1), 66-81. doi:10.1016/j.lingua.2007.04.003

Dijkstra, T., Frauenfelder, U.H., & Schreuder, R. (1993). Bidirectional grapheme-phoneme activation in a bimodal detection task. *Journal of Experimental Psychology: Human Perception and Performance*, *19*(5), 931-950.

Erdener, V.D., & Burnham, D.K. (2005). The role of audiovisual speech and orthographic information in nonnative speech production. *Language Learning*, *55*(2), 191-228.

Escudero, P., & Wanrooij, K. (2010). The effect of L1 orthography on non-native vowel perception. *Language and Speech, 53*(3), 343-365.

Escudero, P. Hayes-Harb, R., & Mitterer, H. (2008). Novel second-language words and asymmetric lexical access. *Journal of Phonetics, 36*, 345-360.

Forster, K.I., & Forster, J.C. (2003). DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments & Computers, 35*(1), 116-124.

Grainger, J., & Ferrand, L. (1994). Phonology and orthographic in visual word recognition: Effects of masked homophone primes. *Journal of Memory and Language*, *33*, 218-233.

Georgiou, G.K., Parrila, R., & Papadopoulos, T.C. (2008). Predictors of word decoding and reading fluency across languages varying in orthographic consistency. *Journal of Educational Psychology*, *100*(3), 566-580.

Halle, P.A., Chereau, C., & Sequi, J. (2000). Where is the /b/ in “absurde” [apsyrd]? It is in French listeners’ minds. *Journal of Memory and Language*, *43*, 618-639.

Hayes-Harb, R., Nicol, J., & Barker, J. (2010). Learning the phonological forms of new words: Effects of orthographic and auditory input. *Language and Speech, 53*(3), 367-381.

Kaushanskaya, M., & Marian, V. (2008). Mapping phonological information from auditory to written modality during foreign vocabulary learning. *Annals of the New York Academy of Sciences*, *1145*, 56-70.

Kim, J., Taft, M., & Davis, C. (2004). Orthographic-phonological links in the lexicon: When lexical and sublexical information conflict. *Reading and Writing: An Interdisciplinary Journal*, *17*, 187-218.

Lee, C.H., & Turvey, M.T. (2003). Silent letters and phonological priming. *Journal of Psycholinguistic Research*, *32*(3), 313-333.

Mayer, P., Crowley, K., & Kaminska, Z. (2007). Reading and spelling processes in Welsh-English bilinguals: Differential effects of concurrent vocalizations tasks. *Read Writ*, *20*, 671-690. doi: 10.1007/s11145-006-9044-8

Ota, M., Hartsuiker, R. J., & Haywood, S.L. (2010). Is a FAN always FUN? Phonological and orthographic effect in bilingual visual word recognition. *Speech and Language, 53*(3), 383-403.

Ota, M., Hartsuiker, R. J., & Haywood, S.L. (2009) The KEY to the ROCK: Near homophony in nonnative visual word recognition. *Cognition*, 263-269.

Pattamadilok, C., Kolinsky, R., Ventura, P., Radeau, M., & Morais, J. (2007). Orthographic representations in spoken word priming: No early automatic activation. *Language and Speech*, *50*(4), 505-531.

Schwartz, A.I., Kroll, J.E., & Diaz, M. (2007). Reading words in Spanish and English: Mapping orthography to phonology in two languages. *Language and Cognitive Processes*, *22*(1), 106-129.

Showalter, C.E., & Hayes-Harb, R. (2011). Unfamiliar orthographic information and second language word learning. *Second Language Research Forum*. Ames, IA, October.

Showalter, C.E., & Hayes-Harb, R. (submitted). Unfamiliar orthographic information and second language word learning: A novel lexicon study. *Second Language Research.*

Simon, E., Chambless, D., & Alves, U.K. (2010). Understanding the role of orthography in the acquisition of a non-native vowel contrast. *Language Sciences, 32*, 380-394.

Simon, E., & Van Herreweghe, M. (2010). The relation between orthography and phonology from different angles: Insights from psycholinguistics and second language acquisition. *Language and Speech, 53*(3), 303-306.

Slowiaczek, L.M., Soltano, E.G., Wieting, S.J., & Bishop, K.L. (2003). An investigation of phonology and orthography in spoken-word recognition. *The Quarterly Journal of Experimental Psychology*, *56A* (2), 233-262.

Taft, M. (2006). Orthographically influenced abstract phonological representations: Evidence from non-rhotic speaker. *Journal of Psycholinguistic Research, 35*(1), 67-78. doi: 10.1007/sl 0936-005-9004-5

Tyler, M.D., & Burnham, D.K. (2006). Orthographic influences on phoneme deletion response times. *The Quarterly Journal of Experimental Psychology*, *59*(11), 2010-2031.

Vendelin, I., & Peperkamp, S. (2006). The influence of orthography on loanword adaptations. *Lingua*, *116*, 996-1007. doi: 10.1016/j.lingua.2005.07.005

Ventura, P., Kolinsky, R., Brito-Mendes, C., & Morais, J. (2001). Mental representations of the syllable internal structure are influenced by orthography. *Language and Cognitive Processes*, *16*(4), 393-418.

Weber, A., & Cutler, A. (2004). Lexical competition in non-native spoken-word recognition. *Journal of Memory and Language*, *50*, 1-25.

Zaba, A., Bolewicz, K., & Hayes-Harb, R. (n.d.). Native English speakers perceiving Arabic pharyngealization contrasts: The effects of vowel context. Unpublished manuscript.

Ziegler, J. C., & Goswami, U. (2005). Reading acquisition, developmental dyslexia, and skilled reading across languages: A psycholinguistic grain size theory. *Psychological Bulletin*, *131,* 3–29.

Ziegler, J.C., Ferrand, L., & Montant, M. (2004). Visual phonology: The effects of orthographic consistency on different auditory word recognition tasks. *Memory and Cognition*, *32*(5), 732-741.

Ziegler, J.C., Muneaux, M., & Grainger, J. (2003). Neighborhood effects in auditory word recognition: Phonological competition and orthographic facilitation. *Journal of memory and language*, *48,* 779-793.