THE EFFECTS OF NOVEL ORTHOGRAPHIC ELEMENTS AND PHONETIC INSTRUCTION IN SECOND LANGUAGE PHONOLOGICAL ACQUISITION

by

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ABSTRACT

Research has demonstrated that exposure to orthographic input can heavily influence a person's phonological representation of a word, with the potential to even be more influential than auditory input when both are available. Previous research has investigated the helpfulness of different types of orthographic input for subjects learning a novel phonemic contrast, and some research has suggested that explicit phonetic training might also have a facilitating effect. The present experiment investigated the influence of novel orthographic elements in the input along with explicit phonetic instruction. Four groups of subjects were taught pairs of Arabic non-words differing by the velar-uvular contrast /k/-/q/ in four different training conditions. These groups differed in the type of orthographic form used to represent the uvular /q/ (either a diacritic <ḳ> or a completely novel grapheme <Λ>) and the amount of specific instruction provided in relation to this phonological contrast. Subjects taught using the novel grapheme outperformed those in the diacritic condition at test, while more explicit instruction only facilitated the learning for those in the diacritic condition. These findings suggest that a novel grapheme is more helpful to learners in forming phonemic lexical representations containing a novel contrast than a diacritic mark, but that the disadvantage of the diacritic can be moderated by explicit instruction.

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CHAPTER 1

LITERATURE REVIEW

1.1 Effects of Orthography

Orthographic input can be used by learners to acquire a novel phonemic contrast, and can perhaps be more beneficial to the learner than auditory input alone (Brown 2015). This shows that orthographic input can indeed be quite useful to learners in learning to encode phonemic contrast information, and has a stronger effect on the encoding of phonemic information than accompanying auditory input.

Learning L2 phonological contrasts can be difficult, especially if the phonemes involved in the contrast do not have direct correlates in the L2. For example, native speakers of Dutch learning English often have difficulty with the vowels found in the English *bed* and *bad*, because this is not a contrast found in Dutch (Cutler & Broersma 2005). The difficulty the native Dutch speakers experience is attributed to the fact that both of the English phones [ɛ] and [æ] map onto a single Dutch phoneme, /ɛ/. However, evidence has shown that learners can make phonological representations of words that differ by such a contrast that does not have an immediate counterpart in their L1.

An experiment done by Weber & Cutler (2004) used eye-tracking technology to observe how subjects perceive auditory input, and to observe how the subjects processed L2 words. They found that learners seemed to be able encode phonological contrasts even if they were not able to perceive them in an online task. This study specifically used words and pictures of objects that contained contrasts that are difficult for native Dutch speakers, such as the English /æ/ and /ɛ/, which does not have an immediate counterpart in Dutch. Because native Dutch speakers cannot perceive the difference between [æ] and [ɛ], the sounds are neutralized and both sounds are equally perceived as /ɛ/. In this study, native Dutch speaking subjects with high proficiency in English were asked to click on one of four pictures on a computer screen, depending on the audio they heard. Of the four pictures on the screen, the names of two of them contained vowels that were not expected to be confused, while the other two contained the novel contrast, such as English /æ/ or /ɛ/ represented by pictures of a panda or pencil, for example. The subjects heard the auditory stimulus and were to then click on the appropriate picture, all the while with their eye movements being tracked. The eye-tracking technology allowed the researchers to see where the subjects gazed after the first syllable, when the stimulus is expected to be ambiguous for listeners with no /æ/-/ɛ/ distinction. They found that if a subject heard the word *pencil* they would look at the picture of the pencil. If the subject heard the word *panda* they would look at the picture of the pencil first (because both vowel sounds are perceived as /ɛ/) then the panda when the second syllable disambiguated the words. Both words were activated if the subject heard *panda* but *pencil* only activated the word *pencil*. This asymmetrical activation would not be predicted if the learners' mental representations of the lexical items was based on auditory perceptual input alone because both vowels would be stored the same way, and the subjects would look at either of the two pictures first upon hearing either auditory stimulus instead of looking only at the pencil first. However, because the subjects consistently looked to the picture of the pencil first, this indicates that the two lexical items must be being stored importantly differently, even if no difference can be heard by the listener. Weber & Cutler (2004) provide a possible explanation for this asymmetry by suggesting that it may be an orthographic effect influencing the subjects. The letters <a> and <e> might cue the subject that the two sounds are importantly supposed to be different, even if that difference might not be perceivable to them, and the subject then is storing these two vowels differently even though both are perceived as /ɛ/.

Cutler et al. (2006) further investigate this orthographic influence that may give rise to this asymmetrical activation. They performed a similar experiment as in Weber & Cutler (2004) but this time with native Japanese speakers learning the English /l/-/r/ contrast, which are easily confused by native Japanese speakers. It was hypothesized by Cutler et al. (2006) that because the Japanese romanization system uses <r>, an orthographic influence might result in subjects asymmetrically activating lexical items using <r> as the dominant category. Similar to the Dutch speakers, the Japanese speakers asymmetrically accessed lexical representations of words. For example, when asked to click on a *rocket* the subjects would look at the picture of a *locker*, whereas being asked to click on *locker* did not have the reverse effect. This seems to show that while the two sounds are difficult to distinguish for the L2 learners, they are crucially not being represented as the same. The speakers are establishing lexically that these words are importantly different, even if that difference may be difficult for them to perceive in an online task. This resulting direction of asymmetry is contrary to the hypothesis that the <r> would form the dominant category as might be expected given the orthography. While these results do not provide much support for a strong orthographic effect, the asymmetry does importantly support that fact learners can lexically encode difficult novel contrasts, even if they are not readily perceived in an online task.

That such contrasts can be encoded was further investigated by Escudero et al. (2008). Escudero et al. (2008) performed an experiment in which English nonwords were taught to native Dutch speakers using the same /æ/-/ɛ/ contrast as in Weber & Cutler (2004). Of two groups of subjects, both were taught words associated with object-like pictures with auditory stimulus, while for one group this was additionally accompanied by orthographic input. After the word learning phase of the experiment, the subjects completed a final test in which they were to click on the picture corresponding to the auditory stimulus heard. Eye-tracking technology was used to track the subjects' gaze and examine how much they focused on the correct picture, its competitor, or the distractor. Looking at the percent correct for the word learning phase, it appears that the subjects learned the words easier if the spelled forms were shown, suggesting that orthographic input aided listeners' to make inferences leading to phonological representations. The results of the test phase showed an asymmetrical activation similar to Weber & Cutler (2004) and Cutler et al. (2006), meaning that the subjects were able to store the words for later use differently even though they might be confusable, and that the spelled forms helped them learn and identify the words more accurately. The abstract knowledge represented by the orthographic input seemed to be used by the learners to make inferences about the phonological contrast leading them to establish distinct phonological lexical representations.

While orthographic input can have an effect on a learner's phonological acquisition, it does appear that there are limits to what types of input may be useful. In an experiment by Showalter & Hayes-Harb (2015), native English speaking participants were taught pairs of Arabic non words in which the first consonants differed by a velar-uvular contrast. The subjects were taught these words in different training conditions characterized by the type of orthographic input that subjects were exposed to. In their first experiment, subjects were divided into one of two training conditions, an "Arabic script" condition in which the Arabic script was used, and a control condition in which a meaningless sequence <ﻁﻁﻁﻁ>, roughly analogous to the English <XXXX>, was used so that the amount of visual input was the same. The tests of the two groups were identical. At test, each participant was shown a picture and heard audio and had to indicate whether the audio and picture were matched or not. The results of this experiment showed no significant difference for a main effect of training group, meaning that whether the subjects were shown the Arabic script or a meaningless sequence of symbols, they showed no difference in their ability to correctly identify matched or mismatched items. The Arabic script was no more useful to the learners than the meaningless sequence. This may be because the script was cursive, or read right to left, but it seems that the script was simply too different from the English orthography the subjects were used to to be useful to the learners.

While the Arabic script in the first experiment done by Showalter & Hayes-Harb (2015) was no more useful to the learners than the control, a follow-up experiment examined the extent to which a romanized input might be used. Because the Arabic script condition might have been too different to the subjects, and perhaps because the contrast was too difficult for native English speakers, the follow-up was done to see if learners could better make phonological inferences if a romanized orthography is used. The same experiment design was used as before, with the same Arabic non-words, but instead of the Arabic script subjects were shown written forms of the words in which the graphemes <k> and <q> were used to represent the phonemes /k/ and /q/, respectively. For example, the auditory input /kubu/ was accompanied by the written input <kubu>, while /qubu/ was written <qubu>. The subjects then performed the same picture matching task as the Arabic Script and Control groups in the first experiment. When compared to the other groups, the accuracy of the Roman script group was significantly less accurate than both the Arabic Script and Control groups. This suggests that while the Arabic Script was no more useful than the meaningless sequence control, the romanized graphemes hindered the subjects in discriminating the minimal pairs. As stated by Showalter & Hayes-Harb (2015), this may possibly be due to the way the Arabic was transliterated. It may be that the use of <q> in the written input is problematic because <q> already has a grapheme-phoneme correspondence (GPC) in English that maps to /k/ (e.g. as in words such as *queen* or *Iraq*), which is also shared with the grapheme <k>. It is possible then that the subjects were inadvertently being told that the two sounds were not different. If this is true, it is possible that using a different grapheme for /q/ may bring different results.

Bassetti (2006) found support for the idea that if the grapheme symbols of the learner's L1 and the L2 are similar, and there is a GPC for a given grapheme in the L1, then learners rely on that existing GPC. She found that the Pinyin romanization of Chinese affected the learners' mental representations of the L2 phonology. The subjects were students of Chinese who had learned to use the Pinyin system, but were also learning Hanzi (Chinese characters). In Pinyin, tripthongs are represented using only two graphemes, e.g. [uei] is written <ui>, whereas the Hanzi do not represent any phonological information. The subjects were given a list of words in Hanzi and were asked to provide the number of phonemes for a given word. When given a list of Hanzi and asked to indicate the number of phonemes present, the subjects consistently did not count each of the vowel phonemes in the tripthongs which are written with only two graphemes in Pinyin. For example, a word with the vowel phonemes that would be romanized in Pinyin as <ui> and pronounced [uei], would consistently be reported as consisting of 2 vowel phonemes instead of the actual 3. This supports the hypothesis that without clues telling them otherwise, learners will default to the existing L1 GPC rather than create a new, conflicting correspondence for the familiar grapheme. Perhaps then while the Arabic script in Showalter & Hayes-Harb (2015) may not have had any existing GPCs to the learner, it seems reasonable that the use of the grapheme <q> with an existing L1 GPC to /k/ may also have interfered with subjects making the required phonological inferences.

Similarly, Young-Scholten & Langer (2015) found support that if grapheme symbols are similar and a phoneme is represented by a familiar grapheme with an incongruent GPC (that is, a known grapheme is representing a new phoneme instead of the L1 phoneme), learners face challenges overcoming the incongruency. This was shown in a longitudinal study of three American students learning German. The study specifically looked at their production of word initial <s>, pronounced [z] in German. After a year of study in Germany, the students generally pronounced initial <s> as [s] instead of the target-like [z]. Young-Scholten & Langer (2015) take this as evidence that it is difficult for a learner to use a familiar grapheme to represent an incongruent phoneme (from the L1 perspective), that is, it is difficult for learners to remap an existing GPC. Perhaps then if the Arabic script may have been too different for the learners, and the romanized <q> has a pre-existing GPC that may prove difficult to remap, then a romanization using a novel grapheme with no interfering GPC, such as <ʁ>, may prove more beneficial.

Showalter & Hayes-Harb (2013) performed a study investigating whether unfamiliar orthographic input in the form of diacritics might have an effect in L2 phonology, specifically, the four-way tone contrast found in Mandarin. In the study, subjects were taught Mandarin words in one of two conditions: Tone Marks or No Tone Marks. Each of the Mandarin words consisted of auditory stimulus, a non-object line drawing to promote word learning, and a written form using Pinyin. The key difference between the two training conditions was that for the Tone Marks group, diacritic marks indicating tone accompanied each word, while the No Tone Marks group only saw Pinyin romanization. For example, the Tone Marks condition used forms such as <fiān>, <fián>, <fiăn> and <fiàn> for the four tones, while the No Tone Marks condition would use <fian> for the same words, regardless of tone. The written input was only shown during the training phase. The test phase consisted of a matching task in which the subjects saw a picture while hearing a word, and were asked to indicate whether they were matched or mismatched. At test, the subjects who were taught using the tone marks significantly outperformed those who did not, suggesting that even though the tone marks are a novel orthographical element, the learners were able to use them to associate tone with the lexical items. This provides evidence that a novel diacritic can be useful to learners in learning new phonemic information such as associating a novel phonological feature with L2 lexical items. If this novel element was useful to encode new phonological information such as tone, then perhaps a novel diacritic may also help learners to associate other information with novel words of a novel contrast as well, for example <ḳ> for /q/ may help learners learn and encode the phonological contrast /k/-/q/.

1.2 The Role of Phonetic Instruction

While orthographic input has an effect on L2 phonological acquisition, it may also be that this effect can be enhanced or reinforced by explicit phonetic instruction. (Cutler et al. 2006:pg. 280) suggested that explicit instruction, especially as it relates to the orthographic form of words, may have played a role in the Japanese speakers establishing a distinction in the lexicon. Even though they could not readily perceive the difference acoustically, it is suggested that they were taught that /r/ and /l/ are supposed to sound different and because of this have stored them differently. They acknowledge that orthography has some effect, but suggest that explicit instruction has led these learners to store words differently in the their mental representations based on information they are not receiving through the perceptual system.

It has been observed that although accurate pronunciation is important in learning a second language, it is not often explicitly taught in the beginning levels (Lord 2005; Arteaga 2002). It may be that in the absence of explicit instruction, learners are forced to rely on their L1 GPCs or other previous knowledge in forming phonological representations, whereas if explicit instruction was used, they may be better able to make the needed inferences. A study by Lord (2005) suggests that explicit phonetic instruction, in this case a course in Spanish phonetics, may help learners produce more target like sounds. In this study, 17 undergraduate students were enrolled in a semester long advanced Spanish phonetics course. The students made baseline recordings of a text, which was never discussed as a class, at the beginning of the semester before any instruction had taken place. The text was chosen because it contained many examples of Spanish phonemes to be measured including: stops /p,t,k/, fricatives /β,ð,ɣ/, trilled /r/, and diphthongs. The treatment over the course of the semester consisted of an advanced phonetics class that provided classroom based instruction about the differences between Spanish and English pronunciation, oral practice, examination of spectrographs to illustrate differences in VOT, and other self analysis using voice analysis software.

At the end of the semester, the students made a post-treatment recording of the same text for comparison. The students' performance for each of the phonemes was compared to a native control group to assess accuracy, as well as to their previous recording to assess improvement. Paired t-tests were performed comparing the baseline recording with the post-treatment recording to find significant differences between the two. For the stops, /p,t,k/ the results did not show statistically significant improvements between pre and post-treatment recordings. However, the pre-treatment values in comparison to those of the native speakers were significantly different, while the post-treatment values were not significantly different, meaning that the learners finished the semester with native-like pronunciations of these stops. The speakers' pronunciations of the the trilled /r/, diphthongs, and fricatives did significantly improve although they were still significantly different than the native values. These results suggest that pronunciation can indeed be taught, although it is not entirely clear what exactly (the classroom instruction, self analysis, practice, etc.) was most effective. However, results do indicated that explicit instruction can be beneficial to learners with regards to accuracy in production. While this instruction can help production, it may also give advantageous cues to the learner and help the learner make the requisite phonological inferences and effectively encode them.

In a later study, Lord (2010) further investigated the acquisition of the Spanish stops /p,t,k/ and their fricative allophones /β,ð,ɣ/ with regards to study abroad and explicit instruction. English has each of these phones, whether phonemically or allophonically in connected speech, but they have a very different pattern from what is seen in Spanish. This is challenging because English L2 learners of Spanish have to learn both articulation differences as well as their distributions. In this study, eight intermediate Spanish learners from a university who had taken approximately the same amount of Spanish classes, took part in a study abroad program. Half of the participants had taken a course in Spanish phonetics and pronunciation within one or two semester before the study abroad, while the other half had not. Lord notes that this course were part of the standard curriculum that all students would complete, the other students would complete it after the study abroad, and that the main goal of the course was to provide both a theoretical and practical knowledge of the Spanish sound system. Oral recordings of each student were collected both before and after the study abroad experience. These recordings consisted of the students reading out load a list of 60 Spanish words and phrases that each contained one token of the phones being examined. All of the students lived with host families and participated in the same classes during the study abroad. After the study abroad, the sounds of interest in the recordings were isolated, analyzed, and given a score of 1 or 0 based on their accuracy so that a percentage correct for each participant could be calculated. It was found in the pre-study abroad recordings that the students that had the instruction performed significantly more accurately than those who had not. The post-study abroad recordings showed that all eight of the students significantly improved their accuracy from before the experience, but that the instruction group still showed significantly more accurate performance than the non-instruction group. This data suggests that while the study abroad experience did help learners improve their Spanish phonology, the explicit phonetic instruction also helped them significantly.

Simon (2010) investigated learners whose L1 had phonological rules not found in the L2 and the extent to which those rules would transfer to the L2. This study used Dutch L2 speakers of English to explore this question because of the word final devoicing and cross-word voice assimilation patterns found in Dutch which are not present in English. It was hypothesized by Zsiga (2003) that intra-word rules are universally higher ranked than cross-word rules and that no language learner would show transfer of a cross-word rule without also showing the intra-word rule. For the Dutch speakers learning English, this predicts that either both the word final devoicing and cross-word assimilation patterns will transfer, or only final devoicing will transfer, but the voice assimilation will not transfer without the devoicing. For this study, 16 native Dutch speaking subjects were recruited who were also studying English in a university setting. The students were then asked to simply speak to each other in pairs about any topic to elicit natural speech. These conversations took place both in English and Dutch and were recorded. It was in general found that both patterns transfered, and that the cross-word assimilation pattern before voiced stops seemed to over rule the word final devoicing, which is not in line with what was predicted. It is suggested that this pattern may have arisen because of the explicit instruction learners have received about word final devoicing not being applicable in English. This suggests that the explicit instruction may have influenced the learners to apply phonological rules differently than they would have without it.

While the last two studies mentioned focused on subjects' productions, a study by Cenoz & Lecumberri (1999) investigated the effects of explicit instruction on the perception of English vowels that were found to be difficult for the subjects, English simple vowels such as /i/, /æ/, and /ɛ/ ,for example. Subjects in this study consisted of 109 university students in English studies, and each were native speakers of Spanish or Basque. The training consisted of a 14 week class with phonetic instruction and practice exercises. The students were instructed in the IPA and the articulation of English sounds in different linguistic contexts (connected speech as well as individually). Half of the class time was spent in exercises and transcription using the IPA as discrimination training. The students were given a pre-training test in which they were presented with audio stimuli of English sounds and were asked to provide the corresponding phonetic symbol. The same test was administered after the training as well. The results of the two tests showed that the students significantly improved their discrimination ability as a result of the explicit training. This shows that instruction did positively affect the subjects' ability to perceive sounds that were classified as difficult.

Saito (2015) investigated two types of instruction, form focused instruction (FFI) and FFI with corrective feedback (CF), and their effects on native Japanese speakers' perceptions and productions of English /ɹ/. Native Japanese speakers learning English were divided into 9 English conversation classes divided into three experimental groups. Each group receive instruction on English argumentative, debate, and public speaking skills, with along with the FFI component meant to help the students notice the English /ɹ/. Each session of this meaning-oriented instruction began with warm-up games in which the students had to distinguish /ɹ/ from /l/ and Japanese tap /ɾ/. The first group received FFI training while the second received FFI with CF and the third group acted as a control and received the same argumentative skills instruction but without the FFI on English /ɹ/. Each of these classes received four 1-hour lessons over the course of 2 weeks and all of the subjects completed posttests and final interviews 2 weeks after the end of instruction. Saito reports that all students took a pretest before the beginning of instruction and no difference in listening performance was found between the three groups. It was found that the FFI group significantly improved over the control group while the FFI with CF group did not. The FFI group significantly outperformed the other groups only when the test items were presented with an untrained talker. Analyses were also done on the formants of students' productions of English /ɹ/ before and after the instruction and found that the FFI and

FFI+CF groups significantly improved their accuracy in production over the control group, although their productions were still significantly different from the native English speaker controls. These results suggest that the use of FFI, even without other explicit phonetic instruction about the phonetics of the sounds in questions, can positively effect learners' phonological performances.

Recently, Brown (2015) found that one type of explicit instruction given in the beginning part of an experimental training had no effect on the subjects' performance at test. This experiment investigated subjects' ability to form phonological patterns using instruction and orthographic input. Brown (2015) specifically investigated word-final obstruent devoicing in German, in which a spelled form such as <krad> is pronounced as [krat], while <krat> is pronounced the same way. Participants in the study were taught German non-words with pictures of non-objects and audio to subjects divided among four groups, No-Spell-Instruction, Spell-Instruction, No-Spell-No-Instruction, and Spell-No-Instruction. The words formed minimal pairs ending in either <b, d, g> or <p, t, k>, but each were pronounced as voiceless. Those subjects in the Spell conditions were taught the German non-words while being shown written forms, while those in the No-Spell conditions did not. Those in the No-Instruction conditions were told simply to learn the new words, while those in the Instruction conditions were additionally given the following instruction: "In German, sometimes the final letter of a word is not spelled the way it sounds. A "b" will be pronounced "p", a "g" will be pronounced "k" and a "d" will be pronounced "t" when at the end of the word"(Brown 2015:pg. 31).

After being taught the words, each of the subjects took a criterion test in which they saw a non-object picture, heard a word, and then indicated whether the audio and picture were matched or mismatched. They were required to pass the criterion test with at least 90% accuracy in order to move on. At test, subjects were shown each of the pictures and were asked to say the words outloud while their productions were recorded. To code the productions, a group of new subjects were recruited. The new subjects listened to each of the productions and indicated the letter that each word they heard ended in. It was found that those subjects who were taught the words without any spelled forms consistently produced the voiced sounds as voiced, while those in the Spell condition produced the sounds voiceless. It was also found that those who received the more specific instruction performed statistically the same as those who did not, meaning the instruction being available had no affect. This suggests that subjects use the orthographic information to make mental representations of lexical items even if it is inconsistent with the auditory input heard, and even if they are given specific instruction. If this form of instruction had no effect on the learners' performance but other forms did, it may be that a more explicit form of instruction might still have an effect.

1.3 Research Question

Can learners use orthographic information to facilitate the acquisition of a novel phonological contrast if a novel orthographic element is introduced? Specifically, can a diacritic mark (such as in <k><ḳ> representing the velar-uvular contrast /k/-/q/) facilitate acquisition, or would learning be better aided by the introduction of a completely novel letter-like grapheme (as in <k><***Л***>) for the same contrast? Also, would that learning be further facilitated by an element of instruction, in which the learners are told that a new sound contrast would be learned, in order to provide a cue in addition to the orthographic input provided?

CHAPTER 2

METHODOLOGY AND RESULTS

2.1 Methodology

2.1.1 Summary of Variables

This study is a true experimental design involving the random assignment of subjects to various experimental conditions, and involves the following variables:

- Picture-Matching Task performance
- Orthographic Input Type
- Instruction

The dependant variable in this experiment is the subjects' performance on the Picture-Matching task. This is an operationalization of the acquisition of the phonological contrast. It assumes that better performance at matching auditory stimulus 'words' with the correct picture is an indication of more successful acquisition of the phonological contrast.

The Orthographic Input condition is an independent variable with two levels: Diacritic or Novel Grapheme. The Diacritic level is characterized as presenting written forms using <k> and <ḳ> for the phonological contrast /k/-/q/, while the Novel Grapheme level uses <k> and <Λ> for the same contrast. Besides these two differences in graphemes, the orthography followed the romanization used by Showalter & Hayes-Harb (2015). The novel grapheme <Λ> representing the phoneme /q/ was used based on a survey done by Capps (2015). This survey took 15 symbols, from rare writing systems and asked participants to rate each symbol according to how letter-like it looked, and how well it might fit with other English letters. These symbols were chosen for being somewhat English-like in form, but also different enough that they would not be confused with other letters or bring any other letter to mind.

The Instruction variable is an independent variable that has two levels in this experiment represented as either Instruction or Without-Instruction. All subjects were given the directions: “This experiment has two parts. In the first part, you will learn some new words in a new language. In the second part, you will be tested on your knowledge of the new words.” The subjects in the Without-Instruction condition were then told at the beginning of the word learning phase of the experiment: “You will be taught some new words. You will see a picture and hear someone pronounce the word. Please try to memorize the new words”.

On the other hand, those in the Instruction conditions were given the same information, but with more explicit instruction about the sounds they would hear. At the beginning of the experiment all subjects in the Instruction condition were given the instructions: “You will be taught some new words. You will see a picture and hear someone pronounce the word. Please try to memorize the new words. This new language has a sound that you may not be familiar with that is similar to English ‘k’.”. The subject then heard examples of the two phonemes of the contrast (/k/ followed by /q/) in initial position of three pairs of Arabic-like nonwords, with each pair of words being a minimal pair and using one of the three Arabic vowel phonemes directly after the initial consonant. This was done so as to give the subjects exposure to the contrast in each of the three possible vocalic contexts. These three pairs of nonwords were recorded by a native Arabic speaker and were each different nonwords than those the subject was going to be learning. Following this, they received the additional instruction: “While these sounds may sound similar to you, they are importantly different in this new language. The written forms of the words may help you learn the difference. One sound is written with k, while the other is written differently. Press the space bar to see the examples written”. The subjects then pressed the space bar and heard the same three pairs of words as before, but this time with romanized forms of the words appearing on the screen at the same time they heard the auditory examples. These written forms used either <ḳ> or <ʎ> for the uvular stop, depending on the treatment condition. Following this instruction, the subjects began the word learning phase of the experiment. Table 2.1 summarizes the experimental variables and conditions of those variables.

Table 2.1. Summary of variables and levels of variables

	Instruction	No Instruction
Diacritic	Diacritic-Instruction	Diacritic-Without Instruction
Novel Grapheme	Novel-Grapheme-Instruction	Novel-Grapheme-Without-Instruction

This experiment involved a word learning phase according to the experimental conditions assigned and a picture matching task that will be described further.

2.1.2 Subjects

For this study, 52 subjects were recruited at a university using a small monetary or course credit as an incentive. Each of these subjects reported having no experience with, nor exposure to, the Arabic language. All subjects also reported being free of any hearing impairment or disorders that may limit their ability to participate in the study. Subjects ranged in age from 18 to 42. Each of the 52 subjects was randomly assigned to one of the following four conditions, resulting in 13 total subjects per condition: Diacritic-Instruction, Diacritic-Without-Instruction, Novel-Grapheme-Instruction, and Novel Grapheme-Without-Instruction.

2.1.3 Stimuli

The stimuli for this experiment consisted of Arabic-like nonwords that feature the velar-uvular contrast /k/-/q/. A total of 12 words were used, consisting of 6 minimal pairs differing by the velar-uvular contrast in initial position only. Three of the pairs were of the structure CV_1CV_1, while the other three were of the structure CV_1CV_2, with each of the three Arabic vowel phonemes /i/, /a/, and /u/ being used as V_1 in two pairs of words. The stimuli were produced by 2 male native Arabic speakers. The example nonwords used in the instruction given to the subjects in the Instruction conditions were produced by a different male native Arabic speaker than those that produced the experimental stimuli.

Each of the 12 words were represented with a picture of an object accompanied with a written form, and an auditory pronunciation of the word. Subjects were shown a picture of an object in order to promote lexical encoding by showing that the different audio inputs were crucially different lexical items. Aside from the change of orthographic information associated with the words, the stimuli used in this experiment were the same as those used by Showalter & Hayes-Harb (2015), and Capps (2015) in order to be maximally comparable with previous research.

Example stimuli can be seen in figure 2.1. The first row of the figure gives the condition of the Orthographic variable, while the second shows the visual stimuli including orthographic input, along with the auditory stimulus. This figure shows the difference in orthographic representation for the uvular stop in both levels of the Orthography training variable, along with representation for the velar stop, which was consistent for all conditions.

2.1.4 Procedure

The experiment consisted of a word learning phase, and a final test. The word learning phase consisted of the exposure to each word twice per block, and each block was presented

Novel Grapheme Uvular Stop	Diacritic Uvular Stop	Both Conditions Velar Stop
		
ʎuthi	**ḳuthi**	**kuthi**
[quθi]	[quθi]	[kuθi]

Figure 2.1. Example stimulus presentation in the word learning phase

four times each, for a total of 24 items per block and 96 items total. This procedure was the same regardless of which condition the subjects were in. The only difference between groups of subjects was in the treatment condition, that is whether the subjects saw <ḳ> or <ʎ> representing /q/, and whether or not they received explicit instruction before the word learning phase that new sounds would be involved. Following the word learning, the subjects were required to pass a criterion test with a score of at least 90 % in order to go on to the final test. This criterion test was a picture matching task in which a picture of an object was shown along with the audio of a word, and the subjects were then asked to indicate whether the sound and picture were matched or mismatched. During the criterion test each item was presented four times, once for each condition (either matched or not) for each talker. If the subjects answered correctly less than 90% of the time they would repeat the word learning phase until they could pass the criterion test. A criterion test was used instead of a fixed number of learning cycles in order to be maximally comparable with previous research using this procedure. Crucially, the criterion test only asked subjects to identify words that were not minimal pairs differing only by the contrast in question.

The final test phase however was a picture matching task specifically testing the subject's ability to discriminate between words using this contrast. Like the criterion test, the subjects were presented with each word four times, once with the picture and audio correctly matched, and once mismatched for each of the two talkers. This final test specifically used words that were mismatched differing solely by the uvular-velar contrast to test to what extent the phoneme had been encoded in the subject's mental representation of the lexical item.

The experiment took place in a sound attenuated booth and was administered using the DMDX experiment presentation software (Forster & Forster 2003).

2.2 Results

The mean number of learning cycles required to reach criterion was 2.6(range 1-5) for the Novel Grapheme-Instruction group, 2.4(range 1-6) for the Novel Grapheme-No Instruction group, 2.9(range 1-5) for the Diacritic-Instruction group, and 2.9(range 1-7) for the Diacritic-No Instruction group. The mean number of learning cycles along is summarized in table 2.2. The number of learning cycles was not significant for the orthography group F(1,48)=.860,p=.358, or the instruction group F(1,48)=.011,p=.918 to reach criterion.

Table 2.2. Mean (standard deviation) learning cycles by condition

	Learning Cycles
Novel Grapheme-Instruction(n=13)	2.6(1.19)
Novel Grapheme-No Instruction(n=13)	2.5(1.13)
Diacritic-Instruction(n=13)	2.9(1.46)
Diacritic-No Instruction(n=13)	2.9(1.55)

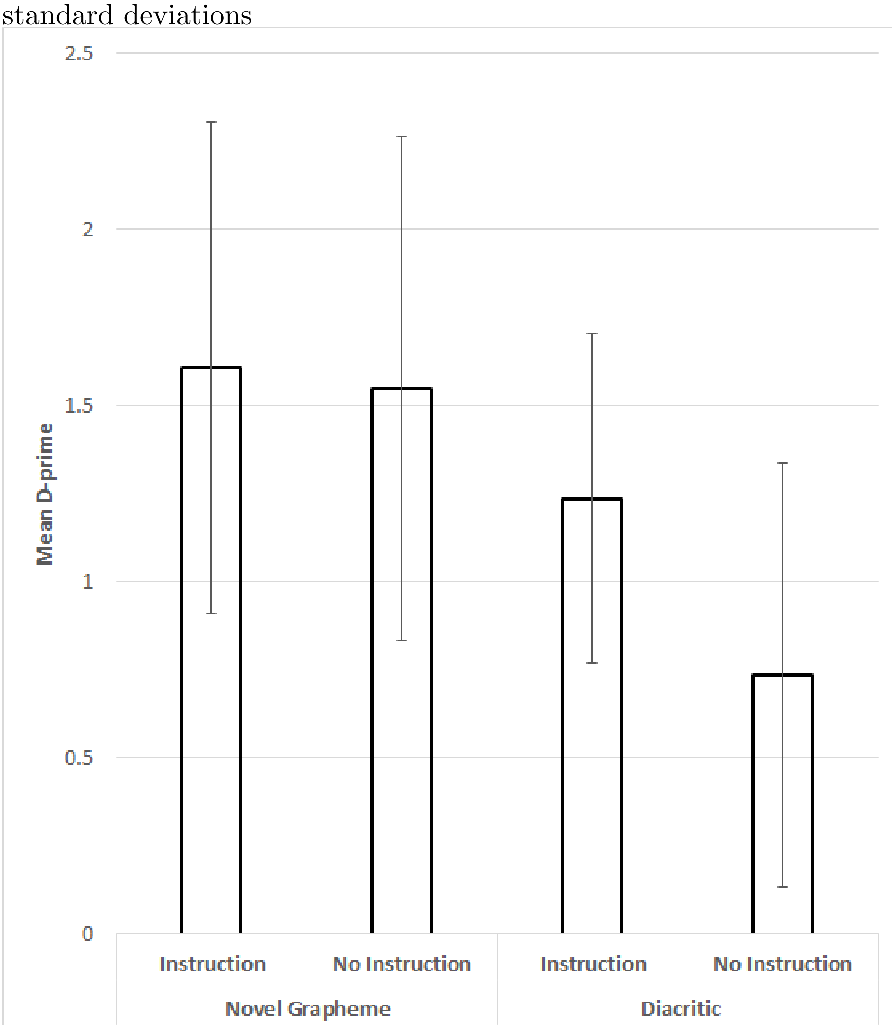
A two-way analysis of variance (ANOVA) was conducted with orthography (two levels: novel grapheme and diacritic) and instruction (two levels: instruction and no instruction) as the between-subjects variables and *d*-prime as the dependent variable. Proportion correct scores were converted to *d*-prime to use as the dependent variable to better assess the assess subjects' abilities to detect the difference between matched and mismatched trial types. Mean proportion correct scores and *d*-primes for each condition are given in Table 2.3. There was a significant main effect of orthography, F(1,48)=11.519,p<.001,η_p^2=.194, no significant main effect of instruction F(1,48)=2.567,p=.116,η_p^2=.051, and no significant interaction of orthography and instruction F(1,48)=1.588,p=.214,η_p^2=.032. Figure 2.2 shows the mean *d*-prime by the orthography and instruction conditions.

Table 2.3. Mean (standard deviation) proportion correct and *d*-prime scores by word learning condition

	Proportion Correct		
	Matched	Mismatched	*d*-Prime
Novel Grapheme-Instruction(n=13)	.901(.062)	.582(.197)	1.607(0.698)
Novel Grapheme-No Instruction(n=13)	.869(.072)	.616(.182)	1.547(0.715)
Diacritic-Instruction(n=13)	.867(.056)	.541(.175)	1.235(0.468)
Diacritic-No Instruction(n=13)	.857(.058)	.369(.197)	0.736(0.602)

Planned pair-wise comparisons were performed after splitting by the instruction condition to examine if the orthographic effect persevered. There was no significant effect of

Figure 2.2. Mean *d*-primes by orthography and instruction conditions; whiskers represent standard deviations



Instruction group, F(1,24)=2.544,p=.124,η_p^2=.096, while the effect for the No Instruction condition was significant, F(1,24)=9.798,p=.005,η_p^2=.290. A similar planned comparison split by the orthography condition was also performed. There was no significant effect of instruction for the novel grapheme condition, F(1,24)=.046,p=.832,η_p^2=.002, or for the diacritic condition, F(1,24)=5.563,p=.027,η_p^2=.188.

Analyses were also done with learning cycles as a covariate, which did not change the pattern of results. With learning cycles as a covariate, the effect of orthography was still significant F(1,48)=11.757,p=.001,η_p^2=.200, with no effect of instruction F(1,48)=2.504,p=.120, η_p^2=.051, and no interaction between orthography and instruction F(1,48)=1.638,p=.207, η_p^2=.034.

The significant main effect of orthography suggests that the novel grapheme influenced subjects to perform more accurately at test, while the diacritic was not as helpful. The fact that the instruction condition had no effect for subjects that received the novel grapheme, but did for those that received the diacritic, suggests that while the diacritic was not as helpful as the novel grapheme, its effectiveness could be enhanced with the addition of instruction.

CHAPTER 3

DISCUSSION

The significant main effect of orthography suggests that exposure to the novel grapheme, as opposed to the diacritic influenced the subjects to be able to perform more accurately at test. This means that the subjects who were in the Diacritic condition were at a significant disadvantage in learning the new contrast found in the words they were required to learn. This disadvantage may have something to do with the similarity that the visual input has with

Because <q> already has a GPC in English, as discussed by Showalter & Hayes-Harb (2015), it could be hypothesized that the diacritic <ḳ> would prove more useful than <q> did to the subjects because the diacritic may serve as a cue that the sound represented is somehow different than what is normally associated with <k>. However it has been observed in this study that the subjects in the diacritic condition were at a disadvantage in learning the Arabic velar-uvular contrast relative to those learning the same contrast in the novel grapheme condition. This disadvantage in comparison to the novel grapheme may be unsurprising given the fact that it already has somewhat of a correspondence because <k> is the main constituent of <ḳ>, which may have led subjects to erroneously conclude that the difference between the two sounds was not as important as it is. One reason then that the novel orthographic symbol may have been more useful to the subjects than the diacritic <ḳ> could be that <𝜦> has no GPC for the English subjects because it does not resemble any English letter, whereas <ḳ> has <k> as a main constituent. Even though the diacritic may have influenced subjects to store the words differently, the novel grapheme did so more effectively, perhaps simply because no part of it had any relation to a pre-existing English GPC. It is interesting to note that in both levels of the orthography variable, some novel orthographic element was introduced to some extent, but the entire grapheme being novel was more beneficial than an addition to one that is already in use.

It is also interesting that while there was a main effect of orthography, there was no main effect of instruction. The Novel Grapheme-Instruction and Novel Grapheme-No

Instruction groups performed with no statistically significant difference, meaning that the with or without the instruction, the subjects who saw the novel grapheme for the uvular stop performed equally accurately. However, when looking at the two groups for which the uvular stop was represented with the novel diacritic, those in the instruction condition performed significantly more accurately than those who did not, suggesting that the inherent disadvantage the <ḳ> may have presented can be moderated by the additional instruction. While the instruction did not seem to help the novel grapheme learners anymore than without it, the learners for which the same phoneme was represented with a novel diacritic learned the contrast significantly more effectively with the instruction than those without it, suggesting that the cue provided by the instruction helped the subjects make the required inferences about the phonological contrast in a way that the diacritic alone could not do. While it could be hypothesized that <ḳ> may have led subjects to conclude that the difference between the sounds was not as important as it was, the more explicit instruction may have resulted in significantly more accurate performance at test because it specifically highlighted the fact that the two sounds were different in this language. The cues provided by the instruction significantly aided the subjects in overcoming the difficulty the diacritic <ḳ> may have presented in comparison to the novel grapheme.

While the instruction provided to subjects by Brown (2015) did not help subjects learn the phonological pattern in an experimental setting, this data shows that some instruction can be efficacious. In her study Brown gave instruction to subjects that certain letters at the ends of words were to be pronounced differently than the subjects might have expected, but found that this instruction did not prove beneficial. The current study provided more explicit instruction in that subjects were told that there would be a sound similar to but different from that used in English, but they were also given audio examples of the contrast along with the contrast being written according to their respective orthography condition. It is unclear what part of this more explicit instruction, if any could be singled out, provided the necessary cues to the subjects in the diacritic condition, but it is clear that the additional instruction was advantageous.

This finding that instruction did play a role for some subjects may also be interesting from a pedagogical perspective. The data suggests that if a person is learning an L2 with two phonemes that are perceived equally the same in the learner's native language, such as the velar-uvular contrast for native English speakers, that learners might be best served if the novel phoneme were represented with a completely new grapheme, and at a disadvantage in learning the new sound contrast if only a diacritic mark were to be used. For example, an English speaker learning the Spanish palatal nasal, which is represented with <ñ>, may have more difficulty in learning the new phoneme than if a novel grapheme was used because this overlaps in visual form with the <n> in the learner's native language. However, this data also suggests that this comparative disadvantage may be alleviated to a significant degree if explicit phonetic instruction is provided.

CHAPTER 4

CONCLUSION

This study has investigated the question of whether learners would use orthographic information to facilitate the acquisition of a novel phonological contrast, specifically whether a diacritic, such as <ḳ>, or a novel grapheme, <Λ>, would better facilitate this acquisition. It was found that indeed the introduction of the novel grapheme better facilitated this acquisition in that subjects for which <Λ> represented the uvular stop in a velar-uvular contrast performed significantly more accurately at test than the group for which the same phoneme was represented with <ḳ>. This finding suggests that learners are better able to use orthographic elements in acquiring novel contrasts if the orthographic form does not already have an existing or conflicting grapheme-phoneme correspondence.

It has also been found that explicit instruction, in which the learner is told that a new sound contrast would be learned and examples given, can play a role in helping learners acquire the contrast, but is not equally helpful in all cases. The learners for which the uvular stop was represented with a novel grapheme performed equally well with or without the more explicit instruction, while the learners for which the same phoneme was represented with a novel diacritic learned the contrast significantly better with the instruction than those without it.

While this study has shown that explicit instruction, even in an experimental context, can have effects, further research should be done to investigate what portions of the instruction provided is most helpful and what other types of instruction in such a context might also prove helpful to learners. While it is clear that the cues provided gave subjects an advantage, it is unclear what portion of the instruction provided the most beneficial cues.

This study has shown that certain types of orthographic input can be more beneficial than others to learners who must acquire a novel phonological contrast. Future research should be conducted to further investigate what types of orthographic input can facilitate this learning, as well as what types of input might inhibit the desired acquisition.

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