ORTHOGRAPHIC INPUT FAMILIARITY AND CONGRUENCE EFFECTS ON PHONO-LEXICAL ACQUISITION OF RUSSIAN BY NATIVE SPEAKERS OF ENGLISH

by

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ABSTRACT

Adult second language (L2) learners often experience difficulty with novel L2 phonological contrasts, limiting their ability to establish contrastive lexical representations of L2 words. It has been demonstrated that the availability of orthographic input (OI), and variables interacting with OI, can shape the inferences learners make about L2 words' phonological forms. The present dissertation focuses on grapheme familiarity and congruence, in addition to L2 experience and the effect of instruction, in the case of native English speakers learning L2 Russian(-like) words presented in Cyrillic. Few studies have directly investigated effects of grapheme familiarity and congruence on phono-lexical acquisition simultaneously, systematically investigated the variables' effects on naïve and experienced L2 learners, or investigated how explicit intervention can mediate OI effects. The present dissertation addresses these gaps in our understanding.

The two studies in this dissertation employed the artificial L2 lexicon paradigm. Taken together, the results indicate the following: (i) native language orthographic interference effects are robust in L2 word learning, especially when grapheme-phoneme correspondences are incongruent (unfamiliar and congruent stimuli did not cause difficulty); (ii) experience with the Russian language mediates this interference, with advanced learners performing near ceiling on all stimuli types and naïve learners performing least accurately; and (iii) naïve learners do not seem to benefit from

textual enhancement and instruction prior to word learning in an experiment. The results of the present dissertation suggest that more research is needed to address the challenges associated with the interference effects of OI in L2 acquisition.

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CHAPTER 1

INTRODUCTION

The present dissertation is an investigation of the effects of orthographic input (OI) variables during second language (L2) phono-lexical acquisition. Chapter 1 provides the background for effects of OI during language acquisition (L2 and first language, L1), as well as the effects of L1 sound-spelling or grapheme-phoneme correspondences (GPCs) on establishing L2 GPCs. Chapter 2 is an initial study investigating the effects of two variables, grapheme familiarity and congruence, during acquisition of pseudo-Russian by naïve native English-speaking listeners. Chapter 3 follows up on the findings in Chapter 2, by expanding the participant population to include L2 Russian learners, comparing performance between naïve learners and learners with varying Russian experience, and includes interventions to mediate effects of OI based upon a systematic investigation of instructional practices by Russian language teachers and how they address observed OI difficulties. Chapter 4 summarizes the findings from the experiments and provides discussion of their contribution to the field, provides avenues for future research, and discusses limitations within the present study and limitation inherent to laboratory studies that investigate OI.

This chapter includes the background of L2 research on GPCs and phono-lexical acquisition, as well as support from L1 GPC research. Second language research

on GPCs differs in the variables that are manipulated and the effects observed. To understand the state of the field and the relation of GPCs and learner acquisition, it is important to understand how both, manipulated variables and the learner, can affect results.

1.1 Effects of orthographic input

Orthographic input (OI) is operationalized here as the written forms of words participants are exposed to within an experiment. For experiments regarding L1 effects, this will be the script of the participant's native language (e.g., English speakers exposed to the Roman alphabet). Typically, an L1 phonological system is learned prior to literacy. Studies of OI and phonology in an L1 have provided evidence that OI can interfere with performance both when OI is present and when it is absent during tasks. This supports claims of the robust nature of OI, affecting the L1 system whether present or absent.

In Dijkstra, Roelofs, and Fieuws (1995), Dutch participants completed a phoneme monitoring task containing nonwords and words that had either one possible spelling or more than one spelling (e.g., identifying /k/ in the real words <kabouter> and <cabaret>, and in the nonword <kadoupel>). Participants were asked to identify specific sounds within auditorily presented words, with the experimental targets being the voiceless stops (/p/, /t/, /k/). For sounds that had more than one possible spelling, reaction times were longer; identifying /t/ in <d> words took longer than identifying /t/ in <t> words. These results suggest that spelled forms affected processing of auditory information for lexical items, even when spelled forms were absent.

In a similar study, Cutler, Treiman, and van Ooijen (2010) found native English

speakers' decisions about phonological forms are differentially affected when the auditory forms can be represented by one or multiple spelled forms. Participants identified when they heard /b, /m/, /t/, /f/, /s/, and /k/ word initially in auditory stimuli. Stimuli were additionally manipulated for word length (measured in phonemes) and lexical frequency. As in Dijkstra, Roelofs, and Fieuws (1995), participant reaction times were faster for phones having less variable or invariable spellings (i.e., /b/, /m/, /t/). For the sounds /f/, /s/, and /k/, having more than one possible spelling (e.g., /f/ can be <f> or <ph>), reaction times were longer.

While the previous studies provided evidence that phoneme detection can be affected by consistency of spelled forms, Tyler and Burnham (2006) found that phoneme deletion (and word identification) can similarly be affected. Native English speakers were asked to remove phonemes from word initial positions to produce new words. For some of the words, deletion of a phoneme resulted in an orthographic form that aligned with an auditory form (e.g., removing [s] from *spin* is <pin>). However, in some pairs, deletion of a phoneme resulted in a word that would be spelled differently than the initial stimulus (e.g., removing [s] from *sphere* is <phere> not <*fear*>). On items that were spelled differently from original word to removal, reaction times were significantly slower. In a second experiment, prior to the task, participants were explicitly instructed not to consider words' spellings when producing answers, as this would lead them astray. Again, reaction times for differently spelled forms were longer than forms spelled in the same manner. Over four experiments with different manipulations of instructions and stimuli, Tyler and Burnham found that differently spelled forms yielded longer reaction times than same spelled forms. The results of Tyler and Burnham (2006) suggest that

orthographic knowledge is difficult to inhibit, even when it leads participants to make incorrect decisions about words. This is consistent with the results found in Castles, Holmes, Neath, and Kinoshita (2003) who conducted a similarly designed study involving children (i.e., "beginner learners").

Ziegler, Ferrand, and Montant (2004) questioned whether words that can correspond to different spelled forms (but similar phonology, e.g., *wine-sign*) would affect performance in lexical decision, rime detection, and auditory naming tasks. Native French speakers listened to auditory words and determined whether the words were real words or nonwords in French. Some words contained spellings that were "subdominant" in French, or would be spellings associated with a phonological rime less often (e.g., for /-ɛ̃/, *-ain* is the dominant spelling and *-aim* is subdominant). In all three tasks, subdominant spellings yielded longer reaction times and higher error rates than other forms. Performance on the lexical decision task was most robustly affected by knowledge of orthographic forms. For more background on effects of number of possible spellings on lexical decisions see Ziegler, Muneaux, and Grainger (2003).

Building on previous studies demonstrating the effect of OI during auditory lexical decision tasks, Petrova, Gaskell, and Ferrand (2011) contained manipulations of the variables of possible spelling (one or more spellings are possible with auditory input) and frequency (lexical frequency: high or low). In a lexical decision task, native French speakers heard French words that had one possible spelling and were high frequency words (e.g., *bouche*), more than one spelling and high frequency (e.g., *bouce*), one spelling and low frequency (e.g., *digue*), or more than one spelling and low frequency (e.g., *dose*). Pseudowords were also included, varying in having either one possible

spelling or multiple spellings. At test, participants heard the auditorily presented word stimulus and determined whether it was a real word or nonword of French. Words with different possible spellings, as well as low frequency words, resulted in longer reaction times (and error rates). Furthermore, while effects of spelling were present with high frequency words, reaction times for words with more than one spelling and low frequency words were significantly longer. This would suggest that more unfamiliar words (i.e., low frequency or new words such as L2 words) are more affected by orthographic knowledge. As both high and low frequency words were affected when spellings could differ, the results suggest that knowledge of spelled forms affect the manner spoken words are lexicalized and/or processed.

Effects of OI and orthographic knowledge on task performance is not only seen in word recognition experiments, but also experiments testing production. Damian and Bowers (2003) examined native English speakers' productions of word initial /k/ and /ʤ/ in a series of four experiments manipulating OI. Participants learned pairs of words in one of three conditions: homogenous, heterogeneous, or inconsistent. Homogenous words' initial sounds and spelling were shared (e.g., *camel, coffee*). Heterogeneous words' initial sounds and spelling were different (e.g., *camel, gypsy*). Inconsistent words' initial sounds were shared but the spellings were different (e.g., *kennel, coffee*). At test, participants produced a response word after being cued by words they had learned (e.g., see *camel, coffee* and then see and produce *cushion*). In the first two experiments, participants saw written forms for all stimuli. In a third experiment, participants only heard the stimuli. In a final experiment, the possible sound-spelling differences were reversed for the inconsistent stimuli. That is, the pairs had the same initial spelling but

differed in pronunciation (e.g., *city, cobra*). In all four experiments, when participants saw word pairs in which the initial letter and sound matched, they were faster in producing the response word; homogenous words facilitated performance. For inconsistent and heterogeneous pairs, performance was inhibited (but not different). Damian and Bowers (2003) indicated that orthographic knowledge affects how phonological input is encoded, with a facilitative effect of OI when GPCs are matched between the prime and target word. For words with GPCs that could be variable, orthographic knowledge can interfere with performance.

In another priming experiment, Taft, Castles, Davis, Lazendic, and Nguyen-Hoan (2008) investigated whether homographs would affect word processing differently than various spellings for a phonologically equivalent word. In their first experiment, Taft et al. had native (Australian) English speakers make lexical decisions about nonwords after seeing primes that were both phonologically and orthographically similar (pseudohomographs; e.g., prime /tr^θ/, target /tru:θ/, <truth>), phonologically similar but orthographically different (e.g., prime /froud/, target /frɔ:d/, <fraud>), or unrelated (e.g., prime /sælt/, target /tri:p/). Stimuli were presented only in auditory form. Reaction times on pseudohomograph trials were faster than trials with orthographically different words. To determine whether awareness of the prime-target relation affected performance, Taft et al. asked participants to indicate how similar the prime-targets were after each trial. Again, reaction times for words with different spellings were longer than pseudohomographs. Participants rated pseudohomographs and differently spelled words as equally similar in prime and target pairs. This suggests that, while participants believed the pairs to be similar phonologically, orthographic knowledge interfered with

performance, causing a delay in decisions to differently spelled words. Similar results were obtained in a third experiment in which participants produced the target words. Pseudohomographs were produced faster than differently spelled targets. The results of Taft et al. (2008) are particularly interesting as participants never saw spelled forms.

The studies reviewed in this section provide evidence that L1 orthographic knowledge can affect performance on experimental tasks, and that phonology and orthography are inexorably linked (as evidenced by effects of OI even in the absence of spelled forms). Information from L1 studies can be used as support in predictions of L2 performance. If effects of OI are robustly observed in L1 studies, there is no reason to believe that they would not be observed in L2 performance.

1.2 Effects of orthographic input during second language acquisition

Research on OI provides evidence for effects of how various types of input contribute to a learner's ability to acquire second language (L2) phonology and word forms—phono-lexical acquisition. A learner can benefit from the availability of OI (e.g., Escudero, Hayes-Harb, & Mitterer, 2008; Escudero & Wanrooij, 2010; Showalter & Hayes-Harb, 2013). However, OI does not always aid a learner in establishing phono-lexical representations. In some instances, there is no beneficial effect for those exposed to OI over those who are not exposed to OI (e.g., Showalter, 2012; Simon, Chambless, & Kickhöfel Alves, 2010). In other cases, the availability of OI can create an interference effect on phono-lexical acquisition (e.g., Hayes-Harb & Cheng, 2016; Hayes-Harb, Nicol, & Barker, 2010). As noted, the effects of OI on learner performance is dependent on

manipulated variables within a specific study and these variables can vary. This section will outline some of these variables and the effects of their manipulation upon participant performance.

1.2.1 Exposure to orthographic input influences performance on tasks

In a series of studies that build upon one another, it was found that OI can be beneficial during lexicalization of words containing difficult-to-perceive contrasts. Weber and Cutler (2004) tracked eye movement of L1 Dutch speakers listening to English or English-like words that contained the English /ɛ/-/æ/ contrast. Cutler, Weber, and Otake's (2006) study included L1 Japanese speakers and the English /l/-/ɹ/ contrast. Both studies presented words differing only in these contrasts in a carrier phrase and tracked the eye-gaze of participants. Participants saw images containing the confusable pair within the first syllable of the target word (e.g., *pencil* and *panda*; *rocket* and *locker),* as well as two other phonologically unrelated pictures (e.g., *dress*; *strawberry).* Results of both experiments indicated a pattern in which participants were more likely to first look at the image containing the sound closest to one of their L1 phonological categories, regardless of the presented target, before hearing the differentiating syllable.

Escudero, Hayes-Harb, and Mitterer (2008) had L1 Dutch speakers undergo a similar experiment, but included spelled forms of the words with the presented pictures and auditory /ɛ/-/æ/ forms in one of two word-learning conditions. Participants either saw spelled forms underneath the pictured meaning of the auditory word (e.g., see pictured *tenzer* and <tenzer> or *tandek* and <tandek>) or only saw the pictured meaning (e.g., see

pictured *tenzer* or *tandek*). At test, participants who were exposed to the spelled forms were more likely to look at the picture with the correct auditory form (i.e., hear an /ɛ/ word, look at /ɛ/ word; hear an /æ/ word, look at /æ/ word). They concluded that the Dutch speakers' knowledge of spelled forms, that <e> and <a> represent the sounds [ɛ] and [æ], respectively, aided in their perception of the auditory forms. Thus, with the availability of OI, participants could establish contrastive lexical representations.

Showalter and Hayes-Harb (2013) looked at whether listeners would be able to make use of novel tone marks presented in spelled forms to make inferences about unfamiliar L2 suprasegmentals, in this case, tonal contrasts. Native English speakers were exposed to pseudo-Mandarin words (i.e., [gi] and [fiɑn] with tone 1, tone 2, tone 3, and tone 4), pictured meanings, and OI in one of two conditions. The first, the Tone Mark condition, contained the Pinyin spelled forms with diacritic tone marks (i.e., <fiān, fián, fiǎn, fiǎn>); the other, the No Tone Mark condition, contained the Pinyin spelled forms without diacritic tone marks (i.e., <fian>). At test, participants who saw the spelled forms provided evidence that they had established phono-lexical representations, and correctly identified matched picture-auditory form pairs over mismatched picture-auditory forms. This study not only demonstrated the effects of OI on the ability to perceive and establish contrastive representations for difficult-to-perceive contrasts, but also participant ability to make use of unfamiliar OI.

Escudero, Hayes-Harb, and Mitterer (2008) and Showalter and Hayes-Harb (2013) focused on perception of difficult-to-perceive contrasts (see Yang, 2015 for the role of OI in allophone perception), but OI can affect inferences made about larger units of phonological forms as well. Lim (2003) investigated the effect of OI upon perception

and production of syllables in native Korean speakers learning English. In some cases, English words are perceived by Korean speakers to have additional syllables. This occurs in words that contain illicit Korean phonotactics, resulting in perceived epenthetic vowels, adding syllables and making it difficult to mark syllable divisions (e.g., English *stamp* [stæmp]; Korean *stamp* [sɨ.t^{h}æm.p^{h}i]; Lim, 2003, p. 86). Lim (2003) found that Korean speakers were more likely to make use of Korean-specific syllabic rules to syllabify English words, resulting in nontarget-like productions (e.g., [sɨ.t^{h}æm.p^{h}i]) and syllable counts (e.g., *stamp* as three syllables). When words are presented visually, perceiving, counting, and segmenting syllable difficulties are mitigated.

Detey and Nespoulous (2008) examined native Japanese speakers learning French. The participants were more likely to perceive epenthetic vowels within L2 syllables containing consonant clusters that are illicit in the L1. Participants were asked to circle the number of syllables that they heard or read within a word that contained consonant clusters word initially, medially, or finally (e.g., /tr/ in /trosema/, /sematro/, /semagotr/). Surprisingly, the conditions containing OI, audiovisual and visual, yielded greater perception of epenthesis and a counting of additional syllables. Detey and Nespoulous posited that the presence of OI required additional resources (e.g., working memory) or triggered incorrect phonological mapping to the OI, causing nontarget-like performance at test.

Ota, Hartsuiker, and Haywood (2009) presented written words that were semantically related to auditory and visual forms of stimuli. Stimuli contained homophonous (e.g., <hear>-<here>) or minimal pairs containing either the /l/-r/ contrast or /p/-/b/ contrast (e.g., <lock>-<rock>; <pet>-<bet>). Participants included native

speakers of Japanese and native speakers of Arabic, who have difficulty perceiving the /l/-/r/ and /p/-/b/ contrasts, respectively. Each pair was also associated with a spelling control, differing only from the difficult-to-perceive contrast in the minimal pair (e.g., <sock>; <jet>). Finally, words were also paired with a semantic associate that was related to the minimal pair counterpart (e.g., <lock>-<hard>; where *rock* would be associated with *hard*). Participants saw spelled forms of the pairs at test and were asked to determine if they were semantically related. Homophonous words, as well as words that included minimal pair difficulty from L1 phonology, had slower reaction times and less accurate performance. Orthographic input containing visual distinctions of phonological contrasts, in this instance, did not mediate difficulty attributed to L1 phonology (contra Escudero, Hayes-Harb, & Mitterer, 2008).

Thus far in this background of L2 orthography-phonology studies, the studies have presented evidence for OI affecting perception of auditory forms and the acquisition of the phono-lexical representation. However, to understand the far-reaching impact of OI on L2 acquisition, it is important to note that OI can affect learner productions as well. It is also important to note that differences in the type of effects on production (aid, hinder, or no effect) vary just as they do with perception. For instance, Vendelin and Peperkamp (2006) found that L1 French-late L2 English bilinguals produced English nonwords according to English GPC rules when presented with spelled forms. That is, even after hearing French-like auditory forms, they were more likely to pronounce them in an English-like manner if they saw spelled forms, but were more likely to repeat the target-like pronunciations sound-for-sound when they only heard them.

The effect that OI has on production can be attributed, in some cases, to the

association of L1 phonological processes and knowledge of GPCs. Smith, Hayes-Harb, Bruss, and Harker (2009) investigated L1 German speakers' ability to produce voiced-voiceless distinctions word finally in English (e.g., *bad*/*bat*). German neutralizes the contrast phonetically (i.e., [bat] for *bad* and *bat*), even though the spelled forms exhibit the contrast. English however, distinguishes the contrast both in spoken and spelled forms (e.g., [bæd] and [bæt] for *bad* and *bat*). Smith Hayes-Harb, Bruss, and Harker (2009) questioned whether OI presentations exhibiting the contrast would aid German speakers in producing target-like forms. Results indicated that the difference in spelled forms in English were not enough to mitigate the L1 phonological process of neutralization.

Also examining word final segment productions, Silveira (2007) looked at the effects of task-type (structured and unstructured tasks) and orthography. Production of word final consonants in English words was of interest, as produced by native speakers of Brazilian Portuguese. Brazilian Portuguese phonotactics allow only four syllable-final consonants, resulting in native listeners perceiving an epenthetic vowel after illicit codas and therefore producing varied syllable structure (especially within nonnative words). Participants completed three production tasks: sentence list reading, reading a dialog, and completing an interview. The comparison made by Silveira (2007) was the rate of epenthetic productions when words ended in an orthographic vowel versus those ending with an orthographic consonant (e.g., *tape* and *tap*). It was expected, based on previous studies, that the presence of OI would result in participants making use of L1 reading strategies (L1 GPC knowledge). Results indicated that sentence reading and the guided interview, as well as words containing an orthographic <e>, yielded the highest percentage of produced epenthetic vowels. This suggests that access to OI results in

greater influence of L1 GPC knowledge interfering with L2 processing.

Nimz (2016) investigated Polish speakers learning German, and the effects of spelled forms on the perception and production of German vowels. In German, vowel length is contrastive, while Polish does not contain contrastive vowel lengthening. For many vowel pairs in German, a single grapheme is used to represent both the short and long vowel (e.g., <e>-/e:/, /ɛ/; <ü>-/y:/, /ʏ/). Polish vowels are in a one-to-one correspondence (e.g., /ɛ/-<e>; /ɨ/-<y>). Participants completed a picture-naming task, with stimuli that were divided according to whether written forms marked the short-long distinction. For instance, an <h> present in a spelled form indicates a long vowel (e.g., *Sahne* 'cream') and two consonants in succession mark short vowels (e.g., *Wasser* 'water'). Forms without these indications were considered 'unmarked' (e.g., long vowel in *Gabel* 'fork' and short vowel in *lachen* 'to laugh). Production results indicated that the knowledge of spelled forms did not yield length differences in productions of the vowels by Polish versus German speakers. Participants also completed an identification task requiring them to indicate whether an auditory form matched a presented picture. Auditory forms contained either a vowel with appropriate length (e.g., [ne:bəl] *fog;* [vo:nən] *to live*) or the length counterpart resulting in a nonsense word (e.g. [nɛbəl]) or different lexical item (e.g., [vɔnən] *delights*). Participants accurately (albeit accuracy was around 65%) made decisions about the matched-mismatched items by length. Performance was similar when orthography (marked versus unmarked words) was analyzed. This suggests that knowledge of spelled forms influenced performance for the L2 German learners. Specifically, performance on the vowels /ɛ-e/ and /o-ɔ/ was likely more affected than other vowels. Nimz pointed out that, in the case of /o:/, Polish

speakers likely erroneously relied on Polish GPCs (<o>-/u/) when producing German (<o>-/ɔ/). Thus, similarities between languages in one aspect (e.g., phonology) but differing in another (e.g., orthography or GPCs) can robustly affect performance.

It is important to consider written forms as powerful input in experiments on phonological inferences. In fact, OI has been found to affect perception even in tasks that do not involve visual input. In auditory only tasks, participants are faster to judge words as a rhymed pair when their written forms are more similar, even when words rhyme phonologically (e.g., *blame-name* versus *blame-claim;* Seidenberg & Tanenhaus, 1979; Zeigler & Ferrand, 1998). From studies of this type, it seems OI can affect mental representations of words (Muneaux & Ziegler, 2004). Brewer (2008) investigated these effects on production of consonants that are written, in English, with different letters but pronounced in the same manner (e.g., *draft, graphed, laughed, staffed* pronounced with an [f]). Words containing consonants spelled with more than one letter were produced with longer durations; however, this effect did not extend to nonword productions (e.g., *snup* and *snupp).* It is important to note that a similar effect of number of consonants to duration was observed in L2 English productions by L1 Italian speakers in Bassetti (2017). In an additional experiment, in which nonwords (e.g., *plut* and *plutt*; *jek* and *jeck)* were elicited via picture naming (sans spelled forms) after word learning, productions for nonwords spelled with more than one consonant were numerically longer; however, the difference between productions for single letters and multiple letters was not significant. The results for the real word productions in her initial experiment, and the longer durations for nonwords *after* word learning in the subsequent experiment, indicate that lexicalized forms, and thus mental representations of their spelled forms, can affect

productions.

While not a study on L2 learners, the results of Brewer's (2008) dissertation present important considerations—OI can cause interference effects in a task involving spelled and auditory forms in the native language (for more, see section 1.2), and that one's knowledge of GPCs and spelled forms is powerful enough to interfere during a task when the written forms are not provided. The latter point introduces the issue of L1 knowledge and the effects it can have on L2 performance when that L1 knowledge is transferred. It is important, then, to consider other variables that interact with OI during word learning, namely, variables that are rooted in L1 knowledge and cause interference when learning an L2.

1.2.2 Grapheme familiarity

Two variables are of focus in the present dissertation: grapheme familiarity and congruence. Previous research has indicated that these variables can significantly affect the performance of participants when making inferences about phonological forms of L2 words. These variables also demonstrate direct influences of L1 knowledge on L2 acquisition. Grapheme familiarity and congruence will correspond differently to orthography, phonology, and an L1 and L2; this results in myriad ways to affect performance. However, they are often confounded with other variables of interest in studies. The following sections will outline research demonstrating the effects of these variables, as well as limitations that are presented in experimental designs and subsequent conclusions that are made about their effects.

The first variable to be discussed is grapheme familiarity. To situate the variable,

remember that OI is written forms to which a participant is exposed during an experiment. In some L2 studies, the scripts of the L1 and L2 do not differ; for example, L1 English speakers learning Dutch do not need to learn a new alphabet, as both use the Roman alphabet. However, learning an L2 can require learning a script that is not used within the L1. A native English speaker learning Arabic will need to learn the Arabic script. In the L1 English-L2 Dutch example, the relationship of L1 graphemes and L2 graphemes is familiar. The English speakers do not need to learn new graphemes. However, in the L1 English-L2 Arabic example, the Arabic graphemes are unfamiliar. The English speakers must learn the new graphemes. The same familiar-unfamiliar relationships are found in phonological acquisition as well. For instance, when learning Dutch, native English speakers will note there are familiar vowels (e.g., [i], [u]) but will need to learn unfamiliar vowels (e.g., [y], [ø]). Finally, there are considerations of familiarity of lexical items; what are the effects of cognates, neighbors, and experience with a language upon performance within L2 acquisition? As the present dissertation is an investigation of OI effects, the focus is on grapheme familiarity.

While still understudied, the current literature on grapheme familiarity provides information about familiarity at different points along a continuum from familiar to entirely unfamiliar. Some studies' research questions have centered on the familiarity variable, but it is important to note that for much of the literature, isolation of the familiarity variable and its effects is often not made or is confounded with other variables. The following studies represent familiarity as the main manipulated variable.

To begin on the unfamiliar side of the continuum, Showalter and Hayes-Harb (2013) presented L1 English speakers with L2 pseudo-Mandarin words written in Pinyin

(Romanized version of Mandarin). They investigated the ability of the native English speakers to make lexical representations for words differing in the Mandarin four-way tonal contrast. For the native English speakers, the segmental information was familiar, while tone was presented via novel diacritic tone marks (e.g., *fiăn, gí*). Participants were exposed to auditory forms, pictured meanings, and OI either with tone diacritics or without tone diacritics (e.g., *fiăn* or *fian*) during a word learning phase. Participants were tested on whether they had lexicalized the new words within an auditory-pictured meaning matching task. For those exposed to the tone diacritics, accuracy at test was higher than those not exposed to the diacritic information. From Showalter and Hayes-Harb (2013), it is inferred that learners can make use of unfamiliar diacritic input to make inferences about the phonological forms of L2 words. It is important to note that a subsequent study (Durham, Hayes-Harb, Barrios, & Showalter, 2016) did not replicate these findings, even after manipulations to the visual input to mediate the difficulty of the tones. Other studies of Mandarin and OI seem to support Durham et al. (2016; e.g., Pytlyk, 2011). As will be discussed in more detail in later sections, Pytlyk's findings (no benefit of an unfamiliar versus familiar orthography) may have resulted from a confound of difficult-to-perceive contrasts.

To determine the extent to which OI can be unfamiliar and still aid participants, Showalter and Hayes-Harb (2015; an extension of Showalter, 2012) exposed native English speakers to pseudo-Arabic words in Arabic script. Participants heard minimal pairs containing the velar-uvular /k/-/q/ contrast, saw pictured meanings, and were either exposed to written forms in the Arabic script or the sequence <ط ط ط ط>. Participants exposed to the Arabic script did not perform more accurately at test than those

participants who were exposed to the sequence of <ط>s. In fact, neither group performed above chance on items that included auditory-pictured meaning pair mismatches. While it is tempting to conclude that low performance accuracy was due to the unfamiliar script, it cannot be done so conclusively. What can be gleaned from the results, comparing those exposed to OI to those not exposed to OI, is that the unfamiliar Arabic script neither helped nor hindered performance.

To ascertain whether the Arabic script, being entirely unfamiliar to the English speakers, was the reason for low test accuracy, Showalter and Hayes-Harb (2015) manipulated the original stimuli. These manipulations included providing instruction prior to word learning (i.e., "Arabic is read from right-to-left"), transliterating the spelled forms into the Roman alphabet (i.e., /k/ written as <k> and /q/ as <q>), and reducing auditory variability (reducing the number of talkers to one). However, none of the manipulations resulted in improved accuracy. Showalter and Hayes-Harb's (2015) findings provide reason to suspect that the difficult-to-perceive /k/-/q/ contrast confounded the ability to separate effects of OI on performance.

Looking at differing degrees of familiarity, Mathieu (2016), compared participant performance across different scripts. Native English speakers learned a set of 12 Arabic words and nonwords (six minimal pairs) containing the uvular-pharyngeal contrast /ħ/-/χ/. Each word was associated with its auditory form, a pictured meaning, and a written representation. Participants were placed into one of four conditions, differing in the script of the written forms: Arabic, Cyrillic, Hybrid (Roman/Cyrillic mix), or no written representation. For the native English speakers, Arabic (e.g., خال) would be entirely unfamiliar. Cyrillic was more familiar despite having unfamiliar graphemes (e.g., хҷб).

The Hybrid script Mathieu employed was a combination of Cyrillic and Roman graphemes (e.g., пub), with the first consonant-grapheme pair being in Cyrillic and the remaining letters in the Roman alphabet. Thus, only the first letter of this condition would be unfamiliar to participants. Finally, to compare performance, there was also a condition without orthographic forms. Instead, participants saw the sequence <xxx>.

Results of Mathieu (2016) indicated that none of the script conditions either aided or provided a hindrance to performance (for more detail, see Mathieu, 2014). That is, participant ability at test to indicate whether auditory-picture pairs were correctly or incorrectly matched did not differ across the three script conditions. This suggests that grapheme familiarity does not affect phono-lexical acquisition. However, as noted with Showalter and Hayes-Harb (2015), it may be the case that the phonological contrast was too difficult for listeners to make contrastive representations regardless of the OI. Relative to the no orthography condition, participants exposed to the Arabic and Cyrillic performed significantly less accurately. Participants in the Hybrid condition had less accurate perform than the No Orthography condition, although the difference was not significant. That the two more unfamiliar scripts yielded less accurate performance than those not exposed to written representations suggests that unfamiliar OI may, at the very least, provide initial delays in phono-lexical acquisition. Given that participants in the Hybrid script condition, the most familiar of the three scripts, did not perform significantly less accurately than the No Orthography (no written forms) condition would indicate that participants were able to make use of the OI when familiar (or more so than the unfamiliar OI).

The results of Mathieu (2016) contribute more information to the topic of phono-

lexical acquisition than the issue of grapheme familiarity. Indeed, Mathieu found that while grapheme familiarity did not affect performance as robustly as expected, the next variable of interest to be discussed, congruence, did.

1.2.3 Congruence: Grapheme-phoneme correspondences

Congruence is defined in different ways within the literature on OI and masquerades under different names. For the present dissertation, I adopt the term *congruence* and define it as the mapping between letters and sounds; in other words, it is a property of grapheme-phoneme correspondences (GPCs). Furthermore, congruence is based on the relation of GPCs between two languages. A congruent GPC is one in which the grapheme and phoneme have the same correspondence or mapping in both languages. A native English speaker learning German will note the <n>-/n/ correspondence is congruent from English to German—both languages map <n> to /n/. An incongruent GPC is one in which the grapheme and phoneme do not have the same mapping between two languages. The native English speaker maps <w> to /w/ in English, but must learn that <w> maps to /v/ in German. The reader will note that unfamiliar graphemes do not fit neatly into the congruent-incongruent description. This is because a learner cannot classify a mapping of a grapheme that is not presently within their system as congruent or incongruent. They must establish the new GPC. A GPC can also be incongruent when there is an unfamiliar phoneme (an L2 specific phoneme) mapping to an L1 grapheme. For instance, a native English speaker learning Dutch must learn that <u> maps to Dutch /ʏ/, a vowel that is not present in the English inventory and different from the English mapping <u>-[u] (or [ə], [ʊ], [ʌ]).

1.2.3.1 Congruence defined as depth/consistency

As expressed above, congruence has, in the past, been subsumed under a broader definition or may correspond to different, albeit related, topics/variables. A term and definition important to understand is that of consistency or depth (for an extended description of the Orthographic Depth Hypothesis, see Frost & Katz, 1989; Katz & Frost, 1992). While this specific aspect of OI will not be of focus in the present dissertation, understanding this term and its effects on phono-lexical acquisition can help situate the present conceptualization of congruence. I present the difference between consistency and congruence as *within* versus *between* language considerations, respectively. Consistency or depth is a function of the number of phonemes or graphemes corresponding to one another *within* a language. English is an example of a deep or opaque system, with many phonemes to a grapheme or many graphemes to a phoneme. For instance, an English speaker encountering the sequence <-ough> must determine whether the pronunciation of the sequence is [u] (<through>), [ɑf] (<cough>), [ɑu] (<bough>), [əf] (<tough>), etc. Alternatively, hearing [i], an English speaker will need to determine whether the corresponding grapheme(s) are <ee> (<bee>), <ea> (<read>), <e> (<she>), <ie> (<believe>), <ei> (<receive>), or <y> (<highly>).

On the other end of the spectrum, Spanish is a language reported to be a shallow or transparent system; Spanish GPCs are typically one-to-one. Because GPCs are consistent and grapheme-phoneme mappings are expected, when a Spanish speaker encounters <i>, the mapped sound will be [i]. Speakers of transparent or shallow systems are said to approach L2 learning differently than speakers of opaque or deep systems. The former will interpret GPCs as shallow, transferring their knowledge of L1 GPCs to the

L2, even if the L2 is deep or opaque. This would be analogous to a Spanish speaker learning L2 English and expecting that <p>, which in Spanish maps to [p] (and [p] only), only maps to [p] in English. However, <p> in English can also map to [f] as in *graph* or [∅] as in *psych*. This can create difficulty during acquisition.

The importance of understanding congruence and consistency/depth (referred to henceforth simply as *depth*) as two separate variables will be observed in the following studies. While related, the differences in the specifics of the variables likely cause learners to approach L2 acquisition in different ways. Depth informs researchers about how learners approach reading and pronunciation via their L1 GPC system, and the difficulty they can encounter from ingrained knowledge about how many correspondences are expected for a given grapheme or phoneme. Congruence informs researchers about how learners approach an L2 via expectations of the L1 system, but does not rely on information about the number of correspondences. Difficulty is instead associated with having to learn and "unlearn" GPCs. Congruence and depth at times overlap, whether authors of studies intend for this to happen or not, which provides insight into gaps in the literature and directions for future research.

Examining depth first, the research indicates that learners bring expectations about GPCs and phonological/reading knowledge with them from their L1, affecting the way they process an L2. Erdener and Burnham (2005) explored the effect of L1 depth on production of nonwords in an L2. Native speakers of Turkish and English, transparent and opaque languages respectively, produced nonwords in Spanish and Irish, transparent and opaque languages respectively. Participants were assigned to one of four conditions: auditory only, auditory-visual, auditory-orthographic, or auditory-visual-orthographic. An

interaction between language background and target language was observed. While OI facilitated pronunciation accuracy overall, the interaction of L1 and L2 depth produced a schism in performance. Native Turkish speakers, with a shallow L1, performed more accurately on Spanish (also shallow) nonwords when OI was present. However, when the Turkish speakers produced Irish (opaque) nonwords, the presence of OI was "detrimental" (Erdener & Burnham, 2005, p. 209) and caused interference (pronounced graphemes as written not as target). Native English speakers did not perform significantly differently on the two nonword groups. As the Turkish speakers were used to transparent, systematic GPCs, the presence of OI affected pronunciations more than the native English speakers, especially on opaque stimuli. It can be concluded from Erdener and Burnham (2005) that variability in correspondences, or the ability to predict correspondences, can be difficult depending on the depth of an L2 relative to an L1.

In his dissertation, Dornbusch (2012) examined the effect of language depth on L2 phono-lexical acquisition. Participants were native speakers of German (transparent) or Dutch (opaque) learning English (opaque), as well as a native English speaker control group. In a rhyme-judgment task, stimuli were English triplets that rhymed auditorily to a target (e.g., *burn*), with one of two nontarget words being identical orthographically (e.g., *turn*) and one being orthographically different (e.g., *learn*). Other triplets included words that did not rhyme with the target, but did rhyme with each other (e.g., target: *bomb*; other words: *tomb, room*). All participants responded more slowly when rhymes of the target-nontarget pairing differed in orthographic form. Native German speakers had the greatest error rate differences between performance on rhyming versus nonrhyming pairs, with English and Dutch speakers performing similarly on the two item groups.

A different task in Dornbusch (2012), a lexical decision task, contained English words and nonwords with either one-to-one correspondences (e.g., <uck>-[ək]) or many-to-one correspondences (e.g., <eap>, <eep>-[ip]). That is, the words conformed to transparent and opaque correspondences, respectively. Participants were required to respond whether an auditorily presented word was a real English word. Performance on this task was consistent with performance in the rhyme task, with longer response times on opaque items for all groups and German speakers having a greater difference between opaque and transparent item accuracy. Dornbusch (2012) posited one conclusion for the results; L1 orthographic transparency can influence the approach a speaker takes in each task and therefore affect the results obtained. In this case, the Dutch speakers' knowledge that GPCs can be highly variable prepared them for varying L2 GPCs. However, the German speakers, coming from a transparent language, took longer to sort out varying GPCs in the opaque, English system.

Rastle, McCormick, Bayliss, and Davis (2011) looked at *inconsistencies* (their operationalization is synonymous with depth) of GPCs and the effects upon spoken word processing (perception and production). Native English speakers were taught auditory form-pictured meaning pairs for pseudo-English nonwords, and later taught the spellings of these words. Spellings were either consistent (i.e., transparent) or inconsistent (i.e., opaque) following English spelling conventions (e.g., /tɪst/; consistent <tist>; inconsistent <thist>). Finally, participants were tested on their knowledge of the words on a variety of perception and production tasks. The regularity of the spelling affected the response time for production and reaction times in the perception tasks. While participants could spell both consistent and inconsistent forms with equivalent accuracy, inconsistencies caused

delay in production and response times.

Also looking at consistency as an experimental variable, Pytlyk (2017) explored the effects of OI on L1 English speakers learning either Russian or Mandarin (see also Pytlyk, 2007, 2012). Pytlyk questioned whether listeners would perceive L2 words differently given their knowledge of spelled forms and expectations of GPCs. For one of the tasks in the experiment, participants completed phoneme counting. It was hypothesized that inconsistent representations (e.g., *семь*-[sʲɛmʲ], four letters, three sounds; *huáng*-[xwaŋ], five letters, four sounds) would provide difficulty for learners over more consistent representations (e.g., *чмо*-[ʃtɔ]; *wèi*-[wej], three letters, three sounds). Spelled forms containing more letters than sounds were expected to result in more counted sounds than those with equal letter-sound correspondents. Both learner groups counted the auditory phonemes more accurately when spelled forms matched the number of letters and sounds than when they did not match. In a task that included L1 homophone words to indicate the extent to which L1 and L2 orthography interacts, it was observed that L1 spelling did not negatively affect performance. Thus, while L1 knowledge did not seem to interfere in this instance, it is the case that OI produces a robust effect on the ability to make inferences about phonological forms of a word.

Other literature provides evidence that L1 GPC knowledge influences how an L2 learner interprets L2 information. Bassetti (2006) included L1 English speakers learning L2 Mandarin, completing phoneme counting and segmentation tasks. Learners were exposed to Mandarin OI via Pinyin. In Pinyin, some main vowel rimes are spelled differently depending on neighboring sounds. For a particular rime, when the main vowel is syllable initial, it is spelled out. However, postconsonantal main vowels are absent in

the spelled form. The rime *iou* would be spelled <you> and <iu>, respectively. In both instances, the main vowel is pronounced (i.e., both [iou]). At test, participants counted and segmented all three vowels when the main vowel was represented in the OI. When the learners saw written forms lacking the main vowel, they did not count or segment that vowel, despite its presence in the auditory form. Bassetti (2006) demonstrated that L2 learners can erroneously rely on their L1 knowledge to make inferences about forms in the L2. In this case, knowledge of English spellings led learners to incorrectly make assumptions about phonological forms. Furthermore, learners in Bassetti were instructed learners, indicating that L2 experience did not outweigh interference from L1 knowledge.

The next study defines congruence more in line with the present dissertation's definition than previous studies. Following Escudero and Wanrooij (2010) and Escudero, Broersma, and Simon (2013)—who found that Spanish speakers have difficulty making inferences about Dutch vowels in the presence of OI (e.g., when Dutch <a>-<aa> pairs with /a/-/ɑ/ and <aa> is not a stand-in for lengthening of /a/)—Escudero, Simon, and Mulak (2014) investigated Spanish speakers' performances with OI that was *inconsistent* (incongruent) with L1 GPCs. Native Spanish speakers, who were either learners of Dutch or had no experience with Dutch, were exposed to auditory input that contained perceptually easy or perceptually difficult phonological contrasts (as per the difficulty described and found in Escudero, Broersma, & Simon, 2013) and OI that was either consistent or inconsistent (congruent or incongruent) with L1 GPCs. Consistent OI contained Dutch grapheme-phoneme pairings that were *nearly* identical to Spanish grapheme-phoneme pairs (e.g., Dutch <i>-<u>, /ɪ/-/ʏ/; Spanish <i>-<u>, /i/-/u/). Inconsistent OI contained Dutch pairings that differed from those of Spanish, as the result

of a grapheme mapping to additional phonemes (e.g., Dutch <i>-<ie>, /ɪ/-/i/; Spanish <i>, /i/) or a grapheme mapping to a Dutch phoneme not present in Spanish (e.g., Dutch <u>-<uu>, /ʏ/-/y/; Spanish <u>, /u/). First language GPC knowledge was expected to interfere during the establishment of lexical representations for the nonwords in the experiment, with inconsistent OI and perceptually difficult contrasts lowering accuracy at test. This hypothesis was borne out, with both experienced learners and naïve learners performing less accurately on inconsistent items, but having facilitated performance on consistent items. Learners had higher accuracy on consistent items over inconsistent, suggesting that, as found in Bassetti (2006), L2 experience does not mitigate L1 GPC interference effects.

In Escudero (2015), however, the effects of OI and easy/difficult perceptual contrasts did not yield robust results with English speakers learning the Dutch lexical items compared to the Spanish speakers above. This result indicates that the relation of the L1 and L2 systems may affect performance, or affect the approach an L2 learner takes to phono-lexical acquisition. Spanish is a transparent language, which may cause speakers to assume that other languages also have one-to-one correspondences. They may rely on spelled forms, erroneously believing that spelled forms will not lead them astray (as posited in Bassetti, 2009). Spanish also has a smaller vowel inventory than Dutch, requiring Spanish speakers to either form novel GPCs or "unlearn" GPCs from the L1 to establish target-like L2 GPCs. English speakers, coming from an opaque language, may be more likely to approach an L2 with expectations that GPCs are not one-to-one. The results of Escudero (2015) also suggest that the difficulty of a phonological contrast may confound effects of OI. In the easier contrast pairs subsumed under the difficult contrast

pairings, participant results provided evidence for an OI effect, but this was not found in other pairings (phonological confounds are addressed in more detail later).

1.2.3.2 Studies examining congruence as defined in the present dissertation

There is literature in which congruence is defined as it is in the present dissertation; these studies help situate the present research questions. Previous sections provide evidence that OI is a powerful variable in L2 phonological acquisition. The studies in this section demonstrate that phono-lexical acquisition is affected by GPC expectations from an L1 to L2, that is, that knowledge from the L1 can interfere with L2 acquisition when GPCs in the languages are at odds with one another.

The first study presents spelled forms that adhere to the present definition of congruence insofar as a portion of the stimuli required participants to "unlearn" knowledge of GPCs from English. Hayes-Harb, Nicol, and Barker (2010) questioned whether adult native English speakers would be affected by differences in phonological and orthographic forms of words in a novel L2. A pseudo language was created, and participants learned new words in the language based on pictured meanings, auditory forms, and spelled forms. Spelled forms were based on English spelling conventions and consisted of four groups: congruent, incongruent-extra letter, incongruent wrong-letter, or no orthography. Congruent forms matched spelling conventions from English (e.g., <gufa>-[gufə]), incongruent extra-letter forms contained letters that were silent (e.g., <kamand>-[kɑməd]), incongruent wrong-letter forms contained letters that had a different GPC in the L2 (e.g., <kezef>-[keʃəf]), and no orthography presentations were

those in which participants saw <xxxx>. During a word learning phase, participants heard the auditory forms; saw the pictured meaning; and saw either congruent spelled forms, congruent forms and incongruent experimental spelled forms, or the <xxxx> sequence.

At test, participants saw a picture, heard an auditory form, and determined whether the pair was matched as presented during the word learning phase. Mismatched auditory forms for stimuli that had congruent spellings were auditory forms associated with another word-picture pair. Mismatched auditory forms for stimuli that had extra-letter spellings were auditory forms containing the extra sound-letter pair (e.g., <kamand>-[kɑmənd]; matched [kɑməd]). Mismatched auditory forms for stimuli that had wrong-letter spellings were auditory forms containing the wrong letter-sound GPC (e.g., <kezef>-[kezəf]; matched [keʃəf]). Performance on matched items was equivalent for the three participant conditions, as was the performance on mismatched items for congruent pairs. Less accurate performance was observed on mismatched items for both incongruent stimuli pairs, with participants exposed to incongruent OI having the least accurate performance overall (although a main effect was found only for the extra letter stimuli). The type of incongruence with the wrong letter stimuli will be examined in the present dissertation (and in the remainder of this section).

Hayes-Harb, Nicol, and Barker (2010) tested naïve learners of the L2 (for a similar study, see Kaushanskaya & Marian, 2008). To an extent, we would hypothesize that participants without previous experience in an L2 would draw inferences from knowledge they have, that is, L1 knowledge. The effects of incongruent GPCs are found in the performance of learners of a target L2 as well. Rafat (2016) found that English speakers produced learned Spanish words with interference effects as the result of

English GPC knowledge (for additional OI-phonology production effects, see Rafat, 2011; Rafat, 2015). Participants were beginner learners of Spanish exposed to different L1-L2 GPC type pairs and OI at varying stages during the experiment. Participants completed a picture naming task, with a training phase (presentation of auditory forms, pictured meanings, and OI/no OI) and production phase (presentation of picture meanings and OI/no OI). Participants were assigned to one of four conditions based on OI exposure: OI in training and production, OI during training only, OI during production only, and no OI. Importantly, GPCs in the stimuli were of two types: English-Spanish congruent (e.g., <n>-[n]) and English-Spanish incongruent (e.g., Spanish <v>-[b]; English <v>-[v] or Spanish <ll>-[j]; English <ll>-[l]). Overall, exposure to OI caused mispronunciations for incongruent GPC words. Participants in conditions with OI present during training produced the most mispronunciations of incongruent GPC words. While different letter-sound incongruences led to different proportions of inaccurate productions, that all incongruent pairs yielded nontarget-like productions demonstrates the effect of the incongruence variable in L2 acquisition.

Similar to Rafat, Vokic (2011) investigated OI effects on production. Native Spanish speakers learning English (advanced learners) participated, which provides an interesting look at OI effects in both language directions, that is, whether OI effects speakers equally depending on their L1 (Rafat, 2016, L1 was English; Vokic, 2011, L1 was Spanish). The study was an investigation of Spanish speakers' productions of English flaps. Due to GPC incongruence from Spanish to English, the rule for flapping is not readily identifiable to Spanish speakers. In English, intervocalic <t>/<tt> and <d>/<dd> represent the phonological flap. In Spanish, <t> and <d> map to dental stops

or [ð] (for <d>), while <tt> and <dd> are not orthographically available. Vokic hypothesized that Spanish speakers would produce <t>/<tt> as [t̪] and <d>/<dd> as [ð], rather than the English mapped phoneme [ɾ], relying on Spanish GPC knowledge. Production results from the read-aloud task indicated that the speakers had interference from Spanish GPC knowledge, producing nontarget-like productions in English. While the extent to which a participant mispronounced the target stimuli varied, interference from Spanish was evident in every participant. Furthermore, experience with the language interacted with performance. The less familiar the English lexical item in the task was, the more likely the participant would rely on Spanish GPC knowledge during production.

While the studies thus far have shown robust effects of incongruence, the next group of studies provide evidence of congruence and grapheme familiarity interactions. Hayes-Harb and Cheng (2016) tested native English speakers learning pseudo-Mandarin with exposure to either Pinyin or Zhuyin. Pinyin is a Romanized version of Mandarin, meaning graphemes are familiar to English speakers. Zhuyin is character based and therefore, graphemes are entirely unfamiliar to English speakers. Participants completed a word learning phase in which they heard auditory forms, saw pictured meanings, and were exposed to OI either in the form of Pinyin or Zhuyin. The Pinyin condition included two forms of stimuli—those with congruent GPCs (e.g., <nai>-[nai]) and those with incongruent GPCs (e.g., <zai>-[tsai]; English [zai]). After word learning, participants completed a criterion test and, if the criterion was not met, they could complete the word learning-criterion test cycle until they met the criterion.

At test, participants indicated whether an auditory word and presented picture

were correctly matched as learned in the word learning phase. Mismatches for congruent forms were a foil phoneme (e.g., for /nai/, hear [dai]), while mismatches for incongruent forms were the English GPC (e.g., for /tsai/, hear [zai]). Two important findings arose in Hayes-Harb and Cheng (2016). First, participants in the Zhuyin condition took longer—they took more word learning-criterion test cycles—to learn the words. However, they performed more accurately overall than the Pinyin condition participants. This would indicate that, in this case, grapheme familiarity is not detrimental to establishing lexical representations. The other key finding was the difference in performance by the Pinyin participants on congruent versus incongruent item trials. Accuracy on congruent mismatch trials was 86.7%, while accuracy on incongruent mismatch trials was 53.3% (Zhuyin participant accuracy was 92.5% and 86.7%, respectively). The (statistically) significant difference in performance by the Pinyin participants indicates that incongruent GPCs robustly affect performance. Interference of L1 knowledge significantly affected the participants' ability to establish target-like lexical representations.

The next experiment included bilingual participants, a group not of interest in the present dissertation, but the design provides insight into the effects of OI on language acquisition. Kaushanskaya and Marian (2009) questioned whether English-Spanish bilinguals are affected by visual input and OI during lexical learning in the same manner as English monolinguals. Written input in Kaushanskaya and Marian (2009) contained English graphemes that differed in mappings (incongruent GPCs) from English to a pseudo language. Stimuli contained familiar phonemes from English and Spanish, but also contained four phonemes that are not found in English and four phonemes not found in Spanish: /μ/, /y/, /χ/, and /ʈ/. These unfamiliar phonemes were associated with familiar

graphemes (i.e., /μ/-<I>, /y/-<U>, /χ/-<G>, /ʈ/-<T>), resulting in incongruent GPCs with English and Spanish.

During word learning, participants heard the nonwords (e.g., /χμʈen/), saw written English translations (e.g., *cloud*), and, dependent on condition, were exposed to the spelled forms of the auditory words (e.g., <GATEN>). Participants were tested on their memory of the pseudo language lexical items and their productions of the nonwords. In the memory test, participants heard the auditory word and matched it with its written form from a group of possible answers. The production test consisted of participants hearing an auditory form and providing the English translation. Exposure to written forms inhibited performance; participants exposed only to auditory forms and translations performed more accurately. It was thought that, due to knowledge of different GPC systems (i.e., English GPCs being many-to-one and Spanish being one-to-one), bilinguals would have less interference, approaching novel word learning without basing assumptions of GPCs on one language. However, monolinguals would be more likely to interpret novel words via their L1 system, even if this would lead them astray (as in e.g., Bassetti, 2006). Indeed, results confirmed these hypotheses, with bilinguals outperforming monolinguals.

The results of Kaushanskaya and Marian (2009) indicate that learners (bilingual learners in this case) with established L2 systems are less likely to experience interference of GPC knowledge. Without the expectation of a GPC type, they are more willing to accept differences in sound-spelling mappings form an L1 to L2. This reflects the importance of the next variable in question, experience, that is, the extent to which knowledge of an L2 interacts with OI and L1 interference effects.

1.2.4 Experience and instruction

1.2.4.1 Literature on orthographic input, experience, and instruction

Another variable of consideration in the present dissertation is that of *experience* with an L2. The effects of OI can vary depending on the extent to which participants in an experiment have been instructed in the L2 or how much exposure they have had to the L2. However, in L2 studies, whether the participants be naïve or actual learners, experience is often confounded by other variables within the experiment. Learner proficiency levels, experimental conditions within the experiment, difficulty of phonological contrasts, and task type are just some of the variables that may confound the ability to make conclusions about effects of OI or evidence-based practices of instruction. Another issue in the OI and instruction literature is the lack of similarly designed studies, making it difficult to draw definitive conclusions about OI effects. As in the OI literature at large, studies on OI and experience/instruction yield varying effects. The following studies provide a foundation for understanding the interaction of OI and experience/instruction in L2 phonological studies.

The first group of studies are those that include participants with no experience in the target language. The target language can be a pseudo language based on the L1 (e.g., English and an English-like pseudo language in Hayes-Harb, Nicol, & Barker, 2010) or an L2 that contains nonwords or other manipulations to target language words (e.g., Showalter & Hayes-Harb, 2013 and pseudo-Mandarin). Showalter and Hayes-Harb (2015; see section 1.2.2 for more detail), tested native English speakers on pseudo-Arabic words containing the /k/-/q/ contrast. After inconclusive results in the first experiment, Showalter and Hayes-Harb attempted to alleviate confounding variables by providing the

participants with instruction. Suspecting that the entirely unfamiliar graphemes, the cursive (rather than print) nature of the Arabic script, and the different reading direction (right-to-left) caused trouble with identifying the contrastive consonants, participants were told to which side of the word to direct their attention with arrows and written directions about the Arabic script. They were also provided examples of each word of the minimal pair, with arrows pointing to the consonants, to directly compare graphemes. At test, participant performance was less accurate than during prior conditions. Why should the group receiving instruction perform less accurately, given that they had explicit information about the stimuli? Other variables likely interacted with the grapheme familiarity, including the difficulty of the phonological contrast and the instruction; too much information may have been provided.

Following Showalter and Hayes-Harb (2015), Jackson (2016) provided more detailed instruction to participants. Again, Jackson (2015) looked at the /k/-/q/ contrast and native English speakers learning L2 pseudo-Arabic, and used the same study format (word learning, criterion test, and final test). Conditions within Jackson included OI with a diacritic (e.g., /k/-<k>; /q/-<ḳ>) and provided instruction, OI with a diacritic and no provided instruction, OI with a novel grapheme (e.g., /k/-<k>; /q/-<ʌ>) and provided instruction, and OI with a novel grapheme and no provided instruction. All stimuli were identical to Showalter and Hayes-Harb (2015); however, the spelled forms contained the graphemes above for /k/ and /q/, and instead of having unfamiliar Arabic script, the remaining letters were all Roman alphabet based. The only grapheme of focus was the first letter representing either /k/ or /q/. Instruction included detail about /k/ and /q/ and their similarity to English, minimal pair examples, and a hint that spelled forms cued the

phonological contrast. Participants exposed to a novel grapheme performed more accurately than those exposed to a diacritic. However, participants exposed to instruction with the diacritic performed (minimally) more accurately than their noninstruction counterparts. This suggests that the instruction and diacritic combination was more beneficial for the naïve learners than the diacritic alone.

The next study examines a similar design with more familiar graphemes to native English speakers. In her thesis, Brown (2015) looked at the variables of OI and instruction in native English speakers learning pseudo-German. German word final obstruents are devoiced; however, this process is not reflected in spelled forms (e.g., *Rat* 'advice' and *Rad* 'wheel' are both pronounced as [rɑt]). For English speakers, the incongruence variable is evident in these spellings (e.g., word final English <d>-[d]; German <d>-[t]). In the word learning phase, with the variables of OI and instruction, there were four learning conditions: spelled forms and instruction, spelled forms and no instruction, no spelled forms and instruction, and no spelled forms and no instruction. Six nonword voiced-voiceless minimal pairs were created (e.g., kreip-kreib). During word learning, participants heard the auditory form, saw pictured meanings, and were exposed to one of the spelled forms-instruction combinations. Instructions informed participants that word final voiced graphemes were pronounced as their voiceless counterpart (e.g., "A 'b' at the end of the word is pronounced 'p'"; Brown, 2015, p. 29). At test, participants saw a picture and produced the associated word. A different group of native English speakers were then recruited to listen to the productions and determine whether they heard a voiced or voiceless consonant word finally. Participants exposed to OI did not consistently devoice word final obstruents; those exposed to spelled forms had a

mean proportion voiceless response of 48%, while those not exposed to spelled forms had a mean voiceless response of 82%. As seen in previous studies, incongruence and exposure to OI inhibited performance. However, in this case, there was no effect of instruction. The mean proportion voiceless response of the instruction group was nearly identical to the no instruction group's mean.

Possible problems with the studies mentioned thus far include the short exposure time and confounds coming from the difficult-to-perceive contrast, familiarity of graphemes, or unreliability of coders (in Brown, 2015). The next set of studies contain actual learners of the L2, ranging from beginners to advanced and from classroom instruction to immersion (defined in the present as language learning in a naturalistic setting sans regular classroom instruction). Like the naïve learner studies, the learner literature similarly yields varying results.

Continuing with L2 German, Young-Scholten and Langer (2015) investigated native English speakers producing German word initial fricatives. In German, <s> is produced as [z], incongruous with English <s>-[s]. Different from the above studies, Young-Scholten and Langer (2015), a case study, included three American adolescents immersed in a German setting (in and out of classes) and who, other than a month of introductory German classes, were not enrolled in specific language classes on German. The English-speaking adolescents would have heard native German speakers producing words with [z] correctly in their everyday interactions. While phonetically the voicing distinction is made, as detailed in Brown (2015), this distinction is not borne out in the orthography. However, it was predicted that the copious experience within the target language setting would override any effects of the incongruent OI on production. The

students were tested 11 times over the course of an immersion year on their productions of word initial <s>. Results indicated that the immersion experience was not sufficient enough to overcome the incongruent GPCs, yielding word initial English [s] productions rather than [z] productions in German. There are two factors to point out in Young-Scholten and Langer (2015). First, the sample size is small; only three participants were included. Second, the participants were exposed to German mainly through a naturalistic setting, with little formal explicit instruction. Thus, as will be tested in the present dissertation, the variables of experience (learners) and instruction (interventions) should be considered separately.

The studies mentioned so far have dealt with participants who had no formal experience with the target language and participants who had a year of a naturalistic learning experience. Is there an effect of experience as operationalized by years of instruction? Bassetti (2006; see section 1.1.3) found that native English speakers interpreted L2 Mandarin words via L1 GPC knowledge. The native English speakers in her study were beginner learners of Mandarin, having formal language instruction for an average of 9 months (Experiment 1; range eight to 23) or 24 months (Experiment 2; range unspecified). Vokic (2011) also found a robust effect of L1 GPC knowledge on L2 performance. In her study, productions of L2 English words by L1 Spanish speakers were affected by incongruent or unavailable GPCs. The experience level of the participants varied and years of formal instruction was not specific. However, the participants had an average age of 37.5 years and began L2 instruction at an average age of 13.7. Comparing participants' current ages to the age of L2 instruction onset, this would indicate a range of years learning English from 13 to 33. However, the extent to which they had formal

instruction between onset and current age was not specified. They had an average of 3.10 years spent in the United States, ranging from 1 month to 12 years. Participants in Escudero, Simon, and Mulak (2014) consisted of Spanish speakers naïve to Dutch, as well as Spanish speakers within an immersion setting in the Netherlands (learners). The Dutch learners had proficiency ranging from beginner to advanced; these learners (from Escudero, Broersma, & Simon, 2013) were learners of Dutch as a third language. Specific detail of their proficiency and the number of learners in each proficiency level was not provided. From these three studies, it can be gleaned that, while the effects of OI are robust, the effects of experience and instruction on performance must be carefully examined.

The next set of studies include more controlled groups of learners. It is important to compare their results to those of the above to determine effects of OI versus other variables such as experience or instruction on performance. Özçelik and Sprouse (2016) investigated the extent to which OI influences learners in making phonological inferences when OI does not systematically encode phonological information. In Turkish, back vowels in loanwords can result in a contrast of a following lateral as either coronal or dorsal; however, both sounds are represented with a single grapheme, <l> (e.g., [koł]-<kol>; [rol]-<rol>). The lateral contrast affects patterns of vowel harmony, with suffix vowels matching backness of the lateral (e.g., [kuł-a]-<kula>; [bel-e]-<bele>). Because the graphemic representation of the lateral does not encode place of articulation, this could cause a learner to harmonize the suffix vowel incorrectly. Özçelik and Sprouse tested native English speakers learning Turkish who were beginner, intermediate, or advanced learners. Learners were divided into proficiency groups based on a proficiency

exam. For half of the trials, participants heard and saw a word or root and were asked to identify the correctly harmonized suffix from four options. For the other half of the trials, participants only heard the word or root and then identified the suffix from the listed options. Results indicated that all groups performed more accurately—chose correct target suffixes—when they were presented with words/roots in auditory only trials. In OI trials, performance accuracy decreased. Participants' performances also indicated that less experienced learners exhibited more interference from OI than more experienced participants. Learners with higher proficiency and more instruction overcame misleading OI. There are two caveats: participant numbers were low and "more accurate performance" meant minimally above chance.

Özçelik and Sprouse (2016) provided results indicating that OI can interfere with low proficiency learners' ability to make inferences about phonological forms. However, with increased proficiency, less OI interference is observed. Bassetti and Atkinson (2015) did not find a similar decline in reliance on orthography by advanced learners. Native Italian speakers completed a series of production tasks in English with OI, including "silent letters" (e.g., <l> in <walk>), vowel length (e.g., differences in <seen> versus <scene>), morphemic endings (i.e., <-ed>), and homophones (e.g., differences inn <son> versus <sun>). Participants had begun learning English at an average age of 7, had taken English in a classroom setting for an average of 10 years, and were 16-19 years old. Results indicate robust effects of spelled forms on productions, including epenthesized segments in silent letter words and longer vowels in words spelled with two vowel graphemes. Less robust, but still prevalent, effects of OI were found in the latter two tasks including epenthesized vowels, voicing of <ed> in past tense forms, and different

productions for homophones. In this study, participants who had more experience with the target language demonstrated interference of spelled forms. It is likely that the native Italian speakers relied on Italian being a language with one-to-one GPCs when reading English. Given the lack of studies in OI-experience/instruction and confounding variables in other experiments, it is difficult to discern whether this effect of OI on experienced learners would be consistently found with similarly experienced participants. In the present dissertation, these effects are subject to the question of whether this pervasive interference may have been mediated early. That is, whether learners could overcome OI effects with early intervention to establish more target-like grapheme to phoneme productions (see e.g., Comer & Murphy-Lee, 2004).

The next study contains familiar graphemes and phonological input, allowing for effects of written forms to be identified more readily. Given the profiles of the participants, it was not included in the prior section. Instead, it provides insight into effects of OI within differing levels of experience. Hayes-Harb and Hacking (2015) investigated the effects of stress marks in acquiring contrastive stress in L2 Russian by native English speakers. Russian stress placement varies depending on the word, morphological environments, verbal and adjectival paradigms, etc., requiring learners to learn stress placement per lexical item. Participants included naïve learners of Russian, as well as 1st- and 3rd-year Russian students. The design of the study was reminiscent of Showalter and Hayes-Harb (2013), also investigating the effects of diacritics in OI. Participants learned six stress-based minimal pairs of Russian nonwords (e.g., [ˈtaba]; [taˈba]). All participants heard the auditory form, saw pictured meanings, and saw written forms. There were four conditions: Cyrillic with or without stress marks and Latin script

with or without tone marks. At test, participants determined whether auditory forms and pictures were correctly paired. Overall, experienced learners (in their 1st or 3rd year of Russian) had more accurate performance than naïve learners (but performance did not differ between the learner levels); however, word-learning condition performances were not significantly different across participants. While the results suggest that language experience contributed to improved test scores, OI did not seem to affect participants. This could be due to stress being difficult to perceive, the unfamiliar stress marks present in the OI, or another factor. Important to note is that experience affected performance, while OI did not appear to have such an effect; however, instruction about the OI and stress may have provided support to participants during word learning or training.

One such study including training as a variable is Burki, Spinelli, and Gaskell (2012). Native speakers of French learned pseudo-French words. The stimuli contained biconsonantal clusters (e.g., /pl/), which in French are reduced by schwa insertion (e.g., [pəl]), but in the present study were produced as [pl]. Each of the nonwords was associated with a nonobject pictured meaning. Participants completed five sessions over 5 days, with the first four sessions consisting of word learning. All participants saw pictured meanings and heard associated auditory forms. During the fourth session, participants saw the written forms of the words and were subsequently tested via picture naming. For half of the forms, an orthographic <e> was included (e.g., <petile>) while the auditory form remained schwa-less. The other half of the words did not include <e> (e.g., <ptile>). During the fifth session, participants completed the picture naming tasks from session four, followed by a test in which they spelled out the word for the presented picture. Importantly, Burki, Spinelli, and Gaskell (2012) found that, even when the

auditory form did not contain the epenthetic vowel, participants established the lexical item as containing a schwa when it was presented in the spelled form (as <e>). This was evidenced in productions and spellings at test. Participants were negatively affected by spelled forms, regardless of the multiple day experience without spellings (that indicated differences in phonological forms).

There is also evidence that written forms and L1 knowledge can interfere during acquisition with respect to word properties such as homophony and word familiarity. Wang, Koda, and Perfetti (2003) found that native Chinese and Korean speakers were differentially affected by written forms during English word reading. The Korean writing system, Hangul, maps graphemes to phonemes similar to the Roman alphabet. Chinese speakers would be exposed to characters, or a nonalphabetic system. Both groups of speakers had approximately 8 years of experience learning English and their proficiency levels were equivalent.

Participants completed a semantic category judgement task (e.g., shown category "*a flower*" determine whether word "*rows*" is a member) and a phoneme deletion task (e.g., shown a word and asked to remove a designated sound; remove /t/ from *might* to yield *my*). Native Chinese speakers relied on OI more, with more accurate performance on less orthographically similar homophone conditions (e.g., *sail* and *sale*) than the Korean speakers. Native Korean speakers yielded less accurate performance on phonologically homophonous stimuli (e.g., *stair* and *stare*) than stimuli that were phonologically unrelated (e.g., *stars*). Wang, Koda, and Perfetti (2003) provided evidence that L1 experience, in this case writing system experience, can affect the degree to which OI may interfere with L2 performance.

Looking at experience as proficiency and familiarity with orthographic forms, Veivo and Järvikivi (2013) tested L1 Finnish speakers on L2 French words that were orthographically or phonologically similar. The Finnish speakers' levels of proficiency ranged from low intermediate to advanced. Stimuli were either homophonous or nonhomophonous in their phonological-orthographic relation. The first experiment was a priming task, with participants seeing a spelled form (repetition, nonhomophone, or control), hearing an auditory word, and indicating whether the auditory form was a real word of French (e.g., <stage>, [staʒ], *yes*). Participants subsequently completed familiarity ratings for the (target) words. Repetition priming improved performance with little effect of the type of prime displayed. Higher proficiency and greater familiarity with target word yielded stronger effects of repetition priming and faster response times. In the second experiment, priming words were based on L1 Finnish orthography, with certain spelled forms retaining homophone status but being semantically or phonologically unrelated to the French target (e.g., Finnish <huivi>-[huivi]-*scarf*; French target [ɥil]-<huile>-*oil*). Results from the second experiment indicated that orthographic effects are mediated by familiarity with lexical items, in this instance as operationalized by learner proficiency. With less reliance on L1 GPCs when making decisions about L2 forms, comes more accurate performance.

The studies in this section have provided evidence that experience and instruction are variables that can interact with OI during tasks. It seems that learners with vastly different levels of experience can have interference effects of OI in performance on phonological tasks. However, what is evident from the studies is that experience, instruction, and grapheme familiarity and congruence are operationalized in different

ways. This causes weaknesses in the ability to draw conclusions about OI effects.

1.2.4.2 Input enhancement, orthographic input, and the present dissertation

A prominent instructional model in second language pedagogy is Input Processing (VanPatten, 1996, 2004, 2007), within which is the instructional technique of Input Enhancement (Sharwood Smith, 1993). While the focus of the present dissertation is not to provide formal instruction, it is of interest to note whether effects of OI, if observed, can be mediated via an intervention. In Jackson (2016) and Brown (2015), it was found that participants (importantly, naïve learners) who were provided with explicit instruction about OI outperformed participants who were not provided instruction, albeit not significantly. If negative effects of OI can be mediated early, given evidence that explicit instruction may provide a benefit, it is worthwhile to investigate how to optimize target-like acquisition in the presence of OI during lexicalization in L2 learners. As Comer and Murphy-Lee (2004) found in L2 Russian learners, those who do not sort out GPCs in the first few weeks of acquisition will fall behind, establishing nontarget-like GPCs. Inadequate knowledge of GPCs can affect larger elements of language knowledge such as syllables and words, leading to communication breakdown. It is important, then, to mediate effects of OI early, not only for reading and writing acquisition, but also phonological acquisition for efficient listening and speaking.

Long (1991) described Focus on Form as the process by which a linguistic element is isolated and studied to aid learners in making connections between a form and its meaning or communicative function. Input enhancement is the practice of making an

element in the input (auditory or written) salient, and aids the learner in determining how to interpret the input to maximize its function in communication (see Van Patten, 2004). In other words, manipulating input in such a manner that the learner gleans knowledge about the form-meaning connection and their subsequent language behavior is altered (Sharwood Smith, 1993). In the present dissertation, as OI is of focus, textual enhancement (TE) is reviewed. Textual enhancement can include bolding, highlighting, underlining, italicizing, capitalizing, making texts different fonts, or other such techniques in which an element of the text is enhanced to draw the learner to make connections about the form and its meaning.

Orthographic input is often a secondary consideration in L2 acquisition, but as Young-Scholten (1995) pointed out, OI provides an explicit representation of L2 auditory forms and acts as "filter" for phonological knowledge (p. 115). An important question to raise is whether input enhancement is beneficial in studies that have made use of it. Like much of the discussion to this point, the effects of input enhancement vary and are dependent on other variables (e.g., the target form) or type of enhancement in the design (e.g., benefit: Jourdenais, Ota, Stauffer, Boyson, & Doughty, 1995; Shook, 1994; no benefit: Izumi, 2002; Overstreet, 1998; no effect or mixed effect: Barcroft, 2003; De Santis, 2008; Leow 1997; for more on aspects of TE studies, see Han, Park, & Combs, 2008). The following outlines some literature in which TE is beneficial, or, at least, has no negative effects on performance. Much of the input enhancement literature is focused upon grammatical or nonphonology specific elements (e.g., tense and aspect, pronouns, determiner clauses). The studies outlined here reflect this, except for the final study discussed.

Leow (2001) investigated the effects of TE on reading and writing L2 Spanish imperatives. Native English speakers saw a text containing either underlined target verbs and bolded imperative forms or no enhancement. Participants completed a recognition task (multiple choice), a writing task (fill in the blank), and a comprehension task. Think-aloud protocols were included to provide information about the participants' decision making. Tasks were administered prior to the reading (pretest) and after (posttest; immediate and delayed). Participants did not have classroom instruction between the pretest and posttest. No difference was found between the enhanced and unenhanced groups regarding their noticing of imperative structures or performance a test. This would indicate, for these L2 learners and the form tested, that TE did not alter the way that the participants comprehended the form and were able to make use of the input. In Jackson (2016), however, more exposure to explicit information (enhanced forms in Leow, 2001 and instruction in Jackson, 2016) indicates a positive relationship to participants' awareness of target forms. Han, Park, and Combs (2008) suggested that one issue in TE studies is the saliency of the form(s) being tested, but that manipulating saliency and improving input quality may facilitate beneficial effects of TE. Improvement of the input provided to participants would, in turn, facilitate acquisition.

Kim (2006) questioned whether TE, as compared to lexical elaboration (providing a word's definition), would affect acquisition of L2 vocabulary. Native Korean speakers learning English read a passage in which lexical items were lexically enhanced (explicitly in one condition, implicitly in the other) and textually enhanced, only implicitly lexically enhanced and textually enhanced, only textually enhanced, explicitly lexically enhanced only, implicitly lexically enhanced only, or had no lexical or TE. Textual enhancement

was operationalized as bolding the lexical item. After reading the passage, participants completed form (recognition of word as being in text) and meaning (recognition of word-meaning pairs) recognition tests. No differences were found in performance by the varying groups on the two tests, suggesting that neither TE nor lexical elaboration, in this study, produced beneficial effects (nor did they yield negative effects).

Leow (2001) focused on a specific verbal form (imperatives) and Kim (2006) focused upon lexical forms. After reviewing the literature, there seem to be few studies looking at TE effects and L2 phonology. One of these, Alsadoon and Heift (2015), examined the effects of TE on Native Arabic speakers' ability to make inferences about vowels in words. Vowels in Arabic are orthographically represented by diacritics, provide only grammatical information, and are not as numerous as in English. When Arabic speakers learn English, "vowel blindness"—ignoring vowel differences—may occur due to these facts. Participants were exposed to sentences that were either textually enhanced (i.e., underlined, vowels bolded, and red font) or not textually enhanced. A multiple-choice (word form and word meaning) pretest and two posttests were completed to indicate the leaners' intake (processing) of the vowels within the passage and target words. Exposure to TE was beneficial as indicated by more accurate performance by the TE group on both posttests, suggesting that TE reduced "vowel blindness." During reading of the passage, Alsadoon and Heift (2015) used eye-tracking to understand how differing treatments may affect fixation on forms. Results indicated that TE significantly affected the length of time participants spent on the target forms (they looked for a longer time), and the authors posited that this likely facilitated intake of the forms. Given the phonological nature of the target item (vowels in words), the results of this study indicate

that similar positive effects may be found with TE of consonants and GPCs in the present dissertation.

The results of Alsadoon and Heift (2015) indicate that more explicit (defined in Sharwood Smith, 1991) TE may lead to more accurate performance. While other studies have also used multiple forms of TE, they have not focused on phonological forms. This area of research, TE and L2 phonology, requires more research.

1.2.5 Situating familiarity and congruence in current theories and models

Second language studies can be informed by and help inform models of lexical representation and access. Effects that are observed can be supported by an understanding of current models' descriptions of how the lexicon is organized and the language components (e.g., phonological input, OI) that interact with it or within it. The present section is not an exhaustive review of models, nor does it contain exhaustive detail of the models presented. It does, however, provide insight into how the interaction of OI and phonology in L2 acquisition is processed and understood, as well as how models may inform the present dissertations' findings.

Based on their research findings and similar literature, Özçelik and Sprouse (2016) posited that L2 phonological acquisition is linked to OI via the reliance a learner places on OI. While acquiring an L1, a speaker is first exposed to the phonological system, only later being exposed to OI when learning to read and write. In an L1, the phonological system is (often) in place prior to becoming literate. However, for the L2 learner, not only is an L2 learned with an L1 phonology-orthography system in place, but

classroom learners are (typically) simultaneously exposed to phonology and orthography. This would suggest that the phonological system of the L2 is heavily based upon the inferences that a learner makes about phonology-orthography correspondences, gained through knowledge of phonology-orthography correspondences in the L1 and predictions for the L2 based on this knowledge.

Observing how learners with different levels of classroom instruction and language experience performed on tasks with OI that would lead them astray, Özçelik and Sprouse (2016) proposed the Orthographic Dependency Hypothesis. In their experiments, the Hypothesis was proposed to either be the Decreasing Orthographic Dependency Hypothesis or the Increasing Orthographic Dependency Hypothesis. Beginner learners in their study relied more on OI, leading to less accurate performance at test. Learners with more language experience overcame the misleading effects of OI, performing in a more target-like manner. These findings supported the Decreasing Orthographic Dependency Hypothesis. While relatively new, this hypothesis is a prime candidate for understanding interactions of OI and its effects on acquiring target-like L2 phonology and GPCs. Consideration for how variables of OI can affect the developing system could be explained by the variables a learner brings to the L2 (e.g., L1 GPCs, instruction), as well as the reliance on L2 orthography a learner may have (which may be mediated or influenced by L1 orthography, as described in e.g., Bassetti, 2006). Further elaboration on this hypothesis—framed as the (more general) Orthographic Dependency Hypothesis—would serve the field well, providing more insight into both L2 acquisition and into OI-phonology correspondences.

In a more detailed model, the Bipartite Model of Orthographic Knowledge and

Transfer (Pytlyk, 2012), OI effects are interpreted via L1 orthographic knowledge, that is, whether the learner makes use of L1 orthographic knowledge in a new language. Pytlyk (2012) described orthographic knowledge as being comprised of two parts: abstract and operational. Abstract knowledge is knowledge of grapheme-phoneme mappings or the assumptions made about grapheme-phoneme mappings (e.g., in English a sound and letter map in some way; therefore, a sound and letter in a different language must also map in some way). The assumptions about mappings are mediated by L1 knowledge, and a literate language user will transfer them when learning a new language. Operational knowledge is the ability to recognize correspondences in a language (e.g., in English <m>-[m]). Operational knowledge prior to literacy is mediated by the L1, but operational knowledge after literacy is not subject to transfer or interference by the L1.

These two types of knowledge interact during acquisition. Abstract knowledge is applied during language learning without fail (initially interpret information via L1), but operational knowledge is newly acquired (create new GPCs). This is especially evident when the learner is naïve, with more exposure to the language yielding more target-like GPCs. Pytlyk (2012) provided evidence to support this model with OI-phonology literature that contained L1 interference (i.e., Bassetti, 2006 and Vokic, 2011 described above). In its entirety, the model seems a sufficient base for the studies in the present dissertation. It is logical to expect that knowledge of GPCs from the L1 would influence how a learner interprets L2 input (as attested in e.g., Bassetti, 2006 or Vokic, 2011). However, while this model provides considerations for differences in experimental results, the wholesale adoption of the model should be done cautiously. Differences between L2 acquisition and acquisition of pseudo languages within an experiment are

important. That is, a learner develops their L2 system, which will include connections between the phonology and orthography of the L1 and L2 that are in flux but stabilizing during acquisition to become target-like. A participant in an experiment that includes a pseudo language may not be forming the same type of stable phonology-orthography connections, and the effect of L1 knowledge may be more influential. Additionally, Pytlyk (2012) grounded the model in evidence that is not well controlled, collapsing pseudo language and L2 experiments, child acquisition and adult acquisition, and experiments of reading skills and phonology. These facets of acquisition are all important, but each needs to be examined in turn.

Described earlier, the Orthographic Depth Hypothesis (ODH; Katz & Frost, 1992), is a description of how orthographic forms and their phonological structures are approached by a learner and subsequently processed. Under this hypothesis, language orthographic systems fall on a continuum from deep (opaque) to shallow (transparent). Deep languages are those in which GPCs are many-to-one or one-to-many, while shallow languages are those in which GPCs are typically one-to-one. Shallow languages should facilitate the ability to recognize or make inferences about phonological forms, as little variation is expected. Deep languages provide difficulty in a priori predictions of GPCs due to variability of mappings. A speaker's L1 orthographic depth is likely to affect how they approach GPCs in an L2. For instance, a speaker from a shallow language may erroneously expect a deep language to have one-to-one correspondences (e.g., a Spanish speaker learning English; see Erdener & Burnham, 2005 for more). Speakers of shallow L1s may have more difficulty (or take a longer time to acquire target-like GPCs) learning deep L2s, as they may expect GPCs to be one-to-one. Furthermore, due to the variability

of correspondences, the ODH predicts that deep L1 speakers will interpret L2s on a lexical basis, while shallow L1 speakers will interpret L2s at the phonological level.

While this aspect of GPCs is not the focus of the present dissertation, the ODH does present an intriguing analysis of the orthography-phonology interaction. The present dissertation is not designed to optimally test this hypothesis, as both languages are on the deep side of the depth continuum, and no additional shallow L1 participants are tested for comparisons of performance. However, if such a group were tested, this would provide further evidence to either uphold the hypothesis or subject it to scrutiny. If the predictions of the present dissertation are not borne out, the ODH may aid with understanding some of the nuances of the orthography-phonology interaction. Russian is slightly less deep than English, but the stimuli conditions in the dissertation experiments would not support this fact, and performances on the lexical tasks may show variations reflected in ODH predictions.

The last model relating to orthography-phonology interactions is the Bimodal Interactive Activation Model (BIAM; Diependaele, Ziegler, & Grainger, 2010; Grainger & Ferrand, 1994, 1996; Grainger & Ziegler, 2008; 2011) based upon the Interaction Activation Model (McClelland & Rumelhart, 1981). The BIAM outlines that auditory and orthographic input interact during processing, and that there is a two-way interaction of the input. This interaction also occurs at both the individual unit level (graphemes and phonemes) and lexical level (spelled word and spoken word). It predicts that, even in the absence of an input type, knowledge about the form of that input type will be activated and be reflected in task performance. However, the BIAM is not a model that is founded in the L2 literature nor does it predict L1-L2 interactions. While models related to the

BIAM have been proposed such as the Bilingual Interactive Activation Model (Dijkstra & van Heuven, 1998) and the Bilingual Interactive Activation Plus Model (Dijkstra & van Heuven, 2002), these models focus on lexical retrieval/processing in bilinguals without orthography-phonology interactions and semantic-orthographic-phonological similarities/neighborhoods, respectively. These no doubt provide more relevant information than other studies, but as a greater whole, will need to be scrutinized to help describe effects observed in the present dissertation.

Ideally, a model will provide predictions and explanation about the relation between L1 and L2 knowledge during acquisition, encompassing knowledge of written forms in both languages. This would include knowledge of graphemes, phonemes, mappings, and interactions of this knowledge within and across languages during acquisition. It would be able to inform us about orthography-phonology interactions in instances with familiarity and congruence differences, and thus predict how a learner would react when L2 input is at odds with L1 knowledge, that is, predict the level of dependency a learner may have upon their L1 knowledge or when they "sort out" differences in an L2. Within a model of L2 acquisition, it would also be helpful to understand how exposure to a language would interact with access and processing of input types and languages. A model should support predictions about differences between the behavior of a naïve learner and experienced (or advanced) learner of a language. Being able to capture differences between a native speaker of a language making inferences about words' forms (given that phonological acquisition precedes literacy) and an L2 learner making inferences (given their simultaneous phonology-literacy acquisition) is a necessary piece of understanding acquisitional stages and trajectories.

1.3 Variables in the present dissertation

The present dissertation is an investigation of how grapheme familiarity and congruence, as well as experience and instruction, affect L2 phono-lexical acquisition. Section 1.2 provided a survey of effects of each variable in previous OI-phonology literature. The following sections describe frequently encountered confounds affecting results and subsequent conclusions, as well as additional notes to situate the present dissertation's innovation and purpose.

1.3.1 Confounding variables in the orthographic input literature

The present dissertation includes two innovative components. First, the L2 that is investigated is written in a script that allows for the variables of familiarity and congruence to be manipulated simultaneously. This allows for a more ecologically valid study, in that we can examine these two variables in the context of a single target language (and thus include both variables as within-participant variables). The second innovation is that the experimental stimuli contain no novel phones or difficult-to-perceive contrasts. As described below, this allows for the effects of OI to be isolated in performance. One possible reason for mixed results found in the literature may be the use of confounding variables within the experimental design.

To date, the notorious variable in OI studies is a difficult-to-perceive contrast. Interpreting results can be difficult if the researchers are unsure whether the OI was misleading participants or whether participants could not perceive auditory forms as being different. In studies containing minimal pairs, this would mean two words are undifferentiated, making, for example, lexical decision tasks uninterpretable. Rafat

(2015) investigated the production of assibilated and fricative rhotics in L2 Spanish by native English speakers. In the background for the experiment, she noted that the sounds are contested insofar as to which class of sounds they belong and their contrastiveness with other sibilants and fricatives. That the experimental sounds may not be classified as different raises an issue with any subsequent findings. It was hypothesized that participants exposed to OI during word learning would be more likely to produce <r> as the assibilated/fricative rhotic [ř]. Those not exposed to OI would be less likely to produce a rhotic, perceiving the sibilant or fricative and producing it over the rhotic. Participants in the OI condition did indeed differ in their productions of assibilated/ fricative rhotics compared to those participants exposed only to auditory input. Rafat claimed that OI may not have been the most influential variable on performance. The acoustic properties and phonological environment of the rhotic in the stimuli might have altered the perception-production process. A reliance on L1 phones, resulting from misperception or inability to produce the target phones, may have also occurred (for the auditory only group). Furthermore, auditory only participants had more /ʃ/ productions than their OI counterparts, which may be perceived as target-like by native speakers. Based on the author's discussion, it is unclear whether OI was responsible for the observed performances, and future studies require isolation of variables and/or native speaker judgments about productions.

In the series of experiments in Showalter and Hayes-Harb (2015), OI did not aid participants nor cause interference. Overall, neither condition group performed highly accurately. When Showalter and Hayes-Harb attempted to mediate effects of OI with instruction and presentation of the Roman alphabet, performance was unaffected. This

led to the conclusion that the phonological contrast (velar-uvular /k/-/q/) was difficult for participants to perceive. This meant that effects of OI on performance were (likely) overshadowed, and conclusions about OI effects on ability to establish contrastive lexical forms could not be made. Difficulty with this contrast was also reflected in participants' performances in Jackson (2016). Mathieu (2016) contained stimuli conditions that were grouped to isolate variables, namely, familiarity. Native English speakers' performances across the Arabic script, Cyrillic script, and Hybrid conditions did not significantly differ. As with Showalter and Hayes-Harb (2015), one of the explanations provided was the difficult-to-perceive uvular-pharyngeal contrast /χ/-/ħ/.

Some researchers (see Escudero, 2015; Escudero, Simon, & Mulak, 2014; Escudero & Wanrooij, 2010 above) have found that OI is not beneficial in all circumstances, with its influence being the result of the relation of the languages included (e.g., are there many difficult-to-perceive contrasts that differ between them), the writing systems (e.g., if the L1 uses an alphabetic system while the L2 is character based), and learner factors (e.g., motivation and language aptitude). Simon, Chambless, and Kickhöfel Alves (2010) reported no effect of OI on English speakers' abilities to learn a French vowel contrast (/u/-/y/). They posited that several variables may have contributed to the lack of effect, unrelated to OI, including the phonological contrast, the number of task items for participants to remember, differing phonological environments interacting with the vowel (or acoustic variability of the stimuli), number of talkers producing the stimuli, and the expectations of GPCs from English that participants brought to French.

The brief review presented here outlines frequently encountered confounds in OI and phonology experiments. The review does not indicate egregious methodological

flaws in the studies, but the awareness that OI and phonology interact on many levels. It is an undertaking to find a balance between languages, auditory stimuli, and written representations that will not be influenced by other variables. The present dissertation contains speakers, stimuli, and a design that isolates each of the experimental variables as well as possible. It is not without some compromise to these variables that the experiments were created.

1.3.2 Grapheme familiarity

In the present dissertation, Russian is the L2 of focus. Russian is written using the (Russian) Cyrillic alphabet. It is taught to learners both in print and cursive, with special attention drawn to the visual differences between lowercase and uppercase letters. To be able to isolate effects of OI and provide the next step in the OI-L2 literature, stimuli in the present dissertation are limited to print and uppercase forms only. In this way, results will be more directly aligned and allow for a better comparison to effects of OI in previous studies. In Showalter and Hayes-Harb (2015), grapheme familiarity was extended to the entirely unfamiliar side of the familiarity continuum. Native English speakers were exposed to Arabic script, which is not Roman based, read right-to-left, and appears to be a single entity (i.e., not individual letters). This degree of unfamiliarity was not beneficial to participants, but neither was the Roman alphabet (familiar graphemes) in subsequent manipulation of the stimuli.

Mathieu (2014) and (2016) contained varying degrees of grapheme familiarity—entirely unfamiliar Arabic script, less unfamiliar Cyrillic, and a Hybrid script in which only the initial consonant of a word was unfamiliar. Compared to participants exposed to

the sequence <xxxx> (No Orthography), performance was less accurate at test. However, across the conditions, performance did not differ. Similar to Mathieu (2014, 2016), Hayes-Harb and Cheng (2016) exposed participants to two different conditions of familiarity. Half of the participants learned Mandarin pseudowords in Zhuyin, which was entirely unfamiliar to the native English speakers, much like the Arabic script. The other half of the participants were exposed to Pinyin, which is a Romanized version of Mandarin and therefore familiar. Performance at test between the Zhuyin and Pinyin groups, overall and regarding familiarity, did not differ.

The variable of grapheme familiarity in the present dissertation is motivated by these previous studies. However, to understand the effects of OI, two innovations to the experimental design were considered. First, there are no difficult-to-perceive contrasts; all phones are familiar (or English-like), minimizing phonological contrasts as a confounding variable as in e.g., Showalter and Hayes-Harb (2015) and Mathieu (2014, 2016). Additionally, while comparing performance across conditions had the potential to yield valuable information about the varying degrees of familiarity in Mathieu (2014, 2016) and Hayes-Harb and Cheng (2016), participants in the groups differed. The present dissertation's design (and the languages/scripts combination) allows the opportunity to investigate degrees of grapheme familiarity (e.g., unfamiliar Cyrillic versus familiar Roman alphabet) within individual participants.

1.3.3 Congruence

As stated in 1.3.2, Russian is an ideal L2 to study with native English speakers when investigating grapheme familiarity and congruence. The GPCs from English to

Russian can be both congruent and incongruent, and can interact with familiarity both graphemically and phonologically. Again, the properties of Russian allow for isolation of the variables to make more precise conclusions about effects of OI. In Escudero, Simon, and Mulak (2014), Spanish speakers learning Dutch performed differently depending on GPC expectations for vowels in the two languages. In their design, however, some of the congruent GPCs were *nearly* identical (due to a nonfamiliar L2 phone), and incongruent GPCs included one-to-many correspondences or Dutch specific graphemes. While the finding that incongruent GPCs yielded less accurate performance at test is informative, this does not match the definition or operationalization of congruence taken in the present dissertation. Congruent GPCs have familiar graphemes and phonemes, and incongruent GPCs have one familiar grapheme or phoneme that maps to a non-L1 phoneme or grapheme.

Hayes-Harb, Nicol, and Barker (2010) included stimuli consistent with the present definition in their Incongruent-Wrong-Letter word-learning condition. Participants were exposed to an unexpected GPC from English to the pseudo language (e.g., that <z> mapped to [ʃ]). This condition resulted in the least accurate scores at test. Taking the findings from Hayes-Harb, Nicol, and Barker a step further, congruence in English-Russian stimuli allows for an insight into real (non-pseudo language) L2 acquisition processes. Real-language congruence was explored in Hayes-Harb and Cheng (2016) with participants in the Pinyin (Romanized Mandarin) condition. Stimuli in the Pinyin condition were divided into congruent and incongruent items. Incongruent items (e.g., <z>-[ts]) yielded the least accurate performance. In their study, unfamiliar graphemes required more time to learn, but incongruent GPCs interfered with the ability to establish

lexical representations. This was also found in Mathieu (2014, 2016). Performance across the varying unfamiliar script conditions did not significantly differ, but Mathieu found that incongruent GPCs affected performance (i.e., <h>-[ħ], <x>-[χ] in Cyrillic).

The variable of congruence is often confounded with other variables (including familiarity) or not defined in a specific (cross-study) manner to interpret robust conclusions. As in the previous section, the experimental languages discussed in this section did not allow for within-participant effects to be calculated. In the present dissertation, individual participants are exposed to both congruent and incongruent stimuli, allowing for an entirely within-participants design. The combination of L1 English and L2 Russian allows for the manipulation of congruence and familiarity (as mentioned in the previous section) within an actual language learning scenario.

1.3.4 Experience and instruction

Often confounded or not systematically considered in the OI and phonology literature, instruction and experience are the last variables included in the present dissertation. Experience is operationalized as native English speakers with no Russian (or Cyrillic alphabet) exposure or learners of Russian (further divided according to years learning Russian and current course level). Instruction, in the literature, is included in experience, operationalized as years learning the L2, time in a country that speaks the L2, type of instruction experience, etc. In the present dissertation, instruction will constitute an intervention that participants receive. The effect of the intervention type(s) will be able to inform instruction and be used for instructional purposes. Comparing studies of OI and phonology containing experience as a variable is troublesome. To date, there is not a

wealth of literature with enough systematicity in the operationalization of the variable to understand how experience affects performance in relation to OI. For instance, Bassetti and Atkinson (2015) included learners with an average of 10 years of classroom experience, Young-Scholten and Langer (2015) included learners over a year of immersion experience, Vokic (2011) included learners with a range of (possible) classroom experience from 13 to 33 years, and Özçelik and Sprouse (2016) included learners with a few years of classroom experience. Not only did years of learning and instruction experiences differ, but so did the number of participants in each of these experiments; Bassetti and Atkinson contained a total of 44 participants, Young-Scholten and Langer (2015) tested only three learners, and Vokic (2011) tested 15. As could be expected, the effect of OI on performance in these four studies differed. The present dissertation is an attempt to synthesize previous studies and, by examining naïve learners and learners, make conclusions about the relationship of experience and OI that can inform future research.

The second experiment in the dissertation reflects upon information from the learner data to mediate effects observed in naïve learner data. It is an attempt to make a connection between experimental and classroom settings. Whether learners perform more accurately as an entire group or perform more accurately within each experience level will indicate that some aspect of experience affects responses to familiarity and congruence. Previous studies have investigated how intervention may mediate effects of OI. In Jackson (2016) and Brown (2015), explicit information about written and auditory forms of words was provided to participants. Participants exposed to instruction in Brown (2015) did not perform more accurately at test, and participants exposed to instruction in

Jackson (2015) performed more accurately, but not significantly so. Both studies, however, had a confounding variable in the phonological input. The present dissertation eliminates phonological difficulty, allowing for a clearer understanding of the interaction between OI and the interventions. The last experiment is grounded in information observed from the first two experiments, instructor feedback, and makes use of the instructional technique of input enhancement.

1.4 Research questions addressed in this dissertation

The present dissertation is an investigation of phono-lexical acquisition of Russian by native English speakers. Russian affords the opportunity to manipulate and obtain results about the effects of grapheme familiarity and congruence on phono-lexical acquisition as within-participants variables. Understanding how both naïve learners and learners respond to these variables provides insight into how grapheme familiarity and congruence can affect performance in a developing phono-lexical system. By examining the effects of OI over experience levels, it informs classroom practices that could promote target-like acquisition. The research questions of the dissertation are twofold:

1. How do grapheme familiarity and congruence interact during second language phono-lexical acquisition?
    a. How do they interact during initial stages of acquisition in naïve learners?
    b. How do they interact during acquisition by experienced learners?
2. Can the effects of familiarity and congruence be mediated by intervention?

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CHAPTER 2

IMPACT OF CYRILLIC ON NATIVE ENGLISH SPEAKERS' PHONO-LEXICAL ACQUISITION OF RUSSIAN[1]

We investigated the influence of grapheme familiarity and native language grapheme-phoneme correspondences during second language lexical learning. Native English speakers learned Russian-like words via auditory presentations containing only familiar first language phones, pictured meanings, and exposure to either Cyrillic orthographic forms (Orthography condition) or the sequence <XXX> (No Orthography condition). Orthography participants saw three types of written forms: familiar-congruent (e.g., <КОМ>-[kom]), familiar-incongruent (e.g., <РАТ>-[rɑt]), and unfamiliar (e.g., <ФИЛ>-[fil]). At test, participants determined whether pictures and words matched according to what they saw during word learning. All participants performed near ceiling in all stimulus conditions, except for Orthography participants on words containing incongruent grapheme-phoneme correspondences. These results suggest that first language grapheme-phoneme correspondences can cause interference during second language phono-lexical acquisition. In addition, these results suggest that orthographic

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[1] Showalter, C.E. (to appear). Impact of Cyrillic on native English speakers' phono-lexical acquisition of Russian. *Language and Speech (Shea Special Issue).* doi: 10.1177/0023830918761489

input effects are robust enough to interfere even when the input does not contain novel phones.

2.1 Introduction

Adult learners of a second language (L2) often have difficulty perceiving novel L2 phonological contrasts, limiting their ability to establish contrastive lexical representations of L2 words (e.g., Cutler, Weber, & Otake, 2006; Escudero & Wanrooij, 2010; Ota, Hartsuiker, & Haywood, 2009). However, learners are able to make use of available input to facilitate word learning; specifically, learners are able to exploit the availability of orthographic input (OI) to learn the phonological content of new words (Escudero, Hayes-Harb, & Mitterer, 2008; Showalter & Hayes-Harb, 2013). For example, Escudero, Hayes-Harb, and Mitterer (2008) found that native Dutch speakers could establish contrastive lexical representations for the difficult to perceive English /æ/-/ɛ/ (e.g., *pat-pet*) vowel contrast when provided written forms that systematically manifest the distinction. Showalter and Hayes-Harb (2013) demonstrated that even unfamiliar OI can be exploited in this way. Roman segmental information with diacritic tone marks presented during pseudo-Mandarin word learning aided establishment of lexical representations compared to participants not exposed to tone marks (e.g., <gǐ> versus <gi>). In contrast with these findings, others have demonstrated either a hindrance or no effect of OI. For example, English learners of Mandarin in Bassetti (2006) were negatively affected by transfer of English orthography conventions during phoneme counting and phoneme segmentation tasks in Mandarin; they failed to count or produce vowels that were not represented in the Pinyin orthographic representations (e.g., /e/ in

/guei/-<gui>). In Simon, Chambless, and Kickhöfel Alves (2010), OI had no apparent effect on participants' ability to make inferences about the phonological forms of words in French (e.g., <dûge>-/dyʒ/, <douge>-/duʒ/, and <dige>-/diʒ/). As a result of these and similar findings reported in the literature, it is well established that OI can affect participants' ability to make inferences about the phonological content of new L2 words. The present study is an attempt to better understand the factors that influence the impact of OI in L2 word learning.

2.2 Background

Recent research on the effects of OI has identified a number of variables that, in certain conditions, shape the inferences that learners draw about words' forms, including phonological contrast difficulty (e.g., Escudero, 2015), instruction (e.g., Jackson, 2016), and word familiarity (Veivo & Järvikivi, 2013). In the present study, we will focus in particular on two of these variables: grapheme familiarity and congruence. Grapheme familiarity refers to the presence or absence of an L2 grapheme in an individual's native or first language's (L1) writing system. For instance, an L1 English-L2 German learner will be familiar with the grapheme <t>, which occurs in both languages. An L1 English-L2 German learner, on the other hand, will need to learn the unfamiliar grapheme <ß> or (diacritic) umlaut <ä>, which occurs only in the L2 German written forms. Congruence is a property of grapheme-phoneme correspondences (GPCs). A congruent GPC is one where the grapheme-to-phoneme mapping is the same in the L1 and the L2 (i.e., L1 English-L2 German, <n>-[n]); in this case, L2 learners do not need to learn new grapheme-phoneme mappings. Incongruent GPCs occur when a grapheme and phoneme

are not mapped in the same way in the two languages (e.g., <w> maps to /w/ in English but to /v/ in German); in this case, L2 learners must acquire new mappings between graphemes and phonemes. Literate speakers of a language with an alphabetic orthography appear to transfer L1 GPCs to L2 word learning, which can lead to nontarget-like knowledge of L2 words' forms (see e.g., Bassetti, 2006). Few studies have directly investigated the effects of grapheme familiarity and congruence simultaneously, as well as their interaction with L1-L2 knowledge; however, each of the variables has been investigated separately.

In a study of the impact of grapheme familiarity, Showalter and Hayes-Harb (2015) investigated the effect of an entirely unfamiliar script on the acquisition of the phonological forms of L2 words. Native English speakers were exposed to a difficult-to-perceive contrast (velar-uvular /k-q/; see Al Mahmoud, 2013 for English speaker difficulty with this contrast) in L2 pseudo-Arabic. During a word learning phase, participants saw either Arabic script (e.g., قينا) or a meaningless sequence of letters (i.e., <ط ط ط ط>). Participants did not benefit from the Arabic script. Even in subsequent tasks designed to facilitate word learning and mediate effects of grapheme unfamiliarity (e.g., transliteration of Arabic script into the Roman alphabet), no effect of OI was observed. Showalter and Hayes-Harb concluded that effects provided from OI may have been overshadowed by the difficult-to-perceive contrast, a result of the entirely unfamiliar script, or a combination of OI, the contrast, and the script.

Other research has focused on effects of congruence of GPCs on L2 phonological acquisition in both perception (e.g., Escudero, 2015; Escudero, Simon, & Mulak, 2014; Hayes-Harb, Nicol, & Barker, 2010) and production (e.g., Rafat, 2016; Vokic, 2011). To

investigate how L1 GPC knowledge may affect the inferences made about L2 words' phonological forms, Hayes-Harb, Nicol, and Barker (2010) presented native English speakers with spelled forms that contained only familiar letters. While the alphabet was familiar, some spelled forms contained incongruent GPCs, either "wrong letter" spellings (e.g., [fɑʃɑ] represented as <faza>) or "extra letter" spellings (e.g., [togɛg] represented as <thogeg>), based on English phonological sequences. In support of their hypothesis, the authors observed that participants exposed to incongruent spellings accepted mispronunciations corresponding to incongruent spelled forms presented during word learning (e.g., [fɑzɑ]/[θogɛg]), and performed less accurately at test than participants exposed to congruent forms. These results suggest that participants may have difficulty inhibiting knowledge of L1 GPCs when presented with incongruent GPCs in an L2.

Two recent studies manipulated both grapheme familiarity and congruence. Mathieu (2016) explored effects of varying grapheme familiarity in novel L2 lexical items. Native English speakers learned the Arabic /ħ-χ/ contrast via auditory forms, pictured meanings, and OI in one of four word-learning conditions: No Orthography (<XXX>), Arabic script (e.g., <بوخ>), Cyrillic script (e.g., <хұб>), or Hybrid script (e.g., <жub>; first letter Cyrillic script and remainder Roman alphabet). It was predicted that as the graphemes became more unfamiliar, there would be more difficulty in acquiring the nonnative contrast (Arabic as most difficult, followed by Cyrillic, then Hybrid). Unexpectedly, Mathieu observed no significant differences among the different script conditions. However, participants exposed to OI with incongruent GPCs, namely in the Cyrillic and Hybrid conditions, performed worse on the incongruent GPCs items at test. That is, knowledge of L1 graphemes <h> and <x> and their corresponding mapping

with the phones /h/ and /z/, /gz/, or /ks/, respectively, appeared to interfere with participants' ability to accurately learn the /ħ-χ/ contrast. As with Showalter and Hayes-Harb (2015), it is unclear whether the results should be attributed to unfamiliarity of the graphemes and phonemes, or the fact that the contrast was too difficult for the English speakers to perceive and acquire.

Because the perceptual difficulty of a novel phonological contrast may obscure the contribution of script familiarity or congruence, Hayes-Harb and Cheng's (2016) materials did not involve novel phonological contrasts; they taught Native English speakers Mandarin with exposure to auditory forms and either Pinyin (Romanized Mandarin) or Zhuyin. Zhuyin is entirely unfamiliar to native English speakers, while Pinyin is written with familiar (Romanized) segments. Pinyin stimuli were additionally divided according to whether the GPC was congruent with English (e.g., <nai>-[nai]) or incongruent (e.g., <zai>-[tsai]; English [zai]). Auditory forms contained familiar and unfamiliar (e.g., /ɕ/) phones, but were not dependent on unfamiliar contrasts (i.e., as in previous studies with /k/-/q/; e.g., there were no /kai/-/qai/ pairs). Participants completed a word learning phase (with either Pinyin or Zhuyin OI, auditory forms, and pictured meanings) and a criterion test assessing knowledge of the newly learned words. A final test assessed participants' ability to remember the phonological forms, presented as matched (i.e., pictured *zai* and [tsai]) or auditory foils/mismatched (i.e., pictured *zai* and [zai]). Zhuyin participants required more word-learning cycles to reach criterion, but Pinyin participants had less accurate performance overall as a result of incongruent forms (e.g., correct <xiu>-[ɕiou], incongruent hear [ziou]). Therefore, while script unfamiliarity created an initial delay in word learning, congruence caused more difficulty at test.

Building on Mathieu (2016) and Hayes-Harb and Cheng (2016), in the present study, we investigate the interaction of grapheme familiarity and congruence during the acquisition of a pseudo-Russian lexicon by naïve English learners. The Russian Cyrillic alphabet provides the opportunity for a more ecologically valid study in that the combination of native English speakers and Russian/Cyrillic allows for grapheme familiarity and congruence effects to be observed within a single writing system. In addition, we control for potential phonological confounds; all auditory forms contain only familiar L1 phones. The elimination of difficult-to-perceive contrasts means any observed performance differences should reflect OI effects. The present study was therefore designed to address the following question: How do grapheme familiarity and congruence interact in the context of native English speakers learning Russian Cyrillic words?

2.3 Method

2.3.1 Participants

Participants were native English-speaking undergraduate or graduate students from the University of Utah, either paid or awarded extra credit for volunteering. Participants had no prior formal (instruction) experience with the Cyrillic alphabet, did not report an L2 that was Cyrillic based, were not heritage speakers of a Cyrillic-based language, and did not have a history of any speech, language, hearing, or motor/neurological disorders. Participants were randomly assigned to one of two word-learning conditions: No Orthography (n = 15) or Orthography (n = 15). The No Orthography condition participants had an average age of 21.4 years (range 18-31) and consisted of 6 females and 9 males. The Orthography condition participants had an

average of 23.9 years (range 18-43) and consisted of 9 females and 6 males.

2.3.2 Stimuli

As previously noted, the use of the Russian Cyrillic script and native speakers of English allows for the simultaneous manipulation of both familiarity and congruence. The Cyrillic alphabet is, like English, alphabetic and read from left-to-right. English is an opaque language with a deep orthography (for more information on depth see Frost & Katz, 1989), while Russian is relatively transparent or shallow. The stimuli included both Russian words and nonwords; this was a consequence of available graphemes, L1-L2 GPCs, and Russian phonotactic restrictions. Stimuli were chosen for one of three conditions (n = 4 words each): Unfamiliar grapheme (Unfam), Familiar grapheme-Congruent GPC (FamCong), and Familiar grapheme-Incongruent GPC (FamIncong). Unfamiliar stimuli included unfamiliar Cyrillic graphemes representing familiar phones (e.g., <Ф>-[f]). Familiar-Congruent stimuli included familiar graphemes, with GPCs being congruent between English and Russian (e.g., <К>-[k]). Familiar-Incongruent stimuli included familiar graphemes and phones, but the GPCs differed from English to Russian (e.g., <В>-English [b]/Russian [v]). A full list of stimuli is in Table 2.1. Crucially, the words did not contain any unfamiliar phones or unfamiliar phonological contrasts. That is, unlike some previous studies that contained phones that would be noticeably novel to participants (e.g., Arabic consonants for native English speakers), we attempted to control for phone familiarity in order to isolate effects of OI. While not all of the phones were identical to English, they were intentionally selected for their similarity to English. The present study differs in this regard from previous studies (e.g.,

Table 2.1. Russian stimuli

	Picture meaning	Orthography representation	Correct Auditory	Foil auditory
Unfamiliar		< Ф И Л >[2]	[fil]	[dil]
		< Г И Л >	[gil]	[zil]
		< Д И Б >	[dib]	[kib]
		< З И Б >	[zib]	[mib]
Familiar Incongruent		< Р А Т >	[rɑt]	[pɑt]
		< С О Т >[3]	[sot]	[kot]
		< Н О М >	[nom]	[hom]
		< В А М >	[vɑm]	[bɑm]
Familiar Congruent		< К О М >	[kom]	[dom]
		< М О Т >	[mot]	[fot]
		< Т А М >	[tɑm]	[gɑm]
		< М А Т >	[mɑt]	[tɑt]

[2]One reviewer pointed out that words in the unfamiliar stimuli group contain the vowel [i], while the other two conditions contain [o] and [ɑ]. This was because < И> ([i]) was the only unfamiliar vowel grapheme. Given the results of the current study, this did not seem to be an issue. However, this is a consideration for future research.

[3]In fact, English <c> can be mapped to /s/ in some contexts (e.g., city, cent). However, this mapping does not occur syllable-initially before <o>, as in the present stimuli.

Hayes-Harb & Cheng, 2016; Mathieu, 2016), and thus minimizes the possibility of confounds between OI effects and perceptual difficulty. All words were of the form CVC, keeping with the format of stimuli in previous literature. The monosyllabicity of the stimuli and the small set (n = 12) was chosen based on what is known about participants' abilities to learn words within an experimental hour. For the FamCong and FamIncong stimuli, the first consonant/letter was manipulated for familiarity and congruence and all other segments/letters in the words were both familiar and congruent. In the Unfam stimuli, all letters were unfamiliar. Each word was associated with a "correct" auditory form and "foil" form, with the foil forms reflecting L1 GPCs for FamIncong stimuli (e.g., <P>-/r/, English /p/) and differing in at least two features of articulation for Unfam and FamCong stimuli (e.g., < Д >-/d/, foil /k/ differing in voicing and place of articulation) so as not to be auditorily confusable or overlap with other words and/or GPC mappings.

Each of the words was randomly associated with a real-object pictured meaning (obtained from the BOSS; Brodeur, Dionne-Dostie, Montreuil, & Lepage, 2010); none of the assigned meanings corresponded to the words' actual meanings in Russian.

The auditory words were produced by a 32-year-old female native Russian speaker from Novosibirsk, Russia. She was a graduate student at the University of Utah and had been residing in the United States for 4 months at the time of recording. The speaker was recorded producing each word three times and the second token of each word was selected for presentation in the study.

It is known that the auditory contrast /b/-/v/ is relatively confusable (see e.g., Ota, Hartsuiker, & Haywood, 2009; Experiment 1). To ensure that results were attributable to

OI effects and not to any auditory confusability of the stimuli, the FamIncong test-foil pair /b/-/v/ was subjected to a categorization task (offline forced-choice identification). A separate group of native English speakers (n = 5) listened to all /b/ and /v/ stimuli produced by the Russian speaker and transcribed what they heard. Responses indicated that all items were identified as the intended forms (i.e., /b/ tokens perceived as /b/ and /v/ tokens perceived as /v/), with the exception of one /v/ production perceived as /b/ by one listener. This production was discarded and replaced by the third token produced by the speaker.

2.3.3 Procedure

The study employed the artificial lexicon design used in a number of previous studies (e.g., Hayes-Harb, Nicol, & Barker, 2010; Showalter & Hayes-Harb, 2013, 2015), implemented using DMDX software (Forster & Forster, 2003). The experiment involved three phases: word learning, a criterion test, and a final test. All participants sat in a sound-attenuated booth facing a computer screen and a keyboard, and heard auditory stimuli over headphones. During word learning, participants heard auditory forms of the words (e.g., [nom]) and saw their pictured meanings (e.g., a baseball). They also saw OI as either written representations in Cyrillic (Orthography Condition; e.g., <HOM>) or a meaningless sequence of letters in an effort to provide an equivalent amount of visual input (No Orthography Condition; i.e., <XXX>). All visual and auditory input was presented simultaneously. An example trial in each word-learning condition is provided in Table 2.2. Each of the 12 words was presented eight times, randomized within four blocks for each participant (each word two times per block; n = 96 presentations).

Table 2.2. Example word learning phase trials

	Matched	
	Orthography	No Orthography
SEE		
	HOM	XXX
HEAR	[nom]	
RESPONSE	no response required	

Participants did not need to respond during this phase, but were instructed to learn the words and their meanings.

Immediately following the word learning phase, participants completed the criterion test, in which they determined whether pictures and auditory forms matched. No OI was presented to either group during this phase. There were 12 matched items (e.g., baseball-[nom]) and 12 mismatched items (e.g., baseball-[zib]). Mismatched words did not involve incongruent GPCs, but were paired auditory forms and picture meanings from different conditions (e.g., see FamIncong picture *glasses*-[sot], hear FamCong [tam]; example in Table 2.3). Participants had 3 seconds to respond before the program counted the response as incorrect and proceeded to the next trial (participants were not

Table 2.3. Example criterion test trials: Matched and mismatched

	Matched	Mismatched
SEE		
HEAR	[nom]	[zib]
RESPONSE	yes	no

provided feedback). To ensure that participants had generally learned the words' phonological forms, a 90% criterion cutoff was required to pass to the final test phase. Participants completed as many word-learning cycles as needed to reach criterion.

The test phase was identical to the criterion test phase, except that mismatched items paired picture meanings with foil auditory forms (Table 2.4). Once participants finished the test phase, they completed a language background questionnaire. The full experiment lasted approximately 30 minutes.

2.3.4 Analysis

2.3.4.1 Learning cycles

Participants in both conditions required between one and three word-learning cycles to advance to the test phase. An independent samples *t*-test was conducted, revealing no significant difference in mean number of word-learning cycles between the Orthography condition (mean = 1.6) and the No Orthography condition (mean = 1.2) ($t(28) = -0.167$, $p = 0.105$; $r = -0.292$).

Table 2.4. Example final test trials: Matched and mismatched

	Matched	Mismatched
SEE		
HEAR	[nom]	[hom]
RESPONSE	Yes	no

2.3.4.2 Mean proportion correct and d-prime

Figures 2.1 and 2.2 present mean proportion correct per stimulus condition during the test phase, for the matched and mismatched trials, respectively. Scores for both matched and mismatched items were near ceiling with the exception of FamIncong stimuli. Orthography participants' proportion correct scores varied as a function of the familiarity and congruence variables (see Figure 2.2): Unfam and FamCong items yielded greater accuracy (100% and 86%) than proportion correct on FamIncong items (62%).

The proportion correct data were converted to d-prime (a measure of sensitivity to stimuli differences, factoring out bias), and these data were submitted to a two-factor mixed-design ANOVA with word-learning condition as the between-participants variable (two levels: Orthography and No Orthography) and stimulus condition as the within-participants variable (3 levels: Unfam, FamIncong, FamCong). Figure 2.3 shows mean d-prime scores by stimulus and word-learning conditions. There was a significant main

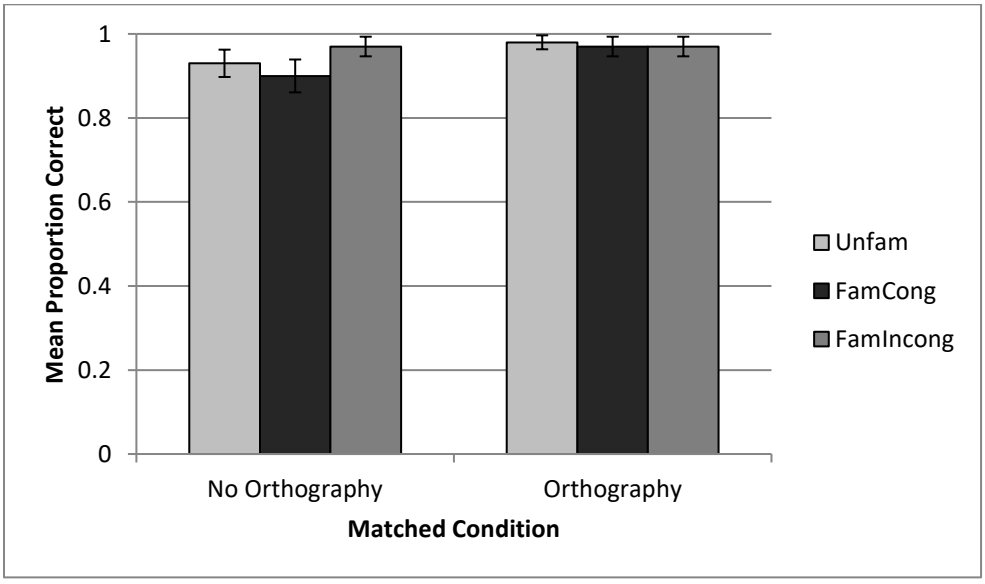

Figure 2.1. Mean proportion correct on matched items by word-learning condition. Error bars represent ±1 standard error.

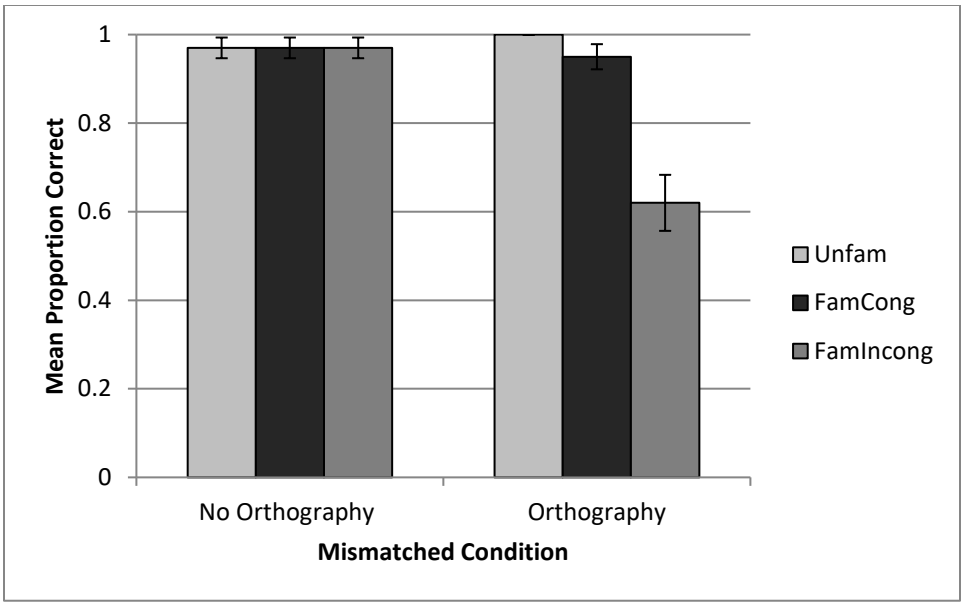

Figure 2.2. Mean proportion correct on mismatched items by word-learning condition. Error bars represent ±1 standard error.

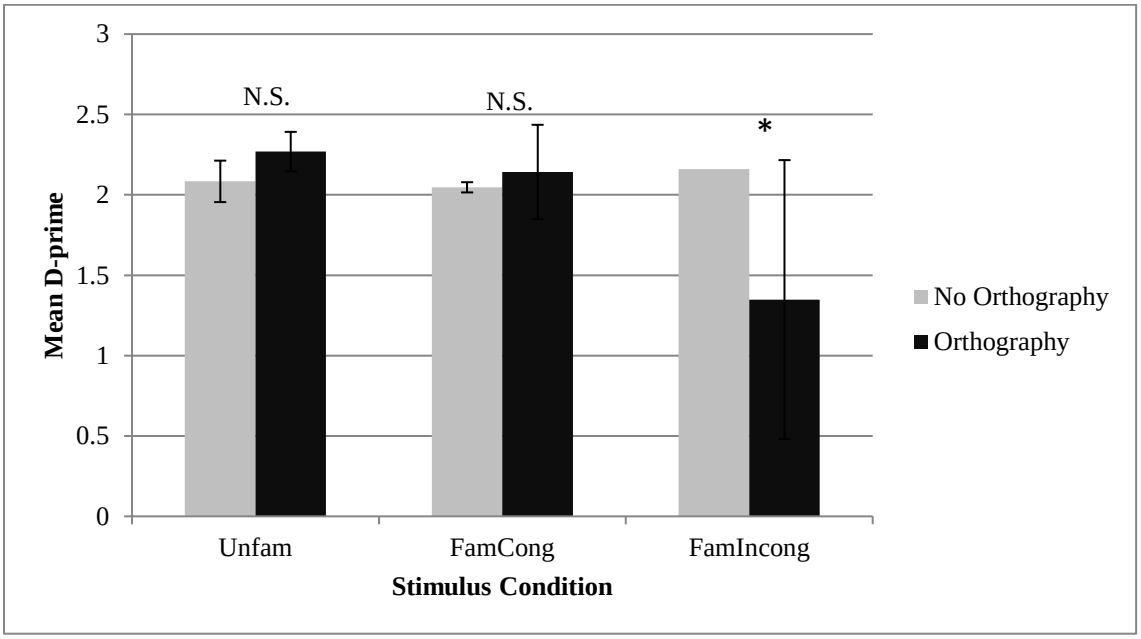

Figure 2.3. Mean d-prime of word-learning condition by stimulus condition. Error bars represent ±1 standard error.

effect of stimulus condition ($F(1, 28) = 6.215$, $p < 0.005$; *partial* $\eta^2 = 0.182$), no significant effect of word-learning condition ($F(1, 28) = 3.413$, $p = 0.075$; *partial* $\eta^2 = 0.109$), and a significant interaction of stimulus condition and word-learning condition ($F(1, 28) = 9.446$, $p < 0.005$; *partial* $\eta^2 = 0.252$).

Following up on the significant interaction of stimulus condition and word-learning condition, we investigated the effect of word-learning condition on performance in each stimulus condition. There was no effect of word-learning condition on either Unfam stimuli ($F(1, 28) = 1.944$, $p = 0.174$, *partial* $\eta^2 = 0.065$) or FamCong stimuli ($F(1, 28) = 0.759$, $p = 0.391$, *partial* $\eta^2 = 0.026$). There was, however, an effect of word-learning condition on FamIncong stimuli ($F(1, 28) = 10.558$, $p = 0.003$, *partial* $\eta^2 = 0.274$), with No Orthography participants outperforming Orthography participants.

Further analyzing the effect found with the FamIncong stimulus condition and word-learning conditions, proportion correct scores for each of the four FamIncong words were reviewed individually. Matched trial performance was near ceiling for all participants. Mismatched trial performance for the No Orthography participants was also at 100% for three of the words and 87% for <BAM>. Orthography participants performed least accurately on <PAT> (44%), with more accurate performance on <HOM> and <BAM> (both 63%), and greatest accuracy on <COT> (88%).

While the sequence <CO> does not map to [so] word initially, that <C> can map to [s] in other environments may have resulted in superior performance on this word. Participants may have used their knowledge of this mapping when they saw <CO>. It is not surprising that the other items have less accurate performance given the unlikely or impossible (English) mappings between the graphemes and target phones. The <B>-[v]

stimulus was vetted for acoustic confusability and found not to be auditorily confusable. Had Orthography participants performed least accurately on this stimulus as the No Orthography condition participants did, it would be of greater concern. Overall, and as reflected in the statistics, it is evident that the incongruent stimuli caused considerable interference for the Orthography participants.

2.4 Discussion

In the present study, we investigated the interaction of grapheme familiarity and congruence in the acquisition of the phonological forms of new words by native English speakers learning a Russian-like mini lexicon. Recall that the research question was, How do grapheme familiarity and congruence interact in the context of native English speakers learning Russian Cyrillic words? Unlike the entirely unfamiliar Arabic script in Showalter and Hayes-Harb (2015), novel graphemes and their GPCs appear to have been learnable within the experimental session in the present study. Incongruent written forms interfered with participants' ability to make inferences about the phonological forms of words. This provides evidence that incongruent OI robustly affects learning of L2 words' phonological forms.

The finding that OI can interfere with learners' ability to make inferences about words' phonological forms is consistent with previous studies (i.e., Hayes-Harb & Cheng, 2016; Hayes-Harb, Nicol, & Barker, 2010; Mathieu, 2016), and contributes to the accumulating evidence in the literature that incongruence poses a substantial challenge to learners. What is noteworthy here is that we observed a robust effect even when the auditory input was entirely familiar to learners (that is, it contained only familiar L1

phones). It is expected that unfamiliar OI or difficult-to-perceive phonological L2 contrasts cause difficulty for a learner; consider, for example, the difficulty that Japanese learners of English have with the /r/-/l/ distinction (see e.g., Cutler, Weber, & Otake, 2006; Iverson et al., 2003). In the present study, however, phonological forms of words were misremembered due to interference from OI even in the absence of difficult-to-perceive contrasts. It thus appears that knowledge of L1 GPCs transfers to L2 acquisition and is not readily "unlearned" even when the input contains evidence of new GPCs.

It may be the case that the susceptibility of an L2 learner to interference from incongruent GPCs depends in part on the nature of the native language writing system with respect to orthographic depth, with learners from relatively shallow L1 orthographies experiencing more interference than those from relatively deep orthographies (see e.g., Escudero and Wanrooij, 2010 for discussion). It would be of interest to investigate the effects of orthographic depth (see e.g., Erdener & Burnham, 2005 or Frost & Katz, 1989 for more information) on inferences made about graphemes and phones in an L2. This is not detailed in the present study, but we acknowledge that English (a deep/opaque language) and Russian (a relatively shallow/transparent language) might affect the manner in which a learner approaches L2 GPCs.

Given that most previous studies of OI in L2 acquisition have been conducted in laboratory settings with naïve subjects and an artificial lexicon paradigm (notable exceptions include Young-Scholten, 2002 and Bassetti, 2006), the effect of OI in actual L2 learners is still relatively understudied. Young-Scholten (2002) found that learners with more exposure to OI during L2 German acquisition did not produce word final devoicing for alternating pairs (e.g., <Tag>-[tɑk] but <Tage>-[tɑgə]) after 11 months of

instruction. Written forms present voiced consonants (e.g., <Rad>), interfering with learner knowledge that final obstruents are devoiced (e.g., <Rad>-/rɑt/). Using an out-loud sentence reading task, Comer and Murphy-Lee (2004) found that native English speakers in a Russian language class tended to mispronounce unfamiliar and incongruent graphemes (e.g., <Ц>, <В>) at 12 weeks of instruction. Future research should investigate whether OI's contribution to learning word forms can be moderated by instruction, and which interventions are most effective. The results found here and in the existing laboratory-based literature with respect to OI have been quite robust; however, it may be the case that experimental settings artificially inflate these effects by either drawing undue attention to aspects of OI or trivializing aspects of language that would otherwise be embedded in a communicative context. Thus, studies with participants who are actual L2 learners are necessary for us to better understand the pedagogical implications of this line of research. Further, as noted by Escudero, Simon, and Mulak (2014), L2 learners are typically exposed to OI in instructed settings. To the extent that actual L2 learners are found to experience difficulty associated with OI, research investigating the role that instruction may play in moderating the interfering effect of incongruence may be beneficial to the field of L2 pedagogy.

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CHAPTER 3

RUSSIAN PHONO-LEXICAL ACQUISITION AND ORTHOGRAPHIC INPUT: NAÏVE LEARNERS, EXPERIENCED LEARNERS, AND INTERVENTIONS

3.1 Introduction

Written forms of words, or orthographic input (OI), can affect learners' ability to establish lexical representations; in some cases, this can lead to an inability to acquire target-like second language (L2) forms. The specific contribution of OI on language performance varies; some studies indicate that OI can aid in the establishment of lexical representations (e.g., Escudero, Hayes-Harb, & Mitterer, 2008; Showalter & Hayes-Harb, 2013), while others indicate that OI can interfere or have no effect on lexical acquisition (e.g., Burki, Spinelli, & Gaskell, 2012; Escudero, Simon, & Mulak, 2014; Simon, Chambless, & Kickhöfel Alves, 2010). Recent research has demonstrated that learners can take advantage of OI when learning the phonological forms of new words. When provided with instruction prior to the experimental task (e.g., Jackson, 2016) or if they are more proficient in the L2 and therefore have more familiarity with the target words (e.g., Veivo & Järvikivi, 2013), learners can make use of OI to bootstrap learning. However, few L2 orthography-phonology studies to date include actual learners of the

target L2 or involve learners at different stages of acquisition. Instead, acquisition is a function of naïve listeners' abilities to learn a pseudo language or language that reflects properties of a target L2. The present study is an investigation of phono-lexical acquisition in the presence of OI by learners of the target language, as well as naïve learners, and is an attempt to mediate OI difficulties observed in naïve learners' ability to establish target-like representations of words during initial stages of acquisition. That is, we ask how L2 OI affects naïve learners' and experienced learners' abilities to make inferences about phonological forms of words when first language (L1) and L2 writing systems differ.

Numerous factors interact with OI during acquisition; these include, but are not limited to, instruction (e.g., Brown, 2015; Jackson, 2016), familiarity and frequency of L2 words (e.g., Veivo & Järvikivi, 2013), the phonological contrasts targeted in the experiments (e.g., Escudero, 2015), and the L1 and L2 that are involved (e.g., Erdener & Burnham, 2005). In the present study, we focus on two variables: grapheme familiarity and congruence. We define grapheme familiarity as the presence or absence of a grapheme within an L2 relative to a speaker's L1. For example, graphemes in L2 Arabic are entirely unfamiliar to L1 English speakers who are accustomed to the Roman alphabet. However, the graphemes used in L2 Spanish will look familiar to L1 English speakers, as both languages are written in the Roman alphabet. A grapheme's familiarity is an indication of linguistic units a learner must acquire; that is, an L1 speaker learning an L2 that uses the same script, will not have to acquire a new alphabet. The second variable of interest is congruence, which we define as the manner in which letters and sounds are mapped (grapheme-phoneme correspondences; GPCs) in a language and the

relation of these mappings in the L1 and L2. An L1 speaker of English learning L2 Dutch will encounter congruent GPCs; for instance, in both English and Dutch <p> is mapped to [p]. An L2 speaker of English learning L2 Dutch will also encounter incongruent GPCs or differences between GPC mappings in English and Dutch; for example, the letter <g> is mapped to [g] in English but to [ɣ] or [x] in Dutch. Therefore, when an L1 speaker of English is learning Dutch, they must "unlearn" the English GPC and learn the new Dutch GPC. These two variables and their effect on phono-lexical acquisition are described in more detail in the following section.

While research suggests that learners transfer L1 rules to the L2 and that transfer is unsuccessful when the conventions between the two languages are different (e.g., Bassetti, 2006; Hayes-Harb, Nicol, & Barker, 2010), few studies have investigated how learners at different stages of acquisition perform relative to one another and how to mitigate these effects or best instruct naïve learners of differences between the languages. In light of results from previous studies and the results from Chapter 2 (Showalter, to appear), we additionally tested the efficacy of interventions to mediate effects of grapheme familiarity and congruence in naïve learners to develop target-like GPCs in early stages of acquisition.

3.2 Background

3.2.1 Effects of grapheme familiarity and congruence

Effects of OI on phono-lexical acquisition have been found to be variable. In Escudero, Hayes-Harb, and Mitterer (2008), native Dutch speakers learning English provided evidence of their ability to make use of OI to establish contrastive lexical

representations for the difficult-to-perceive English contrast, /ɛ/-/æ/. The authors posited that knowledge of spelled forms, that /ɛ/ maps to <e> and /æ/ maps to <a>, gave clues to the Dutch speakers within the experimental task and they were more sensitive to the vowel distinction. In other cases, OI can interfere with the ability to lexicalize L2 words in a target-like manner. In Bassetti (2006), native English speakers erroneously made use of their L1 to count and segment L2 Mandarin vowels. Although pronounced, main vowels in Mandarin are not always spelled out (e.g., [uən]-<un>). Native English speakers failed to identify vowels and syllables in a target-like manner when these vowels were in nonspelled-out forms. Finally, OI may have a null effect on the ability to make phonological inferences about word forms. In Simon, Chambless, and Kickhöfel Alves (2010), native English speakers exposed to spelled forms distinguishing three L2 vowels (e.g., <blûve>-/y/; <blouve>-/u/; <blive>-/i/) did not perform more accurately at test than those not exposed to spelled forms.

One reason that learners may perform in a nontarget-like manner, or be unable to take advantage of OI within tasks, is a reliance on L1 knowledge. An adult L2 learner brings to L2 acquisition the linguistic system of their L1, which contains the L1 phonology, orthography, and GPCs. In the initial stages of acquisition, learners appear to transfer this knowledge to the L2 system. In some instances, the systems are similar enough that little to no effect is observed. However, when a learner erroneously applies their L1 knowledge to an L2, this can result in nontarget-like performance or acquisition (as in e.g., Bassetti, 2006).

Vokic (2011) found that native Spanish speakers applied L1 Spanish sound-spelling correspondence rules to L2 English flap (/ɾ/) production. The Spanish

orthographic system does not map the flap to the same graphemes as English. In English, the flap is mapped to <t>, <d>, <tt>, or <dd> intervocalically; in Spanish, <t> and <d> are mapped to [ð] and [t] in that environment and <tt> and <dd> do not exist. The native Spanish speakers often produced <d>/<dd> as [ð] and <t>/<tt> as [t]. Furthermore, the Spanish speakers were more likely to rely on Spanish mappings for <t> and <d>, and produce the flap in forms spelled with <tt> and <dd> (not present in Spanish). Vokic (2011) found that speakers were influenced by their L1 GPC knowledge, especially when GPCs were incongruent (<t>-[ɾ] intervocalically in English and not <t>-[t] or [t̪]). It is important to note that the learners in this study had an average length of experience of 23.8 years. The full extent of instruction was not clear, but the learners indicated their initial age of L2 English instruction onset, and 23.8 years was the average difference between their initial instruction onset and current age (average length of residency in the United States was 3.80 years). Interference of L1 orthography affected accuracy at test even at an advanced stage of acquisition. A secondary finding was the relation between experience and production; when a word as more familiar to learners, they were more likely to produce target-like phones and mediate L1 GPC interference effects.

The effect of OI (specifically, grapheme familiarity and congruence) on phono-lexical acquisition is also found in nonproduction studies. Showalter and Hayes-Harb (2013) found that native English speakers could take advantage of novel diacritics representing tone in L2 pseudo-Mandarin. Participants were exposed to Pinyin, a Romanized version of Mandarin, meaning all segments were familiar. The four-way tone contrast was represented with diacritics (e.g., <fiăn>), which are unfamiliar to native English speakers. A second group of participants was exposed to written forms that did

not contain the tone marks (e.g., <fian>). At test, participants determined whether a picture and auditory form matched as they did during word learning. Only participants who were exposed to the diacritic marks during the word learning phase exhibited evidence that they had lexicalized the tonal contrast.

In a similar study, Hayes-Harb and Hacking (2015) asked whether naïve English speakers exposed to Russian, as well as learners of Russian, would be able to make use of diacritic marks to make inferences about stress patterns in Russian nonwords. During word learning, participants heard six stress-based minimal pairs (e.g., ['puda] and [pu'da]), saw pictured meanings, and saw written forms in one of four conditions: Latin alphabet with stress marks, Cyrillic alphabet with stress marks, Latin alphabet without stress marks, or Cyrillic alphabet without stress marks. Russian learners were only assigned to the Cyrillic alphabet conditions. None of the four word-learning conditions improved the naïve English speakers' sensitivity to the stress contrasts. While experienced learners had higher accuracy at test than naïve learners, there was no effect of stress marks on participants' accuracy at test over no stress marks. It can be concluded that, in some cases, unfamiliar OI (diacritics) is not beneficial. This may be due to the difficulty that native English speakers have perceiving stress (see Hayes-Harb and Hacking's explanation). As a group, the learners of Russian performed more accurately, likely due to their Russian language experience.

As noted earlier, Escudero, Hayes-Harb, and Mitterer (2008) found that OI can be beneficial to participants' ability to learn L2 word forms. In their study, the alphabets employed by the L1 and L2 were the same (i.e., familiar)—the Roman alphabet. Showalter and Hayes-Harb (2015) investigated whether an entirely unfamiliar

orthography would likewise be beneficial during phono-lexical acquisition. Native speakers of English were exposed to pseudo-Arabic words in minimal pairs containing the /k/-/q/ contrast, pictured meanings, and either OI as the Arabic script (orthography) or a meaningless sequence of letters (no orthography; <ط ط ط ط>). At test, participants exposed to the Arabic script did not perform differently than their no orthography counterparts. Showalter and Hayes-Harb tried to mediate grapheme familiarity in a series of subsequent studies, manipulating the instructions provided to the participants, the script of stimulus presentation (i.e., the Roman alphabet), and the number of talkers. None of the manipulations had an effect on performance. It was posited that participants' low accuracy might have stemmed from the inability to perceive the /k/-/q/ contrast and not difficulties from the OI.

Mathieu (2016) also investigated grapheme familiarity effects. In a similar design to that of Showalter and Hayes-Harb (2015), native English speakers learned words containing the /ħ/-/χ/ contrast, but were exposed to written forms in the Arabic script (completely unfamiliar), the Cyrillic script (unfamiliar), or a Hybrid script (first letter Cyrillic, rest of the letters Roman alphabet). Differences in grapheme familiarity did not affect accuracy; however, Mathieu (2016) found that words containing possible incongruences (e.g., Roman-looking Cyrillic letters <h>) could have led participants to incorrectly make use of their L1 knowledge (e.g., <h>-[h] not target [ħ]) and negatively affect accuracy. As in Showalter and Hayes-Harb (2015), Mathieu (2016) also posited that the contrast may have been too difficult for naïve learners to perceive, and the effects of grapheme familiarity or OI were not interpretable.

Looking at effects of congruence, Hayes-Harb, Nicol, and Barker (2010) found

that native English speakers experienced significant interference when L1-L2 GPCs were incongruent. Native English speakers learning a pseudo language were exposed to auditory forms, pictured meanings, and written forms following English spelling conventions (e.g., [gufə]-<gufa>) or not conforming to English spelling conventions (e.g., wrong letter [keʃəf]-<kezef> or extra letter [degəd]-<degund>). At test, when asked to indicate whether pictured meanings and auditory forms matched, participants exposed to spelled forms that did not conform to English conventions were more likely to accept mispronunciations (e.g., indicate that [kezəf] was a correct auditory form) than those with English-conforming spellings. Specifically, the nonconforming participants' accuracy at test was significantly affected by incongruent spellings.

A similar congruence effect was found in Hayes-Harb and Cheng (2016). In addition to seeing pictured meanings and hearing auditory forms, native English speakers learning pseudo-Mandarin were exposed to either spelled forms in Pinyin or Zhuyin (characters). These two word-learning conditions allowed the researchers to observe effects of grapheme familiarity, with Romanized Pinyin being familiar to the native English speakers and the characters of Zhuyin being unfamiliar. In addition, the effect of congruence was tested, with the Pinyin stimuli split into congruent (e.g., <mie>-[mie]) and incongruent (e.g., <xiu>-[ɕiou], English [ziou]) forms. While the Zhuyin participants required more time to learn the words, Pinyin participants had less accurate performance overall, due to low accuracy on the incongruent stimuli. What is especially important to note in Hayes-Harb, Nicol, and Barker (2010), as well as Hayes-Harb and Cheng (2016), is that neither study contained difficult-to-perceive contrasts. All phones in Hayes-Harb, Nicol, and Barker (2010) were familiar to the native English speakers, and, while some

phones were unfamiliar in Hayes-Harb and Cheng (2016), the ability to make decisions about word forms at test did not rely on contrasts involving new phones. These two studies provide evidence that, even in the context of familiar input, learners are affected by interference effects from incongruence.

The studies thus far indicate that grapheme familiarity and congruence are powerful factors during phono-lexical acquisition. Grapheme familiarity effects are mixed; sometimes familiarity can be used as an advantage, and at other times it does not seem to affect participants. However, investigations of grapheme familiarity have often been confounded by difficult-to-perceive contrasts (e.g., Mathieu, 2016; Showalter & Hayes-Harb, 2015). Congruence, even in cases when phonological input is familiar (e.g., Hayes-Harb, Nicol, & Barker, 2010) or final tests do not rely on novel contrasts (e.g., Hayes-Harb & Cheng, 2016), is a more robust factor on accuracy at test. It seems participants are unable to suppress L1 GPC knowledge to make accurate inferences about L2 phonological forms.

3.2.2 Effects of orthographic input on instructed learners

One question that arises is whether learners of a target L2 overcome effects caused by OI. Previous studies yield mixed results; however, most studies indicate that OI can inhibit accuracy on tasks, even at higher proficiency levels. Learners in Hayes-Harb and Hacking (2015) performed more accurately than their naïve learner counterparts, but did not perform differently (from one another) depending on their word-learning condition. In addition, some naïve learners' results fell into the same accuracy range as the learners. The learners in Vokic (2011) had an average of 23.8 years of

experience (having classroom instruction for an unspecified number of years) and demonstrated that they also relied on their L1 GPCs.

Much like Bassetti (2006) and Vokic (2011), Bassetti and Atkinson (2015) investigated learner productions and effects of L1 GPC knowledge. Native Italian speakers, who had been learning English for an average of 10 years in an instructed setting, read aloud or repeated English words that contained "silent letters" (e.g., <b> in *comb*), vowels that were represented as a single versus double grapheme (e.g., [i] in *these* versus *cheese*), the past tense morpheme <-ed>, and homophones (e.g., [wʊd] <*wood*/*would*>). Despite a decade of language experience, Bassetti and Atkinson found that learners mispronounced words in English, as they applied their knowledge of GPCs in Italian to English. Italian predominantly contains one-to-one grapheme-phoneme mappings. English, however, is notoriously a many-to-one or one-to-many mapping language. Reading English, the learners would pronounce the silent letters in spellings, produce longer vowels when more than one grapheme was present, voice the past tense ending in all instances (include the <e> vowel; i.e., epenthesized the graphemically present <e> in <ed>), and produce homophones in different manners.

Rafat (2016) tested native English speakers who were beginner learners of Spanish on their productions of Spanish words. She found that incongruent English-Spanish GPCs (e.g., <v>, Spanish [b], English [v]) and exposure to OI yielded nontarget-like productions (producing <v> as English [v]). That is, the native English speakers were unable to suppress their knowledge of English GPCs. In Pytlyk (2017) native English speakers learning either Mandarin or Russian (2 years instructed experience) had less accurate performance on a phoneme counting task when they were exposed to OI that

was inconsistent with auditory input (i.e., the number of letters and phones differed; e.g., in Russian, *семь*-[sʲɛmʲ], four letters, three sounds).

Effects of OI are also evident in non-classroom-instructed learners' language performance. Young-Scholten and Langer (2015) followed three English speakers learning German over a year in an immersion (naturalistic) setting (the adolescents did have 4 weeks of instruction). They tested productions (in a reading task) of word initial fricatives. German and English differ in their <s> phone mappings (GPCs are incongruent); in German, <s> maps to [z] and in English, <s> maps to [s]. Over the year, productions for <s> did not become more target-like, and the speakers were unable to overcome the interference of their L1 GPCs, producing <s> in German as [s] despite ample exposure to examples of the target-like mapping.

In some cases, learners with varying levels of proficiency may not be differentially affected by OI, or effects may be dependent on the experimental task. In Escudero and Wanrooij (2010), it was found that native Spanish speakers learning L2 Dutch had varying levels of accuracy during L2 vowel categorization, dependent on the vowel contrast (Dutch contrasts /a-ɑ/, /i-ɪ/, /y-ʏ/, and /ɪ-ʏ/) and availability of OI. Learners in the task were those with the lowest and highest proficiency scores from the participant pool. First, learners completed an XAB task, listening to auditorily presented tokens and clicking on the correct answer. Next, learners completed an XAB task, but chose their answer by clicking on an orthographically represented answer of the auditory tokens (i.e., <aa>, <a>, <ie>, <i>, <uu>, <u>). Difficult-to-perceive contrasts were less likely to be categorized in a target-like manner in the auditory only condition, but the presence of OI aided learners. For less difficult vowel contrasts, results in the auditory

only condition were more target-like, while OI yielded less accurate performance. Accuracy at test between the low and advanced groups did not differ, suggesting that the difficult-to-perceive contrasts and OI affected both learner types in the same manner. In a second experiment, following the same procedures, naïve learners of Dutch were tested, and their results patterned, as the learner answers did, with OI aiding accuracy on trials involving difficult-to-perceive contrasts and not aiding trials of less difficult vowel contrasts.

In some cases, proficient learners have demonstrated that they rely less on L1 knowledge that may interfere in the L2. Veivo and Järvikivi (2013) questioned whether experience with and familiarity of an L2 would mediate effects of OI. Intermediate (low and high) and advanced Finnish speakers learning French completed two priming experiments. In the first, all stimuli were presented in the L2, French, and were divided into repetition OI-auditory presentations (e.g., prime <stage>-[staʒ], target [staʒ]) and pseudohomophone OI-auditory presentations (e.g., prime <staje>-[staʒ], target [staʒ]). Pseudohomophones were spellings that would yield homophonous productions of words in L2 French but were orthographic nonwords. Participants determined whether the presented auditory word was a real French word. In the second experiment, stimuli were based on L1-L2 relationships, with primes being in the participants' L1 and targets in the L2. These were further divided based on L1-L2 orthographic overlap (e.g., L1 prime <huivi>-[huivi] *scarf*, target L2 [ɥil] which is *oil* <huile>) and L1-L2 phonological overlap (pseudohomophone, e.g., L1 prime <yil>-[yil], target L2 [ɥil]). Both experiments' results revealed that lower proficiency learners were more affected by OI, while higher proficiency learners did not rely on OI to the same extent. The higher

proficiency learners' answers were more accurate and target-like overall, with OI facilitating accuracy at test. They had more accurate performance on repetition trials in the first experiment, and accuracy was not adversely affected by pseudohomophone trials. In addition to OI, lexical familiarity was also facilitative for higher proficiency learners, yielding faster reaction times and fewer errors.

Özçelik and Sprouse (2016) compared native English speakers who were beginner, intermediate, or advanced learners of Turkish on their ability to make inferences about morphological endings. In Turkish loanwords, the interaction of pre-consonantal vowels, coronal and dorsal laterals, and vowel harmony is not systematically represented in spelled forms. The two laterals (/l/ and /ɬ/), which determine vowel harmony in the morphological endings, are represented with <l>. Learners were asked to choose the correct morphological form based on vowel harmony, with some learners exposed to both auditory and written forms. Those exposed to written forms performed less accurately than those exposed only to auditory forms. In addition, advanced learners of Turkish performed more accurately than the beginner and intermediate learners. Özçelik and Sprouse posited that the advanced learners relied less on the L2 orthography to make inferences about morphology, given that the orthography could lead them astray.

To the best of our knowledge, there are few studies that investigate the acquisition of L2 Russian phonology in relation to OI (and, additionally, in instructed learners). Comer and Murphy-Lee (2004) provides a foundation, investigating the effects of GPCs on reading and writing accuracy in native English speakers in their first semester of Russian. Comer and Murphy-Lee questioned whether certain Cyrillic letters (and GPCs) would be consistently problematic or whether learners would be able to acquire target-

like Russian GPCs by the end of the first semester. Focus was upon recognition of GPCs and not accurate productions of Russian specific phonology (e.g., palatalization). Learners read aloud sentences that contained familiar and new words during three recordings: after 4, 8, and 12 weeks of instruction.

While students generally improved over the 12 weeks, two crucial findings emerged. First, participants who did not demonstrate improvement within the first 4 weeks fell behind and received lower course grades. There were also graphemes that were difficult for the majority of participants and continued to pose difficulty by the end of the semester (i.e., Ц, ё, Ю, Й, Э; to a slightly less extent Х, б, Щ). Common difficulties with pronunciation included letters differing only in diacritics (e.g., <ё> and <e>), new words or unknown letters (which were either ignored or substituted with a different word), and letters that looked like the Roman alphabet but map to a different sound (e.g., <в>-Russian [v], English [b]). The findings of Comer and Murphy-Lee (2004) suggest that some GPCs are difficult for Russian learners, and that the inability to accurately map sounds and letters early in acquisition can negatively impact language learning success.

Comer and Murphy-Lee (2004) provide evidence that native English-speaking learners can experience difficulties with Russian GPCs; however, the relevance of Comer and Murphy-Lee's findings to those of the present study may be limited. Comer and Murphy-Lee (2004) were interested in the relationship between learners' ability to pronounce sounds represented by graphemes and ultimate success in a language learning classroom, whereas the present study is focused upon the ability to learn the phonological forms of new words. Minimally, Comer and Murphy-Lee (2004) provide evidence that

knowledge of GPCs is correlated with other kinds of success in a language learning classroom.

While the above studies investigated the effects of OI in instructed learners' acquisition, these studies do not systematically include learner types. That is, many studies include only a single group of learners (i.e., only advanced learners), or look at heterogeneous groups of "learners" who have differing experience with the target L2. These studies provide results and conclusion beneficial to understanding OI effects and L2 acquisition, but it is also necessary to understand how variables affect learners over the course of acquisition (i.e., naïve learner, beginner, intermediate, and advanced).

3.2.3 Orthographic input and instruction: Textual enhancement, instruction, and training

It is evident from section 3.2.2 that effects of OI on instructed learners yield varying results. There are studies including instruction (in an attempt) to mediate difficulties associated with OI or other variables (e.g., using OI to enhance performance on L2 contrasts). As with previous literature, accuracy at test within these studies demonstrates varying degrees of beneficence. In Showalter and Hayes-Harb (2015; detailed in section 3.2.1), native English speakers were unable to make use of the Arabic script during word learning. To mediate the suspected script difficulty, Showalter and Hayes-Harb provided a (brief) instruction that included descriptive information about Arabic (i.e., it is read from right to left), as well as examples with arrows pointing to the experimental consonants. Participants were also presented with English examples, showing that the first letter was on the left in English and on the right in Arabic. This

instruction did not assist participants during phono-lexical acquisition of words containing the /k/-/q/ contrast.

Jackson (2016) extended Showalter and Hayes-Harb (2015), by attempting to mediate the difficulty of the Arabic script and /k/-/q/ contrast in two ways: Romanizing the script with a familiar grapheme and either a diacritic or new grapheme for /q/, as well as providing instruction to participants. The new grapheme/diacritic for /q/ in the first condition was <ḳ> and the grapheme in the second condition was <ƛ>. Both <ḳ> and <ƛ> were meant to draw attention to the phone [q], which was posited to be a source of difficulty in Showalter and Hayes-Harb (2015). Participants in the instruction conditions were told, explicitly, about the experimental sounds. They were told that, although new to them, /q/ would sound similar to English /k/, and they were exposed to minimal pair examples. They were then told that the two sounds would be cued in the written forms and they should pay attention to the OI. After this, participants heard the same minimal pairs and saw their written forms. Participants were divided into four word-learning groups: diacritic and instruction, diacritic and no instruction, new grapheme and instruction, and new grapheme and no instruction. Jackson (2016) used the same procedure as Showalter and Hayes-Harb (2015). At test, the accuracy of scores for the four groups did not significantly different from one another. However, participants in the new grapheme and instruction condition had higher sensitivity to the contrast, suggesting that this combination was, to some degree, beneficial to participants in establishing the /k/-/q/ contrast. In addition, while the diacritic was not beneficial, those exposed to instruction with the diacritic were more accurate at test than their diacritic-no instruction counterparts.

It could be that the /k/-/q/ contrast, even with the script and grapheme changes in Jackson (2016), was still difficult for participants and affected accuracy at test, perhaps cancelling out OI effects. Brown (2015) investigated effects of instruction and OI on native English speakers' productions of German word-final devoicing of stops. Participants were either exposed to spelled forms or no spelled forms *and* instruction or no instruction. The instruction alerted participants that spelled forms in German do not always reflect pronunciation (e.g., <g> may be pronounced as [k]), and told them to remember this throughout the experiment. After word learning and the criterion test, participants moved to a production phase in which they saw a pictured meaning and produced the associated word. An additional group of participants then listened to the productions and determined from orthographically presented options (e.g., hear [tri:k], choose <k> or <g>) which consonant they heard word finally. For groups exposed to written forms, words spelled with voiced consonants were less likely to be devoiced during the production task. However, there was no difference observed between the performances of the instruction groups. In this case, instruction prior to word learning did not mediate effects of OI.

There are aspects of Russian phonology that pose difficulties for learners, even those at advanced stages (e.g., palatalization; Hacking, Smith, Nissen, & Allen, 2016). However, learners need to master target-like GPCs early to accurately comprehend and produce Russian in a variety of skills. Bown et al. (2007) investigated effects of English GPCs on the recognition of Russian GPCs, comparing two types of instruction: inductive and deductive. The deductive instruction exposed participants to GPCs prior to learning words. The letters were presented in four English-Russian pairing conditions (e.g., letters

that look and sound the same in English and Russian, letters that look like English but sound different in Russian). After exposure to the graphemes, participants practiced reading the new words before hearing them. The inductive instruction exposed participants to words and assisted them in discovering the GPCs. Participants listened to a story and reviewed the words. To assess their knowledge of GPCs, they were asked to identify which letter corresponded to a presented sound and received feedback about their answers. Participants were naïve learners of Russian. During a pretest and posttest, auditory words were presented, and participants noted the order in which they heard the words (from spelled options). Results indicated that inductive instruction was more beneficial. While Bown et al. (2007) presented several limitations of the study, it stands to reason that the learner-focused exposure to GPCs (inductive instruction), in which participants had to "figure out" the rule, led to a genuine improvement in the results.

The variable of instruction in the first three studies presented did not significantly affect accuracy at test. It may be the case that either the phonological contrast (/k/-/q/) was too difficult to perceive and therefore accurately encode information about words' forms, or that a phonological process (word final devoicing) was unable to be acquired in a target-like manner in an experimental hour (because of L1 knowledge interference). However, the inductive instruction of GPCs in Bown et al. (2007) benefitted participants. The present study removes the confound of difficult-to-perceive contrasts by containing only familiar or English-like phones, which should isolate the OI variables and their effects. Furthermore, the present study investigates how OI is taught in Russian language classrooms, incorporating practices *similar* to those in Bown et al. (2007). Understanding current instructional (classroom) practices may provide the foundation for a more

effective way to mediate OI effects within the experimental design.

3.2.4 Showalter (to appear) and the present study

The present study is an extension of Showalter (to appear); both contain the same methodology, but the present builds on Showalter by adding experienced learners (those with exposure to the target language) and interventions to assist naïve learners with observed OI difficulties. Showalter (to appear) investigated the effects of grapheme familiarity and congruence on native English speakers' ability to make inferences about the phonological forms of L2 pseudo-Russian words. During a word learning phase, participants heard auditory forms of words, saw pictured meanings, and either saw a meaningless sequence of letters (i.e., <XXX>) or saw Cyrillic forms. The stimuli were divided into three types: Familiar Congruent (familiar graphemes and congruent GPCs, e.g., <КОМ>-[kom]), Unfamiliar (unfamiliar graphemes, e.g., <ГИЛ>-[gil]), and Familiar Incongruent (familiar graphemes, incongruent GPCs, e.g., <РАТ>-[rɑt]). All phones were familiar (or English-like), allowing OI effects to be isolated (no confounding difficult-to-perceive contrasts as in e.g., Mathieu, 2016 or Showalter & Hayes-Harb, 2015). Participants were tested on their ability to determine whether auditory forms and pictures were matched or mismatched at test. Auditory forms in mismatched pairings for the Familiar Incongruent stimuli were based on English GPCs (e.g., matched <РАТ>-[rɑt], mismatched [pɑt]). It was found that those exposed to the Cyrillic spelled forms had more difficulty at test than those exposed to <XXX>; specifically, Familiar Incongruent stimuli significantly interfered with participants' accuracy at test.

The results found in Showalter (to appear) provide evidence that incongruent English-Russian GPCs interfere with the ability to make inferences about the phonological forms of L2 words. Unfamiliar graphemes did not affect participants; however, the stimuli in the Unfamiliar condition were structurally different from the other two stimulus conditions. Namely, they had a different vowel (i.e., /i/ versus /ɑ/ and /o/) and *all* graphemes were entirely unfamiliar. These differences may have provided an unintended advantage. Therefore, to address the issue that one group of stimuli were maximally different from the other two, stimuli in the present study will be changed to be more similar to one another.

Another change from Showalter (to appear) is the inclusion of learners. Because Orthography and No Orthography condition naïve learners' performances differed, and interference effects were quite robust, it is of interest to determine when these effects are "overcome" during L2 Russian acquisition. It is expected that learners, at some stage, map Russian graphemes and phonemes in a target-like manner, but whether this is true has not been empirically found. Finally, Showalter (to appear), Comer and Murphy-Lee (2004), and Bown et al. (2007) present evidence that Russian GPCs are difficult for naïve learners and beginner learners. It is expected that learners with more Russian experience will be less affected by "misleading" OI. If more experienced learners do not overcome OI effects, based on results of previous studies, it is of interest whether OI effects can be mediated early so that naïve and beginner learners can acquire Russian in a target-like manner and succeed in Russian courses. The present study is therefore designed to answer the following: How do grapheme familiarity and congruence interact during L2 Russian phono-lexical acquisition? Are grapheme familiarity and congruence effects

mediated as experience increases? Can the effects of grapheme familiarity and congruence in naïve learners be mediated via intervention?

3.3 Method

Russian allows for both grapheme familiarity and congruence to be manipulated within a single script; in relation to English and the Roman alphabet, Cyrillic contains familiar graphemes, unfamiliar graphemes, congruent GPCs, and incongruent GPCs, allowing us to investigate effects of OI on individual participant basis. As mentioned, the present study is an extension of Showalter (to appear), with the inclusion of instructed learners of Russian and interventions designed to mediate OI effects during GPC acquisition. Because the stimuli in Showalter (to appear) included both words and nonwords of Russian, as well as real object pictures, the stimuli in the present study had to be redesigned so as not to inappropriately advantage the learners or negatively affect word learning by, for example, requiring them to learn a new word for a known object. Due to the stimuli changes, we also sought replicate the results of Showalter (to appear) in the two naïve learner conditions (No Orthography and Orthography).

3.3.1 Participants

3.3.1.1 Naïve learners of Russian

There were four groups of naïve learners, who were randomly assigned to one of four word-learning conditions (described later), and were native English speakers with no hearing, developmental, or neurological disorders. All participants were recruited from undergraduate courses at the University of Utah and received course credit or monetary

reimbursement for their participation. Naïve learners had no formal (instructed) Russian or Cyrillic experience, and were randomly assigned to the Orthography (*n* = 20), No Orthography (*n* = 20), Intervention A (*n* = 20), or Intervention B (*n* = 20) word-learning condition described below.

The No Orthography group consisted of 5 males and 15 females, and had an average age of 23.3 years (range 18-39). The Orthography group was comprised of 10 males and 10 females, and the average age was 24.5 years (range 19-48). The Intervention A group consisted of 8 males and 12 females, and had an average age of 21.4 years (range 17-32). The Intervention B group was comprised of 4 males, 15 females, and 1 participant who did not elect to indicate gender. The average age of the Intervention B participant group was 24.8 years (range 17-71).

3.3.1.2 Learners of Russian

Learners of Russian were recruited from Russian courses at the University of Utah and received course credit for participation. To ensure that students in each level would be as homogenous as possible in their exposure and experience with Russian, all testing took place within the first 2 months of the semester and within a 2-week period. Demographic and language learning information for all learners was (nearly) homogenous within the class levels; however, due to the low number of intermediate students (2000 level), learners were divided into beginner and experienced groups based upon a combination of their current class and the number of years they had been learning Russian. Dividing the learners in this manner could make them less distinct; however, only enough learners to reach a reasonable group size from the intermediate classes were

used and they were chosen based upon the years learning that most closely matched the beginner and advanced demographics. Tables 3.1 and 3.2 provide the demographics for the beginner and experienced learners. An independent-samples *t*-test revealed a significant difference between the years learning Russian for the beginner (mean 0.27 years) and experienced (mean 3.28 years) learner groups ($t(38) = -7.59$, $p = 0.00$). This provided confirmation that the beginner and experienced groups were indeed different from one another. Some learners were excluded for previous experience with a Cyrillic based non-Russian language ($n = 2$), being a nonnative speaker of English ($n = 5$), or being a heritage speaker of Russian ($n = 4$). These factors could unduly advantage learners over other learners or naïve learners.

Beginner learners ($n = 20$) were enrolled in Russ 1010 (first semester of university classes; $n = 15$) or 2010 (first semester or 2nd year Russian; $n = 5$) and had been learning Russian for less than a year (except one learner who had 3 years of experience). Time learning Russian ranged from 1 month to 3 years, and the group average was 0.27 years. All beginners self-rated their proficiency as "basic" (options: basic, conversational, fluent), except for two who rated their proficiency as "conversational." The average age for the group was 23.4 years (range 18-63) and consisted of 13 males and 7 females. Other than one participant spending 1 week in Latvia, none of the beginner learners had spent time in a Russian speaking country. For many, the reason for learning Russian was interest in the language and culture, but some indicated learning Russian to qualify for a scholarship or for future employment. Beginner learners did not report using Russian outside of studying or in class, but a few noted (rarely) listening to music, watching videos or movies, or practicing with others.

Table 3.1. Demographics for beginner learners of Russian

Gender	Age	Current class	Self-rated proficiency	Years Learning Russian	Motivation	Time in Russian speaking country	Use of Russian Outside class	Other learned languages
Male	18	1010	Basic	3 months	Area of interest	N/A	Little: reading	None
Male	26	1010	Basic	1 month	Area of interest	N/A	Not used	Spanish Chinese
Male	20	1010	Basic	1 month	Major; area of interest	N/A	Little: social media	None
Female	19	1010	Basic	1 month	Language requirement	N/A	Not used	Spanish
Male	28	1010	Basic	1 month	Prospective job	Latvia, 1 week	Not used	Spanish
Male	19	1010	Basic	1 month	Familial ties	N/A	Little: speaking	Spanish
Male	18	1010	Basic	1 month	Area of interest	N/A	Little: speaking	Spanish
Male	17	1010	Basic	1 month	Area of interest	N/A	Some: speaking	None
Male	26	1010	Basic	1 month	Prospective job	N/A	Little: speaking	None
Female	19	1010	Basic	2 months	Area of interest	N/A	Little: speaking	American sign language
Male	28	1010	Basic	1 month	Scholarship	N/A	Not used	Mandarin
Female	18	1010	Basic	1 month	Area of interest	N/A	Little: speaking, watching films	French Spanish
Male	30	1010	Basic	1 month	Area of interest	N/A	Some: music, reading	Spanish
Female	19	1010	Basic	1 month	Prospective job	N/A	Not used	Japanese
Male	18	1010	Basic	3 years	Familial ties	N/A	Some: speaking	Spanish
Female	63	2010	Basic	9 months	Familial ties	N/A		Spanish French Hebrew
Female	22	2010	Basic	1 year	Prospective job	N/A	Not used	Spanish French Chinese
Male	21	2010	Conversational	1 year	Prospective job	N/A	Little	Tagalog Ilocano French
Female	19	2010	Conversational	1 year	Area of interest	N/A	Some: speaking	Spanish
Male	20	2010	Basic	1 year	Scholarship	N/A	Often: videos, reading	Spanish Portuguese

Table 3.2. Demographics for experienced learners of Russian

Gender	Age	Current class	Self-rated proficiency	Years Learning Russian	Motivation	Time spent in Russian speaking country	Use of Russian Outside class	Other learned languages
Male	20	3060	Fluent	2 years	Religious mission	Russia, N/A	Daily: speaking, reading	None
Male	20	3060	Conversational/ Fluent	2 years	Religious mission	Russia, N/A	Daily: speaking, reading, writing	None
Female	20	3010	Conversational	3 years	Area of interest	N/A	Some: movies, music, Duolingo practice	None
Female	22	3040	Conversational	2 years	Area of interest	N/A	Little: N/A	Spanish Arabic
Male	22	3060	Conversational/ Fluent	4 years	Religious mission	Russia, N/A	Little: videos	Arabic German
Female	23	4610/ 3060	Fluent	4 years	Religious mission	Siberia/Russia, N/A	Little: television, social media	German
Female	21	300	Conversational	2 years	Religious mission	Russia, 18 months	Some: speaking, reading	Spanish French
Male	26	N/A	Conversational	7 years	Religious mission	Latvia, 2 years	Some: N/A	None
Male	23	4610	Fluent	4.5 years	Religious mission	Russia, 19 months	Some: speaking	Spanish
Male	29	4610	Conversational	2 years	Religious mission	Russia, 2 years	Some: speaking, movies	None
Male	24	4610	Conversational	4 years	Prospective job	Russia, 11 weeks	Some: movies, reading, additional studying	Spanish Italian
Female	24	4610	Conversational	4 years	Religious mission	Russia, 16 months	Little: speaking, watching films	Chinese
Male	23	3060	Conversational	7 years	Religious mission	Russia, 2 years	Little: speaking, watching films	Spanish
Male	22	3040	Conversational	1.5 years	Area of interest	Russia, 2 months	Little: N/A	Spanish
Male	21	4610	Conversational	2.5 years	Prospective job	N/A	Little: reading, videos	None
Male	18	3060	Conversational	1 year	Area of interest	Russia, 4 days	Some: movies, reading, music	Spanish
Male	21	3060	Fluent	3 years	Religious mission	Russia, N/A	Some: reading, music	None
Male	20	3060	Fluent	2 years	Religious mission	Russia, 2 yeas	Some: speaking, reading, music	None
Male	35	2010	Basic	4 years	Area of interest	N/A	Some: speaking, music	None
Male	22	2010	Conversational	4 years	Religious mission	Ukraine, 1 years	Little: videos	Spanish German

Experienced learners (n = 20) were students enrolled in a 3000-level class or higher, except for two enrolled in 2010. The average time learning Russian was 3.28 years (range 1-7), the average age was 22.8 years (range 18-35), and the group included 15 males and 5 females. Seven self-rated their proficiency as fluent or between conversational and fluent, while the remainder rated themselves as conversational (and one rated himself as basic). Sixteen of the participants had previously visited a Russian speaking country, and most of them had gone for a religious mission lasting a few weeks to 2 years (with the exception of one person who stayed only four days). For the few who had not listed a mission as their reason for studying Russian, they indicated learning Russian as a language and culture of interest. Overall, the experienced learners reported using Russian outside of class; they watched videos, read books or articles, listened to music, or spoke with native Russian speakers at least once a week, if not more.

All learners of Russian completed word learning with the Cyrillic representations (Orthography condition word learning). A No Orthography Russian learner condition was not included (nor was a No Orthography Intervention condition), as the comparison of primary interest was between the various learner and intervention groups and the naïve orthography group. It is, however, an empirical question whether learners of Russian without OI indeed perform similarly to naïve learners or whether their experience with Russian might affect their Russian-like word learning ability in the absence of OI.

3.3.2 Stimuli

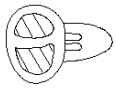
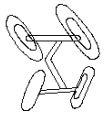
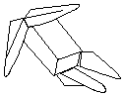
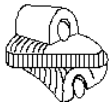
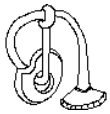
All stimuli contained familiar phones or phones that sound English-like. Three stimuli conditions were constructed: Familiar-Congruent (FamCong), Unfamiliar

(Unfam), and Familiar-Incongruent (FamIncong). FamCong stimuli contained experimental (the initial) consonants in which all graphemes were familiar and mapped to the same phone in English and Russian (e.g., <MAKO>-[mɑkə]). Unfam stimuli contained initial Cyrillic-specific consonants (e.g., <Ш>-[ʃ]), but the remainder of the word was written with familiar graphemes, or those common to English and Russian, and contained congruent GPCs (e.g., <ШОМА>-[ʃomə]). Stimuli in the FamIncong condition were written with familiar graphemes, but the English GPC and the Russian GPC for the word initial consonant were not the same (e.g., <РАМО>- Russian [rɑmə]; English [pɑmə]). All stimuli were of the type CVCV. A full list can be found in Table 3.3.

All stimuli were nonwords (henceforth referred to as *words*) and paired with a nonobject picture. Nonobject pictures ensured that Russian learners would not be learning a new word for a picture already in their lexicon. Nonobject pictures also ensured that, if any experimental words were (similar to) real Russian words, learners would not be inappropriately advantaged; if a word were similar, they might not have to "learn" it again. The words followed Russian phonology patterns. The first syllable was stressed and the final vowel was reduced to [ə]; trochee syllables occur in English (e.g., <mocha>-[mokə]), and should not sound exceptionally unfamiliar to naïve learners. Consonants for each group were distributed as equally as possible, with an attempt to maintain nonword status, have no group overlap, and (as able) avoid English-sounding words.

Each word had associated correct and foil auditory forms. Correct auditory forms followed Russian grapheme-phone mappings. Foil auditory forms for FamIncong stimuli contained the incongruent English mapping (see Table 3.3). Foil auditory forms for the FamCong and Unfam stimulus conditions were at least two articulatory features (initial

Table 3.3. List of stimuli

	Orthography form	Correct Auditory	Foil auditory	Pictured meaning
Familiar Congruent	КАТА	[kɑtə]	[ʃɑtə]	
	МАКО	[mɑkə]	[gɑkə]	
	МОТА	[motə]	[lotə]	
	ТОМО	[tomə]	[nomə]	
Familiar Incongruent	САТО	[sɑtə]	[kɑtə]	
	ХОКА	[hokə]	[zokə]	
	РАМО	[rɑmə]	[pɑmə]	
	НАКА	[nɑkə]	[hɑkə]	
Unfamiliar	ШОМА	[ʃomə]	[bomə]	
	ЗАМО	[zɑmə]	[nɑmə]	
	ЛАКО	[lɑkə]	[vɑkə]	
	БОТО	[botə]	[motə]	

consonant only) away to minimize cross-group form overlap, to exclude English-like words, and to avoid real words of Russian[1]. Minimal overlap across the groups and correct/foil forms occurred (i.e., [motə] was the correct auditory form for <MOTA> and the foil form for <БОТО>), but allowed for avoidance of real Russian words and English-sounding words given the consonants and grapheme-phone combinations available.

FamIncong stimuli were redesigned after review of the stimuli in Showalter (to appear). First, following up on results, we found that all FamIncong stimuli pairs had roughly equivalent accuracy scores and fell below FamCong and Unfam scores. The incongruent <B>-[v] pair was replaced; /b/-/v/ are auditorily confusable (see e.g., Ota, Hartsuiker, & Haywood, 2009; Experiment 1) and the pair had the lowest accuracy scores in Showalter (to appear). Because we were unable to discern if this was due to the OI or auditory confusability, <B>-[v] was replaced with the pair <X>-[h]. While this mapping may occur in English, GPCs of this type do not occur word initially (for more discussion see Hayes-Harb & Cheng, 2016). Scores for the pair <C>-[s] were equivalent to other pairs in Showalter (to appear), supporting inclusion. Again, this mapping is possible in English but is not frequently observed in initial position (i.e., <#CA> is not pronounced as [sa], but the [s] mapping in words such as <science>, <city>, <acid>, etc.).

Unfamiliar stimuli followed the previously stated rules, and whether the

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[1] The stimulus set (presented in Table 3.3) was developed to respond as well as possible to the numerous pressures detailed in section 3.3.2, and in some places involves a compromise between competing criteria. For example, the Unfam nonword [botə] and its foil auditory form ([motə]) are in fact distinguished by one feature (not two). In addition, the ideal of not allowing overlapping stimuli (and foils two features away from the correct auditory forms) was violated with the form [motə] (FamCong correct form and Unfam foil) in order to respect the requirement that stimuli not be real words in Russian.

unfamiliar grapheme would be familiar via exposure to other languages (e.g., Greek letters in sorority or fraternity names). Additionally, in Showalter (to appear), all graphemes in the Unfam condition were unfamiliar. Because only the first consonant is crucial to test, and is of focus in the other stimulus groups (especially FamIncong), only the first consonant was an unfamiliar grapheme in the present. This change could make word learning more difficult, given that all stimuli are now maximally similar (previously, all participants performed near ceiling on Unfam stimuli).

Two native Russian speakers, including the speaker who produced the stimuli, and one nonnative, high proficiency speaker, helped create the nonwords[2], which were also checked against a Russian dictionary. The stimuli were then produced by a native female speaker of Russian (26 years old) from Russia. She had been in the United States for 3 months as a Fulbright Scholar. She read the words three times in a row and read the entire list two times. The researcher chose the best quality correct-foil pair.

3.3.3 Procedure

3.3.3.1 General procedure

Following similar studies (e.g., Hayes-Harb & Cheng, 2016; Mathieu, 2016; Showalter & Hayes-Harb 2013, 2015), the present study contained an auditory word-picture matching paradigm. The experiment was presented via DMDX (Forster & Forster, 2003) in a sound-attenuated booth, with participants seated in front of a computer. There were three phases: word learning, a criterion test, and a final test.

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[2] PAMO, is a name. ШАТА ([ʃɑtə]; a foil form), is a low frequency word, in both languages, meaning “to totter.” Learners did not indicate knowing either word.

Naïve learners were randomly assigned to one of four word-learning conditions: Orthography, No Orthography, Intervention A, or Intervention B. All learners were assigned to the Orthography condition, as we were interested in how OI variables would affect their performance at varying experience levels. During word learning, participants saw nonobject pictured meanings, heard correct auditory forms, and either saw the sequence (<XXXX>; No Orthography) or the words' spelled forms (Orthography, Intervention A, Intervention B). An example trial can be found in Table 3.4 for Orthography and No Orthography participants (intervention conditions are explained in the following section). Participants did not need to provide answers during word learning, but were told to memorize the words and their meanings. All 12 words were randomly presented two times per block in four different blocks for a total of 96 presentations.

After word learning, participants completed the criterion test, which indicated whether they had generally learned the words (i.e., that there were 12 different words). Twelve of the auditory word-picture pairings were matched as presented during word learning, and 12 were mismatched with a word from a different stimulus condition (example trials are shown in Table 3.5). Participants had 3 seconds to answer before the

Table 3.4. Example word learning trials

SEE		
	HAKA	XXXX
HEAR	[nɑkə]	
RESPONSE	no response needed	

Table 3.5. Example criterion test trials

	Matched	Mismatched
SEE		
HEAR	[nɑkə]	[tomə]
RESPONSE	Yes	No

trial time out, the response was marked as incorrect, and the next trial began. If participants did not reach a criterion of 90% accuracy, they repeated the word learning-criterion test cycle, which could be done as many times as necessary.

The final test was identical to the criterion test, but mismatched items were based on foil auditory forms. Participants made decisions about 24 auditory word-picture pairs; 12 of the pairs were matched and 12 mismatched. Example trials are provided in Table 3.6. After participants completed all three phases of the experiment, they filled out a questionnaire detailing their language background and (for learners) Russian learning experience. The entire experiment took approximately 30 minutes to complete.

Table 3.6. Example final test trials

	Matched	Mismatched
SEE		
HEAR	[nɑkə]	[hɑkə]
RESPONSE	Yes	No

3.3.3.2 Interventions

To create interventions grounded in evidence-based practice, we reviewed current Russian instructional materials. Syllabi for 1st- and 2nd-year classes (i.e., Russian 1010, 1020, 2010, 2020) were obtained from three universities. Eight Russian textbooks were reviewed: *Golosa: A Basic Course in Russian, Book One* (Robin, Evans-Romaine, & Shatalina, 2012), *Student Book 1, Russian Step by Step* (Alexandrova, 2015), *Russian Step by Step. Low Intermediate Level 2* (Alexandrova, 2010a), *Russian Step by Step. Intermediate Level 3* (Alexandrova, 2010b), *Russian Handwriting: Propisi Volume 1* (Alexandrova, 2012), *Russian Stage One: Live from Russia!* (Lekic, Davidson, & Gor, 2013), *Russian Stage Two: Welcome Back!* (Doglova & Martin, 2009), and *Beginner's Russian* (Kudyma, Miller, & Kagan, 2015). Finally, Russian instructors completed an online survey about observed GPC and Russian alphabet difficulties.

Syllabi provided detail about the extent to which the alphabet is of focus, indicating that time dedicated to the alphabet lasted anywhere from a few days to roughly 2 weeks (in instructional time; 3-4 contact hours a week). Beyond in-class instructional time, some instructors provided websites or materials for additional reference, but did not explicitly address the alphabet and GPCs again.

Many of the instructors and much of the material indicated that the Cyrillic alphabet can be difficult to learn, and time must be devoted to learning its various nuances: differences between print and cursive; capital and lowercase letters; new sounds and new graphemes; spelling rules that alter expected spellings and pronunciations; palatalization; stress; and, to a minor extent (if at all), that some GPCs differ from English. After introductory time spent on teaching the alphabet, GPCs did not arise again

in the reviewed material. This is counter to other issues (e.g., spelling rules, stress), which are reviewed in various chapters and contexts. Furthermore, the only information about GPCs is placing sounds and letters into groups to be learned with descriptions such as, “letters and sounds that are the same” (friends), “letter and sounds that differ [from English]” (false friends), and “new letters and sounds” (new). In different textbooks, these are divided further (e.g., “familiar Greek letters”) or associated with English words containing the same sound (e.g., from Robin, Evans-Romaine, & Shatalina, 2012, “Ц sounds like ts in cats,” p. 7 or “В sounds like v in volcano,” p. 5). Many instructors noted that reference materials (e.g., textbook appendices) are available, meaning students have access to review and learn GPCs. However, what is contained within this review material is not GPCs but the alphabet (in its four variations: uppercase, lowercase, print, cursive) or rules for phonological patterns and spellings.

One website (which has accompanying textbooks) not mentioned in the survey responses or syllabi specifically addresses GPCs. Между нами (*Mezhdu nami*; deBenedette, Comer, Smyslova, & Perkins, n.d.) provides (more) description and instructional sections on the alphabet and relations between graphemes and phones. The authors make use of terminology from the field of L2 acquisition (yet understandable by the layperson) to describe mappings between letters and sounds. Students are encouraged to learn letter-sound mappings as quickly as possible, being told that this will aid reading and writing skills. Letters are split into groups as mentioned above, with detail about cursive and print differences, but the alphabet (sometimes just as spelling/stress rules) is integrated throughout the curriculum as opposed to being restricted to the first few days.

An online instructor survey was sent to a nationwide Russian instructor listserv to

collect accounts and reactions of GPC difficulties. The survey contained questions regarding instructors' basic language background, Russian teaching experience, and impressions of GPC difficulties learners may have. The full survey can be found in section 3.6. A total of 49 responses were collected; however, due to technical difficulties, only 39 of the responses could be analyzed. Thirty-six instructors reported that they were currently teaching or taught in university/college settings, and 29 instructors had more than 5 years of Russian teaching experience. Instructors also indicated that students typically had no or less than 2 years of Russian experience prior to their classes.

The last section of questions, of most importance, referred to GPC difficulties. A brief paragraph introduced the issue, outlining English-Russian GPC differences and what must be (un)learned by students. Instructors were asked whether they observe issues. If an answer of "NO" was supplied, the respondent was thanked, and the survey ended. If an answer of "YES" was supplied, respondents continued with specific questions about observed difficulties. Eleven of the 39 instructors responded with "NO." The 28 instructors responding "YES" were next provided with the Cyrillic alphabet in both print and cursive, as well as capital and lowercase forms, and asked to indicate which letters provide difficulty or confusion for students. Both print and cursive were included, as some letters may be troublesome in only one form. Of the 33 printed letters, six were identified by eight or more of the instructors as troublesome: Бб, Вв, Йй, Рр, Цц, and Щщ. Of the 33 cursive letter forms, six were identified by eight or more of the instructors as troublesome (provided here in print): Бб, Вв, Гг, Дд, Йй, and Тт. Of the total 66 items, only five were not identified by instructors as causing difficulty (had zero responses; print: Аа, Кк, Лл, Мм, cursive: Кк). Results indicate that letters with

congruent GPCs in English and Russian (Aa, Кк, and Мм) did not cause difficulties; however, unfamiliar graphemes or graphemes in incongruent GPCs do provide some degree of difficulty.

It is evident from the "problem" letters that many instructors do notice alphabet/ GPC difficulty in learners, and they were asked how they address these issues. Only two of the respondents indicated explicitly addressing sound-spelling issues. The majority of instructors' responses mirrored syllabi and textbooks—an introduction is provided and minimal time is spent on the alphabet prior to moving along. A few instructors implied that "good learners" will acquire what is needed to succeed in Russian, while some instructors indicated that they provide additional materials to help students (e.g., handouts, videos, tutoring, flashcards, exercises). Instructors were asked how textbooks and instructional materials handle sound-spelling difficulties, and they unanimously answered that textbooks lack adequate coverage of GPCs. Again, a few instructors mentioned other materials used to assist learners (e.g., flashcards, activities, PowerPoints). However, the information provided was not enough to determine whether these materials were included during classroom instruction.

Comer and Murphy-Lee (2004) found that learners who do not establish target-like GPCs early in their first semester of Russian are more likely to fall behind their peers and receive lower grades. Instructors were asked whether they agreed with this conclusion, and what impressions they had of GPC-Russian performance correlations. Most instructors agreed with Comer and Murphy-Lee (2004), and reported that an inability to establish target-like GPCs affects multiple language skills. This causes students to fall behind, receive lower grades, drop Russian from their course load, or

enter a state of arrested development. Instructors observe sound-spelling difficulties and recognize the consequences this has for learners, especially learners at early stages. Responses to the last question, however, asking whether students "sort out" the difficulties and how instructors attempt to moderate them, were disheartening. Instructors indicated learners require a range of time, from the first few weeks to the end of the second year (fourth semester), to "sort out" the difficulties. Furthermore, many instructors indicated that "serious," "diligent," or "better" language learners would acquire target-like GPCs early. Those who did not fit this learner type would have to study on their own or receive lower grades. A few instructors added that ("basic") GPC difficulties seem to occur in learner productions for long periods of time (i.e., "even 4th- and 5th-year Russian students"), especially during times of stress such as reading aloud or in presentations.

Responses demonstrate that Russian instructors observe GPC difficulties in learners, recognize the inability to establish target-like GPCs early in acquisition is a detriment to progress and success, and agree that current materials do not adequately address and assist with these difficulties. In addition to the Russian instructional materials, instructor surveys, and previous findings of GPC difficulties, we reviewed L2 acquisition instructional techniques. The goal was not to design classroom instruction or to survey the state of L2 Russian instruction, but understand whether an experimental intervention could mediate OI difficulties and facilitate acquisition in naïve learners.

Input enhancement is an instructional technique designed to draw attention (explicitly or implicitly) to a particular L2 form (Sharwood Smith, 1993). Given that the present study investigates the effect of OI, the enhancement of focus is textual

enhancement. The effect of input enhancement on participants' acquisition is debated, largely dependent on the tested linguistic form, task type, or enhancement provided. Some studies report beneficial effects of enhancement on learning L2 forms (e.g., Jourdenais, Ota, Stauffer, Boyson, & Doughty, 1995), and some report no or mixed effects (De Santis, 2008; Leow 1997). Furthermore, input enhancement studies typically focus upon either grammatical elements (e.g., verbal morphology) or lexical learning, with few studies examining L2 phonological acquisition. Those that do focus upon phonological forms (e.g., Alsadoon & Heift, 2015), have found that attention drawn to OI is beneficial in phonological tasks. Enhancing the consonants of focus in the present stimuli may draw attention to familiarity and congruence differences, aiding performance at test.

With the collected information, two interventions were created: Intervention A and Intervention B. Intervention A did not have instruction prior to word learning, reflecting inductive learning. During word learning, the first consonant (of GPC focus) of each word was bolded and enlarged. Other textual enhancement was not chosen, for example, underlining, as this could have been erroneously taken as a diacritic. If this occurred, it would be difficult to determine whether participants interpreted textual enhancement as a reason to focus on the first consonant or believed they were hearing a new sound (and not a familiar phone, drawing attention away from OI). Table 3.7 provides an example of a word learning trial for each stimulus condition.

Intervention B reflected deductive learning and provided instruction prior to word learning. Participants were told that there were "some important points to remember." They were then provided information about the three stimulus conditions. For the Unfam

Table 3.7. Example intervention word learning trials

	Familiar-Congruent	Unfamiliar	Familiar-Incongruent
SEE	 **К** А Т А	 **Л** А К О	 **Н** А К А
HEAR	[kɑtə]	[lɑkə]	[nɑkə]

group, they were told, “some of the spelled forms will have new letters.” After advancing to the next screen, they heard a word from this group and simultaneously saw the pictured meaning and written form (as they would during word learning). For the FamCong group, they were told, “some of the spelled forms will look and sound very familiar,” and the next screen presented a visual and auditory example. For the FamIncong group, they were told, “Some of the spoken words will sound like English, but the spelled forms contain different letters than you might expect.” Again, they were subsequently provided an example. On the next screen, the consonants from the incongruent stimuli (i.e., С, Х, Р, Н) were written in red with the warning, “These letters will sound different than you expect!” The last screen of instruction said, “Take a moment to review the letter groups. The blue letters are new letters. The black letters are familiar letters. The red letters are familiar but sound different.” The accompanying picture included the consonants in their stimuli and color groups: blue letters were <Ш, З, Л, б>, black letters were <М, Т, К>, and red letters were <С, Х, Р, Н>. Instructions were self-paced and participants could take as long as necessary to review them. After the participants had gone through the instruction portion of the intervention, they proceeded to the word learning phase. Word learning was identical to that of Intervention A with the enlarged and bolded forms.

3.4 Results

3.4.1 Cycles

We first reviewed the number of word learning-criterion test cycles required by each group to reach criterion. The following are the mean number of cycles required per group: No Orthography 1.30 (range 1-3), Orthography 1.45 (range 1-3), Intervention A 1.80 (range 1-4), Intervention B 1.90 (range 1-4), Beginner 1.45 (range 1-3), and Experienced 1.20 (range 1-2). The average number of cycles for each group were submitted to a one-way between-subjects ANOVA with word-learning condition as the independent variable (six levels: No Orthography, Orthography, Intervention A, Intervention B, Beginner, and Experienced) and number of cycles as the dependent measure. There was a significant effect of group ($F(5, 114) = 3.48$, $p = 0.006$. *partial* $\eta^2 = 0.117$). Pairwise analyses (independent samples *t*-tests) indicated there were significant differences between the following: No Orthography and Intervention A ($t(38) = -2.21$, $p = 0.033$), No Orthography and Intervention B ($t(38) = -2.92$, $p = 0.006$), Intervention A and Experienced ($t(38) = 2.89$, $p = 0.006$), and Intervention B and Experienced ($t(38) = 3.79$, $p = 0.001$). In each of these pairs, the Intervention condition participants required more cycles to reach criterion than the other pairwise condition. There were two marginally significant differences: Orthography and Intervention B ($t(38) = -2.03$, $p = 0.050$) and Intervention B and Beginner ($t(38) = 2.03$, $p = 0.050$). Again, the Intervention condition participants required more cycles to reach criterion. No other group differences for required cycles were significant.

3.4.2 Mean proportion correct and d-prime scores

Mean proportion correct scores at test per stimulus condition and by word-learning condition are presented in Figure 3.1. All participants had near ceiling accuracy scores (all above 90%) on matched items in all stimulus conditions. Accuracy on mismatched items in the FamCong and Unfam stimulus conditions was also near ceiling (above 92%) for all participants. However, mean proportion correct scores for mismatched FamIncong items were less accurate. No Orthography and Experienced participants had the highest scores (97.5% and 96%), followed by Beginner, Intervention A, and Intervention B participants (90%, 89%, and 86%, respectively). Orthography condition participants yielded the lowest accuracy scores on FamIncong items (79%).

To measure sensitivity to the stimuli differences, proportion correct scores were converted to d-prime scores. Figure 3.2 presents these scores by stimulus condition and

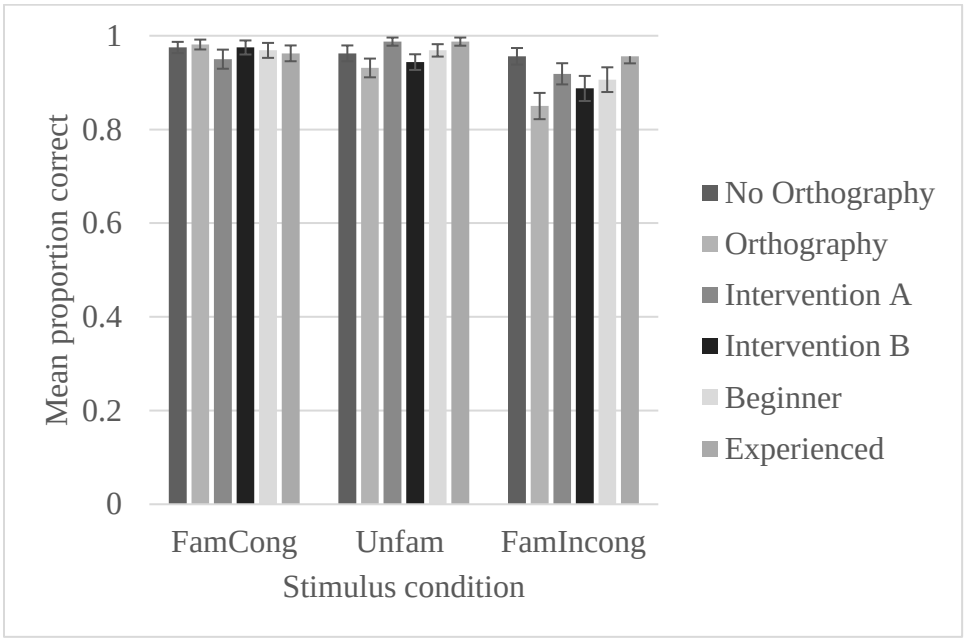

Figure 3.1. Mean proportion correct scores by word-learning condition per stimulus condition. Error bars represent ±1 standard error.

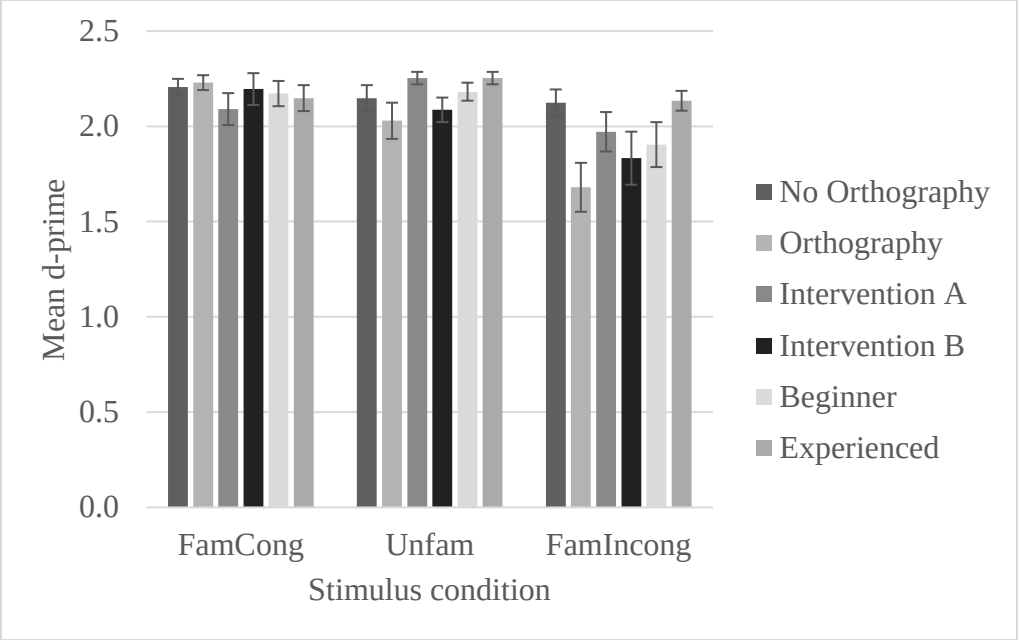

Figure 3.2. Mean d-prime by word-learning condition per stimulus condition. Error bars represent ±1 standard error.

word learning group. The d-prime scores were then submitted to a two-factor mixed-design ANOVA with word-learning condition as the between-participants variable (six levels: No Orthography, Orthography, Intervention A, Intervention B, Beginner, and Experienced) and stimulus condition as the within-participants variable (3 levels: Unfam, FamIncong, FamCong). There was a significant main effect of stimulus condition ($F(2, 228) = 17.80$, $p = 0.000$, *partial* $\eta^2 = 0.135$), a significant interaction of stimulus condition and word-learning condition ($F(10, 228) = 2.15$, $p = 0.022$, *partial* $\eta^2 = 0.086$), but no significant main effect of word-learning condition ($F(5, 114) = 2.07$, $p = 0.074$, *partial* $\eta^2 = 0.083$).

With the finding of a significant stimulus and word-learning condition interaction, the effect of word-learning condition on performance in each stimulus was examined. Three one-way between-subjects ANOVAs with word-learning condition as the between-

participants variable (six levels: No Orthography, Orthography, Intervention A, Intervention B, Beginner, and Experienced) and stimulus condition d-primes as the dependent measures were conducted. There was a significant effect of word-learning condition on FamIncong stimuli ($F(5, 114) = 2.70$, $p = 0.024$, *partial* $\eta^2 = 0.096$), but no effect of word-learning condition on either Unfam stimuli ($F(5, 114) = 2.19$, $p = 0.060$, *partial* $\eta^2 = 0.081$) or FamCong stimuli ($F(5, 114) = 0.552$, $p = 0.736$, *partial* $\eta^2 = 0.023$).

Investigating the effect of word-learning condition on FamIncong stimuli further, a series of pairwise comparisons were conducted (independent-samples *t*-tests). The following differences between conditions' d-prime scores were significant: No Orthography d-primes were higher than Orthography d-primes ($t(38) = 3.04$, $p = 0.004$), and Experienced d-primes were higher than Orthography d-primes ($t(38) = -3.28$, $p = 0.002$). No other differences were significant, but Experienced d-primes were nearly significantly higher than Intervention B d-primes ($t(38) = -2.03$, $p = 0.050$)

3.5 Discussion

The present study was an investigation of grapheme familiarity and congruence effects on phono-lexical acquisition. We tested naïve English speakers who had no formal exposure to Russian, as well as learners of Russian, to determine whether effects of OI are mediated with increased experience. Furthermore, we investigated whether naïve learners could benefit from an intervention, designed to assist in the establishment of target-like GPCs. The stimuli allowed for a within-subjects design, comparing how OI that is familiar-congruent, unfamiliar, and familiar-incongruent affects participants' abilities to make inferences about phonological forms of L2 words. Recall the research

questions: How do grapheme familiarity and congruence interact during L2 Russian phono-lexical acquisition? Are grapheme familiarity and congruence effects mediated as experience increases? Can the effects of grapheme familiarity and congruence be mediated in naïve learners via intervention?

First, we compared the scores of naïve learners of Russian who were either exposed to Cyrillic input (Orthography) or the sequence <XXXX> (No Orthography). Participants exposed to OI performed less accurately at test than those who were not exposed to spelled forms. Specifically, participants demonstrated an interference effect associated with FamIncong stimuli. That is, when GPCs were English-Russian incongruent (e.g., <H>-English [h], Russian [n]), native speakers of English were unable to suppress their knowledge of L1 GPCs to acquire the new L2 GPCs. Accuracy at test for both groups of participants on FamCong and Unfam stimuli was near ceiling, suggesting that, in this case, congruent GPCs and unfamiliar graphemes do not interfere with phono-lexical acquisition. It can be concluded, under the present circumstances, that grapheme familiarity did not affect participants' ability to learn new L2 words; however, the variable of incongruence is a robust factor in acquisition.

Comparing accuracy at test by the naïve learners (Orthography and No Orthography) and the learner groups, similar stimuli condition patterns were found. Overall, FamCong and Unfam accuracy at test was high, but FamIncong stimuli yielded the lowest accuracy. However, as experience level increased, accuracy at test on FamIncong stimuli increased as well. In response to the research questions, effects of OI appear to be mediated with increased Russian (GPC) experience. Indeed, d-prime scores of the (naïve) Orthography and Experienced groups significantly differed on FamIncong

stimuli. While d-prime scores between the Beginner and Experienced groups did not significantly differ (p = .082) on FamIncong stimuli, the Experienced group did have (descriptively) higher d-primes. Experienced learners performed equivalently across stimulus conditions, suggesting that they were not affected (more/unduly) by grapheme familiarity or congruence. Their Russian experience and knowledge of the L2 sound-spelling mappings supported their ability to make target-like inferences about word forms.

It is worthwhile to consider the differences outlined here regarding the distribution of participants in the Russian learner conditions. There were not enough learners recruited from "intermediate" level classes to make up a separate intermediate group. These participants were instead assigned to either the Beginner or Experienced learner condition based upon a combination of their years of experience with Russian and current class (to provide an equal number of participants per condition across all conditions). It is worth nothing that this likely had the effect of increasing variability among each of the two ultimate groups, and this variability might have lowered the power of statistical comparisons between performance by the two groups; however, recall the difference between the performance of naïve learners (Orthography) and Experienced learners was significant.

Finally, the naïve learners in the two Intervention conditions did not perform significantly different from one another, although Intervention B and Experienced participants did have nearly significantly different d-primes on FamIncong stimuli. In this case, the extra instruction provided to the Intervention B participants may have been too taxing, and the extra input to keep in memory while being exposed to textually enhanced

forms, pictured meanings, auditory forms, and written forms caused a decrease in accuracy. It could also stand to reason that, with the Bown et al. (2007) inductive instruction group, Intervention B participants, who needed to figure out the GPC "rules" on their own (not explicitly told the rules as in Intervention A), performed more accurately. However, differences between these groups were not significant. Reflecting on the number of word learning-criterion test cycles required by the groups, Intervention A and Intervention B participants both required more cycles than the other conditions. In fact, all significant pairwise comparisons included one of the Intervention conditions. However, because the Intervention conditions' results patterned as the other conditions did, we posit that the extra cycles were due to the additional input provided in the instruction/textual enhancement and did not unduly affect results.

Intervention participants, similar to participants in all conditions, performed highly accurately on FamCong and Unfam stimuli, but L1 GPC interference in the FamIncong stimulus condition yielded a decrease in accuracy at test. Based on these results, the Intervention conditions did not outperform their nonintervention naïve learner counterparts or the learners. Descriptively, their d-primes were higher than the nonintervention participants and lower than the learners. To some extent, the intervention seems to have aided participants. Surprisingly, the naïve and beginner learners' d-primes were not significantly different (the beginner learners had an average of 0.27 years of experience). A single month of instruction did not provide an advantage, or time to acquire target-like GPCs, to the beginner learners.

Results in the present study comparing the two naïve learner groups (Orthography and No Orthography), were consistent with the results of Showalter (to appear),

suggesting that the interference effect of incongruent GPCs (in the case of Russian Cyrillic) is real and robust. Importantly, the effect of incongruence on results in the presence of familiar phones provides evidence that OI and L1 GPC knowledge are significant factors in the acquisition of novel words. As found in Hayes-Harb, Nicol, and Barker (2010) and Hayes-Harb and Cheng (2016), incongruent GPCs yielded the least accurate performance from participants, while other OI differences (e.g., unfamiliar graphemes in Hayes-Harb & Cheng and the present study) did not negatively affect accuracy. The results of these studies indicate that when learners are exposed to L2 GPCs in conflict with the L1 system, L1 knowledge will interfere.

It can be seen in the d-prime scores, that, as experience increased, accuracy at test increased. The results suggest that naïve learners would not be expected to perform in a target-like manner within a single experimental time. Beginner learners, with formal instruction for an average of 0.27 years, had less accurate performance than their experienced learner counterparts (with 3.28 years of experience). While overall accuracy was quite high, the differences in d-primes between Beginner and Experienced learners suggests that learners in other studies, who have not found target-like performance, could lack needed instruction or experience. For instance, the 1st-year learners of Mandarin in Bassetti (2006) or Rafat (2016) may not have achieved a level of proficiency to overcome effects of interfering L1 knowledge interacting with OI. This, however, does not explain why learners in studies who had studied the target L2 for a longer time than the Russian learners in the present study continued to be affected by their L1 knowledge (e.g., Vokic, 2011 and learners with 23.8 years of experience). It could be the case that other variables aside from OI caused less accurate performance (e.g., difficult phones or contrasts, task

type). Future research must tease apart effects of OI and other variables on performance.

Promising for L2 learners, the present study suggests that factors inhibiting target-like acquisition can be overcome. Learner accuracy at test suggests that, with experience, new sound-letter mappings in an L2 can be acquired in a target-like manner. Özçelik and Sprouse (2016) and Veivo and Järvikivi (2013) also support this conclusion. Results in Özçelik and Sprouse (2016) demonstrated that, with an increase in proficiency, learners relied less on OI, allowing them to make target-like decisions about the phonological forms of morphological endings. Beginner learners relied on OI, making errors when the spellings did not systemically encode phonological variances. In Veivo and Järvikivi (2013), participants with more experience in the target L2 and more familiarity with L2 words performed more like native speakers of the L2 than beginner learners. More proficient learners were not (or at least to a lesser degree) influenced by L1 GPC knowledge (although Veivo, Järvikivi, Porretta, & Hyöna, 2016 found that more advanced learners made more, but advantageous, use of OI). Thus, while OI is a powerful factor in L2 acquisition, experience mediates the reliance on L1 OI knowledge or L2 OI that is misleading.

Current Russian textbooks, instructional materials, and a Russian instructor survey were analyzed to determine whether instructors observed OI difficulties in students and what type of assistance they provide to mediate these difficulties. Current practices are mainly based on instruction of, for example, phonics and the alphabet, but little attention or elaboration is provided beyond the 1st week. Instructors agreed that learners need to acquire target-like GPCs early to succeed in Russian, and that current materials do little to help with encountered difficulties. Based on information from the

instructional sources, studies providing instruction to participants (e.g., Bown et al., 2007; Brown, 2015; Jackson, 2016), and input enhancement studies (e.g., Alsadoon & Heift, 2015; Han, Park, & Combs, 2008), two interventions were designed. The main goal of the interventions was to aid naïve learners in realizing that some Russian graphemes would be new, and some would look similar but sound differently than expected.

For one group, the intervention included only textual enhancement, bolding and enlarging (the experimental) word initial consonants. For the other group, the intervention included textual enhancement and instruction about the included graphemes and GPCs. This instruction reflected what is found in textbooks and during the initial weeks of Russian instruction. The instructor surveys did not provide detailed or explicit information about techniques for assisting learners with development of target-like GPCs. The interventions were a first effort to provide evidence-based assistance with Russian orthography-phonology difficulties. At the very least, the present interventions afforded the opportunity to observe whether a short exposure to enhanced forms and instruction can affect learners' immediate recall of phonological forms over unenhanced OI that interferes with L2 acquisition. The results suggest that, while a statistically beneficial intervention was not provided, exposure to enhanced forms (Intervention A) during initial acquisition may mediate the effects of OI during phono-lexical development as learners attend to input differences but must come to their own conclusions about what is important in the input. This supports the findings of other OI studies that include instruction (e.g., Alsadoon and Heift, 2015; Bown et al., 2007; Jackson, 2016).

The present study provides evidence of the robust nature of OI on participants'

phono-lexical acquisition. Namely, incongruent GPCs significantly interfered with (all) participants' accuracy at test. Native English speakers without Cyrillic experience were unable to suppress their L1 GPC knowledge to make decisions about L2 word forms that contained incongruent GPCs, but were not affected by word forms that contained congruent GPCs or unfamiliar graphemes. Naïve learners exposed to OI had lower accuracy scores at test, as well as significantly different d-prime scores on incongruent stimuli, than participants not exposed to OI. Naïve learners exposed to one of two interventions and OI did not significantly differ from naïve learners exposed to only OI. However, their scores patterned in much the same way in the stimulus conditions, and they descriptively outperformed their nonintervention counterparts. Finally, the same stimulus condition patterns were found with learners of Russian, and more experience yielded higher accuracy at test. Experienced learners descriptively outperformed all other conditions, and they had significantly higher d-prime scores on incongruent stimuli than the Orthography condition. Importantly, given the incongruent GPC effects and that all auditory forms contained familiar phones, results suggest that OI is a crucial portion of the input that participants make use of when making decisions about lexical items. While the exposure to classroom instruction aids performance, the brief interventions provided to naïve learners did not (although, descriptively, it provided a benefit over nonintervention).

3.6 Supplementary material: Instructor survey

1. I am at least 18 years old and am currently teaching/have taught Russian.

- ○ True
- ○ False

2. If you answered 'False' to the question above, we thank you for your participation but ask that you end the survey at this time. If you answered 'True' to the questions above, please continue by pressing the 'Next' button.

3. **CONSET TO PARTICIPATE – PLEASE READ CAREFULLY**

[University of Utah IRB approved consent form]

4. What do you consider to be your native language?

- ○ English
- ○ Russian
- ○ Other/Bilingual ____

Display This Question:
If What do you consider to be your native language? != Russian

5. How would you rate your Russian proficiency? (Please choose and provide an answer for the scale you are most comfortable reporting).

- ☐ Do you have an ACTFL rating? If yes, what is it? _____
- ☐ Do you have an OPI or OPIC rating? If yes, what is it? _____
- ☐ Do you have a CEFR rating? If yes, what is it? _____
- ☐ I do not have an official proficiency score. My self-rated proficiency is... (beginner, intermediate, advanced, native-like). _____

6. Which of the following best describes the institution where you currently teach/taught Russian?

- ☐ Elementary or Secondary School (Middle, Junior High, High School)
- ☐ University or College
- ☐ Other (e.g., a private organization) _____

7. How many years have you taught Russian?

- ○ 0-2
- ○ 3-5
- ○ 6-10
- ○ 11-15
- ○ 16-20
- ○ 20+

8. Which levels do you teach or have you taught?

- ☐ Middle School/Junior High School
- ☐ High School (years 1-2; up to two academic years)
- ☐ High School (years 3+; beyond two academic years)
- ☐ College Year 1 (first semester/second semester)
- ☐ College Year 2 (third semester/fourth semester)
- ☐ College Year 3
- ☐ College Year 4+
- ☐ Other _____

9. Which of the following best describes the typical background of your students?

- ○ My students have not studied Russian prior to my classes.
- ○ My students have either not studied Russian or have minimal Russian exposure prior to my classes.
- ○ My students have usually had some exposure to Russian prior to my classes either in High School, college, or studied independently. The typical amount of time is 0-2 years.
- ○ My students have usually had some exposure to Russian prior to my classes either in High School, college, or independently studied. The typical amount of time is 2-5 years.
- ○ My students have usually studied Russian prior to my classes for an extensive amount of time (longer than 5 years), lived in a Russian speaking country for longer than a year, have a spouse who speaks Russian, or are heritage speakers of Russian.

N/A. The following questions are specific to the present study. Please include all details/information you are able. Native English speakers learning Russian encounter written forms that correspond to different sounds in Russian than they do in English. For instance, English speakers must realize that the Russian word for ‘hand’ is pronounced with a word initial ‘r’ ([r]) sound, despite the Russian spelling <рука>. That is, an English speaker must learn the Russian sound-spelling correspondence [r]-<P>, and “unlearn” the English sound-spelling correspondence [p]-<P>. On the other hand, they must create a sound-spelling correspondence for the Cyrillic letter ‘Д’ because this letter is not present in the Roman alphabet; English speakers must learn the [d]-<Д> correspondence. Consider the following questions about these types of sound-spelling correspondences that must be learned in Russian by a native English speaker.

10. Do you observe sound-spelling issues as described above? For example, when students are reading aloud, do they pronounce the letter <B> as a [b] sound and not a [v] sound?

- ○ Yes
- ○ No

Skip To: End of Survey If 10 = No (2)

11. Please indicate via the numbered answers which letters below are difficult for students (which ones provide confusion or which ones have you noticed provide difficulty to learners). You will note that both print and cursive versions are available, please mark all letters that apply. [It is feasible that some letters are difficult in both print and cursive, while others provide difficulty only when printed or only when in cursive].

1. А а	10. И и	19. С с	27. Щ щ	35. Б б	43. Ии	51. Рр	59. Шш
2. Б б	11. Й й	20. Т т	28. ъ	36. В в	44. Йй	52. Сс	60. Щщ
3. В в	12. К к	21. У у	29. ы	37. Гг	45. Кк	53. Тт	61. ъ
4. Г г	13. Л л	22. Ф ф	30. ь	38. Дд	46. Лл	54. Уу	62. ы
5. Д д	14. М м	23. Х х	31. Э э	39. Ее	47. Мм	55. Фф	63. ь
6. Е е	15. Н н	24. Ц ц	32. Ю ю	40. Ёё	48. Нн	56. Хх	64. Э э
7. Ё ё	16. О о	25. Ч ч	33. Я я	41. Жж	49. Оо	57. Цц	65. Юю
8. Ж ж	17. П п	26. Ш ш	34. Аа	42. Зз	50. Пп	58. Чч	66. Яя
9. З з	18. Р р						

- ☐ 1 (1) […]
- ☐ 66 (66)

12. Do you explicitly address sound-spelling issues or assume that students will "sort

them out" at a later point in learning? How do you help your students learn sound-spelling correspondences? Please explain the instructional technique and/or principles of the instructional technique you typically use.

13. How do textbooks, worksheets, and/or other instructional materials that you use or have used address sound-spelling difficulties and instruction? What strategies are suggested in the materials to overcome the issue? Do you believe students benefit from these resources? [Please provide the name of the book, materials, or provide a reference for these materials].

14. What are your impressions of sound-spelling errors on student performance? Comer & Murphy-Lee (2004) found that students who did not establish correct sound-spelling correspondences in the first few weeks of instruction (in their first semester), had lower course grades than peers who established the correspondences early. Do you observe similar performance effects?

15. Do your students ever "sort out" sound-spelling difficulties? How long does the issue persist? Does there seem to be a time at which most students master correspondences, or have you observed a particular method of instruction or lesson that seems to aid students in mastering the correspondences?

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CHAPTER 4

STATE OF THE FIELD AND FUTURE DIRECTIONS

4.1 Contributions to the field

In recent years, the literature on second language (L2) orthography and phonology has grown considerably. Numerous variables associated with orthography have been explored, providing information about the effects of orthographic input (OI) on acquisition. There are still multiple avenues of research to be conducted, especially given that OI methodologies and OI variables (especially when multiple variables are included in a study) yield varying and often inconclusive results. What is certain is that OI is a robust factor in learners' phono-lexical acquisition. Orthographic input is a source of negative, positive, and null effects, all of which are crucial in understanding acquisition.

In initial stages, L2 learners often rely upon their first language (L1) system. However, when an L1 and L2 differ in respect to, for instance, relationships between orthography and phonology, this can lead learners astray. In Bassetti (2006), native English speakers who were beginner learners of Mandarin did not segment and count vowels in Mandarin that were not represented in spelled forms. The native English speakers expected that, as in English, the vowel would be represented. Similarly, in Bassetti and Atkinson (2015), native Italian speakers, used to a system that transparently

represents the phonology in its orthography, produced English via their Italian system. This L1 interference resulted in production of silent letters, lengthening of double graphemes, epenthesized vowels in <-ed> endings, and differences in homophonous words. Important to note is that these learners had an average of a decade worth of English experience; even at an advanced stage of language experience and proficiency, L1 knowledge can continue to interfere with target-like L2 acquisition. This indicates the robustness of OI and knowledge of graphemes and phonemes in the L1 system, as learners must overcome (interfering) L1 knowledge to acquire an L2 in target-like manner. In fact, studies demonstrate that OI can affect performance on tasks even in the L1 (e.g., Cutler, Treiman, & van Ooijen, 2010; Tyler & Burnham, 2006). That is, the knowledge of grapheme-phoneme correspondences (GPCs) is so robust that it can interfere with participants' abilities to make inferences about L1 (or L1-like) forms.

As stated, varying effects of OI are found in the literature. This is likely a result of different interactions of variables, the task, or a combination of factors. For instance, difficult-to-perceive contrasts in Showalter and Hayes-Harb (2015) and Mathieu (2016) may have confounded effects from the OI. Without being able to perceive differences in minimal pairs, results reflecting OI effects will not be interpretable. In designs that contain familiar phones or new L2 words not dependent on contrasts (e.g., Hayes-Harb & Cheng, 2016), OI effects are more readily observed. In Hayes-Harb and Cheng (2016), sans difficult-to-perceive contrasts, native English-speaking participants were able to make use of OI, even when the OI was presented in unfamiliar Zhuyin characters. Experience with an L2 or the familiarity of L2 words may similarly interact with performance on a task. Veivo and Järvikivi (2013) and Vokic (2011) both found that an

increase in experience or exposure with the target L2 yielded more accurate (target-like) responses at test.

In the present dissertation, to understand the effects of OI more directly, specific variables associated with OI were of focus—grapheme familiarity and congruence. Because these variables are defined in different ways in the literature, to understand our interpretations of the results and their relation to other studies' results, familiarity and congruence were specifically defined in the present dissertation. Grapheme familiarity is the presence or absence of a grapheme in the L2 relative to the L1. Unfamiliar graphemes are L2 specific (e.g., the Arabic script for an L1 English speaker) and familiar graphemes are present in both the L1 and L2. Congruence is a property of grapheme-phone mappings (or GPCs) and the similarities or differences between mappings from the L1 to L2. A congruent GPC is when a grapheme and phone have the same mapping in the L1 and L2. An incongruent GPC is when the mapping in the L1 and L2 differ (e.g., L1 English <j>-/ʤ, ʒ, j, h/; L2 Spanish <j>-/x/).

Current literature on the effects of grapheme familiarity and L2 phono-lexical acquisition contains evidence from the familiar side of the continuum to the entirely unfamiliar side. Studies containing familiar graphemes—the L1 and L2 use the same alphabet—typically involve an additional manipulated variable (e.g., a difficult contrast, L1 Dutch, L2 English: Escudero, Hayes-Harb, & Mitterer, 2008 or grapheme-phoneme mappings, L1 Spanish, L2 Dutch: Escudero, Simon, & Mulak, 2014). It is known that naïve learners can take advantage of OI, even unfamiliar OI in certain cases, to learn L2 words. In Showalter and Hayes-Harb (2013), native English speakers were able to make use of novel diacritics to encode the four-way tone contrast in Mandarin. The same

advantage was not observed with native English speakers learning Russian stress (Hayes-Harb & Hacking, 2015). In some cases, entirely unfamiliar OI can be beneficial in the acquisition of L2 words (e.g., native English speakers and Mandarin Zhuyin characters, Hayes-Harb & Cheng, 2016). However, in the presence of confounding variables, entirely unfamiliar OI may enhance confusion and suppress the ability to learn words (e.g., Showalter & Hayes-Harb, 2015).

In the few studies that operationalize and investigate the effects of congruence as in the present dissertation, congruence proves to be a robust variable during acquisition—specifically, incongruent GPCs interfere with a participants' ability to learn L2 words. Even when difficult-to-perceive contrasts are not present in the study's design, L1 interference from incongruent GPCs hinders accuracy at test (e.g., L1 English, L2 Mandarin and Pinyin forms, Hayes-Harb & Cheng, 2016; L1 English, L2 pseudo language, Hayes-Harb, Nicol, & Barker, 2008).

The studies mentioned are often designed so as to compare effects of variables between subjects, and often include either naïve learners or an unsystematic group of experienced learners (e.g., only one proficiency level or learners with varying amounts of experience who are classified within one proficiency level). In Chapter 2, using English-Russian orthographic relationships, we were able to design a within-subjects study and manipulate both grapheme familiarity and congruence. Importantly, we did not have any phonological confounds, but made use of familiar phones or phones that were English-like. Naïve learners of Russian exposed to OI were not affected by unfamiliar graphemes or congruent GPCs, but their results evidenced an interference effect of incongruent GPCs. In Chapter 3, the same stimuli types (with a few changes) and the same design

were used with the addition of experienced learners at two different levels. The inclusion of the experienced learner population afforded the opportunity to observe at what stage of acquisition effects of OI may be overcome, or how the variables may continue to affect learners who have more experience with the target language. In the absence of variable confounds, the effects of grapheme familiarity and congruent GPCs were not observed in the learners of Russian. The results from Chapter 2 and Chapter 3 both demonstrated that, for all participants, familiar graphemes and congruent GPCs, as well as unfamiliar graphemes, did not provide difficulty in L2 word learning. However, participants had difficulty with familiar graphemes that formed incongruent GPCs; indeed, Familiar-Incongruent (FamIncong) stimuli yielded lower accuracy rates for all participants as compared to Familiar-Congruent (FamCong) and Unfamiliar (Unfam). While performance across the groups did not significantly differ for FamCong or Unfam stimuli, the patterns of results on FamIncong items suggests that learners of Russian are able to overcome the effects of OI and instruction/textual enhancement *may* aid the ability to learn L2 words. The experienced learner and intervention groups' results suggest that more exposure, practice, and explicit evidence of L1-L2 differences are required prior to "unlearning" L1 GPCs and establishing target-like GPCs; FamIncong d-prime scores did significantly differ between the Orthography (naïve learners) and Experienced learner groups.

Results from Chapter 2 and Chapter 3 provide the field with a few pieces of information. First, they indicate that phonological (or other variable) confounds can cause the effects of OI to be overshadowed. This fact can help interpret findings from previous studies in which researchers were unable to locate the reason for lowered participant

accuracy at test or noneffects of OI (e.g., Showalter & Hayes-Harb, 2015). This is especially true given the second finding—unfamiliar graphemes, in the presence of familiar phonological input, do not pose difficulty to learning L2 words. This supports the findings in Hayes-Harb and Cheng (2016), who found that exposure to (entirely) unfamiliar Zhuyin characters did not hinder participants' abilities to make inferences about the phonological forms of words. Third, the results of Chapters 2 and 3 indicate that L1 GPC knowledge can interfere with the ability to establish target-like GPCs, especially when L1 and L2 GPCs are incongruent (the finding was just as robust in Chapter 3 as in Chapter 2, despite stimuli changes). This conclusion supports findings across the L2 phonology-orthography literature, including studies that defined congruence differently than in the present dissertation. What can be drawn from the L2 orthography-phonology literature on congruence (and "congruence," defined or coined differently) is that, when an L1 and L2 have conflicting or differing orthography-phonology mappings, the ability to establish target-like representations is less accurate. Fourth, experienced learners can overcome the (robust) effect of incongruence and establish target-like representations. However, this ability may take several years and may be dependent on other aspects of the orthography, phonology, or involved L1/L2 in a more language-global manner. These other aspects could explain why studies with learners who have multiple years of experience, or have achieved high levels of proficiency, still have interference effects of their L1 (e.g., orthographic depth as in Bassetti & Atkinson, 2015, whose learners had an average of 10 years of experience). Finally, the results indicate that experience and/or instruction (longer than an experimental session) is required to overcome the effects of incongruence. The

interventions in Chapter 3 did not aid naïve learners in the experimental time (accuracy at test by participants in the intervention conditions was not statistically higher than the Orthography participants). Importantly, the review of instructional practices by Russian instructors suggests that GPC difficulties are a problem but are not reviewed as often as other aspects of Russian. Future research should include an attempt to remedy this situation or develop best practices for mediating effects of OI in the early stages of acquisition.

4.2 Instruction, intervention, and bridging laboratory and classroom experiments

In Chapter 3, we designed two interventions based on Russian instructional materials and instructor responses via a survey about GPC difficulties they observe. The interventions were designed to determine whether instruction could be provided to naïve learners to aid in the establishment of target-like GPCs early in the acquisition process (within an experimental session). The assessment of Russian materials was not intended to change current Russian teaching practices or provide an overview of needs or issues in Russian instruction. Instead, the interventions were intended to be evidence-based experimental procedures to aid naïve learners with a difficult variable of language learning—OI. By reviewing current instructional materials and practices, if results evidenced a beneficial effect of one or both interventions, the interventions could be applied within a classroom setting. It is acknowledged, however, that there are differences between an experimental setting and the classroom, and further research would need to be carried out comparing the efficacy of interventions in experimental

versus classroom studies.

The interventions in the present study did not significantly improve the naïve learners' abilities to make inferences about the phonological forms of the Russian nonwords over their nonintervention counterparts. However, their performance was descriptively more accurate than nonintervention participants'. Input enhancement studies conducted in classroom (e.g., Barcroft, 2003) as well as laboratory settings (e.g., De Santis, 2008), provide mixed results as to the effect of enhancement—in these studies, textual enhancement. It could be that the input enhancement or the instruction and enhancement combination, in the present, did not draw participants' attention to the OI. As Han, Park, and Combs (2008) stated, for performance to be affected, a linguistic element must be salient for a learner. It may be the case that phonology, as a part of GPCs, is not a salient enough feature to be noticed in an experimental period. In the present case, because there were no minimal pairs or unfamiliar phones *and* the words were maximally similar, the participants may not have been able to draw any salient information about each word from the auditory input. It also stands to reason that, given only incongruent stimuli affected the groups' accuracy results, L1 GPC knowledge is so robust that no intervention could contribute to higher accuracy at test on incongruent stimuli within an experimental period.

What is evident from previous studies that include an instruction component prior to word learning (e.g., Brown, 2015; Jackson, 2016) is that naïve learners seem to descriptively benefit from added input about orthography-phonology correspondences. It would be worthwhile to determine whether multiple sessions or longer periods of time would increase the benefit to a significant level. Given the results of Chapter 3, and that

learners of an L2 do indeed manage to achieve higher levels of proficiency, it can be inferred that learners acquire aspects of an L2 in a target-like manner. In this case, we are interested in the time required to acquire an L2 in a target-like manner. Not having early target-like forms (GPCs in this case) could otherwise hinder their ability to acquire skills in a language. Comer and Murphy-Lee (2004) found that learners unable to acquire target-like Russian GPCs during the first few weeks of instruction were more likely to receive lower course grades. Current Russian instructors corroborated this assessment and indicated the impact of early GPC difficulty results in myriad problems for linguistic success. An intervention to assist learners with GPCs and acquire them as soon as possible may produce more successful language learners.

The availability of OI in the present dissertation, for incongruent GPC items, significantly affected performance at test. While L1-L2 conflicting input presents challenges when learning a language, novel input is not an impediment. Results from Chapter 2 and Chapter 3, as well as, for example, Hayes-Harb and Cheng (2016) and Mathieu (2016), support this conclusion. These studies present evidence that incongruent GPCs yielded least accurate scores at test, while stimuli containing congruent GPCs or unfamiliar graphemes did not (significantly) lower accuracy. Additionally, Chapter 2 and Chapter 3, as well as Hayes-Harb, Nicol, and Barker (2008), present evidence that, even when auditory input is familiar, reliance on an L1 in test trials with incongruent GPCs will lower participants' accuracy at test.

However, it is important to remember, as discussed by other scholars (e.g., Bassetti, 2009; Escudero, Simon, & Mulak, 2014), that learner exposure to OI comes in different forms and is presented with linguistic input of various types. Results from

experimental settings will need to be replicated in classroom or immersion (naturalistic settings sans explicit instruction) contexts to understand "real-world" OI effects. Consider that, in the present dissertation, stimuli were carefully controlled. In a nonlaboratory setting, learners are exposed to less specifically targeted or less-structured input; however, OI is typically within a context that is presented with cues for learners to make more target-like inferences about forms or have the opportunity for communicative repair. In L2 settings that contain L1 incongruent GPCs, these specific GPCs may arise infrequently or arise in contexts that would not lead to detrimental language acquisition (i.e., communicative breakdown). In other language cases—L1 English-L2 Russian, for example—incongruent GPCs may arise frequently and lead to nontarget-like acquisition and negative effects, as observed in Comer and Murphy-Lee (2004) and the instructor survey responses.

Grapheme familiarity may likewise contribute myriad effects to a learner's acquisition or interact in varying manners with different languages during acquisition. For a native English speaker, in Russian, there are Cyrillic specific graphemes that must be learned and some graphemes correspond to unfamiliar phones. These aspects of the graphemes and phonemes may yield difficulties in acquisition when they interact with other aspects of Russian such as palatalization, stress, etc., which were not included in the present dissertation's stimuli. Difficulties stemming from the Cyrillic specific graphemes, which are only a portion of the alphabet, may be mediated by the familiar graphemes, requiring less resources for the learners to process the linguistic input. Consider, however, a native English speaker learning Arabic. The entirely unfamiliar script, in addition to unfamiliar phones, could tax the learner and result in a longer time needed to

acquire target-like forms and correspondences. This was found in Hayes-Harb and Cheng (2016); native English speakers exposed to Zhuyin characters required more word learning-criterion test cycles than their Pinyin (Romanized Mandarin) counterparts. This may also explain the lack of effects found in, for example, Showalter and Hayes-Harb (2015). Without isolating variables in experimental studies and conducting classroom experiments or experiments with learners at different experience/proficiency levels, conclusions about the precise effects of OI variables on acquisition should be questioned.

While the two variables of focus, grapheme familiarity and congruence, resulted in differing degrees of effects on accuracy at test, the results nonetheless convey important findings. In the present case, with confounding variables (e.g., difficult-to-perceive contrasts) removed from the design of learning isolated words, grapheme familiarity does not interfere with acquisition. However, under these same conditions, incongruent GPCs contribute significant interference effects at test. It may be the case that in more linguistically saturated environments, the extent of these variables' effects on acquisition will differ. When assessing language acquisition and success of learners, knowing that OI can present difficulty could inform language instructors on best practices or areas that may need additional practice.

4.3 Reflection on L2 theories and models

Let us briefly return to the discussion of theories and models introduced in section 1.2.5. Results obtained in Chapter 2 and 3 do not allow for extensive additions to and considerations of current theories and models; however, they do support general claims of current theories and models and provide information for further development.

The chosen languages and the experiments within the present dissertation are not designed to provide information about the Orthographic Depth Hypothesis (for more, see Katz & Frost, 1992), especially given that English and Russian are both deep languages. While Russian is less deep than English, making connections between the participants' performances and the depth of the two languages is tenuous. Similarly, the stimuli were not constructed in a manner that would be informative about the role of language depth on results. It could be said, superficially, that the English speakers did not seem to approach the L2 as a deep language. Instead, they seemed to believe that, if the graphemes were familiar, they would map only one way and this way would reflect the L1 mapping. However, this claim is conjecture, and a different study would need to be designed to understand how English speakers would approach Russian words as related to both languages' depths.

The present results support the Orthographic Dependency Hypothesis, specifically the Decreasing Orthographic Dependency Hypothesis, proposed by Özçelik and Sprouse (2016), finding that learners at higher proficiency levels rely less on their L1 orthographic knowledge in L2 tasks. It is important to note, however, that this statement is not what was proposed by Özçelik and Sprouse. In their study, Özçelik and Sprouse based orthographic dependency on L2 OI dependency. That is, they questioned whether more advanced learners of Turkish would rely more on their knowledge of L2 phonological and morphological patterns and less on L2 OI that was not indicative of the patterns. Therefore, orthographic dependence was based on L2 orthographic dependence and not L1 orthographic dependence. The Hypothesis could be framed, in a more general sense, as Orthographic Dependency. More advanced learners may rely less on OI, whether it be

L1 or L2, if it leads them astray from making target-like inferences about L2 forms.

Taken together, the results from Chapters 2 and 3, as well as those in previous literature, support aspects of the theories and models discussed in 1.2.5. As discussed in 1.2.5, however, there are issues with the models. That is, each one provides detail that is important to understanding L2 phono-lexical acquisition and the interaction of orthographic knowledge, phonological knowledge, and input. Individually, as they are understood, none of the models provide sufficient explanation of results in the present dissertation, or interactions of L1 knowledge, L2 acquisition, and different types of input.

The Bipartite Model of Orthographic Knowledge and Transfer (Pytlyk, 2012) captures results that demonstrate L1 interference. In the Bipartite Model, L1 orthographic knowledge is predicted to influence learners' abstract and operational knowledge of GPCs. Abstract knowledge, in the present dissertation, is that the English speakers know, on some level, that English graphemes and phones map in a certain way; therefore, the graphemes they are presented within the experiment likely map to a phone as well. More importantly, in this model, the assumptions about how L2 graphemes and phones map will be influenced by L1 knowledge (i.e., <p> maps to [p] in English and the <p> seen in the experiment will also map to [p]). Operational knowledge would be the participants' understanding that grapheme-phone mappings occur, but that L2 mappings are different from L1 mappings (i.e., <p> maps to [p] in English, but <p> maps to [r] in Russian). The naïve learners, and to an extent the beginner learners, have not had time to acquire the necessary operational knowledge. Their performance at test reflects their assumptions about L2 grapheme-phone mappings from their abstract or L1 knowledge.

To an extent, the results found in Chapters 2 and 3 also reflect the Bimodal

Interactive Activation Model's tenets (Diependaele, Ziegler, & Grainger, 2010; Grainger & Ferrand, 1994, 1996; Grainger & Ziegler, 2008; 2011). Not only did auditory input and OI interact, but they also seemed to interact at both the unit level (individual graphemes and individual phones) and the lexical level (GPCs and words). Knowledge of the units and words, as they were learned and as interpreted via L1 knowledge, interfered with participants' abilities to make inferences about the new L2 word forms as they tried to "unlearn" (unit level) L1 knowledge.

As previously stated, the models discussed do not provide sufficient explanation of what occurs during L2 phono-lexical acquisition. While portions of the models provide important information—for instance, L1 knowledge at the unit and word level and reliance on this knowledge during L2 acquisition in the Bipartite Model—they lack a comprehensive consideration of the elements an L2 acquisition model or theory should contain. At this point, there is not a model that predicts and provides explanation for the interaction of L1-L2 knowledge (and dependency on the L1/the waning of L1 dependency with experience), interaction of orthography-phonology knowledge at different levels and via different skills (e.g., production versus perception), effects of different types of variables, and expected differences between the performances of native speakers and learners (naïve and experienced). All of these aspects should be contained in a theory or model, and, more importantly, be founded upon previous L2 literature.

4.4 Limitations

There are limitations in the present dissertation that must be acknowledged. While stimuli were carefully designed to fit within the different GPC stimulus conditions, to

avoid overlap between the stimulus conditions and between English and Russian, and to ensure that experienced learners would not be inappropriately advantaged (nonword requirement), the stimuli were certainly not without issues. There is a chance that some of the nonwords were English-like, causing confusability or advantages for naïve learners and experienced learners alike. Furthermore, because of the available familiar graphemes (<К, М, Т, А, О>) and congruent GPCs for which they allowed, this meant that all words were maximally similar after the initial consonant. While 12 words does not constitute an egregious number of words to learn, and minimal pairs or similar sounding words arise often in languages, the similar sounding words in the experiment may have caused undue confusion. Previous studies have created lexicons based on word-initial phonological contrasts with varying remaining segments; in these cases, the words are maximally different (only the initial contrast is different), which may have mitigated confusability.

Unfortunately, there were two unavoidable problems with the Russian learner numbers. Intact classes will only yield the number of students registered for the class and willing to participate. Furthermore, the available number of Russian learners was, at the university of testing, less than other languages (e.g., Spanish). Coming into the study, the number of available participants was already smaller than other populations. While 55 total Russian learners participated, there were exclusions (e.g., nonnative English speakers) that had to be made after running all of the leaners to provide fair opportunity for their class credit. In addition, because of the uneven sizes of the different learners' experience levels, to run statistics and make comparisons, it was best to combine the groups into beginner and experienced learners instead of, for example, beginner, intermediate, and advanced proficiency levels. While the two groups still provide

valuable information, this is less systematic and comprehensive than originally desired.

Upon review of the answers on the participant questionnaire, the nonobject pictures draw some concern. These pictures, or similar nonobject pictures, have been used previously without presenting issue at test for participants (e.g., Escudero, Hayes-Harb, & Mitterer, 2008; Escudero, Simon, & Mulak, 2014; Mathieu, 2016; Showalter & Hayes-Harb, 2013). That is, regardless of the pictures, participants can complete word learning and are able to do so with a high degree of accuracy (consider, for example, that participants in the present dissertation, even on FamIncong stimuli, had proportion correct scores above 79%). Some participants indicated that the nonobject pictures' abstractness was distracting or drew attention away from other presented input. In addition, many naïve learners wrote that they were distracted by the OI, with a few participants reporting that they had covered the written forms or ignored them in order to memorize the new words. Per one participant's response, the OI presented difficulty because the auditory input did not match the "mental representation" from English ("English phonics"). Interestingly, no beginner or experienced learner wrote about the OI, even when asked what they believed was being tested. Learners may have had enough exposure to the GPC differences that they were not distracted by the presentation of OI.

Synthesizing participant feedback, the provided answers may reflect expected results and effects of grapheme familiarity and congruence. Naïve learners, relying on their L1 knowledge, were distracted by OI because they had to "unlearn" GPCs or learn new graphemes. It could be that nonobject pictures or other stimuli did not contribute to accuracy results, but were the only elements that naïve learners could articulate as being different than what they would expect from their L1 knowledge. While future researchers

may wish to consider the use of different nonobject pictures or real-object pictures, it could be that neither directly influence the learnability of words within an experimental session, but interact with other input or are the only "salient" input on which to comment.

The participant questionnaire responses also included comments about the foil forms (in the final test phase). Recall that foil forms for FamIncong stimuli contained the phones for English GPCs, while the foil forms for FamCong and Unfam stimuli differed in at least two articulatory features from the correct forms. These foil groups were meant to be different from the correct forms and not overlap with English words, real Russian words, or other stimuli conditions' forms. Crucially, this meant that the mismatched trials in the final test contained auditory forms that participants had not heard during word learning or the criterion test. However, after the criterion test, the structure of trials and method of responding would have been familiar. In addition, all participants, as stated, had highly accurate scores during the final test. While new auditory forms may have seemed bewildering, the participants could complete the task. The foil forms were necessary to understand how incongruent GPCs affected participants' ability to make inferences about phonological forms. If the FamIncong stimulus condition was the only condition containing new auditory forms at test, this could have altered participant performance by highlighting a difference in forms on only four words. As half of the auditory forms (half of the total number of trials) were different, participants may have been more aware (hence, the comments), but it is likely that they did not get as distracted as they perceived themselves to be. Designs including new test phase auditory input are not unprecedented—both Hayes-Harb, Nicol, and Barker (2010) and Hayes-Harb and Cheng (2016) made use of foil forms of this type. Future research should either contain

studies of this design with other variables to rule out negative effects of "new" test forms, or contain different methodologies for assessing congruence effects at test.

A final consideration in experiments containing OI is the design of No Orthography conditions. Previous studies have made use of a series of nonmeaningful letters (i.e., <XXX> or <ططط>) in an attempt to provide equivalent visual difficulty (and input to process) during word learning. In these cases, participants in both orthography and no orthography conditions were exposed to the pictured representations, auditory forms, and written forms. This design allows researchers to make conclusions about the effects of OI in a more comparable manner across groups, with all participants exposed to spelled forms (even when they do not contribute meaning). Participants exposed to spelled forms that carry meaning and indicate phonological differences are likely to respond differently at test than those who are exposed to spelled forms that do not provide any benefit to learning phonological differences among words. However, in Mathieu (2016), it is noted that presenting the meaningless sequence of letters <XXX> may not provide the type of input differences that researchers posit. Participants exposed to the meaningless sequence may ignore the letter string because it does not change from word to word or convey meaning. This would mean that participants were only paying attention to the pictured meanings and auditory input, perhaps providing them with an advantage during word learning. In his study, Mathieu ran additional "No Orthography" participants, who were exposed to shapes (e.g., a string of squares) instead of letter strings, under the assumption that the shapes would not induce any orthographic or phonological activations. While the participants in this group had different accuracy results at test than those in the Orthography conditions, they did not perform differently

than the meaningless sequence No Orthography participants. This would suggest that the non-OI sequences and the meaningless letter sequences do not provide differing attentional or processing demands. In studies that have No Orthography conditions in which letters or visual input are not presented to substitute for OI (e.g., Hayes-Harb, Brown, & Smith, 2017), similar patterns of performance between Orthography and No Orthography conditions are observed. This suggests that, regardless of the form of input (or no input) to which No Orthography participants are exposed, Orthography participants perform differently than their counterparts, evidencing some form of OI effect. However, it may be worthwhile to determine how other letter sequences affect results. It could be that <XXX> is treated as "nonexistent" input by participants, whereas a sequence carrying possible phonological information (e.g., <SSS>, <EEE>) could alter whether participants believe the sequence to be meaningful input. It remains to be seen whether visual input that could carry phone-letter information to make inferences about words' forms would differentially affect participants at test than nonmeaningful sequences (<XXX>).

4.5 Future directions

As stated, language acquisition (at least, stages of acquisition and interlanguage) will differ in experimental, instructed, and immersion settings. It is therefore important to assess learners' performances on language tasks in these various settings to understand acquisition as a greater whole. From the literature review on studies that include experienced learners, as well as the information collected from Russian instructors and instructional materials, it is evident that difficulties in phonological acquisition arise and

are not always explicitly addressed. One issue may be a lack of research that includes a comprehensive understanding of the stages of (phonological/GPC) acquisition, either comparing learners at various proficiency levels against one another or following learners over the course of acquisition in a longitudinal study. While these designs are not always feasible, this must be considered in order to understand the effects of various types of input on phono-lexical acquisition. In addition, there seems to be a dearth of studies investigating phono-lexical acquisition in instructed settings. The field of L2 acquisition has benefitted from pedagogical studies, exploring the effects of different language backgrounds and linguistic variables on the acquisition of syntax, pragmatics, etc. These same pedagogical studies, save the literature on pronunciation, is not found with phono-lexical acquisition. Bridging the laboratory-classroom research gap will only serve to strengthen the understanding of the effects of different linguistic input on acquisition.

Taking a more focused view, future research should include different variations of the investigation in the present dissertation. Because OI interacts in many ways with other forms of linguistic input, languages and language backgrounds, and, likely, individual factors such as working memory, it is necessary to isolate it from other variables to understand its impact on acquisition (gradually adding other variables back into the design). Looking at familiarity, there is evidence in the literature on OI effects when the OI is familiar but includes a difficult-to-perceive contrast (e.g., Escudero, Hayes-Harb, & Mitterer, 2008), familiar but includes unfamiliar diacritics (e.g., Hayes-Harb & Hacking, 2015; Showalter & Hayes-Harb, 2013), entirely unfamiliar with a difficult-to-perceive contrast (e.g., Showalter & Hayes-Harb, 2015), entirely unfamiliar with familiar phones (e.g., Hayes-Harb & Cheng, 2016; Zhuyin condition), unfamiliar to

different degrees with difficult-to-perceive contrasts (e.g., Mathieu, 2016), and unfamiliar to different degrees with familiar phones (e.g., Showalter, to appear or Chapter 2 and Chapter 3). An innovation of the design in Chapter 2 and 3 was a language that afforded the opportunity to investigate the effects of grapheme familiarity (and congruence) as a within-participant variable. What is not known is how different degrees of familiarity and unfamiliar phones or difficult-to-perceive contrasts may affect phono-lexical acquisition on an individual basis (not between subjects). Similar consideration must be taken with the variable of congruence.

In addition, as it frequently arises in L2 orthography studies, more attention ought to be drawn to orthographic depth. That is, how learners approach and process language based on their L1 system, and how the L2 system may differ from or be the same as the L1 system (and hinder or aid acquisition, respectively). For instance, GPCs in an L2 may be easier to learn if the L1 and L2 share an orthographic depth. If a learner expects an L2 to be opaque (i.e., contain one-to-many or many-to-one GPCs) because their L1 is similarly opaque, they may approach and subsequently acquire language differently than a learner whose L1 is transparent (i.e., contains one-to-one correspondences; see e.g., Erdener & Burnham, 2005). There are L2 orthography-phonology studies that contain considerations of orthographic depth (sometimes defined as “inconsistencies” or a different term); however, there is not systematic investigation of orthographic depth, L2 phono-lexical acquisition, and variables of OI (e.g., unfamiliarity).

Another area of research, related to OI, that is important to consider in L2 acquisition includes reading and processing, reading strategies, and phonology-orthography representations associated with reading. This was not discussed in the

present dissertation as, while phono-lexical acquisition and literacy are related, the two are separate processes. There is no doubt that literacy and phonological acquisition are intertwined in L1 acquisition, but the correlation is not as straightforward in L2 acquisition. Post-L1 literate adults have a system in place when acquiring an L2 phonological system, and the L1 system is likely to interfere with L2 phono-lexical and literacy acquisition on different levels. Findings from research on reading certainly inform phonological acquisition (e.g., orthographic depth, GPCs), and in due time it will be pertinent to understand how these two areas relate to one another in the L2 (especially in instructed settings).

Stimuli in the present dissertation, importantly, did not contain any difficult-to-perceive contrasts or unfamiliar phones. However, as stated previously, it is necessary to investigate how such phonological input would affect performance to situate the present findings in the literature at large. What is understood given the findings in Chapter 2 and Chapter 3 is that OI can be a variable the robustly affects acquisition, even in the presence of familiar phonological input. Learners are unlikely to encounter an L2 that does not contain any unfamiliar phonological input, although in some cases, the number of unfamiliar phones may be few. To truly understand how OI affects learner acquisition, a similar within-subjects and varying stimuli groups designed experiment should be conducted with difficult-to-perceive contrasts or unfamiliar phones (this could be done with Russian). This would present evidence allowing for a more thorough synthesis of findings from previous studies (with between-subject designs, e.g., Hayes-Harb & Cheng, 2016; Mathieu, 2016), reviewing specific correlations of OI and phonological input. Alternatively, difficult-to-perceive contrasts and unfamiliar phones could be assessed in a

design with other variables associated with OI (e.g., instruction, depth). This would allow researchers to situate the effects of such phonological input and OI on acquisition, and draw conclusions about such findings to compare to previous literature. This would serve to both expand present knowledge about the orthography-phonology link and solidify conclusions drawn from previous findings.

4.6 Conclusion

The present dissertation provides insight into the effects of OI, specifically the variables of grapheme familiarity and congruence, during L2 phono-lexical acquisition of Russian. Previous literature indicates that learners rely on their L1 knowledge when making inferences about orthography-phonology relationships in L2 words. The present results support this conclusion, but only when L2 input (GPCs) is incongruent with a learner's L1. Unfamiliar graphemes and congruent GPCs did not significantly interfere with learners' abilities to establish target-like phonological forms of the L2 words. Importantly, the auditory input did not contain any difficult-to-perceive contrasts or novel phones, allowing for OI effects to be isolated. Naïve learners demonstrated interference of L1 GPC knowledge in incongruent stimuli trials, Russian learners' accuracy improved with an increase in experience, and naïve learners did not benefit from exposure to textual enhancement or instruction and textual enhancement. Taken together, the results in the present dissertation suggest that L1 knowledge is difficult to "unlearn," OI is a robust variable during language learning (as evidenced by effects in the presence of familiar auditory input), and, while learners can overcome negative effects of OI, this ability takes more time than an experimental session for naïve learners (or a month of

instruction as evidenced by beginner learners). Comparing the results of naïve learners and (experienced) learners of Russian, it is evident that experience is beneficial to acquisition. However, it remains to be seen what the best practices for assisting learners with difficulties of OI are. Future research should contain a systematic investigation of different OI variables on naïve and experienced learners alike and include a variety of L1s and L2s.

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