ABSTRACT

Orthographic Effects on the Perception and Production of
Certain Japanese Phones by L2 Learners

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The purpose of this thesis is to test the influence of orthography on how second language (L2) learners of Japanese perceive and produce sounds absent from their native language English. The study tests whether Japanese L2 learners perceive and produce the Japanese phones /ɸ/ and /ç/ as closer to their transcription equivalents /f/ and /h/ than non-learners (those not learning Japanese in any capacity) do. The study uses a language (Japanese) where Roman orthography is not used frequently, testing the limits of L1 orthographic effects, as well as looking at the phonemic rather than the word level. It was found that orthography did not influence the perception of Japanese phones at the phonemic level, and that in general there are limits on orthographic effects in this scenario. But, instances of orthographic influence were found for the production of words, which indicates that auditory perception is likely being overridden by an orthographic effect, most likely in the lexical representation of a word.

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ORTHOGRAPHIC EFFECTS ON THE PRODUCTION AND PERCEPTION OF CERTAIN JAPANESE PHONES BY L2 LEARNERS

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By

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DEDICATION

To my amazing family,

whose love and support has kept me going through this college adventure.

CHAPTER ONE

Introduction

This thesis can, most broadly, be seen as addressing the issue of pronunciation difficulties of adult second language (L2) learners. Pronunciation difficulties are a well-established reality for L2 speakers, and it is important to understand where these issues come from, since they can lead to miscommunication. Numerous factors affect L2 pronunciation—most notably, age of acquisition (Flege, 1999). Part of the origin of these difficulties may also lie with speech perception (Rochet, 1995), and teaching methods that promote the use of the L1 in L2 speech perception, specifically through the use of L1 orthography (i.e. the learner's most familiar writing system). To be clear, the perception of L2 phonemes largely determines their classification into L1 categories, and thereby their production (Rochet, 1995). Moreover, the use of an L1 orthography may promote equivalence classifications, in which L2 phonemes are put into L1 classes to which they do not necessarily belong (e.g., pronunciation of French /y/ as /u/ by English L1 learners (Rochet, 1995), or the pronunciation of Arabic /q/ as /k/ by English L1 learners (Showalter & Hayes-Harb, 2015)). Orthography may also play an intermediary role in the formation of a lexical representation (explained later). This thesis will investigate how orthography may influence L2 learners' equivalence classifications and therefore contribute to a better understanding of the role that orthography plays in L2 speech perception.

Different studies point to perception as being the primary influence on production (Bradlow et al., 1997; Rochet, 1995). However, it is unclear how independently the production system operates from the perceptual system. That is, prior research (as shown below) demonstrates that the perceptual and the production systems are linked, but whether there is a direct connection between them, or their connection is mediated by abstract representations (e.g., phonological or lexical representations), is not well established in the research.

Still, an important issue lies in determining what factors may influence the perception of L2 phonemes. Rochet (1995) shows how perceptual categories of sounds in addition to acoustic properties contribute to perception. Rochet uses a French example to show how English L1 and Portuguese L1 learners of French perceive and divide the high vowel continuum between /i, u/ differently, leading to differences in the perception of the French vowel /y/, which is considered to fall in between /i/ and /u/. That is, Portuguese L1 learners will approximate the sound as /i/, while English L1 learners will approximate the sound as /u/ because of how they perceive /i/ and /u/. Rochet also notes that acoustic properties of the L2 sounds can play a role in their perception. For instance, the English /u/ is acoustically more similar to the French /y/ ("tu") than the French /u/ ("tout"), with the implication that perhaps the French /u/ is the more novel L2 sound, even though the IPA transcription is the same. This would provide justification for English L1 learners' tendency to categorize the sound in the way they do. Thus, the perceptual categories of L1 phonemes and their actual acoustic properties play a large role in the perception and subsequent production of novel L2 phonemes.

However, there are other factors that may influence the perception of an L2 sound, with one being orthography. For example, orthography can influence the perception of L2 sounds by cuing learners into certain features (Escudero et al., 2008) or by simply nullifying a contrast to fit a certain L1 perceptual category (Escudero & Wanrooij, 2010; Hayes-Harb et al., 2015; Mathieu, 2016). Orthography has also been found to aid in the creation of lexical representations, which can be used both in perception and production (Cutler, 2015). In production, orthography has been shown to have an effect even in cases apart from reading aloud (Rastle et al., 2011; Ye et al., 1997; Zampini, 1994). However, as mentioned above, it is not entirely clear to what degree orthography may influence perception and production, nor how perception and production are linked.

The current study looks more closely at the role of orthography in how L2 phonemes are perceived. In addition, the study cursorily examines the role of orthography in production, to determine what connection there may be. In order to test whether English L1 learners of Japanese perceive the Japanese phones /ɸ/ and /ç/ as closer to their transcription equivalents /f/ and /h/, the study compares the learners' perception of these phones to L1 English speakers, who do not study Japanese (i.e., non-learners). The study also examines learner production data, in order to explore the links between perception and production in this context. This study is distinct because it uses a language (Japanese) where Roman orthography is not used frequently, testing the limits of orthographic effects. The study also tests at the phonemic rather than the word level. Furthermore, the study tests sounds along a continuum, avoiding a forced categorization in one direction or another.

The organization of the thesis is as follows: First, in an attempt to synthesize pertinent orthographic research, the Chapter Two includes a review of current orthographic research and core concepts (orthography and perception, orthography and production, and the role of different scripts), and a phonetic analysis of Japanese and English sounds. Chapter Two will conclude by examining the current study's research questions, and the role they play in the larger field of orthographic research. Chapter Three will present the methodology of the current study, while the final chapters will present the study results and a discussion of their significance to both the research questions and the broader field of orthographic effects in SLA.

CHAPTER TWO

Background and Motivation

Orthography has been shown to affect L2 learners' perception and production. Studies show how orthography influences the perception of a phonemic contrast (Escudero et al., 2008), and can cue a learner into features of a phoneme when readily available (Escudero & Wanrooij, 2010). Similarly, in cases of production, orthography affects a learner's production of L2 phonemes (Bassetti & Atkinson, 2015; Young-Scholten & Langer, 2015). Despite these findings, it is still unclear to what extent orthography may help or hinder a learner's perception and production of L2 phonemes. Rather than taking the issue through the lens of benefit or harm, however, this study will look at whether orthography affects L2 phoneme perception and production according to its availability to the learner during the process (e.g. read-aloud studies v. spontaneous speech).

One necessary concept in research on orthography is the idea of grapheme-phoneme correspondence (GPC). Any alphabetic language will associate certain graphemes (e.g. "sh", "ll", "é", "ふ", etc.) with a given phoneme (e.g. /ʃ/, /ʝ/, /e/, /ɸu/, etc.). The implication is that written L2 input may be interpreted according to a learner's L1 GPCs. Orthographic effects (assuming the L1 and L2 share the same writing system) may be stronger if an L1 has a transparent orthography (where GPCs are more obvious) rather than an opaque orthography. For instance, Italian speakers may display more orthographic effects in L2 learning because Italian has clearer grapheme-phoneme correspondences (Bassetti & Atkinson, 2015). These GPCs, also called the languages "phonography," are thought to be more or less irrepressible (Mathieu, 2016).

Orthography and Perception

Numerous studies have shown that orthography has an effect in the recognition and creation of a "lexical representation" when it is involved in the perception of an L2. Lexical representation refers to the knowledge of how a word is spelled and how it ought to be pronounced. For example, a Japanese learner will recognize a difference between the words "right" and "light," but they will still perceive and classify the constituent sounds according to the usual equivalence classification scheme. While this leads them to confuse "right" and "light" apart from context, the learners often possess knowledge of how the L2 sound ought to be pronounced and how it is spelled, which Cutler argues is facilitated by orthography (Cutler, 2015 p. 119). In other words, learners have used orthography to create distinct lexical entries. Escudero (2015) further makes the case, based on studies such as Weber and Cutler (2004), that "Dutch learners [exhibit] a lexical contrast that they could not reliably distinguish in perception" (p. 9). Thus, a learner's lexical representation is distinct from the actual processing of the L2 speech sounds per se.

In addition to assisting in the formation of a lexical representation, there is also some evidence that orthography can shift a learner's perception of an L2 phoneme. Escudero and Wanrooij (2010) ran a study on the perception of Dutch vowels by Spanish L1 learners of Dutch to determine what effect orthography may have had on the distinction. They found that, for a purely auditory task, learners were more likely to confuse certain vowel pairs (e.g. /ɑ/ and /a/) when asked to determine which vowel matched the target sound in an XAB format[1]. However, in an orthographic task in which learners were asked to choose the orthographic response to a given auditory stimuli, learners were found to utilize the orthographic information. Namely, /a/ and /ɑ/ were discriminated more accurately, presumably because learners cued into vowel length information based on the Dutch transcription options "a" and "aa." Thus, orthographic representations can have an effect on how a sound is perceived when readily available to the learner. However, it is important to note that this effect was only found in the presence of orthography, i.e. no long-term effects were examined (although researchers did note that there was no effect for length of the learners' Dutch study). This differs from the current study which sought to examine any long-term effects of orthography on perception, even when not available to the learner.

Another study by Escudero et al. (2008) found that learners tended to gravitate towards a certain interpretation of an L2 vowel depending on whether they had learned the orthographic representation of a word. The authors had Dutch L1 learners of English discriminate non-words containing either /æ/ or /ɛ/, a confusable contrast for Dutch learners. When subjects learned the new words with spellings as opposed to without, they displayed an asymmetric confusion in the direction of /ɛ/, rather than a symmetric confusion for auditory-only learners. This implies that orthography does affect the perception—in this case encouraging an equivalence classification. The authors also point out that lexicalization effects—i.e. learners' knowledge of which words contained which phoneme—might have been more pronounced had learning been consolidated

[1] In an XAB format, the target sound X is then contrasted with two competing options A and B. The participant is instructed to match A or B with X.

through sleep. Thus, both studies point to the effects of orthography in changing the perception of an L2 sound. However, neither study examines long-term effects.

Benefit

A further issue in dealing with orthography and its perception is the benefit of orthography in the language-learning process. "Benefit" generally denotes whether or not orthography can lead to a more accurate perception of L2 phonemes. The benefit of orthography mostly derives from the usefulness of the L1's GPCs in the context of the L2.

For example, L1 GPCs can encourage learners to perceive L2 sounds in certain ways. Escudero et al. (2008), as mentioned above, found that the use of orthography as the decision-making tool in vowel contrasts made perceiving some contrasts—such as /a/ and /ɑ/—easier, while other contrasts became more difficult. The researchers surmised that the orthography encouraged learners to cue into certain features of the L2 sound as they sought to find the correct Dutch spelling. The grapheme "aa" for Dutch /ɑ/ encouraged Spanish speakers to pay attention to vowel length, for instance. More broadly, L1 GPCs encouraged learners to perceive the L2 sounds in certain ways. The benefit is a function of their applicability and usefulness.

Other studies point to the irrepressibility of L1 GPCs in second language learning. Mathieu (2016) examined the influence of non-native scripts, specifically whether the degree of script foreignness (Arabic, Cyrillic, or hybrid Cyrillic-Roman) made a difference in acquiring a non-native phonological contrast. Mathieu found that all scripts resulted in lower accuracy compared with a group of learners that received no orthographic training. However, for the Cyrillic condition "the seemingly familiar nature of the letters…[activated] L1 phonological units," and while in the hybrid Cyrillic-Roman condition the phonological contrast was encoded with completely unfamiliar letters, nonetheless, there remained a "strong letter-based effect of perceived L1 GPCs" overall (p. 164). Likewise, Showalter and Hayes-Harb (2015) also tested script unfamiliarity and found that for the acquisition of a non-native phonological contrast, the use of Arabic script had no effect, while the use of Roman script when learning sound-picture correspondences had a detrimental effect on acquisition of the contrast. They concluded that "the transfer of native language grapheme-phoneme correspondences [L1 GPCs] may be difficult to overcome," especially since the English graphemes "q" and "k" used to denote the contrast normally indicate the same /k/ sound in English. Showalter and Hayes-Harb (2015) and Mathieu (2016)'s different results for the Arabic script are possibly due to the different contrasts being tested. To reiterate, both studies point to the effects of L1 GPCs, which in the cases of these two studies were negative.

Incongruent orthography (i.e. "e" for an /a/ sound) has been found to have an effect in novel word learning, further evidence of the role of L1 GPCs. Rastle et al. (2011) found that the opacity or irregularity of the orthography introduced during word-training affected auditory lexical decision-making (indicating if a sound were a word or not). The researchers performed a three-day study for novel word learning, with either congruent or incongruent orthography introduced on the second day. L1 GPCs still produced an interference when incongruent spellings were used, despite only being introduced mid-way through the study. Hayes-Harb et al. (2010) also tested the effect of incongruent orthography for auditory lexical decision-making, and found the same result. In this study, the result held for incongruent sounds (e.g. "faza" instead of "fasha" for

/faʃa/), but not for the addition of silent letters (e.g. "degund" instead of "degud" for /degəd/). This was presumably due to the familiarity of English speakers with silent letters in general (e.g. thumb or hasten). However, both of these studies looked at English sounds rather than novel L2 sounds, in contrast to the present study.

In sum, it is apparent that orthography can play a large role in the perception of L2 phonemes. Orthography contributes to the lexical representation of L2 words (Cutler, 2015), and can influence the perception of L2 sounds by cuing learners into certain features (Escudero & Wanrooij, 2010) or simply facilitating the application of L1 GPCs to a novel contrast (Escudero et al., 2008; Hayes-Harb et al., 2015; Mathieu, 2016).

Orthography and Production

Just as with perception, orthography has been shown to have an effect on the production of L2 phonemes. However, in looking at a link between orthography and production, it will be most helpful to distinguish between cases where orthographic input is present and available (such as reading aloud), and cases where it is not (such as spontaneous speech or character-based orthography). The reason for making this distinction is that in spontaneous speech, for instance, it is more apparent if orthography has affected a learner's lexical representation, or, by corollary, a learner's perception of L2 phones. In other words, without orthography present, a learner will be forced to rely on his or her internal lexical representations rather than immediately being influenced by L1 GPCs present in the orthography. If orthography is available, then it can be hard to distinguish any long-term effects from an immediate reliance on L1 GPCs by the learner.

Orthography Available

There is broad consensus that orthography affects the production of L2 speech sounds when it is readily available. One of the more comprehensive studies is by Bassetti and Atkinson (2015) on Italian L1 learners of English. The researchers found that when asked to read English words aloud, the participants demonstrated epenthesis (the addition of unnecessary phones such as /l/ in salmon), vowel lengthening (e.g. lengthened pronunciation of /i/ in scene vs. seen), over-generalized -ed pronunciation (using /ed/ for words where it is not used such as asked or believed), and differentiation of homophones (e.g. pronouncing “higher” and “hire” differently). The authors emphasize that these erroneous phonological realizations “are almost exclusively caused by orthographic forms” (p. 88). When participants viewed the orthographic form and then listened to the pronunciation (without viewing the spelling) , the effect of orthography diminished—but it still remained. Bassetti and Atkinson also note that the transparency of Italian orthography may have contributed to the strong effects of orthography on production. Nonetheless, the interference of L1 GPCs is evident.

In a similar study, Bassetti (2007) found effects of *pinyin* (the Roman transliteration of Chinese) on the pronunciation of English L1 learners of Chinese. Here, the researcher noted that learners mispronounced certain Chinese triphthongs according to whether the main vowel was present in the *pinyin* transcription or not. Again, the reason for this mispronunciation was orthography, not aural input. Participants also had at least 3 years exposure to Chinese, indicating the effect may persist long-term.

Other studies also point to orthographic effects on pronunciation, even in the long-term. Young-Scholten and Langer (2015) examined English L1 naturalistic language learners of German. The researchers found that when reading aloud, learners continued to pronounce word-initial “s” as /s/ rather than the appropriate /z/, even after being tracked over a period of a year. The authors write that “the culprit seems to be learners’ continued application of L1-based grapheme-phoneme rules” (p. 106). Even though the learners in the study were exposed to primarily oral input, orthography still seemed to be an influence. However, because the study used reading aloud as the methodology, it is difficult to say to what degree they were influenced in the moment or over time. Zampini (1994) found that when reading aloud, learners mispronounced “v” as /v/ instead of /b/ (/v/ does not exist in Spanish phonology). This presents a clear example of L1 orthography influencing the pronunciation of an L2. Zampini also found that learners neglected to spirantize word-medial voiced stops [b, d, g] into [β, ð, ɣ], providing further evidence of L1 transfer. Zampini also found that the effect on “v” strengthened for second-year language students.

In sum, L1 GPCs play a strong role in affecting the pronunciation of L2 phones when orthography is available. However, when orthography is used simultaneously with production, it is uncertain whether the orthography has affected the learner’s perception leading to erroneous mental representations of the L2 sound, or whether the learner is simply using the L1 GPCs encoded in the readily available orthography.

Orthography Unavailable

In the absence of simultaneous orthographic input, the effect of orthography on production is still evident. Rastle et al. (2011), in a different experiment of the same study mentioned above, found picture-naming also to be affected by the congruency of the orthography with the expected L1 GPCs. When participants were asked to use their novel-word vocabulary to name a picture, the congruence of the orthography had an effect, despite the introduction of orthography only on the second day. This study points to the immediate effects of orthography on production.

For language learners (i.e. not novel word learning), orthographic effects are also clear. Zampini (1994), as mentioned above, found that orthography affected L2 production during free speech, in that learners continued to be influenced by L1 GPCs, although the effects were less than compared to reading aloud. Young-Scholten (2004) also found an effect for the pronunciation of German word-final /d/ and /t/. Based on production data of naturalistic learners (L1 English), the researchers point to the effects of orthography, writing in a later summary of Young-Scholten (2004) that the "task of trying to figure out words' underlying representations from aural input is complicated by OI [orthographic input]" (Young-Scholten & Langer, 2015, p. 98). That is, because German uses one grapheme "d" for both the word-medial voiced and word-final devoiced consonant, learners will either classify all phonemes as /d/ or, in the case of one learner, /t/. Either way, orthography can have an effect by facilitating an L1 GPC and/or creating erroneous homophony. The latter point, erroneous homophony, is not as relevant to the current study, but bears mention.

Another case is presented by Ye et al. (1997) (as cited in Bassetti, 2007). In this study, participants read aloud phrases in *hanzi*, the Chinese character-based orthographic system (which does not encode pronunciation information). Ye et al. noted effects of *pinyin* orthography on participants' reading of Chinese *hanzi*, even though *pinyin* was not supplied. Thus, orthography continues to influence L2 production even when not readily available, even for naturalistic language learners.

For production as a whole, orthography seems to have an effect on pronunciation and the application of L1 GPC rules. It also seems evident that the effect of orthographic input persists in a diminished capacity in cases where the orthographic input is not presented simultaneously (Zampini, 1994). The issue of benefit, meanwhile, seems most likely to be an issue of the applicability and usefulness of L1 GPCs, that is, whether an L1 GPC will cause a learner to better encode a difference in pronunciation. However, Cutler (2015), as mentioned above, argues that even if such information is encoded lexically, it may not necessarily result in a change in production for the better. Still, by showing that orthography affects production even in cases where it is not being seen, it is clear that orthography figures in the creation of a lexical representation. Bassetti (2008) maintains that "L1 phonology and orthography interact with L2 auditory and orthographic input to affect L2 learners' phonological representations, which are then reflected in L2 production (pronunciation and spelling) and in phonological awareness tasks) (p. 192).

To connect this section on production and the previous on perception, the perception of L2 speech sounds in some way influences production. Orthography influences this perception, and also contributes to the creation of lexical representations that may or may not be of benefit. In other words, a speaker's phonetic production can stem from orthographically-influenced perception (i.e. orthography leads the perception of L2 phonemes in a certain way) or simply a reliance on orthographically-encoded lexical representations (i.e. a learner's lexical representation is encoded orthographically).

Effects of the Type of Orthography

Since the current study deals with Japanese, a language that utilizes a non-Roman orthography, this section will cover research on the possible effects of non-Roman orthographies for Western L1 learners. Almost all non-Roman orthographies have some type of Roman equivalent for transliteration purposes, which can introduce L1 GPCs that may influence a learner's perception and production.

Two studies cited by Bassetti (2007)—Ye et al. (1997) and Meng (1998)—look at *pinyin* effects on English L1 learners of Chinese. *Pinyin* is the Roman script used to transliterate as well as type Chinese *hanzi*, or characters. Ye et al. (1997) found *pinyin* to have a pervasive influence on the reading aloud of *hanzi*. Meng (1998) found that when learners were coached on *hanzi* pronunciation, their pronunciation improved vis-à-vis *pinyin*, but as soon as *pinyin* was reintroduced, learners reverted to L1 GPC-oriented pronunciations. What seems evident from these two studies is that the Roman orthography is utilized in cases of production, even if it is not readily available. The familiar orthography, then, may influence the creation of a lexical representation.

Another scenario examined by two other studies is novel word learning when no transliteration is provided for a novel script. Two novel word learning experiments by Showalter and Hayes-Harb (2015) and Mathieu (2016) found conflicting results. Showalter and Hayes-Harb (2015) found that for a phonological contrast not present in English, /q/ (voiceless uvular stop) and /k/ (voiceless velar stop), there was no effect of providing an Arabic script during the word learning process, even when one group was coached on the directionality and elements of the Arabic script. Mathieu (2016), in a very similar study, used the contrast between /χ/ (voiceless uvular fricative) and /ħ/

(voiceless pharyngeal fricative). Mathieu found that the provision of Arabic transcriptions during the word learning process resulted in poorer performance compared to the no-orthography condition. The reasons for the different results are unclear, but it could be possibly related to the different contrasts that were tested. Note that neither study provided transliteration of the Arabic script provided.

At least for Chinese, learners continue to utilize the familiar *pinyin* script and the L1 GPCs contained therein for production. But in situations where learners are not taught the L1 script's transliteration (for most Westerners, the Roman orthography), the presence of orthographic effects is inconclusive. Although this uncertainty bears mention, such a scenario is rare in most language learning, and is not applicable to the situation faced by learners in this study.

In Japanese language learning, L1 GPCs are introduced early on in the language-learning process through the *romaji* (Roman) script. This script is also utilized for typing Japanese. The key differences between the Japanese *romaji* and Chinese *pinyin* are 1) Japanese language learners are usually weaned relatively quickly off of the *romaji* script because 2) Japanese has a native orthography, *hiragana*, which encodes pronunciation unlike Chinese *hanzi*.

Japanese and English Phones Used in this Experiment

Since this study will use the two Japanese phones [ɸ] and [ç], this next section will examine their acoustic properties and briefly compare them with the other English sounds used in this study. Rochet (1995) argues that phonetic analysis is necessary since IPA symbols can only convey a rough approximation of the actual phonetic realization of a sound. Rochet writes that "phonetic detail should be supplied in contrastive analysis" in order to accurately describe sounds (p. 388).

In Japanese, the two sounds [ɸ] and [ç] are actually allophones of the consonant /h/, occurring before /u/ and /i/ respectively. Thus, the current study uses the consonant-vowel pairs [ɸu] and [çi] in testing.

The Phones /ɸu/*,* /fu/*, and* /hu/

The voiceless bilabial fricative [ɸu] is the phonetic realization of /h/ before the vowel /u/, as mentioned above. This may be due at least partly to the articulation of the following vowel. Labrune (2012) asserts that /u/ is in fact a vowel whose "phonetic quality varies between [ɯ], [ɯ̈], [ʉ], and [ɨ]," that is to say, it tends toward unroundedness and lies somewhere in the range of a high-back to high-central vowel (p. 25). Labrune argues that there must be at least some roundedness present, since "h is always bilabial before /u/," but the vowel is not fully rounded (p. 25). Thus, the articulation of the vowel is tied to the allophonic realization [ɸ]. Following Labrune (2012), who only uses the IPA symbol [ɯ] only when exactness is desired, the vowel will be denoted as /u/, even though its exact phonetic quality is slightly different. Figure 1 below demonstrates how the vowel formants are present in [ɸ] even before voicing begins at the onset of [u]. Figure 1 below represents one of the stimuli used in this experiment. The spectrogram demonstrates how the fricative [ɸ] seamlessly transitions into /u/.

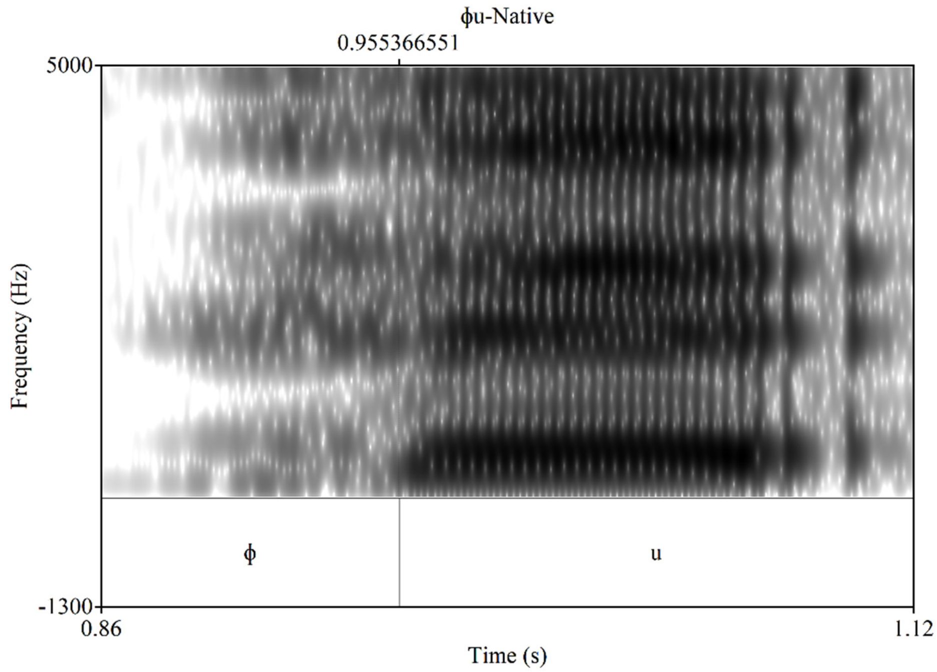

Figure 1: Spectrogram of Japanese [ɸu][2]

In Figure 2 shows the syllable [fu] that aligns with the *romaji* transcription "fu" for [ɸu]. The English voiceless labiodental fricative [f] does not align with the vowel in the syllable [fuː]. There are no prominent formant values to be found, except that there is a general tendency for higher frequencies to be slightly louder, which is characteristic of all fricatives. One also notices the change in formant values for the vowel, indicating its diphthong-like quality. The sample in Figure 2 below is by a native speaker of American English.

[2] All spectrograms were produced using version 5.3.56 of Praat phonetic analysis software.

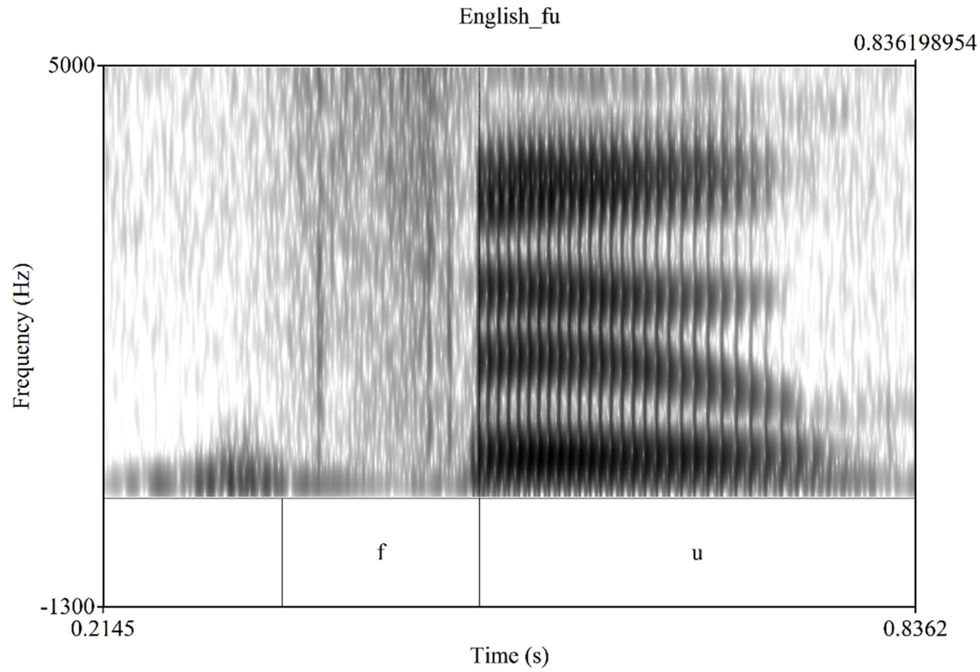

Figure 2: Spectrogram of English [fu]

In Figure 3 shows the English voiceless glottal fricative [h] in the syllable [huː], which differs from the Japanese [ɸu] in the nature of its fricative. Note how the formants in the fricative part of the syllable align with the vowel.

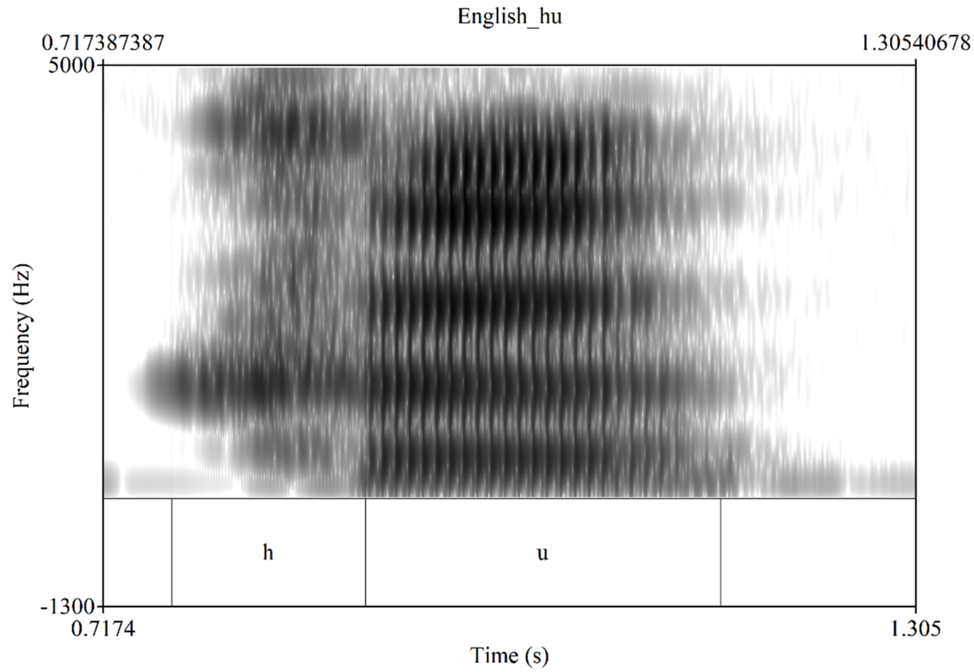

Figure 3: Spectrogram of English [hu]

The Phones /çi/*,* /hi/*, and* /ʃi/

The Japanese voiceless palatal fricative [ç] is, as mentioned above, the allophone of /h/ appearing before [i]. The exact nature of the fricative, however, is uncertain. Labrune (2012) describes the fricative as either [ç] (palatal) or [ɕ] (alveolo-palatal). Tronnier and Dantsuji (1992) also note in their study on German and Japanese instances of the fricatives /h/ and /ç/ that there are different views on how to classify the consonant in [çi]. One view is that it is not really a palatal fricative, but actually the glottal fricative [h]. Others notice that since Japanese features a devoiced high front vowel between voiceless fricatives, the consonant [ç] is actually the devoiced vowel [i̥]. This study will use the IPA /ç/ and classify the consonant as a voiceless palatal fricative, while noting that the value of this fricative varies widely between languages, such as with German (Tronnier & Dantsuji, 1992).

Figure 4 is a spectrogram of the Japanese syllable [çi]. Note how the formant values of the consonant align with those of the subsequent vowel, although less clearly than with [ɸu].

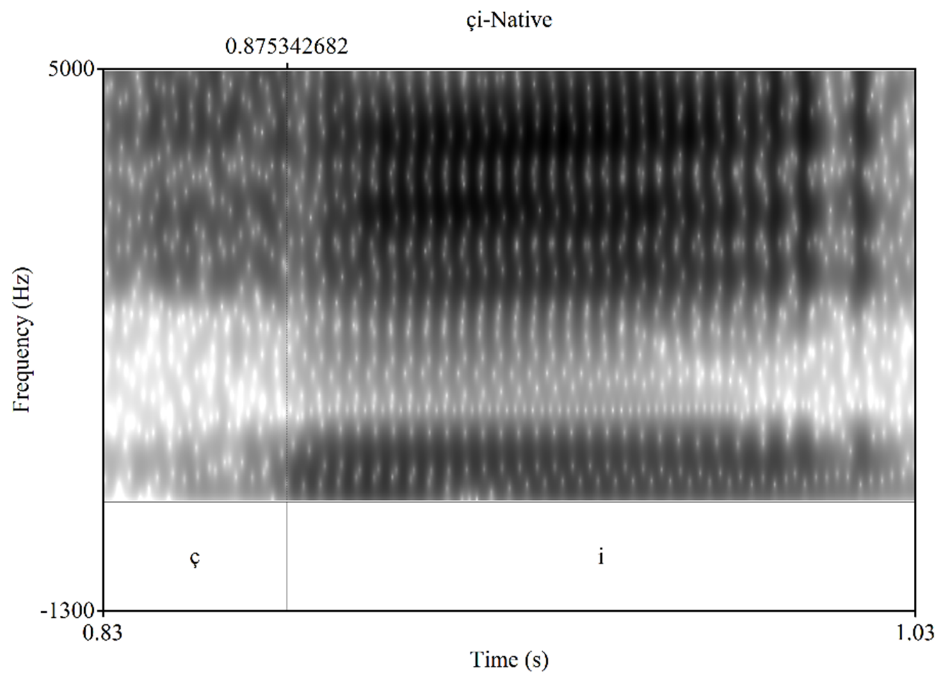

Figure 4: Spectrogram of Japanese [çi]

The English voiceless glottal fricative [h] in the syllable [hi] corresponds to the transcription of the above sound in Roman orthography. The Figure 5 is a sample from the word "heat", which provides a closer approximation, since the vowel is not lengthened. Ladefoged (2012) notes that the glottal fricative /h/ is "usually just a voiceless version of the adjacent sounds," especially before /i/, /ɪ/, and /ɛ/ (p. 120). The spectrogram below testifies to this tendency. Note how the sound is similar to the Japanese [çi] in displaying high formant values, with a gap in the lower range.

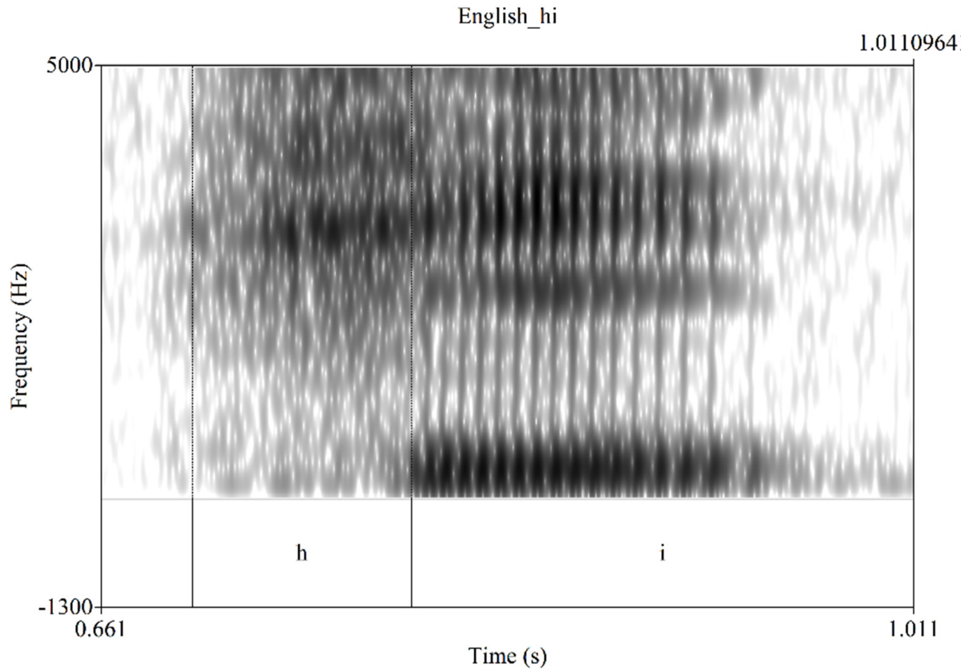

Figure 5: Spectrogram of English [hi]

Figure 6 below is a sample of the syllable [ʃi]. The English voiceless postalveolar fricative [ʃ] is often used by learners to approximate the [ç] sound in other languages, such as German. Notice the much higher formant values present in this fricative. It would seem, then, that the glottal fricative [h] is closer in quality to [ç] than [ʃ] is, at least superficially.

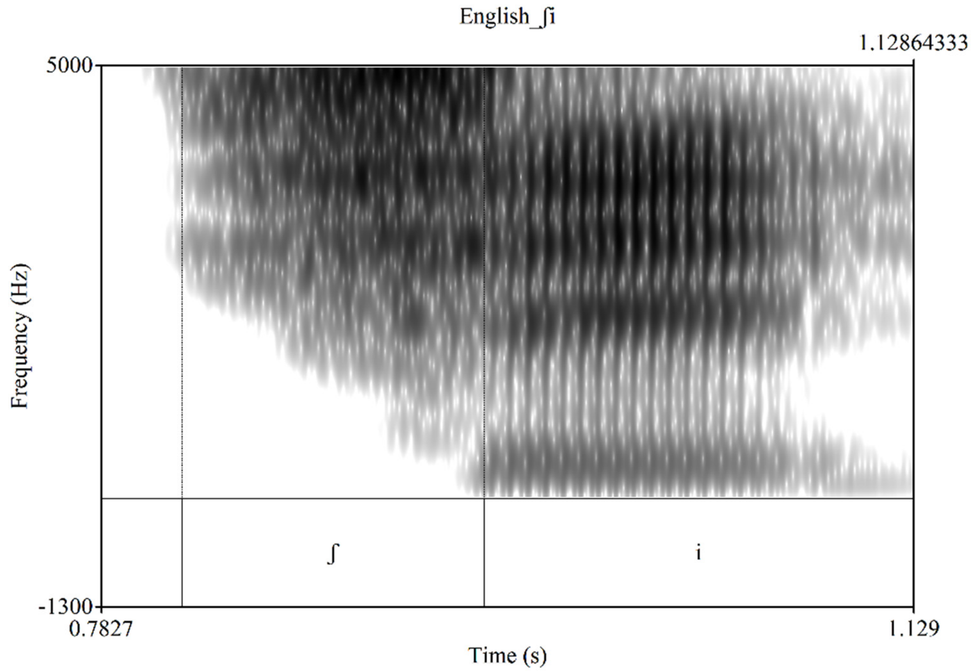

Figure 6: Spectrogram of English [ʃi]

In this section, the various acoustic qualities of the Japanese and the most similar English phones have been examined. The allophonic nature of the Japanese phones is tied to the phonetic quality of the following vowel, unlike in the English phones examined above. One notices how the IPA symbols such /u/ or /ç/ only broadly capture the actual phonetic quality of the sounds.

Current Study

The current study will contribute to the current literature by studying orthographic effects on the perception (and production) of /ɸu/ and /çi/. This study will focus on orthographic effects for English L1 learners of Japanese in the long-term (i.e. not in a novel word-learning scenario) when Roman orthography is used at the beginning of learning but phased out quickly. In addition, the study examines orthographic effects at the phonemic level, rather than whole words. Further, the current study uses second-semester learners and is more in line with Young-Scholten and Langer (2015), Escudero et al. (2008), and Zampini (1994) which also looked at the effects of orthography on language learners, rather than novel word learners. Although novel word learning is a useful tool, the effects of orthography on creating a mental representation of a sound will be clearer in actual learning.

The general use of the Japanese syllabary *hiragana* rather than the Roman orthography in Japanese learning also means that if an effect of orthography is found, it will testify to the pervasiveness of L1 GPC transfer. Japanese learners are taught very early on to use *hiragana* (the native Japanese syllabary) rather than *romaji* (the Roman-character transliteration system). Although *romaji* is necessary for typing, learners in this study are introduced to and required to use *hiragana* from the outset (with the other syllabary *katakana* and the character system *kanji* eventually introduced as well). This study differs from other studies cited above on *pinyin*, because while *pinyin* is a necessary tool to read the Chinese logograms (*hanzi*), which do not encode pronunciation, the Japanese syllabary does and can be used exclusively. Thus, if orthographic effects are found, then it will demonstrate that even in the absence of consistent L1 GPCs (unlike in German for Young-Scholten and Langer (2015)), L1 GPCs nonetheless play a role.

The current study also examines orthographic effects at the phonemic rather than the word level, to see how far orthographic effects will go when there is not necessarily a lexical representation. The phenomenon of orthographic effects is well-attested for words, since orthography aids in the creation of lexical representations (Cutler, 2015), but to understand if orthography shifts perception, testing the phonemic level along the lines of Escudero and Wanrooij (2010) is appropriate.

As stated above, this study seeks to parse out whether Roman orthography, through L1 GPC transfer, changes 1) how a learner perceives an L2 sound and, cursorily, 2) how a learner produces an L2 sound. This study does so by asking participants, learners and non-learners of Japanese, to compare the phones [ɸu] and [çi] to other L1 approximations [fu] and [hu], and [hi] and [ʃi]. Rather than a phonological contrast such as in Hayes-Harb et al. (2015), the current study asks learners to rate the similarity of the L2 sound to the L1 approximation on a scale. Japanese students in the current study learn, at least initially, that the sounds are transcribed as "fu" and "hi" in the *romaji* orthography. If there is an effect of orthography, then learners of Japanese should perceive the Japanese phones as being closer to their transcription equivalents than non-learners—those not learning Japanese—do. Since non-learners have the same L1, English, comparing the two groups will be make it clearer if there are orthographic effects and not simply L1 transfer. Essentially, the current study will test to what extent orthography can override a non-learner tendency. Since it has already been established that the perception of L2 phonemes contributes significantly to their production, the assumption is that perception of these phones will contribute to the production of L2 learners. Nonetheless, a small sample of learners' production is analyzed by examining recordings made during the learner's Japanese classes.

The two main research questions of this study are:

1) Does the orthographic use of "f" influence the perception and production of /ɸu/ by Japanese L2 learners towards /fu/ relative to non-learners?

2) Does the orthographic use of "h" influence the perception and production of /çi/ by Japanese L2 learners towards /hi/ relative to non-learners?

CHAPTER THREE

Methodology

Participants

28 participants were recruited for the present study. Participants were students at Baylor University in Waco, Texas, except for 3 participants. Participants were divided into two groups—Japanese learners (13 participants) and non-learners (15 participants). Due to exclusions that will be explained later, the final data pool consisted of 11 learners and 14 non-learners.

The Japanese learners were recruited from three intact second-semester Japanese classrooms at Baylor University. The Japanese learners were recruited in person. During the recruiting process, the Principle Investigator (PI) visited the classes according to the regular teacher's convenience. The PI explained the purpose of the study, what was required of participants, and how the study would proceed. During the classroom visit, potential participants had the opportunity to sign up for an email list announcing session times for the upcoming research opportunity. Because this list did not obligate participation, the teachers did not know who did or did not participate.

Non-learners were primarily recruited from the general student population at Baylor University. Most non-learners were recruited in person or via email from English and Statistics courses because these courses include many students who do not speak Japanese or another second language. Instructors of these courses allowed the researchers to recruit in class or forwarded a recruiting email to their students. Instructors had no knowledge of who did or did not eventually participate. Other Baylor students were recruited by word of mouth. Three non-learner participants were recruited from the researcher's hometown of Bethesda, Maryland, and participated in the study off-campus. These participants were comparable to the other non-learners as they had not studied Japanese and were university age.

Both groups were also told about the data anonymization procedures and explicitly told that there was no grade given for their performance on the tests or for their participation. Participants had the right to withdraw at any point during the study at no penalty to themselves. Data collected up until the time of the subject's withdrawal was preserved for record-keeping purposes in accordance with IRB guidelines[1] but was not included in data analysis. All participants were paid $5 in cash for their participation.

At the outset of the experiment, both groups of participants completed a language background questionnaire (LBQ) that collected data on gender, age, the languages participants spoke and their experience with those languages, as well as information on participants' country of birth and time spent outside the United States. The LBQ also asked Japanese learners for time spent studying the language, their self-rated proficiency, and how often they used the Roman alphabet (*romaji*) to write in the language. These were rated on a scale from 1 (low) to 10 (high), with *romaji* usage also scored from 1 (all the time) to 10 (never). Results from this questionnaire are displayed in Tables 1 and 2, excluding those participants not part of the final dataset (as explained below).

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[1] All research was conducted in accordance with Baylor University's IRB Guidelines (IRB Reference Number 1032494).

Table 1:

Descriptive Statistics for Participants

Group	Male	Female	Total	Mean Age	SD Age
Learners	2	9	11	20.09	1.78
Non-Learners	9	5	14	21.86	2.92
Total	11	14	25	21.08	2.64

Table 2:

Self-Ratings of Participants' Language Skills

Language Skills[a]	Average	SD
Reading	4.6	1.85
Writing	4.6	1.96
Speaking	4.2	1.72
Speech Comprehension	4.8	1.99
Romaji Use	8.1	3.11

[a]Reading, Writing, Speaking and Speech Comprehension were scaled with proficiency from 1 (low) to 10 (high); Romaji usage was scaled from 1 (all the time) to 10 (never).

Table 2 shows that participants tended to self-rate themselves as at a little less than medium proficiency. They also claimed to generally not use *romaji*, although the SD is quite high at 3.11.

Of the 45 students currently enrolled in Japanese courses, 13 participated in the study. Participants in the Japanese learner group were not initially excluded from participation for any reason, provided they were currently enrolled in the class. 11 of these 13 Japanese learner participants signed a release form allowing use of their speech samples from class to be analyzed for production of the target phones. Professors were aware of these 11 students' participation. All Japanese learners had English as their primary language, with some speaking Chinese and Tagalog as well. Two Japanese Learner participants were excluded from the final results, bringing the total number to 11 (with 10 allowing speech sample use). Of these two that were excluded, one spoke Cantonese as his or her native language with limited proficiency in English, while the other learner did not complete the transcription task correctly.

15 non-learners were initially recruited. One non-learner participant was excluded from the data set, bringing the total number to 14. The excluded non-learner was partially deaf. 13 non-learners in the final participant pool indicated English was their native language, with one Spanish bilingual participant. Some non-learner participants spoke or studied other languages such as Spanish. Participants in the non-learner group confirmed that they did not speak Japanese or have knowledge of languages using the phones under investigation. One participant studied German, but as discussed earlier, the voiceless palatal fricative in this language is substantially different from that used in Japanese.

Materials

Participants completed four tasks which were (1) a language background questionnaire (explained above), (2) an AX discrimination task, (3) a transcription task (only for Japanese learners), and (4) a debriefing questionnaire. In addition, the researchers also retrieved classroom speech samples of the Japanese learners from their Japanese professors at Baylor.

AX Discrimination Task

The discrimination task tested for effects of orthography on the perception of Japanese learners compared to non-learners. To test the hypothesis that Japanese learners would perceive a phone as more similar to its English orthographic equivalent than a non-learner would, an AX discrimination task was created for the two target phones, the voiceless bilabial fricative /ɸu/ and the voiceless palatal fricative /çi/. The stimuli for the discrimination task consisted of 96 AX pairs. Each AX pair contained a target Japanese phone (the control, or A) and either an identical sound or an approximation of that phone (the variable, or X) based on the English sound associated with the two transcription variants. The controls consisted of the two target phones, [ɸu] and [çi], as well as two distractor syllables [ku] and [ɾi]. One of four variables was paired with each phone, as can be seen in Table 3.

Table 3:

AX Stimuli Sets

Control (A)	Variable (X)	Number of Stimuli
[ɸu]	[ɸu]	6
-	[hu]	6
-	[fu]	6
-	[mu] (distractor)	6
[çi]	[çi]	6
-	[hi]	6
-	[ʃi]	6
-	[ki] (distractor)	6
Distractor Sets		
[ku]	[ku], [gu], [tu], [tsu]	24
[ɾi]	[ɾi], [di], [li], [si]	24

For each Control sound, two exemplar recordings were used. For each variable sound, 3 exemplar recordings were used. This was done to control for any variation between exemplars. The controls and variables were paired as can be seen in Table 4. Although this table only shows one set of exemplars, all AX pairs followed the same format.

Table 4:

Control and Variable Pairings Same-ɸ Condition

Control (A)	Variable (X)
[ɸu] (Sample 1)	[ɸu] (Sample 1)
-	[ɸu] (Sample 2)
-	[ɸu] (Sample 3)
[ɸu] (Sample 2)	[ɸu] (Sample 1)
-	[ɸu] (Sample 2)
-	[ɸu] (Sample 3)

Participants rated the similarity of the sounds in each AX pair on a Likert scale. The participants were instructed to give identical AX pairs a rating of 1, and the most different pairs a rating of 7. The Likert scale (from 1 to 7) allowed the researchers to test perceptual similarity more accurately than a binary scale. The answer spaces for each response are shown below in Figure 7, with the full answer sheets located in Appendix B. Participants were instructed to pay the most attention to the consonants rather than the vowel.

1) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

Figure 7: Sample Answer Space for Listening Task

Each control was recorded by a female Japanese exchange student from Tokyo, Japan in a quiet room. Every stimulus was normalized and noise reduced using Audacity sound-editing software to achieve a uniform loudness level for every stimulus. For the variables, every stimulus was recorded by the PI, a male advanced student of Japanese, in a quiet room. These were also normalized and noise reduced in Audacity in the same way. To ensure that the researcher's pronunciation was accurate, every variable sound identical to the target ([ɸu], [çi], [ku], and [ɾi]) was checked by Japanese professors at Baylor University, who are native Japanese speakers. The audio quality was found to be somewhat high pitched (i.e. tinny), but because this was consistent across non-native stimuli, it was not deemed to be a problem.

A Power Point program was created for the purpose of presentation to the participants in the experiment. For each AX pair, a slide was created that contained the two sounds. Each stimulus was cut to 1.5 seconds, meaning when put together there was an approximately one-second gap between each sound. The slides displayed the same scale as in Figure 7 with an instruction to press the spacebar to advance. To control for effects that might stem from the order of stimulus presentation, four different Power Points were created with different pseudo-randomized lists of the auditory stimuli. These four pseudo-randomized lists were created by randomizing the stimuli and manually changing the order of some items such that participants did not hear AX pairs from the same condition more than twice in a row.

Transcription Task

The transcription task tested the orthography used by Japanese learners for the target phones. The stimuli for the transcription task consisted of recordings of 30 Japanese words. 15 words contained the target phone /ɸu/ word-initially, and 15 contained /çi/ word-initially. In order to test whether the participants' transcriptions were consistent for novel and familiar words—and thus whether the orthographic representation of these phones had been memorized or internalized—10 words of each set were drawn from the participants' Japanese coursework, while the other 5 were unfamiliar words. Only one exemplar was used for each word.

Participants listened to each word on their computer and then wrote the words in the Roman alphabet, so that researchers could determine which letters they used for the target phones. Participants also checked boxes to indicate if the word was familiar and if they knew what it meant. They did not need to write down the meaning, however. A sample answer space is shown below in Figure 8.

1) ______________________

☐ I have heard this word before

☐ I know what this word means

Figure 8: Sample Answer Space for Transcription Task

The stimuli were recorded by the same female Japanese speaker as in the discrimination task. These stimuli were also normalized and noise-reduced using version 2.1.2 of Audacity recording and editing software.

Debriefing Questionnaire

The debriefing questionnaire was administered in order to better understand trends in the data. The questionnaire asked participants to explain how they perceived the study, and their perspective on it. In particular, the questionnaire contained questions asking what participants thought the purpose of the study to be, if there were any strategies participants used for the tasks, and anything they noticed about the study. In addition, the questionnaire asked only the Japanese learners if they were aware of different transcription methods for the target phones, and how they perceived their own pronunciation of the target phones.

Speech Samples

To test whether the observed pattern in the Japanese learners' perception of the target phones correlated with their production, speech samples were obtained from the participants' Japanese coursework. The stimuli were class "chapter quizzes" that either asked students to read a passage written in Japanese in one minute, or provided a prompt for spontaneous speech. The rushed nature of these tests discouraged careful attention to pronunciation by the participants. These quizzes were not created by the researchers, but speech samples were obtained for those participants who gave consent. These speech samples were analyzed to test which English sound, if any, the learners used to approximate the target phones. However, the samples obtained were difficult to objectively classify. In addition, since the phones /ɸu/ and /çi/ occur infrequently in Japanese, tokens were not numerous. Because of these difficulties, and because production data was not the main focus of the study, only a few of these samples were analyzed.

Procedures

Participants in both groups completed a single research session. Because of the need for auditory input, the study took place in the Language Acquisition Center at Baylor University, which is equipped with computers and headphones on which to complete the study. Some sessions conducted by the researcher contained multiple participants (the most was 5), but because the room contained 32 computers, participants were seated far apart from each other, and the influence of participants on each other was not deemed to be a problem. The three off-campus participants performed the study in quiet rooms. In both cases, only the researchers and participants were present in the room during the study. The experiment was self-paced, and participants were given one hour to complete the tasks. Times ranged from 20 minutes to one hour, with Japanese learners taking longer because only learners completed the transcription task.

Participants were first asked to give consent, with Japanese learners additionally asked for consent to obtain production data from classroom speech samples. Those learners who declined access to speech samples were still allowed to participate. All participants were assigned a code-number to keep their data confidential. They were then instructed to download and open the experiment Power Point (which was deleted at the end of the experiment). Participants were then given a packet containing the language background questionnaire, the discrimination task answer sheet, the transcription task answer sheet (only for Japanese learners), and the debriefing questionnaire. The Power Point contained instructions for the experiment, such as when to turn pages in the packet, as well as the auditory stimuli for the listening and transcription tasks. The experiment was self-paced, and participants were instructed to complete tasks in the order given without looking ahead in the packet.

Participants first completed the language background questionnaire, while only the learners completed the section at the end of the questionnaire rating their proficiency. Participants were instructed to omit any question on the questionnaire that they preferred not to answer. Next, participants completed the discrimination task. The Japanese learner group also completed the transcription task afterwards. Both groups ended the research session with the debriefing questionnaire and the opportunity to ask questions of the research assistant. Upon completion, participants were given a short explanation on paper about the nature of the study, paid, thanked, and then excused from the lab.

Once all Japanese learner participants had completed the study, the classroom speech data was retrieved from the two Japanese professors for only those participants that chose to allow the PI access to these data.

CHAPTER FOUR

Results

Listening Task

In the listening task, for the purpose of analysis, the participants' ratings for each AX pair were averaged across condition, resulting in a single score for each participant in each condition. That is, since there were 6 instances of each AX condition, participants' scores for each unique stimulus were averaged to produce a single score.

Descriptive results[1] for the different conditions with the voiceless bilabial fricative /ɸu/ and the voiceless palatal fricative /çi/ are shown in Tables 5 and 6, respectively, below. The conditions will hereafter be referred to by the second approximation, i.e. the X part of the AX pair (e.g. Hu to mean the [ɸu]-[hu] pair). The mean describes the number that participants chose on the 1-7 Likert scale.

[1]The statistical analyses throughout this chapter were graciously provided by my thesis advisor, Dr. Nick Henry.

Table 5:

Descriptive Statistics for /ɸu/ Conditions

Phone	Group	Mean	*SD*
Same-ɸu ([ɸu]-[ɸu])	Learners	1.485	0.584
	Non-Learners	1.310	0.319
Fu ([ɸu]-[fu])	Learners	4.909	1.695
	Non-Learners	3.583	1.837
Hu ([ɸu]-[hu])	Learners	2.606	1.440
	Non-Learners	2.762	1.596

Table 6:

Descriptive Statistics for /çi/ Conditions

Phone	Group	Mean	*SD*
Same-çi ([çi]-[çi])	Learners	1.682	1.266
	Non-Learners	1.405	0.456
Hi ([çi]-[hi])	Learners	2.455	1.495
	Non-Learners	2.048	0.818
ʃi ([çi]-[ʃi])	Learners	5.106	1.342
	Non-Learners	3.798	1.579

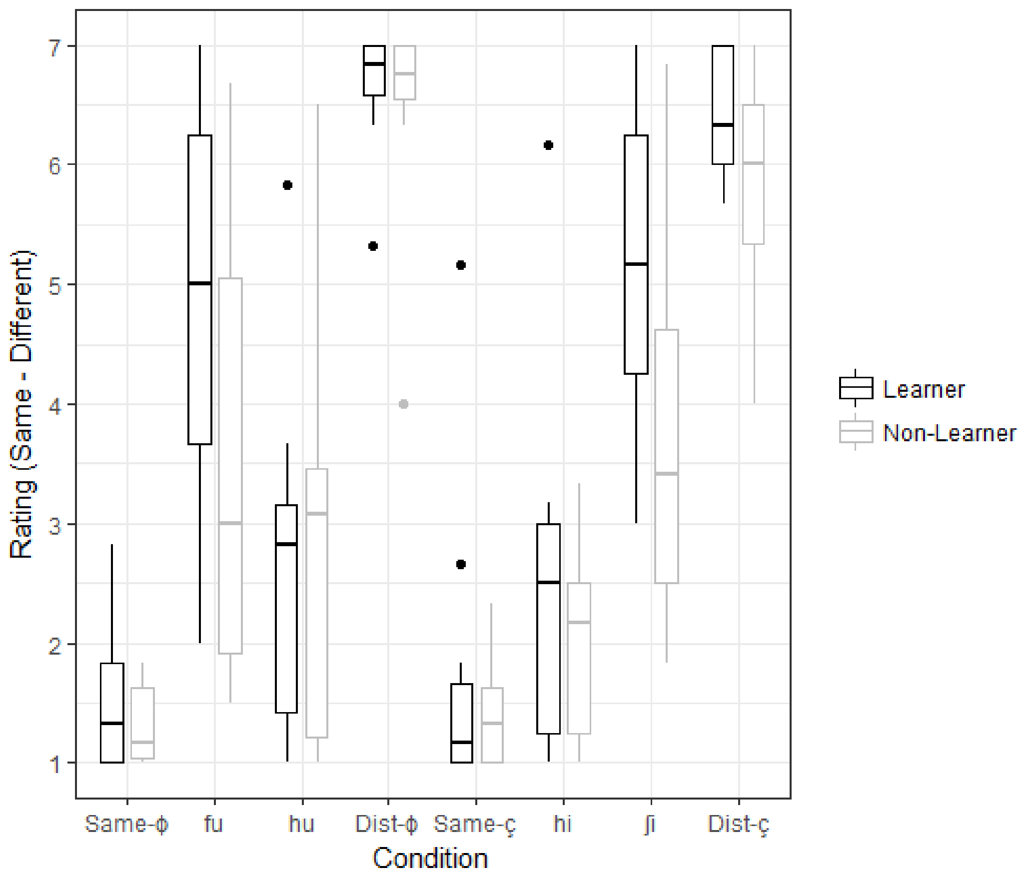


Figure 9: Boxplots for Learner and Non-Learner Ratings for Each Condition

The second ANOVA used the within factor Phone (Same-çi, ʃi, and Hi) and the between factor Group (Learners and Non-Learners). The analysis showed a main effect for Phone ($F(2,46) = 44.670$, $p < .001$, $\eta_p^2 = .660$) and a main effect for Group ($F(1,23) = 4.485$, $p = .045$, $\eta_p^2 = .163$), because the Japanese Learner group overall rated [ʃi], [hi], and [ki] (distractor) as more different from the target [çi] than did Non-learners, particularly with respect to the [ʃi] sound (M = 5.11 vs. M = 3.80). There was no interaction for Phone × Group ($F(2,46) = 1.532$, $p = .227$, $\eta_p^2 = .062$).

In order to interpret the main effects for Phone, Group, and the Phone × Group interaction found in the repeated measures ANOVAs, paired-samples t-tests were used to determine which phones were rated differently from the target.

The results of the paired t-tests are shown below in Table 7. The results showed that all comparisons were statistically significant except for the non-learner pair Fu-Hu, which was marginally significant ($t(13) = 2.045$, $p = .062$). (Fu-Hu compares how non-learner participants rated the phone pairs [ɸu]-[fu] and [ɸu]-[hu]).

Table 7:

Paired Samples t-tests

Learners				Non-Learners			
Pair	t	df	*p*	Pair	t	df	*p*
Same-ɸu - Fu	-6.39	10	<.001	Same-ɸu - Fu	-4.7	13	<.001
Same-ɸu -Hu	-3.78	10	0.004	Same-ɸu - Hu	-3.63	13	0.003
Fu - Hu	3.68	10	0.004	Fu - Hu	2.05	13	0.062
Same-çi - Hi	-3.62	10	0.005	Same-çi - Hi	-3.43	13	0.004
Same-çi - ʃi	-5.94	10	<.001	Same-çi - ʃi	-5.33	13	<.001
Hi - ʃi	-4.48	10	0.001	Hi - ʃi	-3.27	13	0.006

The paired samples t-tests indicated that there may have been a difference between how similar Learners and Non-learners perceived the transcription approximations (relative to the Japanese phone—in particular with respect to [ɸu]). That is to say, Non-learners may have treated Fu and Hu as more similar than Learners, or vice versa. To this end an independent samples t-test was conducted to test if there were a difference between Learners and Non-learners with respect to Fu and Hu, as well as Hi and ʃi. In order to facilitate a direct comparison between the groups, the data were transformed into a difference score. For the voiceless palatal fricative, this was done by subtracting the raw score for ʃi from the raw score for Hi. Likewise, for the voiceless bilabial fricative, the raw score for Hu was subtracted from the raw score for Fu The analyses showed that there was a marginally significant difference between learners and non-learners with respect to how they rated Fu ([ɸu]-[fu]) and Hu ([ɸu]-[hu]) ($t(23) = 2.073$, $p = .050$), because learners rated the pairs as less similar (Fu 4.9 v. Hu 2.6) than non-learners did (Fu 2.6 v. Hu 3.8). There was no significant difference between the groups for Hi ([çi]-[hi]) and ʃi ([çi]-[ʃi]) ($t(23) = -1.128$, $p = .271$).

In sum, there was found to be a statistically significant difference between all conditions for the Learner group except between Fu and Hu, and a statistically significant difference between all conditions for the Non-learner group (this according to the paired t-tests). Non-learners were found to rate Fu and Hu as more similar than learners did according to the independent samples t-test, but this was not the case for Hi and Shi. In addition, the Learner group overall rated the conditions as more different from the target [çi] than did Non-learners per the second ANOVA that found a main effect for Group.

Transcription Task

The transcription task consisted of 30 Japanese words beginning with the target phones /ɸu/ and /çi/ (15 of each phone), which participants listened to before transcribing into *romaji*. This task was performed only by the Japanese learners and was included to test if Learners indeed used the transcription substitutes “fu” and “hi,” even if the words were new.

10 tokens with each target phone were designed to be familiar, for a total of

66.6% of words. Participants marked whether they had heard the word ("heard") or knew what it meant ("known"), but some participants did not follow the guidelines correctly.

For data scoring purposes, the PI first computed the average number of words that were marked as known and familiar for the participants, then divided this by the total number of words in the task. For the main part of the task, transcriptions were coded for their use of the expected transcriptions "fu" and "hi" for /ɸu/ and /çi/ respectively. If the expected transcription was used, the response received a score of 1. If the unexpected transcription was used, the response received a score of 0, and was marked as alternate ("hu" or "shi") or other (e.g. "pu").

Descriptive statistics for the transcription task are shown below in Tables 8 and 9.

Table 8:

Transcription task Results

Phone	Avg Heard	*SD* Heard	Avg Known	*SD* Known	Avg Expected	*SD* Expected
/ɸu/	46.7%	22.0%	30.9%	17.4%	77.0%	23.7%
/çi/	56.4%	30.5%	52.7%	17.9%	98.8%	2.6%
Total	51.5%	27.1%	41.8%	20.7%	87.9%	20.1%

Table 9:

Unexpected Transcriptions

Phone	"hu"	Other
Fu (/ɸu/)	35	3
Hi (/çi/)	1	1
Total	36	4

Three participants consistently transcribed /ɸu/ using the alternate "hu", and account for 26 of the 35 alternate Fu responses. The 35 responses represent 21% of the total 165 Fu responses. 17 of all incorrect responses were marked as heard, while 3 were marked as known.

Production Task

As noted above, production data is here noted only descriptively due to the small sample size and the limited frequency of these phones in Japanese. Read-aloud data was examined, as well as spontaneous speech. For the read-aloud tasks, 22 instances of the target phone /ɸu/ and 15 of /çi/ were found in the readings; for spontaneous speech, no instances of /ɸu/ and 3 of /çi/ were recorded. In the read-aloud task, of these 22 /ɸu/ tokens, 16 were clearly approximated as [fu], and 6 were unable to be classified (i.e. sounding closer to [ɸu]). Of the 15 /çi/ tokens, 13 were clearly [hi], and 2 were unable to be classified (i.e. sounding closer to [çi]). For spontaneous speech, of the 3 instances of /çi/, only 1 was clearly [hi], while the others seemed to fall closer to [çi]. It should be noted that the data was classified only by the researcher, and there is a possibility of bias in classification. Only tokens from the read-aloud data are described below.

Below are the spectrograms of the various learner approximations. Figures 10 and 11 display the Japanese [çi] (used as one of the stimuli in the listening task), contrasted with a learner approximation [hi]. The [h] by the learner displays a slow change in formant values into the [i], consistent with the quality of a voiceless version of the succeeding [i] (in accordance with Ladefoged (2012)). This is unlike the shorter and more articulate [ç]. Figures 12 and 13 display contrast the target [ɸu] and the learner approximation [fu]. Note that there is almost no clarity of formants for [f] when compared to [ɸ].

One learner was found to devoice the entire syllable /ɸu/ in the word [ɸu̥taɾi] (ふたり), shown in Figure 14. Although a spectrogram of the native speaker pronunciation is not shown, the devoicing follows the accepted pattern between two voiceless consonants (Labrune, 2012). This is why the below sample was categorized as hewing more closely to the Japanese /ɸu/. In sum, instances of [fu], [hi], and possibly [ɸu] were found in the production data.

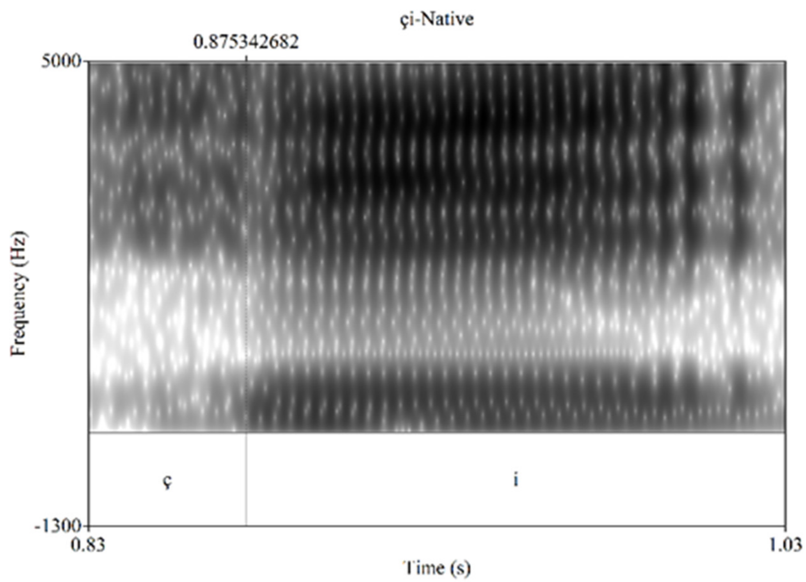


Figure 10: Spectrogram of Japanese [çi] (same as above)

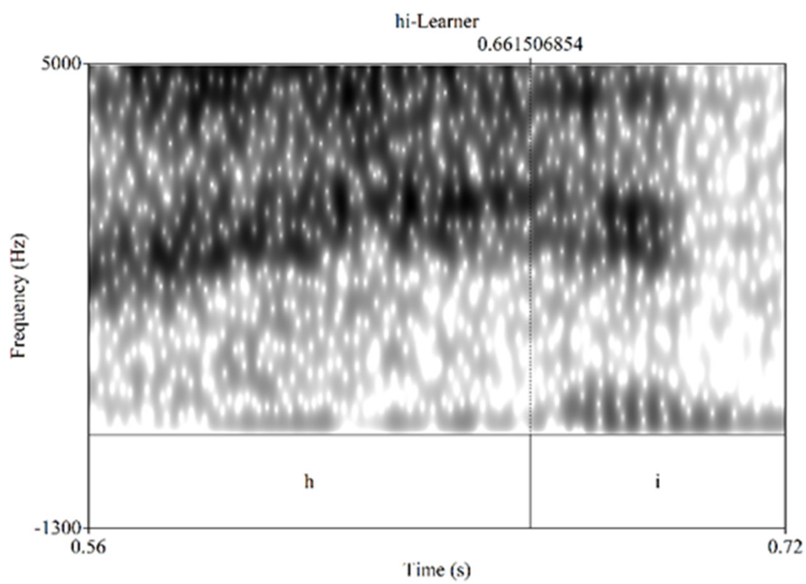


Figure 11: Spectrogram of Learner Approximation [hi] in Production Data

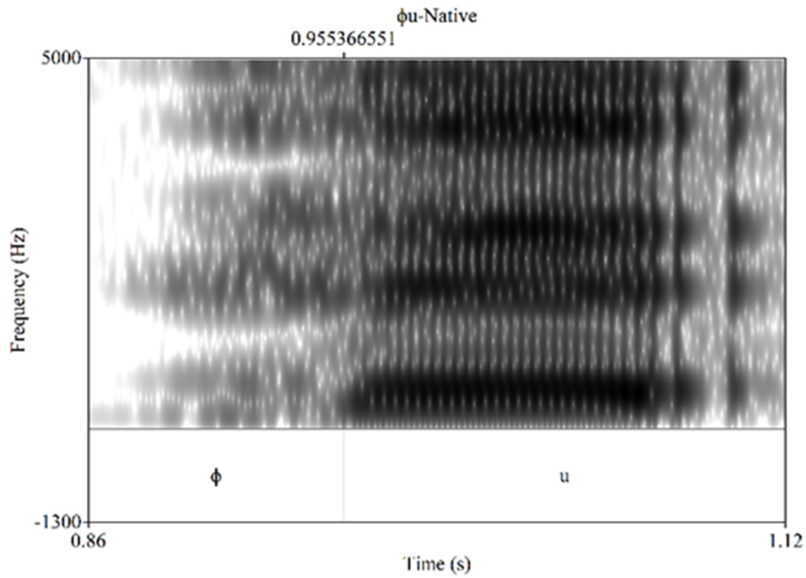


Figure 12: Spectrogram of Japanese [ϕu] (same as above)

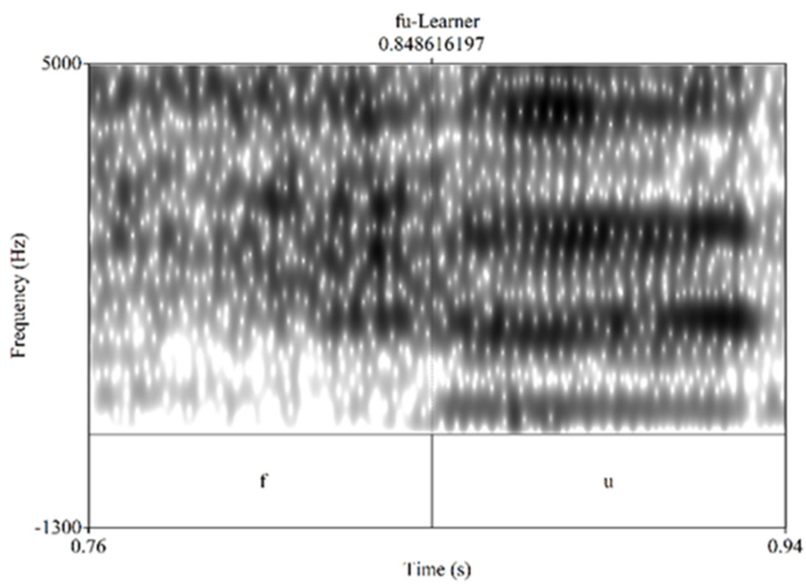


Figure 13: Spectrogram of Learner Approximation [fu] in Production Data

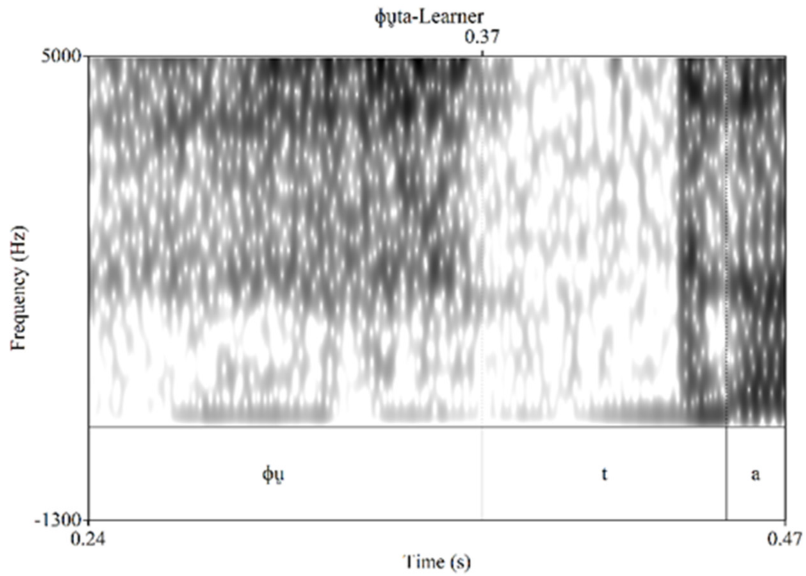


Figure 14: Spectrogram of Learner Approximation [ɸu̥taɾi] in Production Data

CHAPTER FIVE

Discussion

The present study aimed to understand orthographic effects on the perception and production of L2 learners by posing two main research questions: (1) does the orthographic use of “f” influence the perception and production of /ɸu/ by Japanese L2 learners towards /fu/ relative to non-learners?; (2) does the orthographic use of “h” influence the perception and production of /çi/ by Japanese L2 learners towards /hi/ relative to non-learners? Overall, it was found that orthography did not have an effect for /ɸu/ or /çi/ on perception. There are many possible explanations, but experience, supplemented by the distinction between phonemic and lexical testing, may best explain the results. This will be further elaborated on below. However, orthographic effects were found for some learners’ production.

Auditory Task

Two key findings from the auditory task demonstrate the lack of an orthographic effect. First, learners rated [hu] as more similar to [ɸu] than [fu] (i.e. they rated the phones asymmetrically), while non-learners rated [fu] and [hu] as essentially the same in comparison to [ɸu] (i.e. they rated the phones symmetrically). With /ɸu/ the equivalence classification was not readily apparent. The expected result of orthography would be that learners would perceive [ɸu] as closer to [fu]. However, learners instead rated [ɸu] as closer to [hu], which runs counter to the expected orthographic effect. Non-learners had a different pattern of results; however, since both groups share the same L1, and learners ran counter to the expected effect, orthography is not influencing the perception of

Japanese L2 learners. Second, although learners rated [hi], [ʃi], and [ki] (distractor) as more different overall from [çi] than did non-learners, both groups followed the same pattern of similarity (namely, [hi] as more similar to [çi] than [ʃi]). Learners and non-learners demonstrated a similar pattern for [çi] because [hi] is the most obvious choice for an equivalence classification. Although it is possible that orthography could have reinforced the distinction between phones, it seems more likely that orthography did not have an effect given the results for /ɸu/.

There are many possible reasons for the lack of orthographic effects. Experience may be the most likely reason for the lack of orthographic effects, specifically the experience of Japanese L2 learners with the phones. This is possible for two reasons. First, learners distinguished between [fu] and [hu] with regards to [ɸu] while non-learners did not. This means that learners were better able to interpret [ɸu], in this case rating it as closer to [hu], suggesting that learners may have cued in on the acoustic properties that make [fu] and [ɸu] different (most notably, the lack of any formant values during the fricative [f]). They may have viewed [hu] and [ɸu] as very similar because they are acoustically similar due to, for one, the presence of formant values in both (as demonstrated above). Non-learners with no experience could not reliably decide which English sound /ɸu/ resembled, and thus did not cue into the acoustic properties of the sounds as readily. The second reason to argue for the primacy of experience is that learners rated English sounds as more different from /çi/ than did non-learners. More experienced L2 learners would pick out the acoustic differences more readily.

Testing at the phonemic level, as opposed to the lexical level, is another possible explanation for the lack of orthographic effects, even though it does not completely explain the results. With a lexical representation, a learner is aware of how a word ought to be pronounced and perceived, even if the distinction is not manifested in production or perception (Cutler, 2015). However, as Cutler points out, learners misinterpret sounds word-initially, i.e. before the entire word is present (p. 117). It may be that, were learners given an entire word, they would have displayed orthographic effects when asked to interpret the phone. Other studies that found orthographic effects—specifically, the nullification of a contrast to fit a certain L1 perceptual category (Hayes-Harb et al., 2015; Mathieu, 2016)—found effects in word-level processing. It is possible that if the learners had been provided orthographic input during the auditory task, effects would have been found: Escudero and Wanrooij (2010) found effects at the sublexical level for Dutch, and their study showed that the presence of orthography influenced perception. The argument that effects are only found at the lexical level, though, does not account for the notably different results between groups (learners and non-learners), especially for /ɸu/. Although orthography may have more of a role at the lexical level, experience best explains why the results differed between groups.

Another possible explanation for the lack of orthographic effects is that Roman orthography is not used extensively enough to play a role. Note that some studies that looked at orthographic effects in various scenarios used Western languages that shared an L1 orthography (Young-Scholten & Langer, 2015; Zampini, 1994), or Chinese, which uses *pinyin* more consistently (Bassetti, 2007; Meng, 1998; Ye et al., 1997). However, since it is not necessary to use *romaji* because of the native Japanese syllabary *hiragana*, Japanese learners either did not use Roman orthography long enough at the beginning of study, or they were not as consistently exposed. The problem with this explanation, however, is that it does not account for the learners who used "fu" as a transcription for Japanese words, nor does it account for the presence of [fu] in production, both of which point to at least decent knowledge of the Roman orthography. Another possibility is that since learners varied on their use of *romaji* (both "fu" and "hu" are sometimes used to transcribe /ɸu/) there was no clear L1 GPC to sway the perception of the phoneme. But, inconsistent *romaji* usage does not explain the perception in the direction of /hu/. It seems likely that learners do have knowledge of Roman orthography, but are not utilizing it at the phonemic level, and letting auditory experience take over. Furthermore, neither explanation—a lack nor an ambiguity of orthographic knowledge—explains between-group differences.

In sum, auditory task results are may best be explained by experience, supplemented by an understanding of the distinction between phonemic and lexical perception. The infrequency of *romaji* usage does not seem to adequately square with the results from the other tasks, and ambiguity in usage does not seem to adequately explain the results either. However, it cannot be determined with certainty why there were no effects found.

Transcription Task

The intent of the transcription task was to see if learners used or knew the expected transcriptions "fu" and "hi" when listening to the phonemes. In other words, it tested whether the learners were aware of the Roman orthographic correspondence. Learners used the transcription "hi" for /çi/, and used this even for novel words. However, for /ɸu/ it was not clear that learners would consistently use "fu," since the learner average was 77.0% (*SD*=23.7%). Although 3 learners account for the majority of responses, nonetheless there was no uniformity of "fu" usage.

Most likely, perception is influencing the orthographic production of learners due to the auditory nature of the task. Rochet (1995) makes clear that perception of phonemes drives their equivalence classification and production. It could be that when exposed to auditory input in the absence of either *hiragana* or *romaji*, learners rely more on auditory information. Since learners generally perceive /ɸu/ as more similar to [hu], then this would explain the finding. Furthermore, it is possible that for words that lack a lexical representation (i.e. novel words) learners are more inclined to rely on auditory perception. If it can more rigorously be shown that learners use "hu" for unknown and unheard words, then it would be clearer whether lack of a lexical representation has an effect.

Another possible reason for the lack of uniformity in response to /ɸu/ could be that some learners are unfamiliar with the expected transcription "fu" (note that "hu" is sometimes used to transliterate Japanese and can be used when typing). This would especially explain why certain learners neglected to use "fu" at all. However, learners still produced "fu" with good frequency, indicating that they are not entirely unfamiliar with the *romaji,* and production task data also indicates familiarity for some learners. More likely, unfamiliarity contributes to a reliance on auditory perception. For the transcription task, some combination of factors—influence of auditory perception, *romaji* unfamiliarity, and lack of lexical representation—explains the results.

Production Task

In the production task, learners appeared to demonstrate [fu] and [hi] rather than [hu] or [ʃi] in approximating the Japanese phones. However, this task was not systematic, and, as there were no independent raters, it was perhaps susceptible to researcher bias in the interpretation of the results. Overall, the presence of tokens that more closely approximated /ɸu/ or /çi/ for some learners is consistent with increasing experience in the language. Likewise, the presence of [hi] in the production data is consistent with the previous results from the auditory and written tasks. The presence of [fu], though, would seem to run counter to the assertion that perception leads to production. It also shows that at least for some learners, there is an effect of orthography in production, since learners have already been shown to rate [hu] as more similar to [ɸu] than [fu]. Why, then, is there an effect of orthography for some learners here, but not in the auditory task?

The most likely explanation is that orthography has influenced the lexical representation at the onset of learning, and that auditory perception has continued to be overridden in production. That is, learners are relying on an orthographically-influenced lexical representation which persists because L2 learners' interlanguage is in a state of flux, i.e. they have not yet fully acquired the phonology. In this scenario, L2 learners' phonology should improve over time as production "catches up with" auditory perception. Another possibility is that auditory perception is not influencing the lexical representation because the auditory task, as mentioned above, tested at the phonemic rather than the lexical level. Since the production task is testing at the lexical level, orthographic effects will be found. This squares with Cutler (2015) who noticed the lack of an orthographic effect on perception until an entire word was provided, as well as Escudero et al. (2008) who also found orthographic effects on word-level perception. Thus, the auditory task did not display orthographic effects because it tested the phoneme level of perception, while the production task displayed results because it tested at the word level. To better discern if this were the case, testing the production of individual phonemes would be necessary.

Both of explanations above indicate the semi-autonomous nature of perception and production. This allows for the possibility that increased *romaji* usage may lead some learners to more readily produce [fu], which would align with anecdotal evidence by the Japanese professors in this study that certain learners demonstrate *romaji*-influenced pronunciations such as [nɑ.mɛ] instead of [nɑmɑe] for the word spelled "namae." However, a correlation between *romaji* usage and pronunciation would need to be further tested.

A second explanation for the realization of [fu] could be that some learners are utilizing the L1 GPC "fu" for the equivalent *hiragana* or *kanji* only during read-aloud tasks. This would be consistent with the results of Zampini (1994) which found a stronger orthographic effect during read-aloud studies. However, one problem with this explanation is that many of the tokens occurred during reading of *kanji* that do not contain pronunciation information, so there should be no read-aloud effect. Another issue is that read-aloud effects by themselves (i.e. without the explanations above) cannot explain the production of [fu] because otherwise in spontaneous speech learners should overwhelmingly produce [hu]. Since the researcher is highly skeptical that learners would produce [hu] in the absence of orthography, the availability of orthography alone most likely does not explain the presence of [fu]. However, it is still possible that it has some effect.

A third possible factor explaining the presence of [fu] in production data is some level of articulatory difficulty for learners. That is, even though they perceive /ɸ/ as distinct from both /f/ and /h/, and similar to /h/, there is something prompting learners to fall back on /f/. It could be that learners are more inclined to produce the labiodental /f/ because its position is closer to the bilabial /ɸ/. Similarly, it could require some conscious control for a learner to produce [hu], especially given the Japanese vowel sound, and the format of a fast-paced reading task during an exam might explain the tendency to put precise articulation aside. However, this argument does not fully account for the fact that the perception of a sound, not articulatory difficulties, in general leads to its production (Rochet, 1995). But, the effect of the rushed and stressed nature of the production task is likely encouraging learners to take a more expedient route, which may be [fu] due to lexical representation or orthographic familiarity.

A final, possible explanation could simply be biased data given a limited sample size—it is possible that some learners rated [fu] and [ɸu] as more similar, and these were the participants sampled. Whether learners who were inclined to write "hu" were just as likely to produce [fu] as other learners was not clear. In order to best clarify the reasons for orthographically-influenced pronunciations, future research will need to compare non-learner pronunciations, as well as more systematically test learner pronunciations.

Study Limitations and Further Research

There are a few limitations of the study worth mentioning. The most important one is the lack of a group that had been trained on the orthography "hu." If there had been two groups, one trained with “fu” and one with “hu,” then it would have been easier to decipher whether the type of orthography had an effect, or whether, across the board, orthography fails to change perception in the study case. In other words, whether “hu” would have strengthened the similarity of [hu] and [ɸu] for learners, or not.

Another limitation is the number of participants. The number of participants was 11 for the learner group and 14 for the non-learner group, and this may have limited what could be found to be statistically significant. However, the number that was able to be recruited for the learner group was good given the limited number of Japanese second-semester students at Baylor.

More systematic production task data would also have been of use in testing what pronunciation learners used for the sounds, rather than simply finding that [fu] was a possible approximation. Another limitation is that it was not clear to what extent learners internalized L1 GPCs in *romaji*, given the mixed results for the transcription task. Further research would be necessary to parse out when and to what extent learners use L1 GPCs for languages that have non-L1 orthographic systems. This might make the results of the production task more transparent, since what explains the frequency of certain pronunciations, apart from word-level processing, is unclear.

CHAPTER SIX

Conclusion

Experience may be the best explanation for what determines perception at the phonemic level for non-L1 orthography languages, given a lack of orthographic effects. The current study shows that in certain scenarios, such as limited orthographic usage and more experience with the language, orthography does not have an effect on perception as far as equivalence classification is concerned. This would seem to counter other studies mentioned above have found effects of orthography on perception (Cutler, 2015; Escudero & Wanrooij, 2010; Escudero et al., 2008; Hayes-Harb et al., 2010; Mathieu, 2016; Rastle et al., 2016; Showalter & Hayes-Harb, 2015). However, the main difference between the current study and these studies is testing at the phonemic level (as opposed to word-level perception) and testing without the presence of orthography (in contrast to Escudero and Wanrooij (2010)). There appear to be limits on the influence of orthography in certain perceptual scenarios.

The presence of production data that does not match with the perception of certain phonemes, though, indicates that for certain learners either orthography (here *romaji*) affects production at the lexical level, or possibly that production is tied to the orthography present (here *kanji* and *hiragana*), even if it is non-L1 orthography. This seems to support the idea that the auditory perception and production systems are not directly linked, but rather that the connection is mediated by abstract representations. That is, either auditory perception of phonemes can take place autonomously from lexical production, or perhaps orthographic influence on lexical representations persists despite development in the ability to auditorily perceive L2 speech sounds. Further research is necessary on production to more clearly determine to what extent there is a difference between auditory perception and lexical production, and to what extent further improvement of a learner's interlanguage results in improved pronunciation.

The results of this study point to limits on the effect of orthography, and it will be necessary to more clearly determine what these limits are. However, as can be seen from the limited production data, orthographic effects persist even in non-L1 orthographic languages, and even when auditory perception contradicts orthographic production. It is important for L2 learners and teachers to be aware of the effects of L1 GPCs in all languages, and the continued necessity to address these effects.

APPENDICES

APPENDIX A

Language Background Questionnaire

Subject Number: ____________________ Date: ____________________

Language History Questionnaire

This questionnaire is designed to give us a better understanding of your experience with other languages. We ask that you be as accurate and as thorough as possible when answering the following questions.

Part I

1. Gender: ____________________
2. Age: ______ years
3. Do you have any known visual and/or hearing problems (either corrected or uncorrected)?
   - ❑ No
   - ❑ Yes [Please explain: ____]
4. Native Country/Countries (Please check all that apply.)
   - ❑ United States
   - ❑ Other [Please specify: ___________________]
5. Native Language(s) (Please check all that apply.)
   - ❑ English
   - ❑ Other [Please specify: ___________________]
6. Language(s) spoken at home (i.e., with family). (Please check all that apply.)
   - ❑ English
   - ❑ Japanese
   - ❑ Spanish
   - ❑ German
   - ❑ Chinese
   - ❑ Korean
   - ❑ Other [Please specify: ____________________________________]

Part II
The next section of the questionnaire deals with your second language learning experience.

7. Have you studied any second language(s)?
   - ❑ No → **If NO, please stop here and notify the lab assistant.**
   - ❑ Yes → If yes, which language(s)? ____________________________________
8. If you studied any second language(s) (including Japanese) before college, please check all of the following that apply and indicate the starting age and length of study for any second language(s) learned before college.
   - ❑ Home/Outside of School – Language(s): ______________________________
     Starting age? __________ How many years? _____________
   - ❑ Elementary School – Language(s): ______________________________
     Starting age? __________ How many years? _____________
   - ❑ Middle School – Language(s): ______________________________
     Starting age? __________ How many years? _____________
   - ❑ High School – Language(s): ______________________________
     Starting age? __________ How many years? _____________

Page 1 of 3

Subject Number: ____________________ Date: ____________________

9. Have you studied any second language(s) (including Japanese) in college?
   - ❑ No → **If NO, please go to Question # 11.**
   - ❑ Yes → If yes, which language(s)? ____
     For how long (not including the current semester)?
     - ❑ Less than one semester
     - ❑ 1 semester
     - ❑ 2 semesters
     - ❑ 3 semesters
     - ❑ 4 semesters
     - ❑ 5-6 semesters
     - ❑ 7-8 semesters
     - ❑ 8+ semesters

10. Are you currently taking any language courses at Baylor?
    - ❑ No
    - ❑ Yes → If yes, which course(s)? ____

11. Have you studied and/or lived abroad? If you were not born in the United States, please include your stay(s) in the United States in the table below.
    - ❑ Yes
    - ❑ No

    If YES, where and when did you study, for how long, and what language(s) did you speak?

Country	Approx. dates	Length of Stay	Language

12. What do you consider to be your primary second language? (You may check more than one if you feel that you have multiple "primary" second languages.)
    - ❑ English
    - ❑ Spanish
    - ❑ Japanese
    - ❑ German
    - ❑ Chinese
    - ❑ Korean
    - ❑ Other: Please specify ____

If you have no experience with Japanese, please stop here and notify the lab assistant.

Subject Number: ____________________ Date: ____________________

Part III

Only complete this section if you speak Japanese. In this section you will rate your skills in Japanese.

13. Your reading proficiency in Japanese. (1=not literate and 10=very literate)

    1 2 3 4 5 6 7 8 9 10

14. Your writing proficiency Japanese. (1=not literate and 10=very literate)

    1 2 3 4 5 6 7 8 9 10

15. Your speaking ability in Japanese. (1=not fluent and 10=very fluent)

    1 2 3 4 5 6 7 8 9 10

16. Your speech comprehension ability in Japanese. (1=unable to understand conversation and 10=perfectly able to understand)

    1 2 3 4 5 6 7 8 9 10

17. How often do you use *romaji* (Latin alphabet) when writing Japanese? (1=all the time and 10=never)

    1 2 3 4 5 6 7 8 9 10

APPENDIX B

Listening Task Answer Sheet

Listening Task Answer Sheet

In the following task, you will listen to pairs of sounds. For each pair, please rate how similar the two consonants at the beginning of the word sound. You do not need to think too long or hard on each question.

Example:

You first hear the sound "koo" followed by "too." The "k" sound and the "t" sound are very different, so you would mark as follows:

Ex) 1=no difference (same); 7=very different

1 2 3 4 5 6 ⑦

1) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

2) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

3) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

4) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

5) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

6) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

7) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

8) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

9) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

10) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

11) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

12) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

13) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

14) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

15) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

16) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

17) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

18) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

19) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

20) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

21) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

22) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

23) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

24) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

25) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

26) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

27) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

28) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

29) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

30) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

31) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

32) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

33) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

34) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

35) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

36) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

37) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

38) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

39) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

40) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

41) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

42) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

43) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

44) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

45) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

46) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

47) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

48) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

49) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

50) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

51) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

52) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

53) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

54) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

55) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

56) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

57) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

58) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

59) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

60) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

61) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

62) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

63) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

64) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

65) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

66) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

67) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

68) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

69) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

70) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

71) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

72) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

73) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

74) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

75) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

76) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

77) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

78) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

79) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

80) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

81) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

82) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

83) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

84) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

85) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

86) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

87) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

88) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

89) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

90) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

91) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

92) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

93) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

94) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

95) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

96) 1=no difference (same); 7=very different

1 2 3 4 5 6 7

APPENDIX C

Debriefing Questionnaire

Debriefing Questionnaire

For the following questions, think about the research activity that you just competed.

1. What do you think was the purpose of this experiment?

2. Were there any tricks or strategies that you used to help you get the answers correct during the activity? What were they? Were these strategies successful?

3. Do you think the activity taught you anything? What did you learn from doing this activity?

4. Is there anything you noticed or found interesting during the experiment that you would like to add?

If you are learning Japanese, please complete the back side. If not, you may give this questionnaire to the lab assistant now.

5. Did you know that ふ/フ could be written as both *fu* or *hu*?

6. If so, do you only use one method or switch?

7. How do you think you pronounce ふ/フ ; do you ever substitute it with the sounds *fu* or *hu*?

8. How do you think you pronounce ひ/ヒ; do you ever substitute it with the sounds *hi* or *shi*?

APPENDIX D

Japanese Learner PowerPoint

Welcome to the Japanese Learning Experiment!

Press the Spacebar to continue.

This PowerPoint will guide you through the experiment and contains the different tasks you will need. The experiment will last about 45 minutes.

Use the spacebar to navigate between slides unless otherwise directed. When using the packet, do NOT proceed to the next task until directed to do so. You will have a total of four tasks in this experiment.

If you experience any difficulties or have any questions, please stop immediately and notify the experimenter. We are here to help!

Press the Spacebar to continue.

Please make sure you have signed the consent form before you begin the experiment.

Press the Spacebar to continue.

The first part of the experiment is a Language Background Questionnaire.

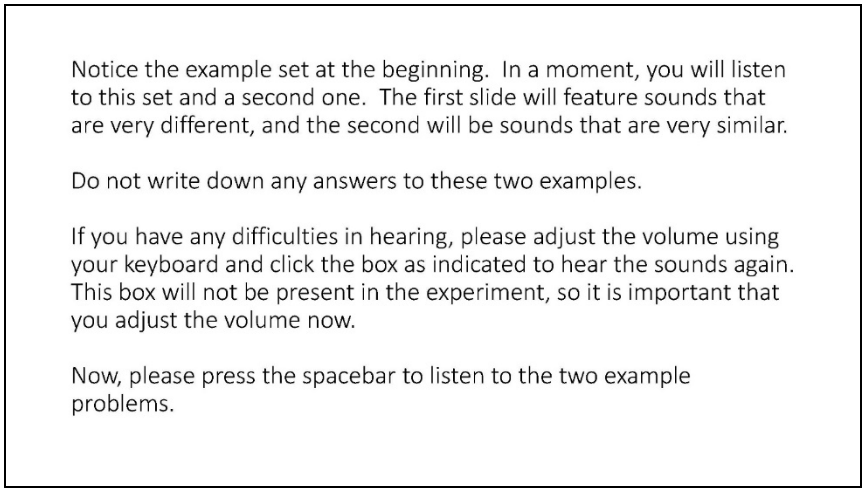
Please turn to the "Language Background Questionnaire" in the packet and open it. Fill out the questionnaire to the best of your ability. If there are any questions you would rather not answer, you may leave these blank.

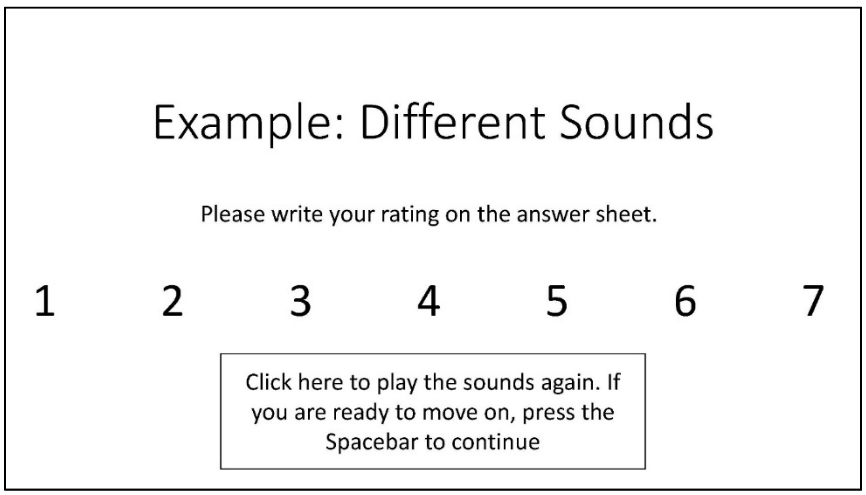
Press the spacebar to continue

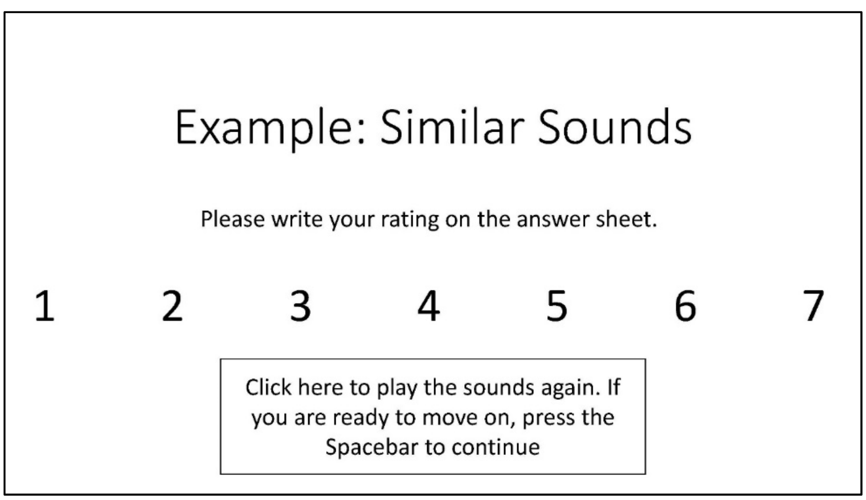
Next you will complete the listening task. You will need your headphones for this task, which are located to your left.

Please turn to the page in the packet entitled "Listening Task." Please take a moment to read through the instructions on the answer sheet before continuing with the PowerPoint.

Press the spacebar to continue with instructions.


Notice the example set at the beginning. In a moment, you will listen to this set and a second one. The first slide will feature sounds that are very different, and the second will be sounds that are very similar.
Do not write down any answers to these two examples.
If you have any difficulties in hearing, please adjust the volume using your keyboard and click the box as indicated to hear the sounds again. This box will not be present in the experiment, so it is important that you adjust the volume now.
Now, please press the spacebar to listen to the two example problems.


Example: Different Sounds
Please write your rating on the answer sheet.
1 2 3 4 5 6 7
Click here to play the sounds again. If you are ready to move on, press the Spacebar to continue


Example: Similar Sounds
Please write your rating on the answer sheet.
1 2 3 4 5 6 7
Click here to play the sounds again. If you are ready to move on, press the Spacebar to continue

As you can see, the sounds will start immediately after you move to the slide.

Not all slides in this experiment will have sounds that are clearly similar or different. You may use the entire scale to mark how similar or different you think they are.

Make your best judgement about the sounds on your first impression. Press the spacebar to move on to the next slide only when you feel ready to do so.

Do not attempt to listen to the sounds more than once. If you have had trouble hearing the sounds, please raise your hand and the experimenter will assist you.

Please press the spacebar to continue.

This concludes the practice.

As you complete the task, please make sure that the slide number matches the answer space. If you are ever unsure, please stop and raise your hand for the experimenter!

As soon as you are ready, you may begin.

The task will start immediately when you use the mouse to click
>HERE<

The next task is a writing task.

Please turn to the page titled "Writing Task." Take a moment to read through the instructions at the beginning.

You will only hear each word once. You will now listen to the example problem from the beginning.

Please press the spacebar to continue

Example

Please transcribe the word you hear on the answer sheet.

Click here to play the sounds again. If you are ready to move on, press the Spacebar to continue

---

This concludes the practice.

As soon as you are ready,

please click below to begin the task.

The task will start immediately when you click

>HERE<

The last task is a debriefing questionnaire.

Please find the page in the packet entitled “Debriefing Questionnaire.” This questionnaire will help us know what you thought of the experiment. Fill it out to the best of your ability.

When you are finished, please turn to the next page in the packet.

Press the spacebar to continue.

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