Accepted, *Journal of Second Language Pronunciation*
huensch@usf.edu

# Perceptual Phonetic Training Improves Productions in Larger Discourse Contexts

Amanda Huensch
University of South Florida

Address for correspondence: Amanda Huensch, Department of World Languages, University of South Florida, Tampa, FL, 33620, USA. Email: huensch@usf.edu

Acknowledgements
I would like to thank Chris Carignan for his help in developing and modifying the scripts used to automate processes for segmenting and normalizing data in Praat. I would also like to thank Liam Moran, a consultant for ATLAS Digital Media at the University of Illinois at Urbana-Champaign, who created the Pierceive software and Lisa Pierce at the University of Illinois at Urbana-Champaign, who allowed us access to the training paradigm she created for the purposes of using it as the control group training. I would also like to thank Annie Tremblay, Editor Dr. John Levis as well as three anonymous reviewers for their valuable comments on my manuscript.

Revised manuscript submitted March 2016

huensch@usf.edu

Abstract

Previous work has shown that perceptual training can lead to improvements in production which generalize to new words and talkers. The current study investigated the effects of perceptual training on productions in larger discourse contexts of continuous speech, and additionally examined whether training generalized to a new syllable structure and across grammatical domains. Participants included Korean L2 learners of English in a pretest-training-post-test design. An experimental group completed perceptual training on singleton coda palatals, and a control group completed training on an unrelated target. Results indicated that perceptual training on singleton coda palatals was successful in significantly improving learners' productions in continuous speech. Learners were able to generalize production improvements to a new syllable structure (simple vs. complex coda), but not across grammatical domains (*–ed* ending morphemes). These findings provide further support for the use of perceptual training in pronunciation classrooms, but demonstrate some limitations to its generalizability.

*Keywords*: phonetic training, L2 speech perception and production, pronunciation teaching

## 1. Introduction

When investigating pronunciation instruction and the acquisition of second language (L2) phonology, perception has played a central role. Teacher training guides (e.g., Celce-Murcia, Brinton, Goodwin, & Griner, 2010) emphasize the importance of perception in improving pronunciation and pronunciation assessment experts (e.g., Isaacs, 2014) call for the testing of perception skills for diagnostic and achievement purposes. The central role perception plays in L2 phonological development is also highlighted in existing theories of L2 speech learning such as the Speech Learning Model (SLM) (Flege, 1995, 2003) and the Perceptual Assimilation Model (PAM) (Best, 1995; Best & Tyler, 2007). The SLM, given its focus on investigating age-related constraints, has examined mostly ultimate attainment learners and their acquisition of L2 consonants and vowels. Within this model, it is hypothesized that children learning their first language (L1) become attuned to the segmental contrasts of whatever language they are learning and store L1-specfic features as phonetic categories. Nevertheless, because these categories are not fixed, it is possible for them to change over time given the opportunity to do so. The SLM also hypothesizes that some production problems may have their roots in inaccurate perception. Therefore, this model highlights the importance of restructuring the perceptual space in the acquisition of an L2 phonological system.

The PAM has its roots in Direct Realism (see e.g., Fowler, 1986) and unlike the SLM, proposes that information about the L1 system is stored as articulatory gestures, rather than as phonetic categories from acoustic properties of the speech signal. The PAM posits that non-native speech sounds will be perceived in relation to their articulatory similarities to and differences from native speech sounds (Best, 1995). While the PAM was originally intended to explain cross-linguistic speech perception, the PAM-L2 (Best & Tyler, 2007) extended the model to L2 speech learning and hypothesized that success in acquiring L2 speech sounds first relies on whether the L2 sound has been perceptually assimilated as the “L1 phonological entity” (p. 27). However, unlike the SLM, the PAM-L2 argues that assimilation relies on similarities and differences not only at the phonetic level, but also the phonological level. An important similarity between these two models is that both allow for adults to continue learning, which means that categories may change over time. While the SLM and the PAM-L2 differ in the primitives of speech perception that are assumed (acoustic cues vs. articulatory gestures) and whether equivalence is considered at the phonetic level or also the phonological level, both emphasize the role of perception in L2 phonological acquisition and could account for improvements in perception leading to improvements in production.

One way to aid the restructuring of perceptual space involves perceptual phonetic training. A highly successful training paradigm that has been implemented in the literature (and is the basis for the perceptual training in the current study) is called high-variability phonetic training. This paradigm entails perceptually training learners with multiple words from multiple talkers. The goal is to expose L2 learners to varied phonetic input that allows them to establish more robust categories which in turn allows them to generalize learning to new words and new talkers. Research implementing high-variability phonetic training has provided evidence that acquiring perceptual contrasts (e.g., Jamieson & Morosan, 1986; Lively, Logan, & Pisoni, 1993; Logan, Lively, & Pisoni, 1991; Wong, 2014) and improving production (e.g., Bradlow, Pisoni, Akahane-Yamada, & Tohkura, 1997; Bradlow, Akahane-Yamada, Pisoni, & Tohkura, 1999; Huensch & Tremblay, 2015; Lambacher, Martens, Kakehi, Marasinghe, & Molholt, 2005; Thomson, 2011; Wong, 2013) are possible.

The influential work of Logan, Lively and Pisoni (1991) and Lively, Logan and Pisoni (1993) introduced an effective perceptual training method. Motivation for these studies stemmed from prior work failing to show generalizability of training to novel stimuli and novel talkers. The segments in question were /ɹ/ and /l/ and participants were Japanese L2 learners of English. The general organization of the method includes a pretest/post-test design with a period of perceptual training using a forced-choice word-identification task in between. Logan et al. and Lively et al. demonstrated that by using natural stimuli produced by multiple talkers, learners were able to generalize learning to both novel words and novel talkers. This is attributed to the fact that natural stimuli and multiple voices contain more variation than synthetic stimuli or a single talker. These results highlight the importance of being trained with natural stimuli and multiple talkers for robust category formation to take place.

As an extension of this work, Bradlow et al. (1997) tested the production accuracies of /ɹ/ and /l/ of Japanese L2 learners of English who had been perceptually trained. A similar pretest/post-test design with a period of perceptual training in between was employed to determine if training improved L2 learners' perception and production of these sounds. Results indicated that trained learners' perception scores were significantly higher than the untrained learners' scores. More importantly, they then compared these perception scores to production scores and examined whether perceptual training had a positive effect on production accuracy. Their results indicated that perception training did result in production improvements, but that individual differences in production gains were evident.

Perceptual phonetic training has also focused on the acquisition of vowel segments (Lambacher et al., 2005; Thomson, 2011; Wong, 2013, 2014) and novel syllable structures (Huensch & Tremblay, 2015). For example, Thomson (2011) trained Mandarin L2 learners of

English on 10 English vowels and determined that training improved intelligibility of these vowels and in some cases was able to extend to new phonetic contexts (e.g., training on /bV/ and /pV/ extended to /zV/ and /sV/, but not to /gV/ and /kV/). There is growing evidence that the benefits of perceptual phonetic training can extend to pronunciation improvements without explicit production practice (Bradlow et al., 1997; Huensch & Tremblay, 2015; Lambacher et al., 2005; Thomson, 2011). These are promising findings for the field of computer assisted pronunciation training because they provide support for adopting these methods to supplement pronunciation instruction. However, much of this training has focused on the perception and production of segments in isolated words, with one exception being Huensch and Tremblay (2015), in which training was conducted both isolated words and words in carrier sentences. Results from that work indicated that perceptual phonetic training improved the perception and production accuracies of learners in the trained contexts, and that learners were able to generalize learning to new words and new talkers. Nevertheless, the possible generalizability of perceptual training to novel production domains has not yet been fully explored, and as Thomson and others (e.g., Thomson & Derwing, 2015) have indicated, it is yet unknown whether the improvements in production extend to larger discourse contexts of continuous speech. One exception is the work of Wong (2013, 2014), which included tests of contextualization (TC) in which words with target segments were presented in a short paragraph reading. Wong (2014), which perceptually trained Cantonese L1 learners on the English /e/-/æ/ contrast using isolated words, showed no production improvements in the TC tests. Wong (2013) investigated the effects of perception and production training on the acquisition of the /i/-/ɪ/ contrast in English by L1 Cantonese speakers assigned to one of four groups: perception training only, articulation (production) training only, both perception and articulation training, and no training (control). Results from the TC test, in which 30 /i/-/ɪ/ words appeared in context in a 200 word paragraph, indicated improvements only for the group that received both perception and articulation training. Thus, while perception training has been shown to generalize to larger discourse contexts of continuous speech, this is only the case with concurrent production training.

Ultimately, it is important to further investigate the effects of perceptual training on productions in continuous speech because that context, as opposed to isolated words or words in carrier sentences, involves more variation in the surrounding phonetic context and may make it hard for learners to produce the trained elements. In addition, learners might have more difficulty attending to all aspects of their pronunciation in such a task as it is more demanding than, for example, repeating an isolated word or a word in a carrier sentence. Therefore, examining productions in larger discourse contexts of continuous speech would provide a more robust test of the effect of perceptual training than words in isolation or carrier sentences. This is an important consideration for pronunciation teachers: If training is to be implemented in- or outside of classrooms, having evidence of its effectiveness beyond the trained contexts is critical.

The current study extended the findings of Huensch and Tremblay (2015) by investigating whether the perceptual phonetic training on isolated words and words in carrier sentences implemented in that study led to production improvements that generalized beyond those in new words (of the same type) and new talkers to production improvements in larger discourse contexts of continuous speech. Additionally, the current study examined whether this perceptual phonetic training generalized to a new syllable structure (simple vs. complex codas) and across grammatical domains. The grammatical domain in question was the past tense –*ed* ending morpheme, as these morphemes have been shown to result in production difficulties even for advanced/experienced L2 learners. For example, Lardiere (1998) investigated the tense morphology and pronominal case usage of a Chinese-speaking L2 learner of English using naturalistic production data from interviews. This longitudinal study demonstrated that even after living in the US for 18 years, a learner who mastered pronominal case (supplying it 100% of the time in obligatory contexts) still only supplied past tense marking in 34% of obligatory contexts. The current study thus asked the following research questions:

1. Does perceptual phonetic training improve production accuracies in larger discourse contexts of continuous speech?
2. Does perceptual phonetic training generalize to a new syllable structure?
3. Does perceptual phonetic training generalize across grammatical domains?

The data reported in this article and Huensch and Tremblay (2015) come from a larger study investigating the relationship between the perception and production of L2 learners of English who speak Korean as a first language (L1). The target features are palatals /ʃ ʧ ʤ/ in coda position. These features were chosen because previous perceptual training studies have almost exclusively focused on individual segments or segment contrasts. Focusing on palatals in coda position extended this work to investigate the effects of perceptual training on syllable structure constraints. Additionally, Korean speakers learning English have also been shown to have production difficulties with English palatals, for example, producing epenthetic vowels after palatals in coda or word-final position (Schmidt & Meyer, 1995). English syllable structure allows a variety of consonants, including the palatals /ʃ ʧ ʤ/, in coda position (Kessler & Treiman, 1997). In contrast, Korean has an extensive system of coda neutralization (Yeon, 2004). For example, Korean contains the voiceless palatal /ʧ/ in onset position, but this sound is realized as an unreleased voiceless stop /t/ in coda position (Cheon, 2005). This neutralization occurs across obstruents such that only lenis voiceless stops occur in coda position (Yeon, 2004).

Korean does not contain the voiced affricate /ʤ/, and only contains the voiceless palatal fricative /ʃ/ as an allophone of lenis /s/ before high vowels (Schmidt, 1996). It is also the case that English loanwords adopted into Korean are modified such that word-final palatals include an epenthetic vowel (Kim, 2009). Based on previous work and a comparison of the sound systems of English and Korean, it is therefore predicted that Korean learners of English will demonstrate difficulty with perception and production of word-final palatals and that one possible solution at their disposal to modify productions is to produce an epenthetic vowel in final position (e.g., *edge* produced as *edge*[i]).

The perception and production of Korean L2 learners of English has been studied with a variety of segments, including /ɹ/-/l/ (Borden, Gerber, & Milsark, 1983), word-final stops (Tsukada, Birdsong, Mack, Sung, Bialystok, & Flege, 2004), vowels (Ingram & Park, 1997; Tsukada, Birdsong, Bialystok, Mack, Sung, & Flege, 2005), and /s/-/ʃ/ (Fox, Jacewicz, Eckman, Iverson, & Lee, 2009), among others. There is also work that considered the coda consonants of Korean L2 learners of English, but it focused on non-palatal obstruents (/p b f v θ ð t d s z/) (De Jong & Park, 2012). Yeon (2008) investigated the perception and production of palatals in coda position and used an isolated word perception training component. Results indicated that participants who received perceptual training on isolated words improved their perceptions of these words on both an immediate and delayed (3 months later) post-test. However, production improvements were not found at either the immediate or delated post-test for the group (although the author notes that some individuals showed improvement).

The participants and procedure of the current study are the same as those reported in Huensch and Tremblay (2015). As discussed previously, results from Huensch and Tremblay indicated that perceptual phonetic training on palatal codas in isolated words and words in carrier sentences improved the perception and production accuracies of learners in the carrier sentence context, and that learners were able to generalize learning to new words (of the same type) and new talkers. Results from current study provide a more comprehensive understanding of the benefits of perceptual training on singleton palatals, if any, on productions of palatal codas in larger discourse contexts of continuous speech, and specifically whether improvements generalized to a new syllable structure and across grammatical domains.

Several predictions can be made based on previous empirical studies and the SLM and the PAM-L2. Both the SLM and PAM-L2 posit a relationship between speech perception and speech production systems although they differ in the exact nature of this relationship. What is important for the current study is that if speech perception and production systems are linked, and learners have the ability to continue learning into adulthood, this would imply that improvements in perception could lead to improvements in production. With regard to predictions related to whether perceptual phonetic training will lead to improvements to larger discourse contexts of continuous speech, the results of Wong (2014) did not indicate transfer, although training was on isolated words only. Wong (2013) did provide evidence of transfer, but only with a group that also received production training. Thus, given that the current study did not include production training but did provide training in sentence contexts, it is difficult to predict whether training will lead to improvements. With regard to the benefits of perceptual training on productions of palatals in a new syllable structure (simple vs. complex codas), previous research with /ɹ/ and /l/ (Bradlow et al., 1997) has demonstrated that training with these segments in certain contexts can have benefits for the production of these sounds in other contexts (e.g., being trained on initial singleton and cluster contexts, but being tested on initial triplets). Therefore, it is possible that training on singleton palatal codas may extend to a new syllable structure. With regard to the benefits of perceptual training on productions of palatals across grammatical domains (e.g., *–ed* ending morphemes), to the best of my knowledge this has not been addressed in the training literature; however, given the learnability problem these morphemes pose (DeKeyser, 2005; Lardiere, 1998), it may be the case that perceptual phonetic training does not generalize to this context.

## 2. Method

The participants, stimuli, and procedure used for testing and training in isolated words and in carrier sentences were described in detail in Huensch and Tremblay (2015). In the current report, therefore, a brief summary of those methods are presented and the reader may refer to the earlier work for more details. The current report describes in detail the stimuli, procedure, and analysis of the production test of generalizability not reported on previously.

### 2.1. Participants

Twenty-four adult Korean L2 learners of English were recruited via flyers posted on a university campus and on a local Korean community blog. They were randomly assigned to an experimental group (*n*=12) and a control group (*n*=12). The experimental group participated in perceptual training on palatal codas, and the control group participated in a perceptual training task unrelated to palatals (vowels contrasts in monosyllabic nonce words). Each group completed perception and production pretests and post-tests. All participants completed a language background questionnaire and a cloze test proficiency measure. Participants reported similar years of English instruction (experimental group: *M* = 10, range 3-22; control group; *M* = 9, range 5-17), years living in an English-speaking environment (experimental group: *M* = 4.1, range 0-10; control group; *M* = 4.5, range 0.2-13.2), and had similar cloze test results (out of a possible 50: experimental group *M* = 28, range = 9-38; control group *M* = 27, range = 15-38).

## 2.2. Materials

Pretests and post-tests included both perception and production tasks. The perception task was a forced-choice word-identification task. Two production tasks were implemented: a read-aloud task in which participants read the words from the perception task and a second task in which participants read dialogs/paragraphs eliciting palatal codas in continuous speech. The continuous speech task included a variety of phonetic contexts including, but also extending beyond, those contexts that are the focus of the training.

Experimental stimuli for the perception task were comprised of both real and nonce words and included 48 minimal pairs (24 real, 24 nonce) of natural tokens of words with (a) singleton palatals in coda position and (b) their disyllabic adjectival derivation (e.g., real words: *flash*/*flashy*, nonce words: *fatch/fatchy*). Nonce words were included because of the limited number of real word pairings in English. Each of the three palatals (/ʃ ʧ ʤ/) included eight minimal pairs used in the perceptual training as well as eight additional pairs used in the pretests/post-tests. Thus, only a subset of stimuli was presented in the training condition.

For both the perception tests and the experimental training, stimuli were encountered in isolation as well as within carrier sentences (“He said X angrily” and “He said X frequently”). Participants thus encountered the 48 stimuli three times. All stimuli were recorded by six native speakers of English (3 from the Midland, 2 from the Inland North, and 1 from the South [Labov, Ash, & Boberg, 2006]) who had been living in the place of testing (a Midwestern city) for at least four years. Recordings from four of these native speakers were used in the pretests/post-tests as well as the training, while the recordings from the other two native speakers were used only in the pretests/post-tests.

The purpose of the second production test was to investigate whether production improvements extended to larger discourse contexts of continuous speech. It consisted of a dialog/paragraph reading task (with only real English words) containing palatals in a variety of contexts including, but also extending beyond, those that were the focus of the training. Conditions included singleton codas and their disyllabic counterparts (e.g., *push*/*pushy*), complex codas including /n/, /l/ or /ɹ/ before the palatal (e.g., *pinch*, *perch*, *mulch*), and each of these conditions before *–ed* morphemes (e.g., *perched*, *dodged*).[1] The conditions that matched the perception tests (i.e., singleton codas and their disyllabic counterparts) had a total of eight targets in each context (before a consonant, before a vowel, phrase-final), for a total of 72 items per consonant type (/ʃ ʧ ʤ/), or 216 words. Complex coda words included three consonants in the pre-palatal environment: /ɹ n l/ in words like *perch*, *pinch*, and *squelch*. Where possible, conditions contained ten targets, although in some cases, real English words were limited (e.g., /ɹʃ/). A complete list of stimuli as well as a count of each category and the contexts in which they appeared can be found in Appendix A. Appendix B provides an excerpt from one of the paragraphs.

## 2.3. Procedure

The experiment was conducted over approximately 10 days, and the procedure consisted of a pretest, online perceptual training, and a post-test identical to the pretest.

### 2.3.1. Pretest and Post-test Tasks

During the pretest, participants completed both the perception and production tasks. The perception tests included two tasks: A forced-choice word-identification task of words in isolation and another of words in carrier sentences and were presented using E-Prime (Schneider, Eschman, & Zuccolotto, 2002). For each trial, participants heard a word or a sentence, were shown the two words/sentences from the minimal pair, and were instructed to choose the correct response. Participants completed two blocks of perception testing, one with words in isolation and one with words in carrier sentences. Each block began with practice items to familiarize participants with the procedure. The isolated-word block lasted approximately 15 minutes and the carrier-sentence block lasted approximately 30 minutes.

After the perception pretests, participants completed two production tasks: a read-aloud task which included all of the words/sentences from the perception task and a dialog/paragraph reading task to elicit palatals in continuous speech. Participants were balanced such that half completed the read-aloud task modeled on the perception task first and the other half completed the dialog/paragraph reading task first. In the read-aloud task which included all the experimental stimuli, participants received a visual word/sentence prompt using PowerPoint and were instructed to read it. Participants read at their own pace and were instructed to give their 'best guesses' for any unfamiliar words. This task lasted approximately 15-30 minutes.

For the continuous speech task, participants received a print-out packet containing each dialog/paragraph on a separate page. Because of the large number of targets, the 14 dialogs were randomly divided into three sets, and participants were balanced as to whether they started with the first, second, or third set. Participants read at their own pace and were instructed to give their 'best guesses' for any unfamiliar words. Each set took approximately 10-12 minutes to read, resulting in a total task time of approximately 30-40 minutes.

### 2.3.2. Perceptual Training Tasks

Both the experimental group and the control group completed online perceptual training tasks. Both tasks consisted of eight daily sessions of online training. The task for the experimental group was comprised of 20-minute sessions delivered on consecutive days via Paradigm Player (Perception Research Systems, 2007). Each training session was comprised of a forced-choice word-identification task identical in procedure to the one used in the perception pretest/post-test, except feedback was provided and the words appeared before the sound file was played. For every response, participants heard the stimulus again during the feedback screen, which indicated whether their selection was correct or incorrect. During each training day, learners heard stimuli from two different and spent approximately 20 minutes on task for a total of approximately 160 minutes of perceptual training.

The perceptual training for the control group was delivered via Pierceive and was created by another researcher conducting a different perceptual training study. It focused on three vowel contrasts, /æ/-/ɛ/, /i/-/ɪ/, and /oʊ/-/ʊ/, presented in monosyllabic nonce words that always occurred in isolation. Stimuli were recorded by eight native speakers of North American English. Similar to the experimental training task, the testing phase for this group was a forced-choice word-identification task; however, parts of the training allowed participants to listen to words at their own pace. Although participants in the control group were instructed to spend approximately 20 minutes on task to parallel the experimental training task, they did not do so. As reported in Huensch and Tremblay (2015), time on task differed significantly between groups. Nevertheless, it was also shown that for the control group, there was no relationship between the amount of time an individual spent on training and their perception improvement score.

### 2.4. Data Analysis

Recall that the 14 dialogs/paragraphs from the continuous speech production task, which included only real words (see Appendix C), were separated into three sets for data collection. Productions from this task were rated for the presence/absence of the palatal consonant as well as the presence/absence of the final [i] vowels, all other errors were ignored (i.e., if a participant produced *age* instead of *edge*, the item was coded as accurate; however, if the participant produced *edgy* instead of *edge*, the item was coded as inaccurate). All data were coded by the author and 20% of the data (five participants) were coded by a trained English pronunciation teacher (both coders are native speakers of English). The second rater was recruited because of his experience rating similar diagnostic tests at the local IEP and was unaware of the purpose of the experiment. The rater completed the 30 ratings (three sets of five speakers including pretest and post-test) in four rounds and was instructed to listen to the recordings by set (e.g., the rater listened to the dialogs/paragraphs from set 1 in a round, then continued with set 2). The recordings were comprised of intact dialogs/paragraphs, thus, the target items were encountered in context. The rater was provided with a word document that indicated the target items with numbered boxes above each item. The recordings in the rating rounds were mixed such that both pretest and post-test files were included, but never from the same participant. The rater was instructed to rate the presence/absence of the palatal consonant and final [i] vowel and to indicate any instances where the consonant produced was not a palatal (e.g., di[ŋ]y vs. din[ʤ]y). Inter-rater reliability showed a high coefficient ($r$=.917, $p$<.001).

In some cases, participants produced a consonant other than the target palatal (e.g., /ɡ/ *doggy* instead of /ʤ/ *dodgy*), most likely as a result of orthographic influence. Several common patterns of errors included: (1) substituting /ŋ/ for /nʤ/ in low frequency words like *dingy, mangy, stingy*; (2) substituting /ɡ/ for /ʤ/ in low frequency words like *clergy, bulgy, fudgy, stodgy*; and simplification of *–ed* endings in environments where simplification is not allowed in English (e.g., before a vowel as in *matched only*). These were indicated during rating by each rater. This happened to a varying degree with different participants. If a participant produced a consonant other than the palatal, then determining palatal accuracy with regard to the presence or absence of a final vowel would be impossible, so these items were excluded from analysis. The two raters agreed at a rate of 96% regarding what was ratable vs. not ratable. For the final analysis, of a total 8,856 items, 742 (8%) were excluded because either the pretest, the post-test, or both versions were coded as not ratable.

## 3. Results

As previously stated, the data reported in the current study are part of a larger investigation of the perception and production of palatal codas by Korean L2 learners of English. Huensch and Tremblay (2015) reported that the perceptual phonetic training in isolated words and words in carrier sentences led to improvements in perception and production for words in carrier sentences for the experimental group, but not the control group. In the current analysis, the generalizability of these production improvements is investigated. The focus is on whether production improvements from perceptual phonetic training extended to productions in larger discourse contexts of continuous speech, and whether improvements generalized to a new syllable structure and/or across grammatical domains. To examine research question one, whether perceptual phonetic training improved production accuracies in continuous speech, the production results from the continuous speech task that parallel the words from the perceptual training are reported (i.e., those with singleton word-final palatals, *push*, and singleton palatal + [i], *pushy*), as seen in Figure 1.

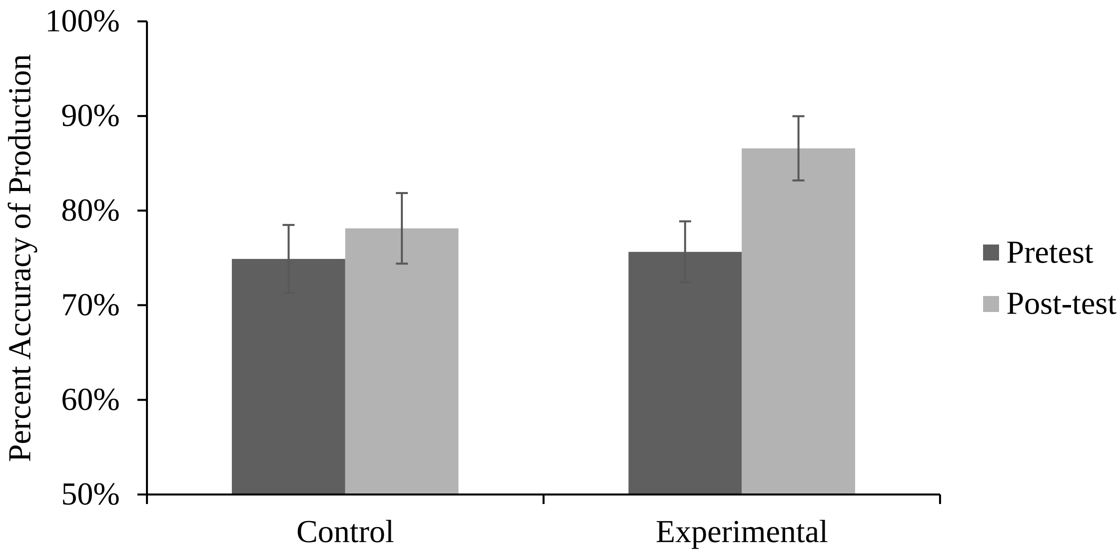


*Figure 1.* Production task pretest and post-test accuracies for palatal coda words in the continuous speech task separated by group

As can be seen in Figure 1, it appears the experimental group improved their productions of palatal coda words in continuous speech. A mixed-design repeated-measures ANOVA was performed on the accuracy scores with test (pretest, post-test) as within-subject variable and with group (experimental, control) as between-subject variable. Test had a significant effect, $F(1,22)=26.58$, $p<.001$, partial $\eta^2 = .547$, and there was an interaction between test and group, *F*(1,22)=7.85, *p*=.01, partial $\eta^2$ = .263. There was not a significant main effect for group, *F*(1,22)=0.94, *p*=.342. Given the significant main effect of test and the significant interaction of test and group, post-hoc paired-samples *t*-tests were conducted, with alpha levels adjusted to *p*<.025, comparing the pretest and post-test for each group. A paired-samples *t*-test showed no significant difference between pretest and post-test scores for the control group, *t*(11)= -1.77, *p*=.104. There was, however, a significant difference between the pretest and post-test scores for the experimental group, *t*(11)= -5.32, *p*<.001, *d* = 1.54. In addition, the effect size for the improvements of the experimental group was large. Thus, the experimental group showed significant improvement between the pretest and post-test on the production of palatal codas in continuous speech, but the control group did not.

Research question two examined whether perceptual phonetic training generalized to a new syllable structure. Recall that the dialog/paragraph production task included palatals in complex codas including /n/, /l/ or /ɹ/ before the palatal (e.g., *pinch*, *perch*, *mulch*), whereas the perceptual training only included singleton codas (e.g., *fish*). Figure 2 displays the pretest and post-test results separated by simple vs. complex codas for the experimental and control groups.

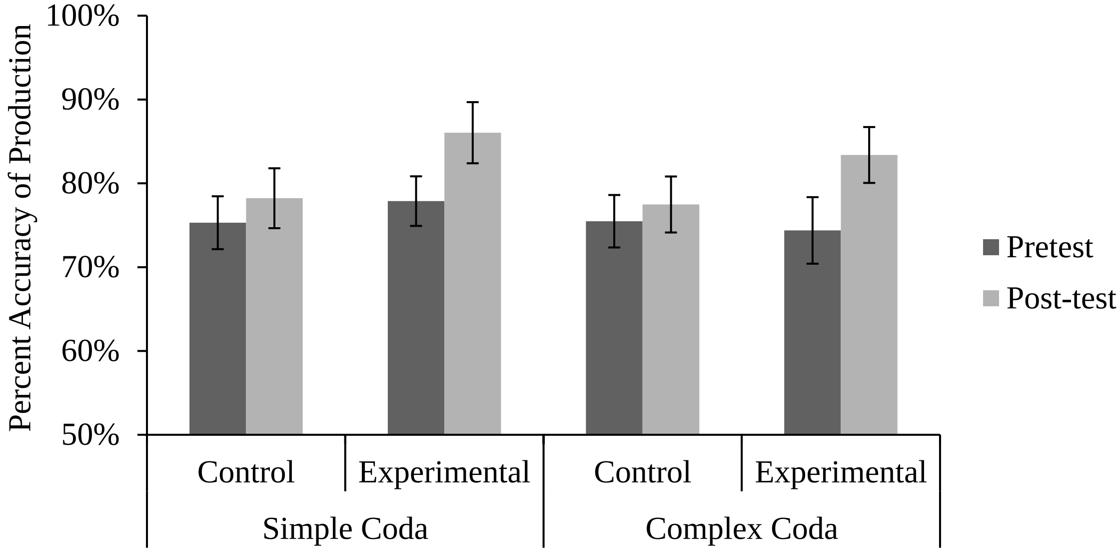


*Figure 2.* Continuous speech production task pretest and post-test accuracies separated by simple and complex codas and by group

As can be seen in Figure 2, whether the palatal was in a simple vs. complex coda does not seem to have an effect on improvement in that learners in the experimental group appear to be improving equally in both environments. A mixed-design repeated-measures ANOVA was performed on the production accuracy with test (pretest, post-test) and syllable type (simple, complex) as within-subject variables, and with group (experimental, control) as between-subject variable. Test had a significant effect, $F(1,22)=21.33$, $p<.001$, partial $\eta^2 = .492$, and there was an interaction between test and group, $F(1,22)=6.55$, $p=.018$ partial $\eta^2 = .230$. There was not a significant effect for group, $F(1,22)=0.77$, $p=.390$, nor was there a significant effect for syllable type, $F(1,22)=1.20$, $p=.285$, nor were there significant interactions between syllable type and group, $F(1,22)=0.83$, $p=.372$, syllable type and test, $F(1,22)=0.00$, $p=.978$, or syllable type and test and group, $F(1,22)=0.35$, $p=.560$. These results suggest that syllable type did not affect production results, which indicates that improvements occurred similarly in simple and complex codas for the experimental group.

Research question three examined whether perceptual phonetic training generalized across grammatical domains, or more specifically, to words containing a past tense –*ed* ending morpheme. Figure 3 presents the experimental and control groups' pretest and post-test results for the palatal words with –*ed* ending morphemes (e.g., *pushed*).

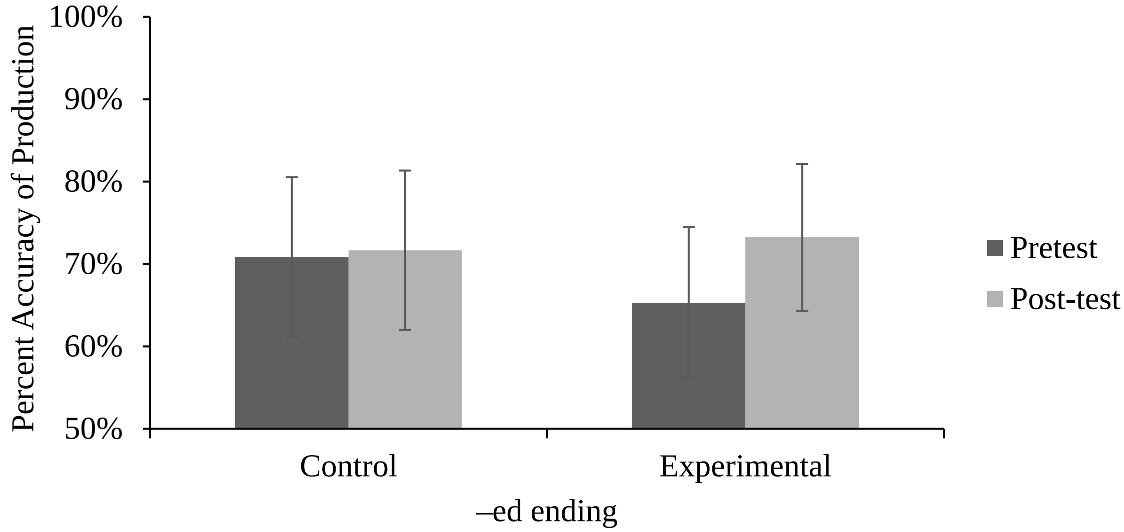


*Figure 3.* Continuous speech production task pretest and post-test accuracies for the –*ed* ending words separated by group

As can be seen in Figure 3, learners' overall accuracy with palatal codas before –*ed* endings appears to contain greater variability than in the other contexts, as indicated by the error bars. A mixed-design repeated-measures ANOVA was performed on the accuracy scores with test (pretest, post-test) as within-subject variable, and with group (experimental, control) as between-subject variable for the –*ed* ending words. There was no effect of test, $F(1,22)=3.30$, *p*=.083, or group, *F*(1,22)=0.00, *p*=.961, and no interaction between test and group, *F*(1,22)=1.80, *p*=.194. This suggests that learning did not generalize to words with *–ed* ending morphemes.

Taken together, results from the dialog/paragraph reading task provide evidence that perceptual training has a beneficial effect on words with palatals in continuous speech. It was found that learning generalized to a new syllable structure (simple vs. complex codas), but not across grammatical domains (*–ed* endings).

**4. Summary of Findings and Discussion**

The goal of this study was to determine whether perceptual phonetic training on palatal codas, which has been shown to improve productions in trained contexts and also generalize to new words (of the same type) and new talkers, extended to production improvements in larger discourse contexts of continuous speech and whether improvements generalized to a new syllable structure and across grammatical domains. In response to the first research question, the findings indicated that learners in the experimental group were able to generalize their learning from perception training on singleton palatals to productions in larger discourse contexts of continuous speech. Examining productions in continuous speech provides a more robust test of the effect of perceptual training because that context, as opposed to isolated words or carrier sentences, is more demanding than an isolated word task in that it involves more variation in the surrounding phonetic environment and requires learners to attend to all aspects of their pronunciation. Despite the potential difficulty of this task, the experimental group's productions improved from the pretest to the post-test. Both the SLM and PAM-L2 can account for this improvement because both posit a relationship between speech perception and speech production systems as well as the ability to continue learning into adulthood. As this work and others have shown, perceptual training can indeed lead to improvements in production. These results differ from the results of Wong (2014), which did not indicate production improvements in larger discourse contexts of continuous speech. One consideration to keep in mind is that learners in this study were trained on both isolated words and words in carrier sentences, whereas much of the previous training literature, including Wong (2014), has involved training only in isolated words (see e.g., Bradlow et al., 1997; Lambacher et al., 2005; Thomson, 2011; Wong 2013, 2014). It might be the case that training in the additional context of words in carrier sentences provided added variation for learners and thus allowed for more robust category formation to take place. Additional evidence for the hypothesis that training using words in carrier sentences attributed to benefits in production might come from the fact that the learners in Yeon (2008)'s study, who were trained exclusively on isolated words, did not show production improvements at the group level. The current study did not examine this question directly, however, in that it did not compare training using isolated words only to training using words in carrier sentences. Therefore, future research could be undertaken to determine the relative benefits of different types of training stimuli.

The second and third research questions examined the generalizability of production improvements to a new syllable structure and across grammatical domains. The findings indicated that learners' improvements generalized to the untrained context of a new syllable structure: palatals in complex codas in words like *perch*. It was not the case, however, that learners were able to generalize to across grammatical domains in words containing *–ed* ending morphemes. The finding regarding generalizability to a new syllable structure is in line with previous work with /ɹ/ and /l/ (Bradlow et al., 1997). One possible explanation for the lack of generalization to words with *–ed* ending morphemes could be related to orthographical influences. Bassetti and Atkinson (2015) demonstrated with Italian learners of English that despite being able to produce word-final consonant clusters, and even after an average of 10 years of instruction, when producing *–ed* ending morphemes learners still produced /Vd/ 25% of the time in /d/ contexts and 20% of the time in /t/ contexts. Their production of /Vd/ in /Vd/ contexts was 95% accurate. These production accuracies are in line with the results of the current study where both the control and experimental groups' production accuracies were around 70%. Bassetti and Atkinson also noted that it is not likely the case that epenthetic vowels were inserted as a result of L1 syllable structure restrictions because productions were almost exclusively of the form /Vd/, not /Vt/, even in /t/ contexts. Thus, it may be the case that orthographical influences resulted in the learners in the current study not generalizing improvements of palatal productions to this context.

Findings from this study also provide methodological implications for future work and pedagogical implications for utilizing perceptual training to supplement pronunciation instruction. Recall that the control group was able to choose how much time they spent on training and ultimately spent less time than the experimental group. Therefore, when creating perceptual training programs for research or pedagogical purposes, designing programs which require a certain amount of time on task might be beneficial. A related issue with perceptual training when pedagogical feasibility is considered is the interest level of users. Participants in this research often commented on the 'less-than-exciting' nature of the perceptual training tasks. Some researchers (e.g., Lim & Holt, 2011; Wade & Holt, 2005) have attempted to overcome this issue by using methods other than forced-choice word-identification tasks with explicit feedback. In Lim and Holt's (2011) work investigating the /ɹ/-/l/ contrast, a custom computer videogame was used that connected target sounds to certain characters in the game and required participants to use visual and aural information to correctly identify and interact with those characters to be successful in the game. In this way, they did not participate in overt categorization, nor did they receive explicit feedback. With only 2.5 hours of training, the videogame paradigm also showed perceptual improvements similar to those found using perceptual training paradigms similar to those of the present study that included training for much longer periods of time. While potentially difficult to implement (e.g., because of the technical skills required to design and implement a computer videogame), creative methods like this are not only successful at inducing learning, but also might be motivating and provide an alternative to the practical concern of some 'less-than-exciting' varieties of perceptual phonetic training. Fortunately, the data in the current study indicate that even short amounts of training can have enhancing effects and these benefits extend to productions in continuous speech.

While the current study has demonstrated that perceptual training results in improvements in larger discourse contexts of continuous speech, it does not provide evidence that perceptual training extends to spontaneous speech. Part of the reason evidence for improvement in spontaneous speech has not been demonstrated relates to methodological considerations. It can be difficult, for example, to elicit naturalistic data that include the target items under investigation. If target items are elicited, it might be difficult to obtain enough items to conduct statistical analyses and to do so within a reasonable time frame as to not demand too much investment from participants. Even if enough target items can be elicited, it is then difficult to control for the phonological environment in which they appear. For example, consider the design for the dialog/paragraph reading task which included words balanced for context (before a consonant, before a vowel, phrase-final) and complex coda clusters (e.g., /ɹʃ, lʃ, nʃ). Some of the words in the latter context are low-frequency (e.g., *marshy*) and are unlikely to be elicited (and perhaps it is unlikely that learners would even know these words). When eliciting naturalistic data, obtaining this type of consistency and balance is impossible. These are just a few methodological reasons why extending laboratory research to naturalistic contexts is difficult and has therefore not been frequently done. Nevertheless, the current study provides evidence that benefits from perceptual training extend to larger discourse contexts of continuous speech and thus, this type of training is one promising means of supplementing out-of-class activities in pronunciation classes.

# References

Bassetti, B., & Atkinson, N. (2015). Effects of orthographic forms on pronunciation in experienced instructed second language learners. *Applied Psycholinguistics*, *36*, 67-91.

Best, C. T. (1995). A direct realist view of cross-language speech perception. In W. Strange (Ed.), *Speech perception and linguistic experience* (pp. 171-204). Timonium, MD: York Press.

Best, C. T., & Tyler, M. D. (2007). Nonnative and second-language speech perception: Commonalities and complementarities. In M. J. Munro, & O.-S. Bohn (Eds.), *Second language speech learning: The role of language experience in speech perception and production* (pp. 13-34). Amsterdam: John Benjamins.

Borden, G., Gerber, A., & Milsark, G. (1983). Production and perception of the /r/-/l/ contrast in Korean adults learning English. *Language Learning, 33,* 499-526.

Bradlow, A., Akahane-Yamada, R., Pisoni, D. B., Tohkura, Y. (1999). Training Japanese listeners to identify English /r/ and /l/: Long-term retention of learning in perception and production. *Perception & Psychophysics*, *61,* 977-985.

Bradlow, A., Pisoni, D. B., Akahane-Yamada, R., & Tohkura, Y. (1997). Training Japanese listeners to identify /r/ and /l/ IV: Some effects of perceptual learning on speech production. *Journal of the Acoustical Society of America*, *101*, *4,* 2299-2310.

Cheon, S. Y. (2005). *Production and perception of phonological contrasts in second language acquisition: Korean and English fricatives* (Doctoral dissertation, University of Hawai'i).

Celce-Murcia, M., Brinton, D. M., Goodwin, J. M., & Griner, B. (2010). *Teaching pronunciation: A course book and reference guide* (2nd ed.). Cambridge, UK: Cambridge University Press.

De Jong, K., & Park, H. (2012). Vowel epenthesis and segment identity in Korean learners of English. *Studies in Second Language Acquisition, 34,* 127-155.

DeKeyser, R. M. (2005). What makes learning second-language grammar difficult? A review of issues. *Language Learning*, *55*, 1-25.

Flege, J. E. (1995). Second language speech learning theory, findings, and problems. In W. Strange (Ed.), *Speech perception and linguistic experience* (p. 233-277). Timonium, MD: York Press.

Flege, J. E. (2003). Assessing constraints on second-language segmental production and perception. In A. Meyer and N. Schiller (Eds.), *Phonetics and phonology in language comprehension and production: Differences and similarities* (pp. 319-35). Berlin: Mouton de Gruyter.

Fowler, C. (1986). An event approach to the study of speech perception from a direct-realist perspective. *Journal of Phonetics, 14,* 3-28.

Fox, R. A., Jacewicz, E., Eckman, F., Iverson, G. K., & Lee, S. A. (2009). Perception versus production in Korean L2 acquisition of English sibilant fricatives. In M.-G. Pak's (Ed.), *Current issues in unity and diversity of languages* (pp. 2661-2680) (CD-ROM version). Seoul: The Linguistic Society of Korea.

Hahn, L. D., & Dickerson, W. B. (1999). *Speechcraft: Discourse pronunciation for advanced learners.* Ann Arbor, MI: The University of Michigan Press.

Huensch, A., & Tremblay, A. (2015). Effects of perceptual phonetic training on the perception and production of second language syllable structure. *Journal of Phonetics, 52,* 105-120.

Ingram, J., & Park, S.-G. (1997). Cross-language vowel perception and production by Japanese and Korean learners of English. *Journal of Phonetics, 25,* 343-370.

Isaacs, T. (2014) Assessing pronunciation. In A. J. Kunnan (Ed.), *The companion to language assessment* (pp. 140-155). West Sussex, UK: Wiley-Blackwell.

Jamieson, D., & Morosan, D. (1986). Training non-native speech contrasts in adults: acquisition of the English /ð/-/θ/ contrast by francophones. *Perception and Psychophysics, 40*, 205-215.

Kessler, B., & Treiman, R. (1997). Syllable structure and the distribution of phonemes in English syllables. *Journal of Memory and Language, 37*, 295-311.

Kim, K. (2009). Coronals in epenthesis in loanwords with comparisons to velars. *Toronto Working Papers in Linguistics, 30*, 53-67.

Labov, W., Ash, S., & Boberg, C. (2006). *The atlas of North American English: Phonetics, phonology and sound change.* Berlin: Mouton de Gruyter.

Lambacher, S. G., Martens, W. L., Kakehi, K., Marasinghe, C. A., & Molholt, G. (2005). The effects of identification training on the identification and production of American English vowels by native speakers of Japanese. *Applied Psycholinguistics*, *26*, *2*, 227-247.

Lardiere, D. (1998). Case and tense in the 'fossilized' steady state. *Second Language Research, 14,* 1-26.

Lim, S. –J., & Holt, L. L. (2011). Learning foreign sounds in an alien world: Videogame training improves non-native speech categorization. *Cognitive Science*, *35,* 1390-1405.

Lively, S. E., Logan, J. S., & Pisoni, D. B. (1993). Training Japanese listeners to identify /l/ and /r/ II: The role of phonetic environment and talker variability in learning new perceptual categories. *Journal of the Acoustical Society of America, 94, 3,* 1242-1255.

Logan, J. S., Lively, S. E., & Pisoni, D. B. (1991). Training Japanese listeners to identify /r/ and /l/: A first report. *Journal of the Acoustical Society of America, 89, 2,* 874-886.

Perception Research Systems. (2007). *Paradigm*, retrieved from http://www.paradigmexperiments.com

Schmidt, A. M. (1996). Cross-language identification of consonants. Part 1. Korean perception of English. *The Journal of the Acoustical Society of America, 99, 5,* 3201-3211.

Schmidt, A., & Meyer, K. (1995). Traditional and phonological treatment for teaching English fricatives and affricates to Koreans. *Journal of Speech and Hearing Research, 38,* 828-838.

Schneider, W., Eschman, A., & Zuccolotto, A. (2002). E-Prime User's Guide. Pittsburgh: Psychology Software Tools, Inc.

Thomson, R. I. (2011). Computer assisted pronunciation training: Targeting second language vowel perception improves pronunciation. *CALICO Journal, 28, 3,* 744-765.

Thomson, R. I., & Derwing, T. M. (2015). The effectiveness of L2 pronunciation instruction: A narrative review. *Applied Linguistics, 36, 3,* 326-344.

Tsukada, K., Birdsong, D., Bialystok, E., Mack, M., Sung, H., & Flege, J. E. (2005). A developmental study of English vowel production and perception by native Korean adults and children. *Journal of Phonetics, 33,* 263-290.

Tsukada, K., Birdsong, D., Mack, M., Sung, H., Bialystok, E., & Flege, J. E. (2004). Release bursts in English word-final voiceless stops: A cross-sectional and longitudinal study of Korean adults' and children's speech production. *Phonetica, 61,* 67-83.

Wade, T., & Holt, L. L. (2005). Incidental categorization of spectrally complex non-invariant auditory stimuli in a computer game task. *Journal of the Acoustical Society of America, 118*, 2618-2633.

Wong, J. W. S. (2013). The effects of perceptual and/or productive training on the perception and production of English vowels /ɪ/ and /iː/ by Cantonese ESL learners. In F. Bimbot, C. Cerisara, C. Fougeron, G. Gravier, L. Lamel, P. Pellegrino, & P. Perrier (Eds.), *Proceedings of the 14th Annual Conference of the International Speech Communication Association* (Interspeech 2013) (pp. 2113-2117). Lyon, France. Retrieved from: http://www.isca-speech.org/archive/archive_papers/interspeech_2013/i13_2113.pdf

Wong J. W. S. (2014). The effects of high and low variability phonetic training on the perception and production of English vowels /e/-/æ/ by Cantonese ESL learners with high and low L2 proficiency levels. *Proceedings of the 15th Annual Conference of the International Speech Communication Association* (Interspeech 2014) (pp. 524-528). Singapore. Retrieved from: http://www.isca-speech.org/archive/archive_papers/interspeech_2014/i14_0524.pdf

Yeon, S. H. (2004). Teaching English word-final alveopalatals to native speakers of Korean. (Doctoral Dissertation, University of Florida).

Yeon, S. H. (2008). Training English word-final palatals to Korean speakers of English. Applied Language Learning, 18, 51-61.

huensch@usf.edu

Endnotes

[1]–*ed* endings in environments that undergo consonant cluster simplification were not included. This simplification occurs when the ending is located between two consonants, but not when the second consonant is /w h j ɹ/. For example, *saved stamps* undergoes simplification while *scorched with* does not (Hahn & Dickerson, 1999).

# APPENDIX A: Complete List of Stimuli from Dialog/paragraph Production Measure

| ʃ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vpal | | | | | | | | | | | |
| Vpal | | | Vpal + i | | | Vpal + ed | | | Vpal 2 syll | | |
| brush | | | ashy | | | pushed | | | finish | | |
| F (8) | Before C (8) | Before V (8) | F (9) | Before C (7) | Before V (8) | F (5) | Before C (1) | Before V (5) | F (2) | Before C (2) | Before V (2) |
| | | | flashy | | | | | | | | |
| posh | cash | fish | squishy | | mushy | | | | | | |
| posh | fish | rash | pushy | cushy | bushy | | | | | | |
| flesh | cash | rash | mushy | squishy | fishy | | | | | | |
| rash | posh | squash | ashy | ashy | squishy | trashed | | sloshed | | | |
| hush | fresh | fresh | fishy | flashy | pushy | clashed | | crashed | | | |
| leash | posh | lash | bushy | bushy | trashy | rushed | | pushed | | | |
| bush | dish | wish | cushy | mushy | flashy | gnashed | | washed | foolish | Spanish | English |
| fish | trash | crash | flashy | slushy | fishy | washed | rushed | washed | selfish | English | selfish |

| ʃ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| n/l/ɹ pal | | | | | | | | | | | |
| n/l/ɹ pal | | | n/l/ɹ pal + i | | | n/l/ɹ pal + ed | | | n/l/ɹ pal 2 syll | | |
| marsh | | | banshee | | | NONE | | | NONE | | |
| F (4) | Before C (4) | Before V (4) | F (2) | Before C (2) | Before V (2) | F | Before C | Before V | F | Before C | Before V |
| Walsh | Welsh | kolsch | | | | | | | | | |
| Walsh | Walsh | Welsh | | | | | | | | | |
| marsh | kirsch | harsh | banshee | banshee | banshee | | | | | | |
| harsh | harsh | marsh | marshy | marshy | marshy | n/a | n/a | n/a | n/a | n/a | n/a |

| tʃ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vpal | | | | | | | | | | | |
| Vpal | | | Vpal + i | | | Vpal + ed | | | Vpal 2 syll | | |
| bleach | | | catchy | | | matched | | | sandwich | | |
| F (9) | Before C (8) | Before V (8) | F (8) | Before C (8) | Before V (8) | F (5) | Before C (0) | Before V (5) | F (2) | Before C (2) | Before V (2) |
| match | | | | | | | | | | | |
| itch | beach | much | grouchy | splotchy | witchy | | | | | | |
| beach | witch | rich | touchy | scratchy | sketchy | | | | | | |
| roach | switch | reach | itchy | kitschy | grouchy | | | | | | |
| ditch | which | which | twitchy | blotchy | touchy | touched | | touched | | | |
| touch | touch | such | bitchy | blotchy | twitchy | matched | | watched | | | |
| scratch | much | watch | touchy | grouchy | kitschy | touched | | matched | | | |
| watch | speech | peach | touchy | touchy | itchy | watched | | screeched | sandwich | spinach | sandwich |
| much | much | which | itchy | peachy | peachy | reached | | etched | spinach | sandwich | spinach |

| tʃ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| n/l/ɹ pal | | | | | | | | | | | |
| n/l/ɹ pal | | | n/l/ɹ pal + i | | | n/l/ɹ pal + ed | | | n/l/ɹ pal 2 syll | | |
| inch | | | crunchy | | | pinched | | | research | | |
| F (10) | Before C (10) | Before V (10) | F (7) | Before C (7) | Before V (7) | F (10) | Before C (2) | Before V (10) | F (1) | Before C (1) | Before V (1) |
| cinch | cinch | French | | | | blanched | | blanched | | | |
| pinch | hunch | inch | | | | hunched | | clinched | | | |
| lunch | branch | bunch | | | | clenched | | wrenched | | | |
| stench | squelch | finch | raunchy | crunchy | crunchy | crunched | | drenched | | | |
| lunch | French | lunch | paunchy | raunchy | stenchy | pinched | | hunched | | | |
| March | birch | search | paunchy | bunchy | stenchy | marched | | torched | | | |
| perch | perch | march | stenchy | paunchy | raunchy | perched | | marched | | | |
| birch | church | perch | crunchy | grinchy | punchy | arched | | arched | | | |
| church | search | church | starchy | starchy | churchy | scorched | hunched | searched | | | |
| search | church | birch | churchy | churchy | starchy | searched | marched | lurched | research | research | research |

| **dʒ** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Vpal | | | | | | | | | | | |
| Vpal | | | Vpal + i | | | Vpal + ed | | | Vpal 2 syll | | |
| badge | | | dodgy | | | staged | | | cabbage | | |
| F (9) | Before C (8) | Before V (7) | F (8) | Before C (8) | Before V (8) | F (5) | Before C (1) | Before V (5) | F (2) | Before C (2) | Before V (1) |
| Hodge | | | | | | | | | | | |
| edge | fudge | | edgy | veggie | pudgy | | | | | | |
| grudge | judge | sludge | cagey | dodgy | pudgy | | | | | | |
| edge | pledge | huge | pudgy | fudgy | edgy | | | | | | |
| pudge | page | edge | edgy | veggie | dodgy | staged | | caged | | | |
| dodge | lodge | rage | edgy | edgy | stodgy | dodged | | dodged | | | |
| judge | huge | hedge | stodgy | stodgy | cagey | paged | | ridged | | | |
| age | edge | cage | veggie | pudgy | fudgy | staged | | wedged | college | language | |
| bridge | stage | grudge | dodgy | wedgie | veggie | smudged | edged | aged | message | forage | damage |

| **dʒ** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| n/l/ɹ pal | | | | | | | | | | | |
| n/l/ɹ pal | | | n/l/ɹ pal + i | | | n/l/ɹ pal + ed | | | n/l/ɹ pal 2 syll | | |
| change | | | dingy | | | ranged | | | orange | | |
| F (10) | Before C (10) | Before V (10) | F (7) | Before C (7) | Before V (7) | F (10) | Before C (4) | Before V (10) | F (2) | Before C (2) | Before V (2) |
| strange | strange | range | | | | cringed | | cringed | | | |
| binge | change | lounge | | | | changed | | lunged | | | |
| lounge | cringe | cringe | | | | lunged | | lounged | | | |
| singe | sponge | sponge | dingy | stingy | mangy | binged | | plunged | | | |
| twinge | fringe | change | mangy | bungee | stingy | ranged | | changed | | | |
| splurge | George | verge | grungy | spongy | grungy | purged | | merged | | | |
| Marge | purge | charge | stingy | dingy | spongy | charged | changed | verged | | | |
| George | large | gorge | dingy | bulgy | dingy | splurged | tinged | splurged | | | |
| large | urge | urge | clergy | splurgy | orgy | purged | charged | verged | lozenge | orange | challenge |
| charge | purge | purge | clergy | surgy | clergy | gorged | merged | purged | challenge | lozenge | lozenge |

APPENDIX B: Excerpt from a Dialog/Paragraph Reading

The most interesting experience was the mud bath. I almost **lurched** away when I saw it. You wouldn't believe the **stench**! The mud looked like a pile of **sludge** and smelled like a **marsh**. When I **plunged** into the tub it **sloshed** over the **edge**. What a mess! It kind of had a **spongy** consistency and was **squishy** between my toes, but they said it would be good for my **ashy** skin. I also got a mud mask which I thought would be **itchy**. While I did have to **squelch** the **urge** to **touch** my face, it didn't make me too **twitchy**. After a while it felt sort of **cushy**. I could have **lounged** in that tub all day.