An experimental investigation of the perception and production accounts of loanword adaptation

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1. Introduction

A veritable industry has arisen over the past several decades to address the various types of adaptation patterns found in loanword data (Calabrese and Wetzels 2009), making it as divisive a topic as vowel harmony, the universality of certain layers in the prosodic hierarchy, or derivation capable approaches to Optimality Theory. Drawn to loanwords for their ability to explore the uniformity of synchronic grammars (Ito and Mester 2009) and the boundaries of the phonetics-phonology interface (Zuraw 2007), phonologists, phoneticians, and psycholinguists were quick to stake their claim in the rich landscape of data and draw theoretical battle lines for a turf war that has raised more fascinating questions than it has answered. However, in recent years a school of thought has gained traction which views loanword adaptation as a multi-faceted process that has at its disposal both production and perception-based mechanisms (Boersma and Hamann 2009a). This paper corroborates such unified approaches using an online adaptation task to demonstrate that a speaker's language background determines which mechanisms they can employ.

In the study under consideration, previously unborrowed Russian words containing palatalized consonants were auditorily presented to monolingual English speakers and bilingual English-Russian speakers, who were then asked to repeat the words aloud in an American English accent or Americanize them. The resulting adaptations demonstrate that monolinguals often incorporated coarticulatory effects while bilinguals largely did not. These results best make sense using a model that permits monolinguals to only adapt words perceptually but gives bilinguals the option of adapting them via perception or production since they have both the acoustic and underlying representations available to them.

2. Background

Loanword adaption is the process of importing a lexical item from one language into another. The language from which the word is taken is called the *source language*, while the language that receives the word is referred to as the *borrowing language*[1]. Loanwords themselves can be divided into two types, sound-based or meaning-based. In this paper, I will only focus on sound-based forms.

In sound-based adaptation, the borrower imports the surface form of a source word as faithfully as they can given the restrictions of the borrowing language. For instance, the English word 'bike'-[baɪk] was borrowed into Japanese as 「バイク」 - [bai.kɯ]. Since the archiphoneme [N] and the first half of a geminate are the only licit coda segments in Japanese, [ɯ] is epenthesized after the singleton coda [k] in order to make the form comply with Japanese phonotactics.

Two well-established yet conflicting approaches to explaining loanwords like [bai.kɯ] are the production and perception models of loanword adaptation. Proponents of the production approach (Paradis and LaCharite 1997; Paradis and LaCharite 2008) argue that adaptation takes place when a speaker familiar with both the source and borrowing languages (henceforth an *experienced speaker*), retrieves the unspoken surface representation[2] for a source lexeme and uses it as the input to the borrowing phonology. Any differences between the source and borrowed form are thus the results of phonological production grammar and the phonological production grammar alone. To ground this perspective with an example, let us return to the Japanese borrowing for 'bike'. Assuming an Optimality Theoretical production model[3], a Japanese-English bilingual must have accessed the English word for 'bike', retrieved its underlying representation, ran it through their English phonology, and then fed that output to their Japanese phonology. Here, in the Japanese production grammar, EVAL selected [bai.kɯ] as the winner and not the fully faithful candidate [baɪk] since the former best satisfies the constraint hierarchy for Japanese.

Advocates of the perception model argue that adaptation takes place when a speaker who does not know the source language (henceforth a *naive speaker*), hears the acoustic form of a source word and then parses that continuous acoustic representation as a string of discrete phonemes (Peperkamp, Vendelin, and Nakamura 2008; Peperkamp 2004). Any differences between the source and borrowed forms are thus the result of the phonetic decoding module that is part of the speech perception system (Peperkamp 2004, 7). To make this concrete, let us again return to the Japanese borrowing for 'bike'. According to the perception model, a monolingual Japanese speaker must have heard the acoustic form of the word 'bike' and then parsed it as [bai.kɯ]. Evidence for the insertion of vowels during perception or 'perceptual epenthesis' comes from a now famous study conducted by Dupoux et al. (1999), in which Japanese and French speakers were asked to identify whether or not they heard the vowel [u] in nonce words such as [ebuzo]. Even when the vowel in said forms was completely spliced out, Japanese speakers reported hearing [u] about 60-75% of the time while French speakers reported hearing it

[1] In the literature, alternative terms for 'source' and 'borrowing' language found are 'donor' and 'recipient' language or 'L2' and 'L1'.

[2] See Paradis and LaCharite (1997, 394–396) for a discussion of why the input to the borrowing phonology is the source lexeme's unspoken surface representation and not its underlying representation.

[3] Formally, proponents of the production model do not work in Optimality Theory but instead use a collection of principles (i.e. the Category Preservation, Category Proximity, and Minimality principles) to explain adaptations. Because the system is obscure, I present the production model in Optimality Theoretic terms for reasons of accessibility.

approximately 10-20% of the time. Since [b] is always followed by a vowel in Japanese due to phonotactic restrictions, it is argued that Japanese speakers report hearing a vowel after [b] because they only possess category representations for [b] which are followed by vowels. On the other hand, French speakers were less likely to report hearing an [u] after [b] because [b] is permitted at the ends of syllables in French. Taken together, the behavior of both populations demonstrates the influence of phonotactic knowledge in perception and makes the perception model of loanword adaptation plausible.

The production approach rests on the idea that unfaithfulness in loans is the result of the phonology forcing illicit structures to conform to the borrowing language's restrictions, while the perception approach is based on the notion that adaptations reflect phonetically minimal transformations that occur during speech perception. The classic conflict between the perception and production accounts is exemplified by the data sets below, which I will now present in turn. Before continuing, it should be noted that my own interpretation of the data will be relegated to footnotes so that my arguments are not confused with the arguments of the various authors.

(1)	*Stop Adaptation in MC*				*Coda Nasal Adaptation in Japanese*
	a. 'pizza':	**pʰ**itsə	>	**pʰ**isa	d. '本- hon' (jpn.): ho**N**
	b. 'bandage':	**b**æn.dɪdʒ	>	**p**aŋ.ti	e. 'screen'(eng.): skɹi**n** > sɯ.kɯ.rii**N**
	c. 'hippies':	hɪ.**p**iz	>	si.**pʰ**iʂ	f. 'piscine'(frn.): pisi**n** > piʃːi**n**ː**ɯ**

Using a corpus of English loans in Mandarin Chinese (MC), Paradis and Trembley (2009) argue that a perception account cannot explain the robust adaptation patterns for stop consonants illustrated in (0). Since aspirated and plain stops contrast in MC, speakers should be adept at distinguishing the presence or lack of aspiration in a word. A perceptual account would therefore predict that aspirated stops would be nativized as aspirated stops and unaspirated stops as unaspirated stops. Looking at (0) and (0) we see that this prediction is borne out, since the initial aspirated voiceless stop in 'pizza' is adapted as an aspirated stop and the initial unaspirated voiced stop in 'bandage' is adapted as an unaspirated stop. The problem for the perception model occurs in (0), where the medial unaspirated voiceless stop is adapted as aspirated. Since there is no perceptual evidence that can explain why an unaspirated stop would be borrowed as an aspirated one in this situation, the perception model fails to account for the data[4].

Conversely, perception-model advocates argue that a production-based approach cannot reliably account for the borrowing of coda nasals in Japanese. As stated earlier, the only permissible coda consonants in Japanese are [N] and the first half of a geminate. The fact that [N] is a licit coda is demonstrated by the native word in (1.d) and the English loan in (1.e). However, as (1.f) shows, the coda nasal in French borrowings undergoes gemination and has the vowel [ɯ] epenthesized after it. Although [piʃːinːɯ] appears to be the deviant borrowing, Peperkamp et al. (2008) claim[5] that [sɯkɯriiN] is

[4] These patterns could be accounted for if borrowers had access to the orthography during the adaptation process--- orthographic 'p' was borrowed as [pʰ] and orthographic 'b' as [p].

[5] In earlier work, Peperkamp (2004) argues that the French loan [pi.sinːɯ] is the deviant borrowing because it represents an unnecessary adaptation from the perspective of the native Japanese phonology. It

actually the deviant one because both French and English have been argued to syllabify certain coda consonants into empty headed syllables (p.135). To flesh out their argument in my own words, the production account would predict that a French-Japanese bilingual took the UR for /pisin/, ran it through their French phonology to get the phonological surface representation [pi.si.**n**] (note that the coda nasal is now the head of its own empty syllable), and then ran it through their Japanese phonology to get [piʃːi**n**ː**ɯ**]. If it is true that English coda nasals are syllabified the same way as French coda nasals, the production account would predict that /skɹi**n**/ should be adapted as [sɯ.kɯ.ri**n**ː**ɯ**]. Since '*screen'* is borrowed as sɯ.kɯ.riiN, the production approach cannot account for the loans in (0).

In order to establish if both experienced and naïve speakers are capable of borrowing words and to test the predictions of production and perception models, an online adaptation task (OAT) was conducted[6]. In an online adaptation task, words are presented to participants who are then asked to nativize the word. In the OAT presented here, Russian-English bilinguals and English monolinguals were auditorily presented with previously unborrowed Russian words containing palatalized consonants and asked to repeat them aloud in an American English accent or Americanize them. Palatalized consonants were selected because they have robust coarticulatory effects that are only expected to surface in the adaptations of those dependent on the acoustic form--- that is, the adaptations of monolingual English speakers. To elaborate, when palatalized consonants are produced, the tongue body is raised towards the hard palate (Kochetov 2002). Since palatalization raises F2 and back vowels have a low F2, when palatalization raises F2 on the initial portion of a back vowel, the coloring is expected to be so robust that the naive listeners will parse/reanalyze the colored portion as a front vocoid (e.g. tʲa > tia). Naïve adaptations of palatalized consonants followed by front vowels on the other hand are not predicted to contain a novel vocoid since front vowels already have a high F2 and the coloring caused by palatalization will not be distinct enough to be parsed as an independent vocoid (e.g. tʲi> ti). Because the novel vocoid corresponds to an actual component in the acoustic signal, *this process should be considered a type of reanalysis and not perceptual epenthesis*. It should be noted that several other types of reanalysis were expected to occur in the OAT presented. However, due to space limitations only the vocalic reanalysis data will be discussed in this paper.

The borrowings of English-Russian bilinguals were not predicted to contain any vocalization. This is because bilinguals are familiar with the aforementioned co-articulatory effects and are expected to be able to undo them in order to correctly identify the words before adapting them (Ohala 2012).

3. Experiment

3.1 Methods

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cannot be accounted for by co-phonologies because *loanword adaptations do not involve synchronic alternations, but rather consist of transformations that are applied only during the introduction of the loanword*. (p.5)

[6] At the time the experiment was conducted I was unaware of any prior attempt to collect online adaptations. However, it should be noted that Shinohara (1997) had collected online borrowings from English and French speakers.

The experiment was conducted at the UCSC Perception and Recording Laboratory in a sound attenuated booth using an AKG-C520 head-mounted condenser microphone run through an M Audio AudioBuddy Dual Mic Preamp with Phantom Power into a PC. The monolinguals were told they would hear foreign words and be asked to repeat them aloud in an American English accent or Americanize them; they were explicitly told not to imitate the accent of the speaker. The bilinguals were essentially given the same instructions, the only difference being they were told that they would be Americanizing Russian words. The words were presented in four blocks and were each separated by a break, the duration of which was controlled by the participant. Each block contained the tokens from one speaker's repetition. The blocks and tokens within each block were randomized by E-Prime. A practice session using dummy items preceded the main portion of the experiment.

Each token was preceded by 250ms of silence. After each token played, the subject had exactly 3 seconds to Americanize the word before the next token began to play. Subjects were given 3 seconds in order to have enough time to repeat the word without feeling too rushed but not so much time as to overthink how they would adapt the word. Each subject's adaptation was saved as a WAV file by ePrime.

3.2 Tokens

There were a total of 64 unique tokens in the experiment. 32 were fillers containing either non-native English segments (i.e. [x, ɹ, ʒ] or [t͡s]) or illicit English clusters (i.e. [stv, sv, zv, gv, zm, gr, kr, tr, xl,] or [kn]). Of the remaining 32 items, 17 were experimental tokens and 13 were control tokens. The 17 experimental tokens each contained a 'target syllable'. The prevocalic consonant in each target syllable was palatalized and had one of four manners of articulation: stop, fricative, nasal, or liquid. The vowels in these syllables could be either [i, u, or a]. These particular vowels were chosen in order to test the hypothesis put forth at the end of the last section regarding the possible reanalyses we might expect from naïve speakers.

Since unstressed syllables undergo reduction in Russian, in order to ensure that the vowel following the palatalized consonant was the one wanted, the target syllable was always stressed. Besides the palatalized consonants, no other illicit segments or illegal clusters appeared in the experimental or control tokens. Since natural tokens were used, it was not possible to control the non-filler tokens more. However, whenever possible I tried to make sure that the target syllable was always open, word initial, and had a simple onset and that the word itself was disyllabic and contained no other palatalized consonants.

The words discussed above were compiled into a list for recording; dummy items were added at the beginning and end of it to avoid a list intonation on the tokens of interest. Two native Russian speakers were asked to provide three casual repetitions of the list. Only two of the repetitions from each were used in the actual experiment; the third acted as a backup in case there was an issue with one of the tokens in the initial two repetitions. If speakers misarticulated an item while reciting the list they were instructed to repeat the item and continue on. One speaker was recorded in a quite room on a 2010 MacBook Air and the second was recorded in a sound attenuated booth at the Stanford Linguistics Lab. The tokens were extracted into individual wav files using Pratt and then

RMS normalized using a script. No further modifications were made to the tokens in order to leave them as naturalistic as possible.

3.3 Participants

7 subjects participated in the experiment--- 4 were naïve speakers while the remaining 3 were experienced speakers. According to the language background questionnaire administered before the start of the experiment, the 4 naïve speakers were only native speakers of American English. All of them reported studying Spanish in high school but none claimed fluency. As UCSC students, they were compensated with course credit. The 3 experienced speakers were fully fluent in both American English and Russian. One Russian speaker acquired English at the age of 24 and another was a heritage speaker of Russian, which is to say he was natively conversant but illiterate. The illiteracy of this Russian speaker is relevant to the interpretation of the results later since a potential orthographic effect emerges only in the adaptations of literate speakers. The Russian speakers were compensated $10 for their time.

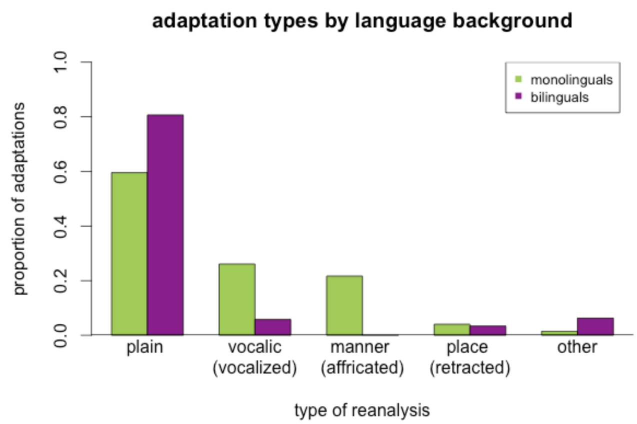
3.4 Coding

The naïve speaker borrowings were transcribed into IPA by several trained undergraduate linguistics students. The students were not told any details about the experiment until after they completed their transcriptions. Each subject's adaptations were transcribed by two different transcribers in order to ensure that one coder's bias did not unduly affect the results. The bilingual adaptations, which were collected several months after the monolingual adaptations, were coded by the principle investigator due to limits on access to undergraduate transcribers.

Using the transcriptions, each token was tagged based on how the palatalized consonant was adapted. If the subject borrowed a palatalized consonant as the plain version of that consonant (e.g. **t**ʲu > **t**u), it was coded as '*no reanalysis*' or '*plain*'. If a palatalized consonant was borrowed with a 'novel vocoid' between the consonant and vowel (e.g. **t**ʲu > t**i**u/t**j**u), it was coded as having undergone a '*vocalic reanalysis*'. A 'novel vocoid' was defined as a vowel or glide that appeared in the adaptation but would not appear in the actual Russian surface representation.

3.5 Results

(2) *Reanalysis Rates By Type*



The bar graph in (2) shows the overall borrowing patterns for tokens containing palatalized consonants for both monolinguals and bilinguals. As can be seen, Monolinguals reanalyzed palatalized consonants as 'plain' 60% of the time and 'vocalized' 26%; bilinguals adapted palatalized consonants as 'plain' 81% of the time and 'vocalized' 6%. While adapting palatalized consonants as 'plain' was overwhelming the most popular strategy for both populations, monolinguals were much more varied in their adaptation strategies.–An in-depth view of the variation in rates of adaptation amongst the subjects can be found in (3).

(3) *Different percentage rates of reanalysis for different subjects*

	Naïve (Monolinguals)				**Experienced (Bilinguals)**		
TYPE	**S1**	**S2**	**S3**	**S4**	**S101**	**S102**	**S103**
plain	**51**	**71**	**62**	**54**	**93**	**82**	**71**
vocalization	**44**	**9**	**24**	**28**	**0**	**6**	**12**
affrication	**25**	**21**	**24**	**19**	**0**	**0**	**0**
fric. retract.	**6**	**1**	**0**	**3**	**0**	**0**	**0**
nas. retract.	**0**	**0**	**3**	**3**	**0**	**6**	**4**

Two fixed effects were thought to influence whether or not a palatalized consonant would cause vocalization in borrowings. The first was language background since monolinguals but not bilinguals were expected to vocalize given their lack of knowledge about how palatalization robustly raises F2 on the proceeding vowel. The second factor thought to affect vocalization rates in fricatives was vowel backness. It is a well-established fact that F2 correlates with vowel backness such that back vowels have a low F2 and front vowels have a high F2. Given that palatalization raises F2 and back vowels have a low F2, when palatalization raises F2 on the initial portion of the back vowel, the transition is expected to be so robust that the monolingual listeners will parse the colored portion of the vowel as a front vocoid. Palatalized consonants followed by front vowels are not expected to cause vocalization since front vowels already have a high F2. This means the coloring caused by palatalization will not be distinct enough to be parsed as an independent vocoid.

(4) *Categorical Regression for Vocalization*

fixed effects		**estimate**	**std. error**	**z-val**	**p-val**
vocalized	(intercept)	-5.01	0.51	-9.80	<.001
language background	(monolingual)	1.88	0.33	5.62	<.001
vowel backness	(back)	2.96	0.44	6.68	<.001

The regression was run on all adaptations based on the experimental tokens. Looking at the results of the regression in (4), we see that language background and vowel backness were highly significant. Specifically, when all other factors are held constant, the probability of a monolingual English speaker vocalizing the portion of a back vowel colored by palatalization is 45.76% while the probability of a bilingual doing so is 0.66%. These results are consistent with our hypothesis.

A regression using acoustic predictors was conducted to see if back vowels increase the likelihood of vocalization because the robust differences in F2 are more noticeable on back vowels. To this end, the beginning and end of the vowels in the stimuli were marked so that two measures could be extracted, the difference in F2 at the beginning and midpoint of a vowel and the percentage of the vowel that was colored by palatalization. The start of the vowel was taken to be the start of the first robust periodic cycle following the preceding consonant; the end of the vowel was taken to be the end of the last robust periodic cycle before the following consonant. In order to acquire the difference in F2 between the colored and uncolored portions of the vowel, we followed Ni Chiosain & Padgett (2012) and subtracted the value of F2 12.5ms after the start of the vowel from the value of F2 at the vowel's midpoint. In order to acquire the duration of coloring, a script was created which started at the beginning of the vowel and measured, in 5ms intervals, how long it took for the F2 value in a vowel to come within 100 Hz of the F2 at the midpoint. This 'coloring duration' was then divided by the total duration of the vowel in order to arrive at the percentage of the initial vowel with a substantially elevated F2. All formant measures were extracted using Praat's Burg algorithm, with a window of 25 ms, set to find five formants in a 5500 Hz range, time step of 2.5 ms, and preemphasis from 50 Hz.

(5) *Acoustic Regression for Vocalization*

fixed effects		**estimate**	**std. error**	**z-val**	**p-val**
vocalized	(intercept)	-2.9491	0.2773	-10.635	<.001
percentage colored		7.0410	1.0536	6.682	<.001
F2 difference		-0.0011	0.0005	-2.35	<.05

(5) contains the results of the regression using vocalization as the dependent variable and percentage-of-coloring and F2 difference as the predictor variables. The regression was run on all experimental items containing palatalized consonants. Both predictors had a p-value less than the predetermined significance level of .05. According to the model, when all other factors are held constant, the average coloring duration of 19.57% in back vowels following palatalized consonants increases the odds of vocalization by 50.9%, which supports my hypothesis. However, the average 308 Hz increase in the transitional F2 in back vowels followed by palatalized consonants *decreases* the odds of vocalization

by 5.23%. This does not support my hypothesis since it's predicted that vocalization will *increase* as the difference in F2 becomes more robust.

4. Discussion

The results of the experiment support both the perception and production accounts of loanword adaptation in that the borrowings of monolinguals were in accordance with the predictions of the perception model and the borrowings of bilinguals were in accordance with those of the production model. To elaborate, it was predicted that monolingual adaptations would incorporate the coarticulatory effects of palatalization since they are not familiar with said effects nor do they access to the underlying forms of the words. Since monolinguals had a noteworthy tendency of adapting the coloring on back vowels as high front vocoids 26% of the time, positive evidence for the perception model was found.

Conversely, because bilinguals are aware of the coarticulatory effects that accompany palatalized consonants and have access to the underlying representations of the words being borrowed, it was predicted that they would be able to correctly identify the word and then use the underlying representation they had as the basis for adaptation. Given that very few bilingual adaptations underwent vocalization, this hypothesis was largely supported. However, bilinguals did adapt 6% of tokens with vocalization, which has two possible explanations. First, it is possible that the bilinguals adapted that small set of tokens using their English perception grammar. The second possibility is that those tokens are actually being influenced by Russian orthography.

In Russian orthography, palatalization is carried by vowels such that when a consonant precedes a palatalizing vowel that consonant becomes palatalized (e.g. д:[d] + я:[ja] = дя:[d^ja]). When no consonant precedes a palatalizing vowel, the palatalization manifests itself as a palatal approximate (e.g. ⃠ + я:[ja] = я:[ja]). If per chance the Russian speakers accessed the orthographic representation of the word instead of its phonological representation, it is possible for the phonology to have received an input with a palatal approximate which then surfaced faithfully in their adaptations.

Corroborating the possibility of orthography-based adaptations in our data is the fact that the bilinguals who produced borrowings with vocalization were exactly those who grew up in Russia and reported being 'fluent' in their ability to read and write in Russian. The third bilingual, who never vocalized, reported not being able to read and poor writing ability in Russian. Analysts unfamiliar with Russian might have doubts about an orthographic account based on the fact that vocalization was only seen before both [u] and [a] but not [i], which is exactly where a perceptual account would predict vocalization should take place. However, there is no grapheme in Russian that represents [ji], which means an orthographic approach would predict no vocalization before [i] either.

Appealing to orthography to explain vocalization clearly requires a formal method for mapping graphemes to phonemes as well as some sort of probabilistic access component for representations in order to explain why vocalization only occurs in some of the borrowings. To my knowledge, only Mathieu (2012) has attempted to formally model orthographic effects. In his model, orthographic and phonological representation are collapsed before undergoing an Optimality Theoretic evaluation, where in faithfulness constraints pressuring the preservation of orthographic and phonological units interact with markedness constraints to govern the appearance of orthographic effects. For example, the French word for ‘pavilion’ is written as ‘pavillon’ and is produced as [pa.vi.jon]. Note, the digraph ‘ll’ manifests itself not as the alveolar liquid [l] but as the palatal approximate [j]. This fact is relevant because the Romanian borrowing for ‘pavillon’ is [pa.vil.jon], which possesses both the unspoken [l] and the unwritten [j].

(6) Orthographic account of the Romanian loanword ‘pavilion’ from French

		IR: $/p_{S,T}a_{S,T}v_{S,T}i_{S,T}\{l_T,i_S\}o_{S,T}n_{S,T}/$[5]	MAX-IO$_S$	MAX-IO$_T$	BEFRENCH = $(C_nVG)_{\sigma\#}$
a.	☞	[pa.vil$_T$.j$_S$on]			
b.		[pa.vij$_S$.l$_T$on]			*!
c.		[pa.vi.l$_T$on]	i$_S$!		
d.		[pa.vi.j$_S$on]		l$_T$!	
e.		[pa.vjon]	i$_S$!	l$_T$!	

Looking at (6), we see that Mathieu captures these facts with the high-ranking faithfulness constraints MAX-IO$_S$ and MAX-IO$_T$, which are violated when input segments or graphemes are deleted respectively. Following the same logic, we can explain bilingual vocalization in tokens with palatalized consonants, like ‘мясо’-‘meat’ for instance, if we assume that the written form ‘мясо’/‘mjaso’ and its phonetic form [mʲasə] are amalgamated as /m^j_S j$_T$ a$_{S,T}$ s$_{S,T}$ o$_{S,T}$/. As (7) shows, the form with vocalization emerges as optimal in the borrowing grammar if we assume the ranking MARK, MAX$_T$, MAX$_S$ >>FAITH. In this toy analysis, MARK is used to represent the markedness constraints responsible for preventing non-native segments like [mʲ] and illicit sequences like [mja] from surfacing and FAITH represents all faithfulness constraints except MAX-IO$_S$ and MAX-IO$_T$. Given this ranking, the optimal candidate is [mi.a.sə] since it only violates the faithfulness constraint that punishes candidates for changing the features for palatalization in their consonants and the faithfulness constraint that punishes candidates for changing the syllabicity of their consonants. That is, [mi.a.sə] only incurs two violations on the lowly ranked FAITH: one for removing the palatalization in [mʲ] and the other for vocalizing or syllabifying the [j] as [i].

(7) An orthographic account of vocalic reanalysis in bilinguals

/m^j_S j$_T$ a$_{S,T}$ s$_{S,T}$ o$_{S,T}$/	MARK	MAX$_T$	MAX$_S$	FAITH
[mʲja.sə]	* mʲja			
[mʲa.sə]	* mʲ	*j		*j
[mja.sə]	* mja			*ʲ
[ma.sə]		*j$_T$		*ʲ
☞ [mi.a.sə]				*ʲ *[-syllabic]

The idea that vocalization is orthographic in nature is certainly debatable, especially since the stimuli were presented auditorily, which makes a perception based account more intuitive. To test the idea that orthographic representations can yield vocalization in borrowings, future research should look at whether English-Russian bilinguals presented with orthographic forms adapt words with vocalization.

Taken together the behavior of these two populations demonstrate that any speaker is capable of borrowing a word but that their language background significantly affects the types of adaptations they can generate. Any complete theory of loanword adaptation must therefore be able to account for the borrowings of naïve *and* experienced speakers. That is, a formal model with both perception and production machinery, such as the BiPhon Model (Boersma and Hamann 2009a; 2009b), is required.

The results of the online adaptation task presented in this paper also have implications for how we interpret the results of loanword corpus investigations. Paradis and LaCharite (2008) argued that loanword adaptation is overwhelmingly phonological based on the fact that naïve phonetic approximation represents a low percentage of cases in corpora even when there were less bilinguals in the population. The methodological flaw with the investigation conducted was that it limited what counted as perception-based borrowings to instances of phoneme deletion and phoneme reanalysis. However, as was observed in Section 3, monolingual speakers, who had no choice but to borrow the words perceptually, adapted the majority of palatalized consonants as the plain version of that consonant. According to Paradis and LaCharite's metric, the majority of perception-based borrowings in this study would therefore be classified as production-based! The core problem with the argument they present is that it assumes perception-based adaptations will always display perceptual artifacts, which I have shown is clearly not the case. In short, while loanword corpus investigations can be insightful, we must be cautious about the conclusions drawn from them.

5. Conclusion

Motivated by persistent claims in the literature that loanword adaptation is largely driven by naïve speakers adapting words perceptually *or* by experienced speakers adapting words via their production grammars, I presented words containing palatalized consonants to English monolinguals and English-Russian bilinguals. The results showed that the adaptation patterns of each population were affected by their language backgrounds. Specifically, monolingual borrowings were heavily influenced by co-articulatory vowel coloring, which was expected given that the acoustic form was the only form available to them. Bilingual borrowings were largely insensitive to co-articulatory effects, which was not surprising considering they have access to the underlying forms of the words. Based on these findings, I argued that a hybrid model with both perception and production machinery is required.

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