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JOURNAL ARTICLE

Sociolinguistic effects on loanword phonology: Topic in speech and cultural image

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There is variation in the pronunciation of loanwords, because they can be pronounced with native sounds or non-native sounds. For example, loanwords from te reo Māori to New Zealand English (NZE) are sometimes pronounced with native rhotic sounds (e.g., *ko*[ɹ]*u* and *ma*[ɹ]*ae*) and sometimes with non-native rhotic sounds (e.g., *ko*[ɾ]*u* and *ma*[ɾ]*ae*). This study aims to explore the relationship between the selection of a variant in loanword phonology and situation-specific sociolinguistic factors such as topic in speech and cultural images. Additionally, we explore the effects of speaker- and word-specific sociolinguistic factors on the likelihood of choosing a variant. In order to explore these effects, a set of two experiments was conducted, and the results demonstrate that the selection of a variant in NZE loanword phonology is influenced by some sociolinguistic factors. It is argued that these findings can be encapsulated by an exemplar-based approach. More specifically, they can be neatly captured by positing that exemplars with native sounds and those with non-native sounds are represented in the cognitive system of a borrower and updated on the basis of linguistic experience, and exemplars with non-native sounds are stored in relation to a social category associated with the source language and its culture.

Keywords: cultural image; Exemplar Theory; loanword phonology; topic in speech; variation

1. Introduction

When a word is borrowed from a foreign language, the word may include structure that is not permitted in the grammar of the borrowing language, that is, a phonologically ungrammatical structure. This ill-formed structure is called non-native structure (see Paradis & LaCharité, 1997, 2011; LaCharité & Paradis, 2005). Non-native structure may be altered into a well-formed structure that conforms to the phonology of the borrowing language, or it may be retained without phonological modification (Haugen, 1950; LaCharité & Paradis, 2005; Broselow, 2006; Kang, 2011). Because of these two consequences, there is variation in the pronunciation of loanwords. For example, English has a coronal approximant /ɹ/ as a rhotic phoneme, while German has a uvular approximant /ʁ/ as a rhotic phoneme. That is, the retroflex-coronal /ɹ/ can be regarded non-native to the German phonology. Loanwords from English to German are sometimes pronounced with adapted structure [ʁ] and sometimes with imported structure [ɹ] (see Itō & Mester, 2001), with the result that there is variation in loanword pronunciation.

This raises a question: What governs the selection of adapted structure and imported structure? Why are loanwords sometimes pronounced with adapted structure and sometimes with imported structure? Previous literature demonstrates that the selection may be influenced by several factors: level of bilingualism (Haugen, 1950; Friesner, 2009; Lev-Ari, Giacomo, & Peperkamp, 2014; Aktürk-Drake, 2015, 2016); degree of linguistic

integration (Haugen, 1950; Poplack & Sankoff, 1984; Poplack, Sankoff, & Miller, 1988); age and social class (Friesner, 2009, 2010); prestige in semantic domain (Lev-Ari & Peperkamp, 2014; Lev-Ari et al., 2014); language dominance (Aktürk-Drake, 2015, 2016). Despite these previous studies, it still remains a question what exactly determines the likelihood of adaptation versus importation. The effects of sociolinguistic factors on variation in loanword adaptation are especially unexplored, as Friesner (2009, p. 9) notes that "Although several authors refer to the relevance of social factors as predictors of the outcome of borrowing, few studies address this issue directly," and Lev-Ari & Peperkamp (2014) note that "Despite the wide agreement that social factors can influence sound change, this question has not been examined in relation to sound adaptation in loanwords." The aim of this study is to fill this gap, thereby increasing our understanding of the variation in loanword phonology.

In particular, we will explore two situation-specific sociolinguistic factors: topics in speech and cultural images. Topic effects are well-explored in the literature on linguistic variation, but they have not been discussed in relation to loanword phonology, to the best of our knowledge. This study aims to test whether this effect extends to loanword phonology. The effect of cultural images on linguistic variation has hardly been discussed in general. Although the image effect has been discussed in relation to speech perception (Hay & Drager, 2010), it has not, to the best of our knowledge, been explored in relation to speech production. We aim to test whether this effect extends to the production of a linguistic variant in loanword phonology. Additionally, we will explore the effects of speakers' and words' association with the source language and its culture. The following question is addressed through a set of two experiments in the current paper:

(1) Research question addressed in this study
Is the likelihood of choosing adapted structure and imported structure affected by (i) topics in speech, (ii) presented cultural images, (iii) speakers' association with a source language and its culture, and (iv) words' association with a source language and its culture?

In the following section, the literature relevant to this question is reviewed, and the theoretical predictions are put forward. We will examine these effects through the lens of treating our linguistic knowledge as a large cloud of exemplars and categories, allowing us to inform the understanding of how adapted structure and imported structure are represented in the mind of a borrower.

This paper is organized in the following way. Section 2 reviews relevant literature and lays out theoretical predictions for the above research question. In Section 3, we illustrate research designs, while in Section 4 we show the statistical results. Section 5 discusses the results in comparison with the theoretical predictions, and we conclude this paper in Section 6.

2. Background

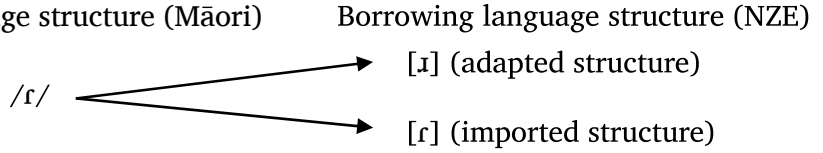
2.1. Loanword phonology in New Zealand English

Loanword phonology in New Zealand English (NZE) is chosen as a test case to address the above research question. This is because NZE speakers very frequently use loanwords borrowed from te reo Māori, which is the language spoken by Polynesian people who arrived to New Zealand about 1,000 years ago. NZE has borrowed a great number of words from te reo Māori, since the 19th Century when a large number of European people started immigrating to New Zealand. Many place names in New Zealand are borrowed from te reo Māori, and many public signs are written in te reo Māori as well as English. Some common nouns such as *kumara* 'sweet potato' and *whānau* 'family'

are commonly used in NZE speech. Therefore, New Zealanders are exposed to Māori loanwords every day, and they know a large number of Māori words (see Macalister, 2005; Calude, Miller, & Pagal, 2017), although most of them are not able to speak te reo Māori (Te Puni Kōkiri, 2006).

The two languages, te reo Māori and NZE, have different phonological systems. For example, the Māori phonological system includes five short vowels /i, e, a, ɔ, u/, five long vowels /iː, eː, aː, ɔː, uː/, and ten consonants /p, t, k, f, h, m, n, ŋ, ɾ, w/, whereas the NZE phonological system includes a larger set of phonemes as in other varieties of English (see Biggs, 1961; Bauer & Warren, 2008). Hence, when words are borrowed from te reo Māori to NZE, the words may include non-native structure. For example, the tap sound [ɾ] can be regarded as non-native to NZE, because it is Māori's rhotic phoneme, whereas NZE has a coronal approximant [ɹ] as its rhotic phoneme. In NZE speech, this non-native rhotic sound is sometimes adapted to a native rhotic sound (e.g., *ko*[ɹ]*u* and *ma*[ɹ]*ae*) and sometimes imported without modification (e.g., *ko*[ɾ]*u* and *ma*[ɾ]*ae*) (see Maclagan & King, 2005). For simplicity, the current study focuses on the non-native rhotic sound /ɾ/, in order to discuss the likelihood of choosing adapted structure and imported structure. The reason for selecting this variable under study is three-fold. First, the distinction of imported [ɾ] and adapted [ɹ] is acoustically clear, with the detail in Section 3.5. This allows us to secure the objectivity of classification. Second, this variation seems salient even for NZE speakers without linguistic knowledge. The pronunciation of /r/ sounds in Māori loanwords is sometimes discussed in daily conversation in New Zealand. Third, there is a large enough number of loanwords with /r/ that are frequently used in daily life (e.g., *ko<u>r</u>u*, *kuma<u>r</u>a*, and *ma<u>r</u>ae*).

(2) Variable under study in this paper



As the current study focuses on this variable, the term 'imported structure' refers to tap sounds [ɾ], and 'adapted structure' refers to approximants [ɹ] throughout this article.

2.1.1. Tap sounds in Māori loanwords versus flapped variants of /t/ in native words

An anonymous reviewer questioned whether it is plausible to regard tap sounds [ɾ] as non-native to NZE, because a coronal plosive phoneme /t/ may be realized as a flapped or voiced variant [D] in the NZE native phonology (see Hay & Foulkes, 2016), which may be similar to tap sounds in the NZE loanword phonology. For convenience, we assume that the imported structure [ɾ] is cognitively different from a flapped variant [D] to NZE speakers. This assumption is justified from the following two perspectives.

First, these two sounds seem to be intuitively different. NZE speakers do not seem to have an intuition that the Māori rhotic sound is similar to the flapped /t/ variant, and some NZE speakers even call the non-native rhotic 'rolled-r' or 'Māori-r.' When I tell some NZE speakers that Māori-r is similar to word-medial /t/-sounds in words such as *bu<u>tt</u>er* and *wa<u>t</u>er*, they have difficulty in understanding this. In this way, NZE speakers do not seem to relate imported [ɾ] with a coronal plosive phoneme /t/.

Second, tap sounds [ɾ] and flapped sounds [D] are phonologically different. As will be discussed in Section 5, tap sounds can occur in a variety of phonological environments including word-initial position (e.g., *<u>r</u>ata* and *<u>r</u>imu*) and main-stressed syllables (e.g.,

Aka<u>ɾ</u>oa and *kaka<u>ɾ</u>iki*). On the other hand, flapped variants are usually produced in an intervocalic trochaic environment (V́_V̆), while they are hardly produced in word-initial position (Holmes, 1995) and in main-stressed syllables (Hashimoto & Hume, 2018). It is also worth noting that tap sounds [ɾ] in Māori loanwords are very likely to be produced in word-list reading tasks. Approximately 64.3% of the /r/ realizations in Māori loanwords are tap sounds in the word-list reading task reported in the current study, as discussed in Section 5. Previous literature demonstrates that flapped variants [D] of a coronal plosive phoneme /t/ are very unlikely to be produced in word-list reading tasks (Fiasson, 2015; Hashimoto & Hume, 2018): 3.7% of trochaic /t/ realizations are flapped variants in the data of Fiasson (2015), and only 2.2% of trochaic /t/ realizations are flaps in the data of Hashimoto and Hume (2018). In this way, their phonological distributions are largely different.

As the reviewer pointed out, it is still an empirical question how different tap sounds [ɾ] in Māori loanwords and flapped variants [D] in native words are from phonetic perspectives. We would like to mention that tap sounds in Māori loanwords are impressionistically longer than flapped variants in native words. It is worth exploring the exact phonetic features of these two sounds in future study.

2.2. Exemplar Theory

In order to deduce the prediction related to the research question in (1), we employ the usage-based theory, more specifically, Exemplar Theory (Pierrehumbert, 2001, 2002; Foulkes & Docherty, 2006). This section reviews some theoretical hypotheses about representations in the mind of a speaker, the activation of a category, and the selection of an exemplar for production.

2.2.1. Representation of exemplars and categories

Exemplar Theory assumes that linguistic knowledge is built up by representing in memory previously encountered speech with detailed phonetic information. These episodic memories are called exemplars. Exemplars with similar perceptual values cluster together, with the result categories (e.g., lexical categories, phonological categories, and social categories) formed in the cognitive system. It is assumed that exemplars and categories are connected in a complex manner. An exemplar can be associated with several categories simultaneously (see Docherty & Foulkes, 2014). For example, when we hear [pɛŋgwən] produced by a girl, the perceived token may be stored as an exemplar associated with a lexical category 'penguin' and social categories 'female' and 'young' simultaneously. A category can be associated with another category. Fiasson (2015) argues that allophonic categories, such as a released variant [t] and a fricated variant [F] of a coronal plosive phoneme /t/, are cognitively linked, on the basis of his finding that shadowing a short medial fricated variant [F] causes a medial released variant [t] to be shorter (see also Nielsen, 2011). In this way, a large cloud of memories is complexly represented in the cognitive system of a speaker.

In the case of loanword phonology in NZE, we specifically hypothesize that (a) a NZE speaker stores exemplars including adapted structure [ɹ] and imported structure [ɾ] in her mind, and the phonological categories, 'adapted structure [ɹ]' and 'imported structure [ɾ],' are formed in her mind. This is because NZE speakers are exposed to the two structures in daily speech. Next, we hypothesize that (b) the imported structure [ɾ] is closely socially associated with the social category 'Māori,' because imported structure is identical to the structure used in the Māori language and society and promoted in Māori community. These two theoretical hypotheses are illustrated in **Figure 1**. The letters inside the cloud represent individual exemplars, and the labels represent categories formed by exemplars with similar phonetic values. Note that each exemplar may also be associated with a lexical category

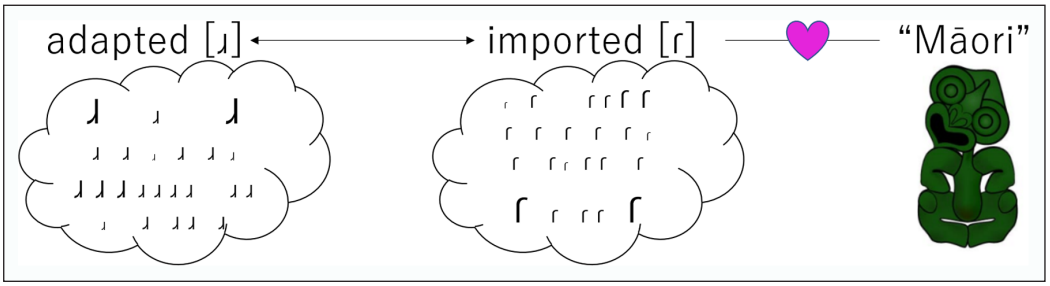


Figure 1: Category and exemplar association.

such as *koru* and *marae* depending on which loanword the /r/ sound is produced in, and a social category such as ‘female’ and ‘young’ depending on who produced the /r/ sound.

2.2.2. Activating category and choosing exemplar

Exemplar Theory assumes that speakers begin speech production by activating a particular category they want to produce and choosing an exemplar belonging to the category. For example, when speakers want to produce the word “cat,” they may first activate the lexical category *cat* and phonological categories /k/, /æ/, and /t/ before production. Then, they may choose exemplars belonging to the activated categories.

The likelihood of activating a particular category could depend on the strength of the exemplars belonging to the category and the activation of the relevant category. First, a category represented by a larger number of exemplars encoding frequent and recent tokens is more likely to be activated due to its potential dominance, all else being equal. This successfully predicts that a frequently used word is likely to be selected in production and perception in comparison to other words. Second, a particular category is likely to be activated due to the activation of other relevant categories. For example, Hay and Drager (2010) demonstrate that female NZE speakers tend to perceive synthesized vowels as those produced by Australians, when they are exposed to visual stimuli associated with Australia. This can be accounted for by positing that the visual stimuli raise the activation of a social category ‘Australia,’ and consequently exemplars with vocalic features associated with the social category are activated and they have advantages in perceptual competition (see also Hay, Nolan, & Drager, 2006).

In the case of NZE loanword phonology, we can present the following hypotheses: (c) the likelihood of activating adapted structure and imported structure potentially depends on the strength of the exemplars belonging to each category. The strength of an exemplar is represented by the size of a letter in **Figure 1**. We hypothesize that the linguistic category called imported structure is more likely to be activated, if a speaker is exposed to imported structure more frequently, with the reverse true for the adapted structure. This is because a category is represented by a larger number of exemplars with variants, which a speaker is more frequently exposed to. Next, we also hypothesize that (d) the activation of the social concept ‘Māori’ may raise the activation of the linguistic category called imported structure, because it is hypothesized above that (b) imported structure is closely associated with the social concept ‘Māori.’ Finally, we assume that an exemplar belonging to the activated category is chosen for production. For example, if imported structure is selected during the category activation, then an exemplar with [ɾ] is chosen for production.

2.3. Predictions

The aim of this section is to review previous literature related to the four sociolinguistic effects in the research question in (1), and deduce the prediction on the basis of the hypotheses presented in the preceding section.

2.3.1. Topic in speech

First, let us review literature related to topic effects on linguistic variation. Although topic effects have yet to be discussed with regard to loanword phonology, the effects are well explored in relation to sociolinguistic variation such as dialect shifts and style shifts. For example, Mendoza-Denton, Hay, and Jannedy (2003) explore the speech of Oprah Winfrey (an American media proprietor) in a TV show *The Oprah Winfrey Show*, and examine the phonetic realization of /ay/, which is realized as a monophthong [a:] in African American English. They found that more African American English variants [a:] are produced when she introduces African American guests in comparison to when she introduces non-African American guests. To take another example, Love and Walker (2013) show that soccer fans produce a higher number of American English variants when they talk about American football. These effects can be captured by exemplar-based approaches: Speaking about a particular topic may raise the activation of the relevant social category. For example, speaking about other African Americans may activate the social concept 'African American.' Consequently, a linguistic category associated with the social category may also be activated, and an exemplar belonging to the category may be more likely to be chosen in production.

We will explore this effect on the likelihood of choosing a variant in loanword phonology. In the case of NZE loanword phonology, the following prediction can be put forward. Speaking about Māori may raise the activation of a social category of 'Māori.' We hypothesized that the activation of the social concept 'Māori' may raise the activation of the linguistic category called imported structure [ɾ]. Consequently, an exemplar with imported [ɾ] is likely to be chosen for production, as we assume that an exemplar is chosen in accordance with the activated category:

(3) Prediction 1: topic effect
Imported structure [ɾ] is more likely to be produced, when topics in speech are related with Māori.

2.3.2. Cultural image

Next, we would like to consider cultural image effects. Scarce work has been done on the effect of cultural images on linguistic performance in general. To the best of our knowledge, the effect is discussed only by Hay and Drager (2010) with regards to speech perception. They ran a unique experiment to explore this effect. In the beginning of the experiment, a NZE speaker was exposed to either a stuffed kiwi bird toy or a stuffed kangaroo toy. It is assumed that a kiwi bird is culturally associated with New Zealand, while a kangaroo is associated with Australia. After the exposure to one of the cultural images, the speaker completed a forced-choice task, in which they listened to a sentence with a target word and continua of synthesized vowels. Their task was to answer which synthesized vowel is close to the vowel heard in the target word. The continua range from New Zealand-like vowels to Australia-like vowels. It was found that female speakers exposed to a kangaroo toy tend to choose an Australia-like vowel, with the reverse true for those exposed to a kiwi bird toy. The exemplar-based approaches can account for the cultural image effects. The exposure to a particular toy may be akin to the exposure to a concept of a dialectal region. That is, the exposure to a kiwi bird toy may raise the activation of the concept 'New Zealand,' and that to a kangaroo toy may activate the concept 'Australia.' As a result, the relevant linguistic category and the exemplars belonging to the category are also activated, and they have advantages in perceptual competition. For example, the activation of 'New Zealand' may raise the activation of exemplars produced by New Zealanders, and consequently exemplars with New Zealand-like vowels are more likely to be chosen in perception.

In the same way, we can expect that cultural images may affect the selection of a variant in production. That is, it can be expected that a cultural image may raise the activation of the relevant social concept, and sequentially the linguistic category associated with the concept may be more likely to be activated and chosen in production. In the case of NZE loanword phonology, we crucially hypothesize that the exposure to a Māori cultural image raises the activation of the social concept 'Māori.' This social concept activation raises the activation of imported structure [ɾ] sequentially, as hypothesized in Section 2.2. Consequently, imported structure is likely to be chosen for production, because the selection of an exemplar depends on the category activation:

(4) Prediction 2: cultural image effect
Imported structure [ɾ] is more likely to be produced, when a Māori cultural image is presented in speech.

2.3.3. Speakers' association with the source language and its culture

There is no doubt that the selection of a linguistic variant depends on speakers' social properties. For example, a speaker's relationship with a social group may affect the selection of a linguistic variant. Labov (1972) shows that speakers with working-class backgrounds tend to realize /θ/ as [t]. This variation can be interpreted to mean that speakers are passive users of the linguistic features associated with a particular social group or value (Wolfram & Schilling, 2016, p. 301). In other words, the selection of a linguistic variant may be determined by the exposure to a particular variant used in the community to which a speaker belongs. From an exemplar-based point of view, this effect can be neatly captured by the potential strength of a category. The more often a speaker is exposed to a particular variant, the higher number of exemplars with the variant are stored in her cognitive system. As the category with numerous exemplars has advantage in the competition (Pierrehumbert, 2001), the speaker is more likely to produce the variant to which she is frequently exposed to.

As another social property of a speaker, attitudes towards a social group are also known to affect the selection of a linguistic variant. Bell (2014, Ch. 11) notes "speakers intentionally stylize linguistic features in order to call up associations with particular groups or identities." For instance, Eckert (2000) demonstrates that teenagers in Detroit employ linguistic variants in accordance with a local social category with which they wish to affiliate rather than their parents' socioeconomic status. These studies suggest that the selection of a linguistic variant is determined not only by the exposure to a particular sociolinguistic variant but also by the attitudes towards a social group or value. Once again, the exemplar-based approaches provide a theoretical account for the attitude effects. The attitude effect can be captured by the activation of the relevant category. Drager, Hay, and Walker (2010) note that "The degree of activation depends on the speaker's attitudes and social biases. Positive attitudes and biases toward a social group result in activation of phonetic representations indexed to the social group." That is, speakers may potentially activate a particular social concept, which they have more positive attitudes towards or wish to associate with, and consequently they are more likely to produce exemplars associated with the social concept.

Based on these previous studies, we expect that the likelihood of choosing adapted structure and imported structure in loanword pronunciation may also depend on speakers' social properties. In particular, we will explore speakers' relationships with and attitudes towards the source language and its culture. As for the relationship, the following prediction can be put forward from the hypotheses presented in Section 2.2. A speaker strongly related with Māori may be frequently exposed to imported structure [ɾ], the result

of which is that a higher number of exemplars with imported structure [ɾ] are stored in the mind of the speaker. This is because imported structure is considered more likely to be used in the Māori language and community, as it is the structure identical to te reo Māori, and the usage of the structure has been promoted by the Māori community. It is hypothesized in Section 2.2 that the likelihood of activating a category potentially depends on the strength of the exemplars belonging to the category. Hence, imported structure [ɾ] should be selected by speakers frequently exposed to the structure:

(5) Prediction 3a: relationship with Māori
Imported structure [ɾ] is more likely to be produced by a speaker strongly related with Māori.

With regards to speakers' attitudes towards Māori, our exemplar-based approach can deduce the following prediction: A speaker with more positive attitudes towards Māori potentially activates the social category Māori. We hypothesized in Section 2.2 that the activation of the social concept may raise the activation of a linguistic category called imported structure via the socio-indexical link. That is, a speaker with more positive attitudes towards Māori should be more likely to produce imported structure in general:

(6) Prediction 3b: attitudes towards Māori
Imported structure [ɾ] is more likely to be produced by a speaker with more positive attitudes towards Māori.

2.3.4. Words' association with the source language and its culture

Finally, we will consider the effects of the usage of words in relation to social factors. A word-specific factor may be one of the least-studied sociolinguistic properties. Hay and Foulkes (2016) show that words likely to be used by younger speakers are more likely to be produced with innovative allophonic variants, whereas words likely to be used by older speakers are more likely to be produced with conservative allophonic variants. That is, the variation in word pronunciation depends on who is likely to produce the word (see Walker & Hay, 2011 for word perception). The exemplar-based approaches can capture this word-specific effect in the following way: Words used more often by younger speakers may be heard with innovative allophonic variants, while those used frequently by older speakers may be heard with conservative variants. As a result, a lexical category associated with younger people is represented by a larger number of exemplars with innovative variants. Due to the number of exemplars, innovative forms are more likely to be produced for the lexical category. The reverse is true for a lexical category associated with older people.

It can be expected that the word-specific effect may be observed in loanword phonology. Given that imported structure [ɾ] is used more often within the Māori community, imported structure may be heard more frequently in loanwords strongly associated with Māori. Consequently, exemplars with imported structure may have higher strength amongst exemplars associated with the lexical categories. As we hypothesized in Section 2.2 that the likelihood of activating a category potentially depends on the strength of the exemplars belonging to the category, an exemplar with imported structure may be more likely to be produced for the production of a loanword associated with Māori:

(7) Prediction 4: words' association with Māori
Imported structure [ɾ] is more likely to be produced in loanwords strongly associated with Māori.

3. Research design

The aim of this section is to lay out research designs to test the above five predictions in relation to the research question in (1).

3.1. Participants and procedure

Thirty-two NZE speakers took part in a set of two experiments, and filled in a questionnaire. The participants were recruited through advertisements on the Facebook page of the University of Canterbury Students' Association. By specifying in the advertisements, it was ensured that all the participants are non-bilingual Pākehā New Zealand English speakers aged between 18–35. 'Pākehā' is an ethnicity term that usually refers to New Zealanders who are descendants of European immigrants. The reason why only Pākehā speakers were examined is that there is a different sociolinguistic variety associated with Pākehā speakers and Māori speakers (King, 1993; Szakay, 2007, among others), and Māori speakers may be exposed to te reo Māori in a different way from Pākehā speakers. Focusing on Pākehā speakers allows us to control the effect of these sociolinguistic differences. Note that three of the participants identify themselves as Māori as well as Pākehā, because their distant relatives such as great grandparents were Māori. The age requirement of 18–35 allows us to control the effect of a diachronic change. The participants were tested individually by the author in a sound booth at the University of Canterbury, and received a 15 NZD voucher at the end of the experiments.

Experiment 1 was designed to explore the topic effects on the likelihood of selecting adapted structure and imported structure, whereas Experiment 2 was designed to explore the cultural image effects. The questionnaire was used to measure speaker- and loanword-specific sociolinguistic properties. The set of these experiments was approved by Kaiārahi Māori Research and Human Ethics Committee at the University of Canterbury in 2017, and was pre-registered as #5095 using AsPredicted (https://aspredicted.org/index.php).

3.2. Experiment 1: Passage-reding task

First, the participants took part in a passage-reading task. In this task, they were asked to read 10 short passages, four of which are passages about leisure in New Zealand (hereafter referred to as neutral passages), four of which are passages about Māori culture (hereafter referred to as Māori passages), and two of which are filler passages. This manipulation of topics allows us to test the topic effects on loanword phonology. The two types of passages both include the following target loanwords, which are assembled into four groups:

(8) Four groups of Māori loanwords
Group A: *Rotorua*, *Taranaki*, *Whangarei*
Group B: *Akaroa*, *Aoraki*, *Kaikoura*, *Moeraki*
Group C: *Oamaru*, *Tauranga*, *Timaru*, *Tokoroa*
Group D: *Maruia*, *Paeroa*, *Porirua*, *Rangiora*

Note that these words are all place names, because topics are easy to manipulate naturally. They all include word-medial rhotics /r/, of which the realizations can be classified into adapted structure [ɹ] or imported structure [ɾ] (see Section 2.1). In Experiment 1, only the word-medial rhotics are analyzed, and the word-initial rhotics in *Rangiora* and *Rotorua* are not discussed. Note that *Porirua* has two word-medial rhotics, which are annotated separately. These target loanwords were mentioned twice within a passage. Hence, 2,048 /r/ tokens are supposed to be collected (16 word-medial /r/ × 2 times mentioned in a passage × 2 topics × 32 participants). It was made sure that the target loanwords occur

sentence-medially in the target passages. The passages employed in this task are available in Appendix D of Hashimoto (2019).

The stimuli were presented using E-prime 2.0 software (Psychology Software Tools, Pittsburg, PA). Each participant was asked to read the passages in a natural way. At the beginning of each trial, the passage appeared on the screen of a computer, and remained there for the rest of the trial. After the participants pronounced the whole passage, they pressed the space bar and the next passage appeared on the screen. They repeated this procedure until they finished reading all the ten passages.

The order of the passages was pseudo-randomized using R (R Core Team, 2016) in the following way. The passage topic alternated every two passages; that is, participants read two Māori passages after reading two neutral passages, or they read two neutral passages after reading two Māori passages. The order was counter-balanced, i.e., half the participants began with Māori topics and the other half began with neutral topics. In addition, it was ensured that the first four passages included all the loanwords belonging to the four groups. This combination was also counter-balanced, i.e., half the participants pronounced Group A and Group B loanwords in Māori passages first, and the other half pronounced Group A and Group B loanwords in neutral passages first. There were two filler passages between the first four target passages and the second four target passages, and there was a short break between the first five passages and the second five passages. The procedure of the passage-reading task is generalized in **Table 1**.

3.3. Experiment 2: Word-list reading task

After Experiment 1, the participants took part in Experiment 2, in which participants were asked to read aloud Māori loanwords and native words within a carrier sentence while seeing a cultural frame. The target loanwords are listed in (9). They include word-initial and/or word-medial /ɾ/, of which realizations can be classified into adapted structure [ɹ] or imported structure [ɾ]:

(9) 36 target loanwords in word-list reading task
Akaɾoa, Aoɾaki, Aoteaɾoa, Haeɾe mai, haɾakeke, Kaikouɾa, kakaɾiki, kauɾi, Kia oɾa, koɾu, kumaɾa, Maoɾi, Maɾuia, Mataɾiki, maɾae, Moeɾaki, Oamaɾu, Paeɾoa, Poɾiɾua, Rangi, Rangioɾa, Rangitoto, Rotoɾua, ɾata, ɾimu, taɾakihi, Taɾanaki, Tauɾanga, te ɾeo, Timaɾu, Tokoɾoa, tuataɾa, Waimaiɾi, Waimakaɾiɾi, Waiɾoa, Whangaɾei

Table 1: Procedure in Experiment 1.

Participants A (P1, P5, P9, P11.)	**Participants B (P2, P6, P10, P14.)**	**Participants C (P3, P7, P11, P18.)**	**Participants D (P4, P8, P12, P19.)**
Māori passages with groups A or B	Māori passages with groups C or D	Neutral passages with groups A or B	Neutral passages with groups C or D
Neutral passages with groups C or D	Neutral passages with groups A or B	Māori passages with groups C or D	Māori passages with groups A or B
Filler passage	Filler passage	Filler passage	Filler passage
Short break	**Short break**	**Short break**	**Short break**
Filler passage	Filler passage	Filler passage	Filler passage
Māori passages with groups C or D	Māori passages with groups A or B	Neutral passages with groups C or D	Neutral passages with groups A or B
Neutral passages with groups A or B	Neutral passages with groups C or D	Māori passages with Groups A or B	Māori passages with groups C or D

Four of the target loanwords include two /r/ sounds (*Porirua*, *Rangiora*, *Rotorua*, and *Waimakariri*), and they are annotated separately. Hence, 40 realizations of /r/ can be collected from this set of target loanwords. In addition to these target loanwords, the participants read aloud 74 filler words including Māori loanwords without /r/ and native words.

Each participant was asked to pronounce these words within a carrier sentence "Say _ please" while seeing a cultural frame. The stimuli were presented using E-prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). At the start of each trial, a word written in English orthography appeared within a carrier sentence on the screen of a computer and remained there for the rest of the trial. After the participants pronounced the word within a carrier sentence, they pressed the space bar and the next word appeared on the screen. They repeated this procedure until they pronounced all the words. After they finished the task, they retook the same task again; that is, each speaker took the same task twice. Hence, 2,560 tokens (32 participants × 40 /r/ tokens × 2 times) are supposed to be collected throughout this experiment.

In order to test the effect of cultural images on the likelihood of adaptation versus importation, the cultural frames were manipulated on the screen. Every time a participant pressed the space bar, a cultural frame alternated along with the word. The frames in **Figure 2** were employed. The left-hand one is supposed to be strongly associated with Māori because it includes Māori cultural expression, koru, and the right-hand frame is not associated with Māori because they look like western photo frames. When this experiment was designed, some New Zealanders were asked whether the left-hand frame looks Māori-like. All the New Zealanders said that they definitely look Māori-like. Hereafter, the former types of cultural frames are called 'Māori cultural frames,' and the latter types of frames are called 'neutral cultural frames.' Note that both the types of cultural frames were coloured in four ways (red, black, light-brown, and dark-brown); that is, there are four Māori frames and four neutral frames that are employed in this experiment (see Hashimoto, 2019, Appendix E).

The order of the words and the frames was pseudo-randomized using R (R Core Team, 2016) in the following way. First, the loanwords were assembled into two sets, Set A and Set B. In one task, Set A loanwords appeared within Māori cultural frames and Set B loanwords appeared within neutral cultural frames. In the other task, Set A loanwords appeared within neutral cultural frames and Set B loanwords appeared within Māori cultural frames. The order was counter-balanced; that is, half the participants (Participants A) pronounced Set A loanwords within Māori cultural frames first, while the other half

Figure 2: Cultural frames: Māori cultural frame versus neutral cultural frame.

(Participants B) pronounced Set B loanwords within Māori cultural frames first. The other native words appeared within either Māori cultural frames or neutral cultural frames in a random way. The procedure is summarized in **Table 2**. It was made sure that the same cultural frames were not consecutively presented, the first cultural frame was always neutral, and the first word was always a native word.

3.4. Questionnaires

After the two experiments, the participants filled in questionnaires (see Hashimoto, 2019, Appendix C, for details). In order to test Predictions 3 and 4, the questionnaires consist of two main parts. One part is about speaker-specific properties, and the other part is about word-specific properties.

As for speaker-specific properties, the participants answered 19 questions about their relationship with Māori people, culture, and language. For example, they were asked how often they watch Māori TV programs and attend Māori cultural events. They were also asked how many Māori friends and relatives they have. They also answered eight questions about their attitudes towards Māori culture and language. For instance, they were asked whether they respect fluent speakers of te reo Māori, and whether they think that it is important to study Māori culture. Most of these questions were adapted from Te Manatū Taonga (2009) and Te Puni Kōkiri (2009). Although these national surveys use Likert scales, a linear scale was employed in this study (see Dollinger, 2015, p. 251). For example, questions about the relationship with Māori were presented as in (10). The participants were asked to mark at anywhere on a horizontal line to show their answers. The line is 100 mm long. The distance of the marked point from the left edge is regarded as a rated value, that is, the point ranges between 0–100.

(10) Questionnaire examples: Speaker-specific properties
A. How often do you do the following? Please mark anywhere along the horizontal line.
a. Greet in Māori
Very Seldom ---------- Very Often
b. Watch Māori language TV programs
Very Seldom ---------- Very Often
c. Access websites that contain Māori language resources
Very Seldom ---------- Very Often
(adapted from Te Manatū Taonga, 2009; Te Puni Kōkiri, 2009)

Principal component analyses were performed on the answers about the speaker-specific properties, with the result that the answers were reduced into three principal components, as listed in (11). The point of inflection was determined by a parallel analysis executing the *fa.parallel()* function (Revelle, 2017), and the model with the three factors can account for 50% of the total variance. Note that individual proficiency refers to the proficiency of a participant in te reo Māori, and neighbourhood proficiency refers to that of a community to

Table 2: Procedure in Experiment 2.

	Participants A (P1, P3, P5…)	**Participants B (P2, P4, P6…)**
1st Task	Loanwords A/Māori frame	Loanwords A/Neutral frame
	Loanwords B/Neutral frame	Loanwords B/Māori frame
2nd Task	Loanwords A/Neutral frame	Loanwords A/Māori frame
	Loanwords B/Māori frame	Loanwords B/Neutral frame

which a participant belongs (see Poplack et al., 1988). As stated above, all the participants are not speakers of te reo Māori, and thus individual proficiency does not contribute to PC-culture so strongly, that is, the factor loading is lower in comparison to the other questions.

(11) Three principal components representing speaker-specific properties
PC-attitude: attitude towards Māori culture and language
PC-culture: relationship with Māori culture and language, and individual proficiency
PC-people: relationship with Māori people, and neighbourhood proficiency

As for word-specific properties, the participants were explicitly required to answer how strongly a target loanword is deemed to be associated with Māori. The questions were designed to measure the words' association with Māori in general (i.e., culture, people, and language) rather than their association with the Māori language. They rated all the Māori loanwords employed in Experiments 1 and 2, by answering the question as in (12). As with the speaker-specific properties, a linear scale was employed to measure the word-specific properties, and the distance of the marked point from the left edge is regarded as a rated value.

(12) Questionnaire example: word-specific properties
How strongly do you think the following words are associated with Māori? (Some words are associated with Māori very strongly. For example, I feel that *takahe* is not strongly associated with Māori but *hāngi* is more strongly associated with Māori.) Please mark anywhere along the horizontal line.
1. Akaroa
Very Weakly ---------- Very Strongly

The raw data was standardized by *z*-scoring within each speaker, because the ranges of subjectively rated values vary in accordance with participants. A *z*-scored value tells us how a data point x_i deviates from the mean for a particular participant, and enables us to compare two data points that come from different participants. The *z*-scored values of subjectively rated loanwords' association with Māori are fitted into the following statistical models, and they are called wordMaoriness. The peanut plots in **Figure 3** represent the overall distribution of wordMaoriness in Experiments 1 and 2 respectively. Note that *z*-scoring was performed on solely a set of loanwords used in each experiment.

As another word-specific variable, we will statistically analyze word-frequency as a control variable in what follows. This is because the adaptation rate is known to be affected by word frequency (see Haugen, 1950; Poplack & Sankoff, 1984). There is not a large number of tokens of Māori loanwords in any corpora, and thus it is difficult to measure their objective word frequency. Hence, subjective word frequency is employed in this study. The participants were asked to rate how often they use each target loanword. This questionnaire also uses a linear scale as with the above questionnaires. As with words' association with Māori, the rated values were standardized by *z*-scoring within each speaker.

3.5. Classification of /r/ realizations into adapted structure and imported structure

After the experiments, the realizations of /r/ in target loanwords were analyzed. This study is mainly based on the acoustic visualization to classify the realization of /r/ into imported structure [ɾ] and adapted structure [ɹ]. As stated below, about 90% of the /r/ realizations were annotated acoustically with a use of spectrograms. The acoustic classification was performed using Praat (Boersma & Weenink, 2016).

Following previous literature (German et al., 2013), voiced sounds with clear consonantal edges in sound spectrograms were annotated as taps [ɾ]; see **Figure 4**. Their domains were usually determined on the basis of soundwaves. In particular, domains without vocalic waves (i.e., major periodic waves) were labelled.

Voiced sounds without clear consonantal edges in sound spectrograms were classified as approximants [ɹ] if their F3 is lowered. It is well-known that retroflex approximants lower F3 (Olive, Greenwood, Colemen, 1993, Ch. 7; Ladefoged, 2006, p. 196). It is not easy to exactly determine the duration of [ɹ], as the formant structure is continuant with surrounding vowels. We made an attempt to annotate the domains including consistent F2 around the F3-lowering in most cases, because F2 is known as an indicator of consonantal domains in many phonetic studies (see Lavoie, 2001, p. 69, and her citations). However,

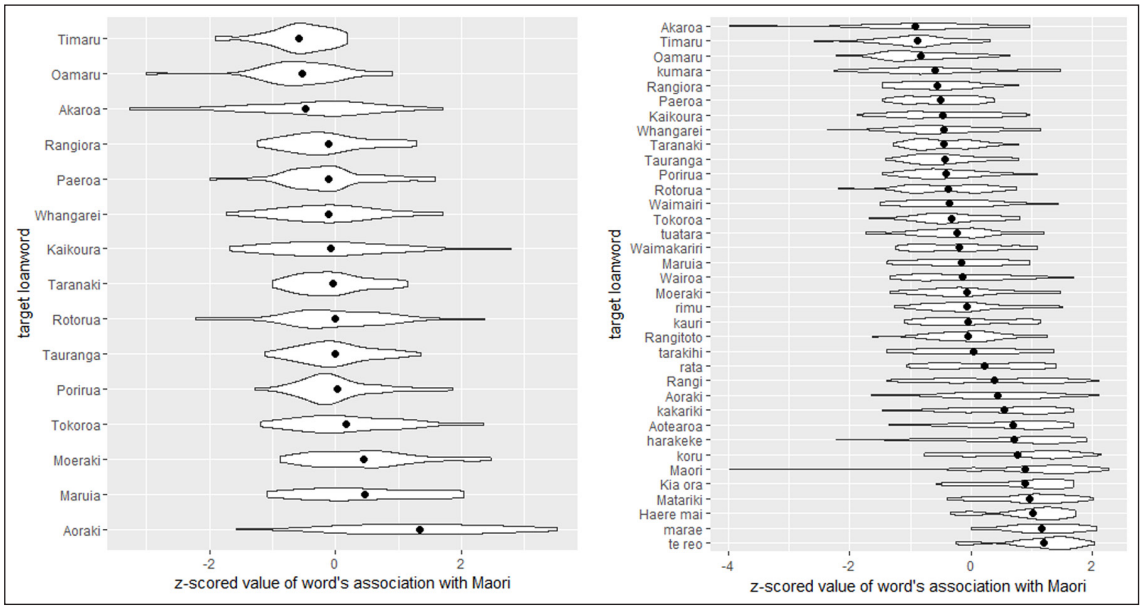


Figure 3: wordMaoriness of target loanwords in Experiments 1 (left) and 2 (right).

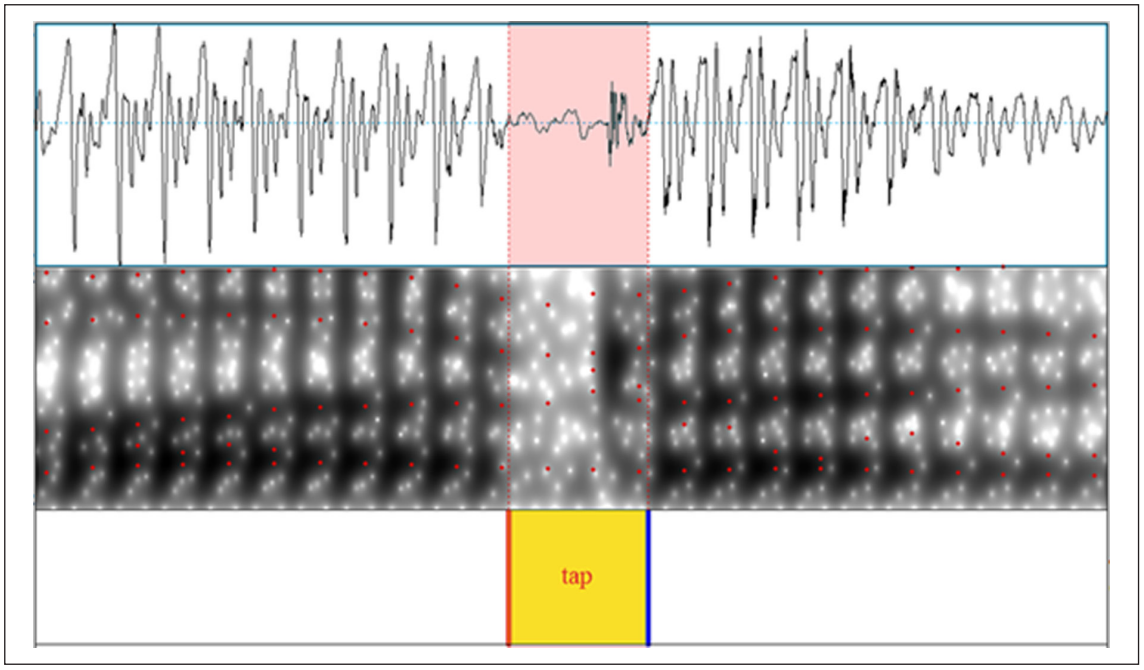


Figure 4: Sample spectrogram of imported structure (“Oamaru” by P3).

we must admit that the annotation of the boundaries is still arbitrary to some extent. In fact, Umeda (1977) also notes "Some consonants such as /h/, /r/, /w/, /y/, and word-final /1/ were totally impossible to measure." The sample annotation is shown in **Figure 5**.

The remaining productions (e.g., voiced sounds without clear consonantal edges and without lowered F3) were classified impressionistically into [ɾ], [ɹ], and others (i.e., sounds that could not be identified acoustically and impressionistically). The classification results in the two experiments are reported in Sections 4.1.1 and 4.2.1 respectively.

4. Results

The aim of this section is to illustrate the results of the two experiments, and show the statistical analyses. The results of Experiment 1 are shown in Section 4.1, and those of Experiment 2 are reported in Section 4.2.

4.1. Experiment 1: Topic effects

4.1.1. Number of observations

As was explained in Section 3.2, 2,048 tokens of /r/ were supposed to be collected. Seventeen tokens were excluded because of mispronunciation or disfluency. One hundred seven tokens were removed, because participants did not know some loanwords. Finally, 1,924 tokens were left, and they were classified as shown in **Table 3**.

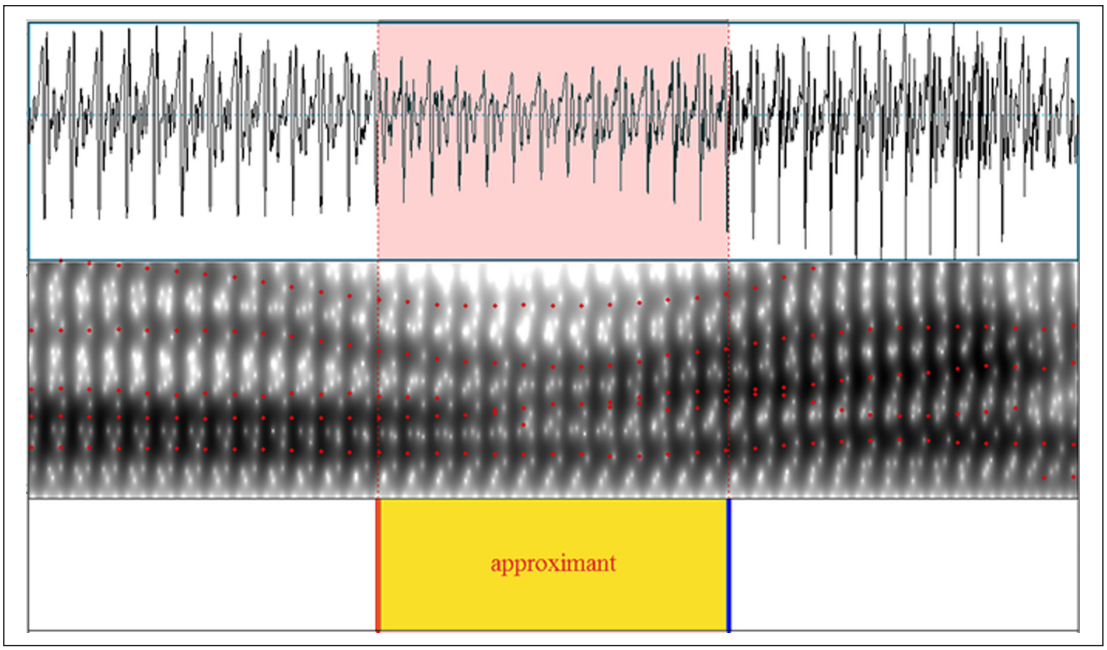


Figure 5: Sample spectrogram of adapted structure ("Moeraki" by P5).

Table 3: Total number of observations in Experiment 1.

Annotation	Number
Acoustically identified tap [ɾ]	848 (44%)
Acoustically identified approximant [ɹ]	904 (47%)
Impressionistically identified tap [ɾ]	108 (5.7%)
Impressionistically identified approximant [ɹ]	14 (0.7%)
Others	50 (2.6%)
SUM	1,924

4.1.2. Variables

4.1.2.1. Response variable: Adaptation versus importation

The response variable is a binary variable: adapted structure [ɹ] versus imported structure [ɾ]. As discussed in the preceding section, the realizations of /r/ were classified into the five classes. For the sake of this study, tokens identified as 'others' (only 2.6% of the whole dataset) were excluded from our analyses. In addition, acoustically identified tokens and impressionistically identified tokens were collapsed into a single class (either adapted structure or imported structure), because logistic regression analyses can only handle binary variables. As a result, 918 tokens with adapted structure (48.9%) and 956 tokens with imported structure (51.1%) are statistically analyzed.

4.1.2.2. Key predictors: Topics and association with Māori

The variable of most interest is a binary variable Topic (see Prediction 1 in Section 2.3.1). As stated above, the experiments were designed to make sure that participants read passages about Māori culture and those about general leisure in New Zealand. The tokens produced in Māori passages were coded as Māori Topic (937 tokens) and those produced in neutral passages were coded as neutral Topic (937 tokens). As some participants began with Māori passages and the others began with neutral Topic, another binary variable, firstTopic (Māori Topic versus neutral Topic), is also explored. The tokens produced by speakers beginning with Māori passages were coded as Māori (918 tokens), and those produced by those beginning with neutral passages were coded as neutral (956 tokens).

In addition, the potential associations of speakers with Māori are also key factors (see Predictions 3a and 3b in Section 2.3.3). As stated in the preceding section, their associations with Māori were measured through the questionnaire, and they are mostly captured by the three principal components: PC-attitude (mean: −0.27; *SD*: 1.16), PC-culture (mean: 0.11; *SD*: 1.11), and PC-people (mean: 0.103; *SD*: 1.19). These variables are numeric.

Finally, a word's association with Māori is also a variable of interest (see Prediction 4 in Section 2.3.4). As stated above, this variable is measured through the questionnaire, and each speaker was asked to rate how strongly a loanword is associated with Māori. The ratings were standardized within each speaker, and the standardized numeric variables are examined further on (see **Figure 3**). This variable is treated as wordMaoriness in our data frame. This variable is also numeric (mean: −0.001; *SD*: 0.91).

4.1.2.3. Control variables

In addition to the variables of interest, some control variables are also explored. First, word frequency is examined, because it has been pointed out by previous literature that loanwords are more likely to be adapted as they are used more frequently (Poplack & Sankoff, 1984; Friesner, 2009, 2010). As noted in 3.4, word frequency was measured in the same way as wordMaoriness, that is, it was subjectively rated by a participant and *z*-scored within the participant (mean: 0.16; *SD*: 0.88). This variable is called subjFreq.

As all the target loanwords are place names, the places which speakers come from and the places which a loanword refer to are also taken into account. These two variables are treated as speakerPlace (North Islander [643 tokens] versus South Islander [1,231 tokens]) and wordPlace (North Island [969 tokens] versus South Island [905 tokens]) respectively. As the North Island has more Māori people, speakers from the North Island may store more imported structure and produce imported structure more frequently, as with Prediction 3a. Loanwords referring to the North Island may be stored with imported structure more often, and they are more likely to be remembered with imported structure, as with Prediction 4.

Five phonological variables (folSt, precSt, folBr, precBr, and NofSeg) are also examined. folSt is a binary variable (following vowel is main-stressed [321 tokens] versus not

main-stressed [1553 tokens]); precSt is a binary variable (preceding vowel is main-stressed [706 tokens] versus not main-stressed [1,168 tokens]); folBr is a binary variable (there is a prosodic break immediately after the target loanword [282 tokens] versus no break [1,592 tokens]); precBr is a binary variable (there is a prosodic break immediately before the target loanword [164 tokens] versus no break [1,710 tokens]); NofSeg is a continuous variable (number of segments in loanwords/mean: 6.77; *SD*: 0.66). We annotated impressionistically precSt and folSt while taking intensity and pitch patterns in spectrograms into consideration.

Finally, three experimental variables (Session, Mention, and SpRate) are also examined. Session is a binary variable (produced in the first session before the short break [939 tokens] versus the second session after the short break [935 tokens]); Mention (mentioned first in a passage [949 tokens] versus second in a passage [925 tokens]); SpRate (syllables per second/mean: 4.54; *SD*: 0.53).

4.1.3. Logistic regression analyses

The 1,874 tokens of /r/-sounds were hand-fitted into a mixed-effects logistic regression model with bobyqa optimizer using the *glmer* function in the *lme4* library (Bates, Maechler, Bolker, & Walker, 2015) implemented in R (R Core Team, 2016). We started with a model with all the variables and two random intercepts for speaker and item without any interactions. Then, some variables were removed one-by-one through pairwise comparisons of models with and without each variable. As for these variables, their interactions with the other variables were not examined, because the model including their interactions did not converge well and their *p*-values were not significant at all. Then, backward elimination was run manually through pairwise model comparisons using ANOVA tests by taking into consideration all the two-way interactions of the remaining variables. The elimination was based on *p*-value; that is, either a single effect or an interaction with the highest *p*-value was eliminated one-by-one. If a model comparison showed no significance ($p > .05$), then the smaller model was adopted; otherwise, the larger model was implemented. After the elimination of the non-significant variables, by-speaker random slopes for wordMaoriness and Session and by-item random slopes for PC-attitude were added to the model, as they improve the model. Finally, the model in **Table 4** was selected as the best-fitted model. A Variance Inflation Factor (VIF) test was performed on the model, and all VIF scores were below 4, which suggests that there is no multicollinearity in the model. The marginal R squared value is 0.16, and the conditional R squared value is 0.88, according to *r.squaredGLMM* function in the *MuMIn* package (Barton, 2018). Note that the reference level is set as Topic Neutral, Session First, and firstTopic Neutral.

Table 4: Best-fitted model to predict the likelihood of choosing adapted structure [ɹ] versus imported structure [ɾ] in Experiment 1.

	Estimate	***SE***	***z* value**	**Pr(>|z|)**	
(Intercept)	−2.0172	0.8502	−2.373	0.017660	*
PC-attitude	1.7165	0.4956	3.464	0.000533	***
Topic Māori	2.5085	0.3218	7.794	6.48e-15	***
Session Second	1.4084	0.2909	4.841	1.29e-06	***
firstTopic Māori	0.1478	1.0805	0.137	0.891177	
Topic Māori:Session Second	−0.9698	0.3554	−2.729	0.006357	**
Topic Māori:firstTopic Māori	−1.7942	0.3410	−5.262	1.42e-07	***

The response variable (adapted structure [ɹ] versus imported structure [ɾ]) is converted to a so-called dummy variable (i.e., 0 is given to the adapted structure [ɹ] and 1 is given to the imported structure [ɾ]) in the above model. Hence, positive slopes indicate higher likelihood of choosing imported structure, and negative slopes indicate higher likelihood of choosing adapted structure. According to the model, the fitted logit value for the intercept is −2.017. This corresponds to a fitted proportion of choosing imported structure of 0.117. That is, this model predicts that 11.7% of /r/ realizations are imported tap sounds when PC-attitude value is 0, Topic is Neutral, Session is First, and firstTopic is Neutral. The fitted logit value for the effect of Topic is 2.508. This suggests that the fitted logit value becomes 0.491 (i.e., −2.017 + 2.508), when Topic shifts from Neutral to Māori as long as PC-attitude is 0, Session is First, and firstTopic is Neutral. The fitted logit value is equal to a fitted proportion of importation of 0.62. That is, the importation rate increases by 50.3%, when topic shifts from Neutral to Māori and the two variables Session and firstTopic are First and Neutral respectively.

As two significant interactions of Topic with other variables are observed, let us consider the interactions. The interaction between Topic and Session indicates that the magnitude of the topic effect is significantly smaller in the second session than in the first session ($\beta = -0.96$, $z = -2.72$, $p < 0.01$). This interaction is illustrated in **Figure 6**. The left-hand figure illustrates the raw probability, and the right-hand figure illustrates the probability predicted by the best-fitted model. This is why the subsets of data including tokens produced in the first session and those produced in the second session were also explored. Then, the effect of Topic was still found to be significant in both the first session ($\beta = 2.75$, $z = 7.1$, $p < 0.001$) and the second session ($\beta = 1.08$, $z = 3.11$, $p < 0.01$).

The other interaction between Topic and firstTopic suggests that the effect of Topic is stronger when participants begin with neutral passages than when participants begin with Māori passages. Once again, this interaction is illustrated by **Figure 7**. The subset analysis was performed, and it was found that Topic is significant when speakers begin

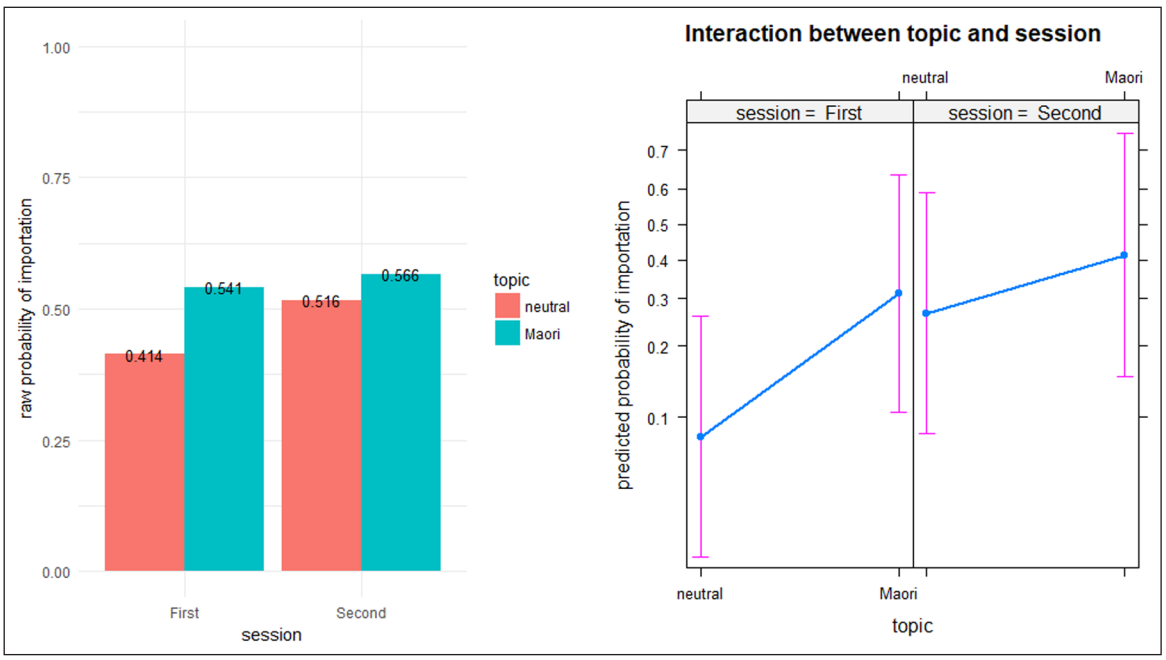


Figure 6: Interaction between Topic and Session: Raw probability (left) and model prediction (right).

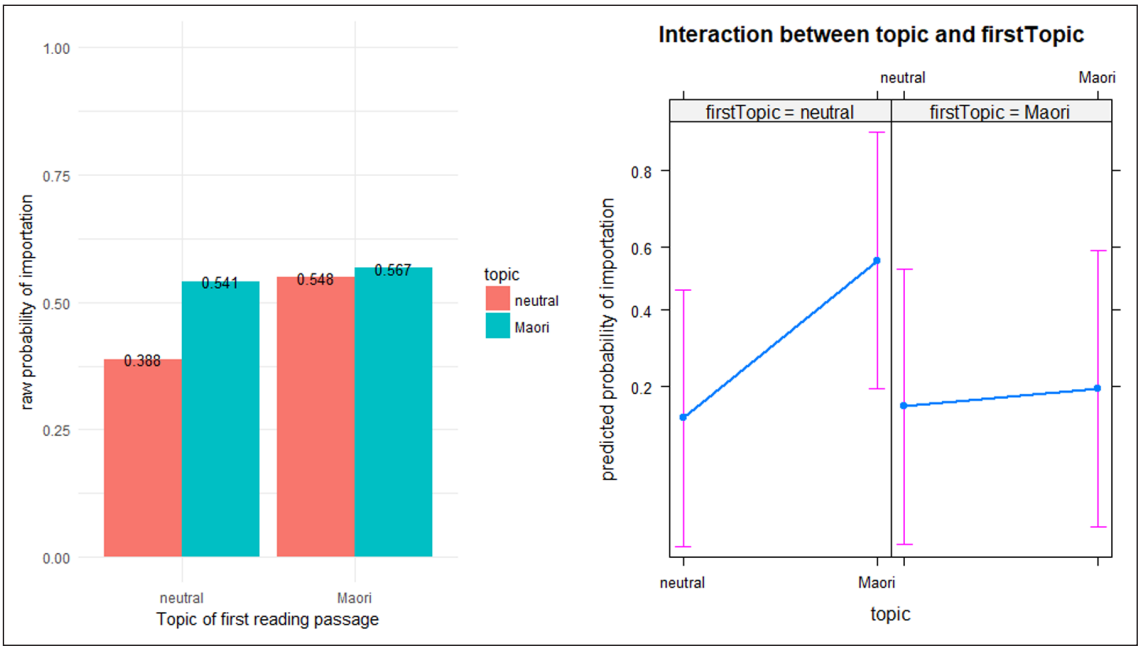


Figure 7: Interaction between Topic and firstTopic: Raw probability (left) and model prediction (right).

with neutral passages ($\beta = 2.92$, $z = 7.5$, $p < 0.001$) while Topic is non-significant when speakers begin with Māori passages ($\beta = 0.27$, $z = 0.9$, $p = 0.36$).

In addition, the speakers' potential association with Māori is also found to affect the likelihood of importation to some extent. The PC-attitude coefficient is positive and highly significant ($\beta = 1.71$, $z = 3.46$, $p < 0.001$). As PC-attitude means "positive attitudes towards Māori culture and language," this coefficient indicates that imported structure is more likely to be produced by speakers with more positive attitudes towards Māori culture and language. The PC-culture was removed from the best-fitted model, as its p-value is 0.08. Note that PC-culture was significant ($p < 0.05$) unless by-item random slopes for PC-attitude were added to the model. The PC-culture did not achieve sufficiently significant effects, but the slope is positive and it might imply that speakers strongly related with Māori culture and language tend to use imported structure more often. On the other hand, PC-people was not significant at all ($p = 0.31$), and thus it was removed from the model. The variable speakerPlace was non-significant but does trend ($p = 0.07$). The direction indicates that North Islanders are more likely to use imported structure than South Islanders.

Next, words' association with Māori is not found to be significant ($p = 0.11$), although the direction was as predicted, i.e., words strongly associated with Māori are more likely to be produced with imported structure. The variable wordPlace was non-significant but shows a trend ($p = 0.07$). The direction suggests that place names in the North Island are pronounced with imported structure more often. As these two variables do not reach significant levels, they were removed from the best-fitted model as with other non-significant variables.

As for other control variables, only Session shows a significant effect ($p < 0.001$). As the reference level is the first session and the slope is positive, this effect suggests that speakers are more likely to produce imported structure after a short break, that is, as the experiment progresses.

As a whole, the variables showing significant effects or showing a trend are as follows. Variables showing trends are shaded in **Table 5**.

Table 5: Summary of finding in Experiment 1.

Topic	When a passage is about Māori, speakers are more likely to produce imported structure ($p < 0.001$). However, speakers beginning with neutral passages do not show this topic effect ($p = 0.36$).
PC-attitude	Speakers with more positive attitudes towards Māori are more likely to produce imported structure ($p < 0.05$).
PC-culture	Speakers strongly related with Māori culture and language are more likely to produce imported structure ($p = 0.08$).
speakerPlace	North Islanders are more likely to produce imported structure ($p = 0.07$).
wordPlace	Loanwords referring to places in the North Island are more likely to be produced with imported structure ($p = 0.07$).
Session	Speakers are more likely to produce imported structure in the second half of the experiment than in the first half of the experiment ($p < 0.001$).

Table 6: Total number of observation in Experiment 2.

Annotation	Number
Acoustically identified tap [ɾ]	1,372 (57.9%)
Acoustically identified approximant [ɹ]	774 (32.7%)
Impressionistically identified tap [ɾ]	116 (4.9%)
Impressionistically identified approximant [ɹ]	50 (2.2%)
Others	55 (2.3%)
SUM	2,367

4.2. Experiment 2: Cultural image effects

As stated in Section 3.3, 2,560 tokens of /r/ were supposed to be collected in Experiment 2. Fifty-nine tokens were excluded because of mispronunciation or disfluency. One hundred thirty-four tokens were removed, because participants did not know some loanwords. **Table 6** shows the total set of the remaining tokens.

4.2.1. Variables

4.2.1.1. Response variable

As with Experiment 1, the response variable is a binary variable: adapted structure [ɹ] versus imported structure [ɾ]. Tokens identified as 'others' are excluded from our statistical analysis, and acoustically identified tokens and impressionistically identified tokens were collapsed into a single class, because logistic regression analyses can only handle a binary variable. Consequently, 1,488 tokens with imported structure (64.3%) and 824 tokens with adapted structure (35.7%) are statistically analyzed.

4.2.1.2. Key variables

The variable of most interest is Frame (see Prediction 2 in Section 2.3.2). As stated above, the experiments were designed to make sure that participants read aloud loanwords while seeing either a Māori cultural frame or a neutral cultural frame. The tokens produced while seeing a Māori frame were coded as Māori (1,163 tokens) and those produced while seeing a neutral frame were coded as neutral (1,149 tokens). This variable is a binary variable.

As with the preceding section, the speakers' association with Māori is also examined (see Predictions 3a and 3b in Section 2.3.3). As was explained above, their association can be

captured by three principal components: PC-attitude (mean: −0.25; *SD*: 1.14), PC-culture (mean: 0.11; *SD*: 1.107), and PC-people (mean: 0.12; *SD*: 1.202). These variables are numeric.

Finally, words' association with Māori is also an important predictor (see Prediction 4 in Section 2.3.4). As was explained in Section 3.4, participants were asked to answer how strongly each target loanword is associated with Māori, and the rated values were *z*-scored within each speaker (mean: −0.003; *SD*: 0.94). This variable is treated as wordMaoriness in our data frame.

4.2.1.3. Control variables

As with Experiment 1, we examine subjectively rated word frequency called subjFreq (mean: 0.15; *SD*: 0.96), and speakerPlace (a participant comes from North Island [803 tokens] versus South Island [1,509 tokens]). In Experiment 2, some target loanwords are not place names, and therefore we cannot fit wordPlace. Instead, wordType (common noun [736 tokens] versus proper noun [1,576 tokens]) is examined as a word-specific control variable.

As participants completed this word-list reading task twice, we explore Session (first session [1,163 tokens] versus second session [1,149 tokens]) as in the previous section. The preceding section demonstrates that speakers become more likely to produce imported structure later in the experiment. Hence, it can be expected that participants may produce more imported structure later in the experiment.

We also examine some variables that may affect the phonetic properties of /r/ realizations: position (word-initial [357 tokens] versus word-medial [1,955 tokens]), speechRate (vocalic elements per second within a word/mean: 7.308; *SD*: 1.45), NofSeg (number of vocalic elements in loanwords/mean: 6.682; *SD*: 1.54), precSt (preceding vowel is main-stressed [808 tokens] versus not main-stressed [1,504 tokens]), and folSt (following vowel is main-stressed [1,503 tokens] versus not main-stressed [809 tokens]).

4.2.2. Logistic regression analyses

The 2,312 tokens of /r/-sounds were hand-fitted into a mixed-effects logistic regression model with bobyqa optimizer using the *glmer* function in the *lme4* library (Bates et al., 2015) implemented in R (R Core Team, 2016). The model selection was performed through pairwise model comparisons using ANOVA tests in the same way as the statistical analyses performed on the results of Experiment 1. As for random slopes, by-item slopes for PC-attitude, speakerPlace, and Session, and by-speaker slopes for Position and wordMaoriness were added to the model. The best-fitted model is shown in **Table 7**. A Variance Inflation Factor (VIF) test was performed on the model, and all VIF scores were below 4, suggesting that the model has no multicollinearity problem. The marginal R squared value is 0.35, and the

Table 7: Best-fitted model to predict the likelihood of choosing adapted structure [ɹ] versus imported structure [r] in Experiment 2.

	Estimate	*SE*	*z* Value	Pr(>|z|)	
(Intercept)	3.7243	0.9606	3.877	0.000106	***
PC-attitude	1.6865	0.4535	3.719	0.000200	***
wordMaoriness	0.2568	0.1281	2.004	0.045024	*
speakerPlace South	−3.4659	1.1668	−2.970	0.002974	**
Session Second	0.2939	0.1715	1.714	0.086542	.
Session Second:PC-attitude	−0.2570	0.1265	−2.031	0.042236	*

conditional R squared value is 0.84, according to *r.squaredGLMM* function in the *MuMIn* package (Barton, 2018). Note that the reference levels for the following summary are speakerPlace North and Session First.

As in Section 4.1.3, the response variable (adapted structure [ɹ] versus imported structure [ɾ]) is converted to a so-called dummy variable (i.e., 0 is given to the adapted structure [ɹ] and 1 is given to the imported structure [ɾ]) in the above model. That is, positive slopes indicate higher likelihood of selecting imported structure, whereas negative slopes indicate higher likelihood of selecting adapted structure. Let us discuss key variables first. PC-attitude and wordMaoriness show significant effects in the predicted direction. The coefficient of PC-attitude is positive ($\beta = 1.68, z = 3.71, p < 0.001$), and it suggests that NZE speakers with positive attitudes towards Māori culture and language are more likely to import non-native structure. The coefficient of wordMaoriness is also positive ($\beta = 0.25, z = 0.12, p < 0.05$). This suggests that loanwords strongly associated with Māori are more likely to be produced with imported structure. The interaction between PC-attitude and Session is significant, and it was found that the effect of PC-attitude is slightly weaker in the second session, as shown in **Figure 8**. The subsets of data including tokens produced in the first session and in the second session were explored. It was found that the effect of PC-attitude is significant in both the first session ($\beta = 1.55, z = 3.23, p < 0.01$) and the second session ($\beta = 1.34, z = 2.85, p < 0.01$).

As for the other three key variables, they do not show significant effects in our data set: Frame ($p = 0.09$), PC-culture ($p = 0.52$), and PC-people ($p = 0.81$). Note that Frame does trend in the predicted direction, that is, imported structure is slightly more likely to

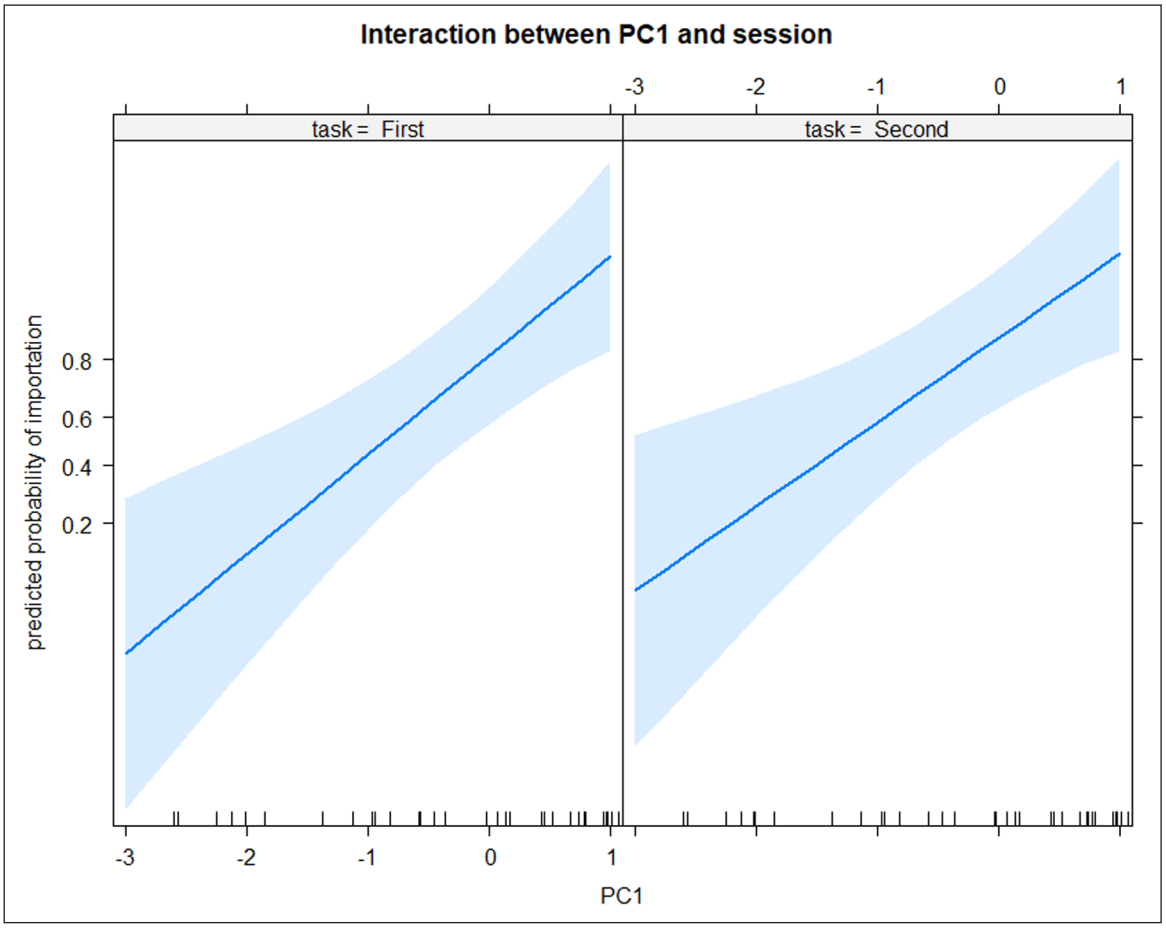


Figure 8: Interaction between PC-attitude and Session.

be produced when Māori cultural images are presented on screen. This is illustrated in **Figure 9**. The importation probability is 2.2% higher given a Māori frame (65.4%) than given a neutral frame (63.2%).

As for control variables, most variables are not significant, and they were removed through pair-wise comparisons. Only speakerPlace shows a significant effect ($\beta = -3.46$, $z = -2.97, p < 0.01$), and it was found that South Islanders are more likely to use adapted structure than North Islanders. Note that Session shows a trend, and it was found that imported structure is more likely to be produced at the second session ($\beta = 0.29, z = 1.71$, $p = 0.08$).

As a whole, the variables showing significant effects and a definable trend can be summarized in the following way. Variables doing trend are shadowed in **Table 8**.

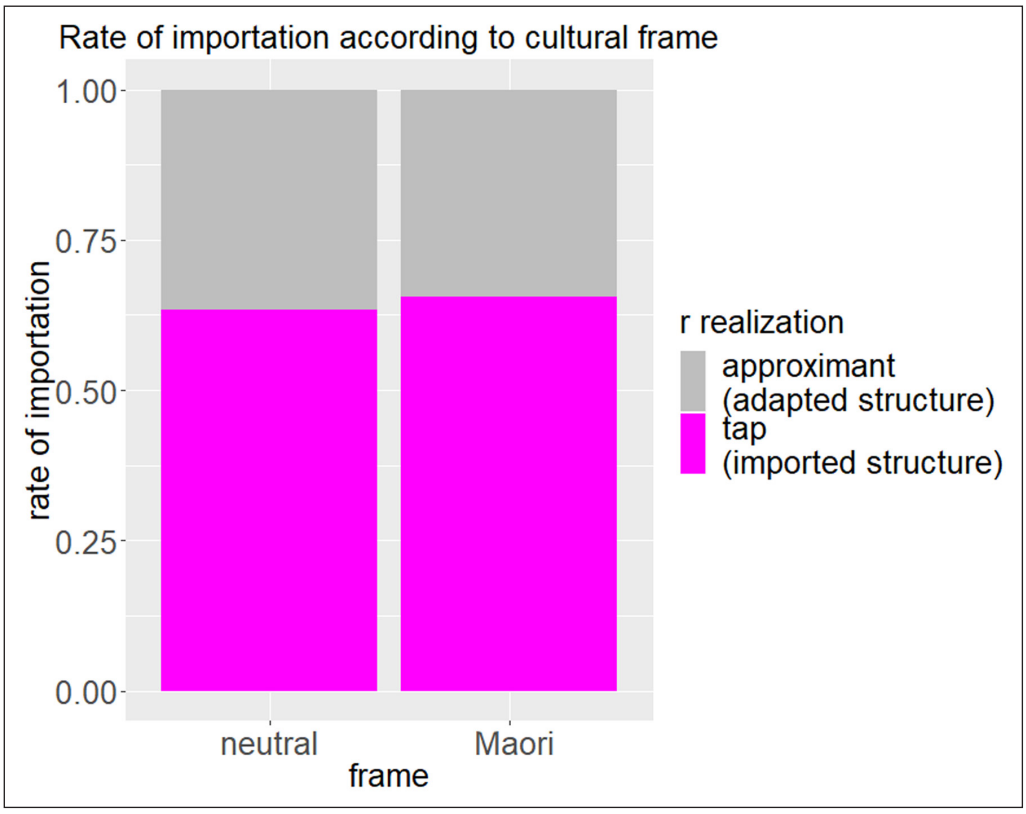


Figure 9: Rate of importation according to presented cultural frame.

Table 8: Summary of finding in Experiment 2.

Frame	Speakers are more likely to produce imported structure while seeing Māori cultural images (p = 0.09).
PC-attitude	Speakers with positive attitudes towards Māori are more likely to produce imported structure (p < 0.001). This effect is more robust at the first session than at the second session (p < 0.05).
wordMaoriness	Loanwords strongly associated with Māori are more likely to be produced with imported structure (p < 0.05).
speakerPlace	North Islanders are more likely to produce imported structure (p < 0.01).
Session	Imported structure is more likely to be produced at the second session than at the first session (p = 0.08).

5. Results

Now, let us discuss the statistical results of Experiments 1 and 2. In general, it was found that young NZE speakers produce imported structure at a very high rate. The importation rate is 51.1% in the passage-reading task (Experiment 1) and 64.3% in the word-list reading task (Experiment 2). **Figure 10** illustrates the importation rate per speaker. The bars indicate the rate of imported structure in the word-list reading task (Experiment 2), while the dots represent the rate of imported structure in the passage-reading task (Experiment 1). For most of the participants in this study, the importation rate is higher in the word-list reading task than in the passage-reading task, as the edges of most of the bars are further to the right than the dots in **Figure 10**. The reason may be three-fold. First, it is known that a word is pronounced more carefully in a word-list reading task than in a passage-reading task (Labov, 1972). As young NZE speakers tend to try to conform to the original Māori pronunciation (Hay, Maclagan, & Gordon, 2008), the participants might employ more imported structure in the careful manner of speech. Aktürk-Drake (2015, p. 83) also notes that the formality of the context may affect the likelihood of adaptation versus importation. Second, it might be because the word-list reading task was completed after the passage-reading task. As discussed in Section 5.1, the representations of a social category 'Māori' and imported structure are activated by a Māori topic, and the activation seems to continue to some extent throughout the task. It is unsurprising that this activation still lasts even after the passage-reading task, and imported structure is more likely to be produced in the word-list reading task. Finally, it may be because the word set is larger in this task than in the preceding task. As was seen in the peanut plot (**Figure 3**) in Section 3.4, many words strongly associated with Māori (e.g., *te reo*, *marae*, *Haere mai*, and *Matariki*) are those employed only in this word-list reading task. Due to their strong word association with Māori, the importation rate might be inflated in this task.

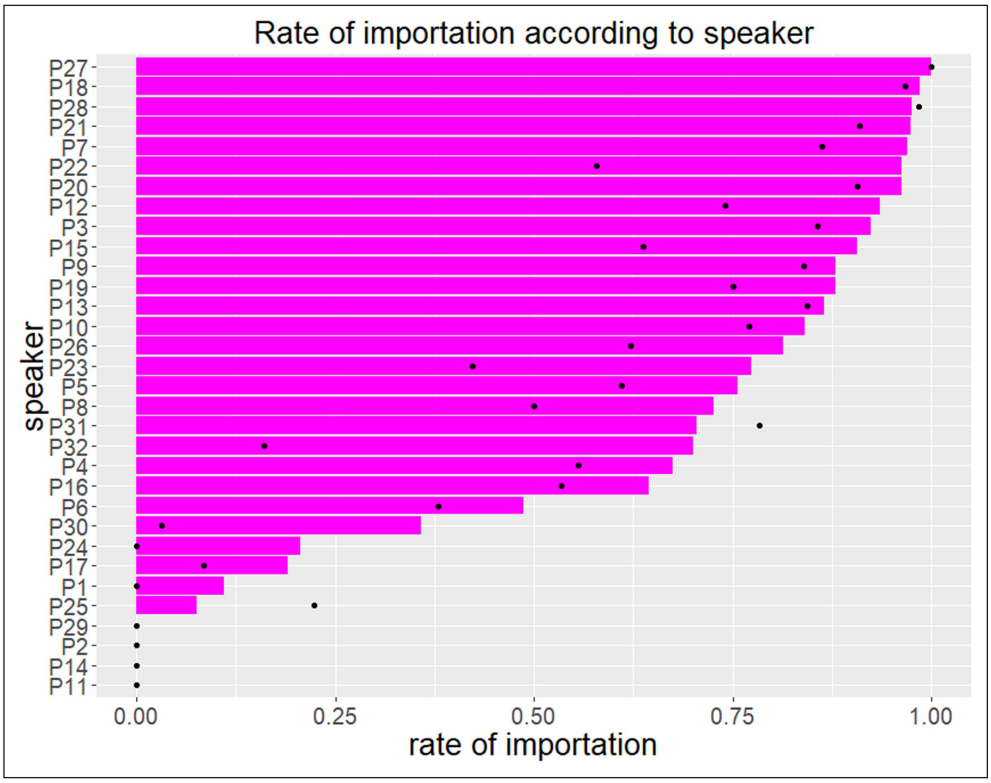


Figure 10: Importation rate according to a speaker (bar indicates the rate in word-list reading task and point indicates the rate in passage-reading task).

It is worth commenting on the four speakers (P2, P11, P14, and P29), who did not produce imported structure at all in the experiments reported in this paper. It is not clear whether they did not have the ability to produce imported structure or they did not produce imported structure on purpose. The subset of the data excluding these four speakers was explored, which allows us to explore the sociolinguistic effects among speakers who are certainly able to produce imported structure. We ran the best-fitted models in the two experiments for the subset data, and it was found that the significant values of the variables are basically the same as reported in the preceding sections. This demonstrates that the significant predictors are not artefacts of some participants' lacking the ability to produce the sound.

As for control variables, all the phonological variables such as prosodic positions were not significant, and thus they were removed from the best-fitted models. A reviewer questioned whether a tap sound [ɾ] in Māori loanwords phonologically behaves in the similar way to a flapped variant [D] of a coronal plosive phoneme. As reviewed in Section 2.1.1, flapped variants of /t/ are unlikely to occur in word-initial position and in main-stressed syllables. According to the logistic regression analyses, we did not observe these environmental effects in relation to tap sounds in Māori loanwords, i.e., the difference between main-stressed syllables versus non-main-stressed syllables is not significant ($p = 0.99$ in Experiment 1, $p = 0.96$ in Experiment 2); that between word-initial and word-medial positions is also not significant ($p = 0.56$ in Experiment 2). Recall that only word-medial /r/ was explored in Experiment 1. The number and proportion are shown in **Table 9**.

Note that the current study is not well-designed to explore these phonological variables, because the number of phonological variables is not well-balanced. For example, there are only 357 tokens of tokens produced in word-initial position, while there are 1,955 tokens in word-medial position in our dataset. The non-significance of these variables may be due to this data structure rather than their irrelevance for the likelihood of importation.

The reviewer also questioned whether there are speakers who are not able to produce tap sounds [ɾ] in phonological environments where flapped variants [D] are hardly produced, that is, main-stressed syllables and word-initial position. In order to address this question, we first excluded the four speakers (P2, P11, P14, and P29), who did not produce imported structure at all in the experiments. It was found that the rest of the speakers are all able to produce tap sounds in main-stressed syllables. On the other hand, it was found that four of the speakers (P1, P4, P6, and P32) did not produce imported structure in word-initial position. Once again, our data may not be sufficient to conclude that these speakers have difficulty in producing tap sounds in word-initial position, because the number of tokens produced in word-initial position is very small. For example, only 12 tokens produced in word-initial position were collected from P4, whereas 65 tokens produced in word-medial position were collected. Further exploration of environmental effects on importation of tap sounds in Māori loanwords is left for future study.

Table 9: Environmental effects on the selection of imported structure.

		adapted [ɹ]	imported [ɾ]	*p*-value
Exp.1	Main-stressed	151 (47.1%)	170 (52.9%)	$p = 0.99$
	Non-main-stressed	767 (49.4%)	786 (50.6%)	
Exp.2	Main-stressed	310 (38.8%)	499 (61.7%)	$p = 0.96$
	Non-main-stressed	514 (34.2%)	989 (65.6%)	
	Word-initial	173 (48.4%)	184 (51.6%)	$p = 0.56$
	Word-medial	651 (33.2%)	1,304 (66.8%)	

Although previous literature demonstrates that higher frequency words are likely to be adapted (Haugen, 1950), our result did not show this effect. The reason might be that many of the words examined in this experiment are place names and they all have a low frequency in daily usage. For another reason, we employed subjectively rated word frequency as a predictor. Lev-Ari et al. (2014) also report that subjective word frequency is not a significant predictor.

In what follows, we will discuss the results relevant to the five predictions in Section 2.3. Then, we will also discuss two control variables speakerPlace and wordPlace. The discussions develop the understanding of how adapted structure and imported structure are represented in the mind of a borrower. By discussing the results reported above, we could assess the hypotheses about mental representations of adapted structure and imported structure and category activation, which were posited on the basis of Exemplar Theory in Section 2.2. At the end of the theoretical discussion, we also consider the social meanings expressed by choosing adapted structure versus imported structure.

5.1. Topic in speech

It was predicted that, speaking about Māori activates the social concept 'Māori' and a representation of imported structure, the result of which is that imported structure is more likely to be produced (see Prediction 1 in Section 2.3.1). Our result reported in Section 4.1 shows a robust topic effect on the likelihood of adaptation versus importation, and the direction is as predicted. Although topic effects have been reported in literature on sociolinguistic variation, such as style shifts and dialect shifts, they were yet to be explored with regards to loanword phonology. This study has extended the effects to the domain of loanword phonology, which has rarely been discussed in relation to sociolinguistic factors.

As for topic effects, there are two significant interaction effects. One interaction is with Session. This interaction indicates that topic effects are more robust earlier in the experiment in comparison to later in the experiment. This finding seems to be in line with Exemplar Theory. The exemplar-based account is as follows. The representations of the social concept 'Māori' and imported structure are not especially activated at the beginning of the experiment, that is, the likelihood of activating adapted structure and imported structure depends on the potential strength of each structure at this stage. As is assumed in Exemplar Theory, the potential strength is a function of the frequency of each structure, and the strength of each structure may differ in accordance with speakers and loanwords. As the experiment proceeds, participants have opportunities to read Māori passages, which further raise the activation of the social concept 'Māori.' Once the social concept is activated further, the extra-activation continues to some extent, and imported structure is more likely to be activated in general via the socio-indexical link between imported structure and the social concept 'Māori.' Consequently, topic effects become less robust in the second half, as the social concept is already activated to large extent and less likely to be activated further by a Māori topic in speech. This exemplar-based account may also be supported by the observation that the importation rate is in general higher in the second half of the experiment in comparison with in the first half (see **Figure 6**). It could be speculated that the extra-activation of the social concept 'Māori' in the first half of the experiment continues, and thus imported structure is more likely to be produced during the second half of the experiment.

The other significant interaction is that with firstTopic. Recall that some participants began with Māori passages whereas the other participants began with neutral passages. This interaction suggests that only speakers beginning with neutral passages changed their importation rates in accordance with topics of reading passages. This finding can also be captured as with the interaction of Topic and Session. When speakers begin with Māori

passages, the social concept 'Māori' receives further activation at the very beginning of the experiment. The extra-activation may continue throughout the rest of the experiment, and the topic alternation does not affect the activation of the social category and imported structure anymore. On the other hand, when speakers begin with neutral passages, the representation of the social category 'Māori' is not especially activated at the beginning of the experiment. That is, the likelihood of adaptation versus importation purely depends on the potential strength of adapted structure and imported structure at the initial stage of the experiment. Once passages shift to those about Māori, the representation of the social concept 'Māori' starts to be further activated, and imported structure becomes more likely to be initiated via the socio-indexical link, that is, imported structure becomes more likely to be chosen in production. This is why topic effects are robust for speakers beginning with neutral passages. This exemplar-based account may be supported by the observation that participants beginning with Māori passages are more likely to produce imported structure in general (see **Figure 7**).

5.2. Cultural image

On the basis of previous literature, it was predicted in Section 2.3.2 that, when a cultural image associated with Māori is presented in speech, NZE speakers may be more likely to produce imported structure in speech (see Prediction 2). Our result reported in Section 4.2 indicates that this effect is tentative. As predicted, the rate of importation is slightly higher when a Māori cultural frame is presented in comparison with when a neutral cultural frame is presented (see **Figure 9**). However, this difference is statistically non-significant ($p = 0.09$). Although it was demonstrated by Hay and Drager (2010) that speech perception is influenced by cultural images as reviewed in Section 2.3.2, our result might indicate that speech production is less likely to be affected by cultural images.

Before concluding this section, we would like to point out four possible reasons which may account for the non-significant effect of cultural images on production of a linguistic variant. One reason is that participants took part in this experiment after the passage-reading task (Experiment 1). As was discussed above, the representation of a social category 'Māori' may be already activated to the point of saturation during Experiment 1, and this category activation may have resided until after the experiment. This is why cultural images could not further activate the representations of a social concept 'Māori' and imported structure, and they do not change the likelihood of adaptation versus importation significantly.

Another possibility is that participants could not pay enough attention to cultural images due to the experimental design. In this experiment, a cultural frame and a word both shifted together, when a participant read aloud a word and pressed a space bar (see Section 3.3). Although the time was not formally measured, a cultural frame may have shifted every few seconds. As a frame shifts very quickly, speakers may not have looked at frames. Besides, participants focused on a word shown at the centre of a screen, so they may not have looked at a frame shown at the edge of a screen. As a result, their speech production may not be significantly affected by a cultural frame significantly.

The null result might also be due to the nature of a word-list reading task. In Experiment 2, the effects of cultural images were explored using a word-list reading task, which may cause speech to be more careful (Labov, 1972). Due to the careful manner, the pronunciation of Māori loanwords becomes less natural and the likelihood of producing imported structure becomes higher in general, as noted above, the result of which is that the effects of cultural images may be concealed.

The other possibility is due to the degree of consciousness. Alternating images may be less explicit in comparison to alternating topics in speech, because the exposure to a cultural image is subtle and it is not exactly a part of a speech act. Our speculation is as follows:

Because of the different degrees of consciousness, Māori topics may strongly raise the activation of the social category 'Māori,' the result of which is that the linguistic category called 'imported structure' is activated sequentially; Māori images may raise the activation of the social category weakly, and the activation is not strong enough to activate imported structure. Hence, topics could change the importation rate significantly, but images could not, as illustrated in **Figure 11**.

If this speculation is true, then one might wonder why Hay and Drager (2010) observed the image effects on dialect perception (see Section 2.3.2). The reason might be that they explored gradient difference between vocalic variants (e.g., higher [ɪ] ⇔ lower [ɪ]), while the categories discussed in the current study have a discrete nature (i.e., tap [ɾ] versus approximant [ɹ]). It could be speculated that shifts between discrete categories require stronger activation of categories in comparison to gradient shifts, because exemplars belonging to different discrete categories may not be stored so closely as those belonging to a gradient continuum. This may be why alternating images could not significantly influence the likelihood of choosing a variant in the current study. Since the current study could not replicate cultural image effects in relation to speech production of categorical variants, it will be worth exploring the image effects by studying variants with gradient nature in future study.

5.3. Speakers' association with the source language and its culture

As for speakers' association with the source language and its culture, we deduced two types of predictions: the effects of relationship (Prediction 3a) and the effects of attitudes (Prediction 3b). First, the effects of relationship are not statistically supported in the current study. PC-people (i.e., relationship with Māori people) is not significant at all in the two experiments, despite the fact that some previous literature shows that the importation rates are affected by the relationship with the source language speakers (Poplack et al., 1988; Lev-Ari et al., 2014). The reason why the current study does not find this significant effect may be because most participants in the current study have a very weak relationship with Māori people and speakers. The answers to the questions about Māori people and speakers show that the participants have almost no Māori friends and

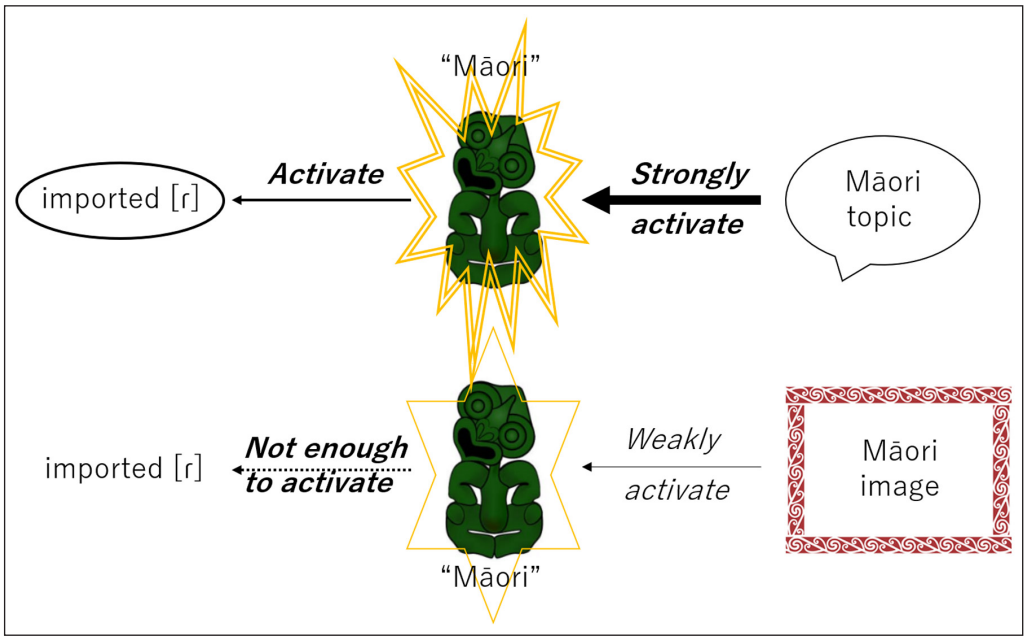


Figure 11: Difference in social category activation between topic and image.

are familiar with almost no Māori speakers. The participants in the current study might not be suitable to test this variable.

Although PC-culture (i.e., relationship with Māori culture and language) does not achieve a significant level, it does trend in the predicted direction ($p = 0.08$) in Experiment 1. This suggests that there is a slight tendency that speakers strongly related with Māori culture and language are more likely to produce imported structure. This finding is in line with Prediction 3a (see Section 2.3.3). The effect of relationship with the source language and its culture may also be supported by the significance of speakerPlace ($p < 0.01$) in Experiment 2, which suggests that North Islanders are more likely to produce imported structure in comparison with South Islanders. As expected in Section 4.1.2.3, this is unsurprising from the point of exemplar view. There are more Māori people living in the North Island, so North Islanders may have more opportunities to hear and store imported structure. As a result, they are more likely to produce imported structure because of its potential strength in exemplar space. This may be in line with Prediction 3a.

Prediction 3b (attitudes towards Māori) is statistically well-supported. It was found that the effect of PC-attitude is highly significant in the two experiments. As PC-attitude means "attitude towards Māori culture and language," this finding suggests that speakers with more positive attitudes towards Māori culture and language are more likely to produce imported structure. To the best of our knowledge, this study is the first to show that importation rates are affected by attitudes towards the source language and its culture. The effect of this attitude can be captured by exemplar-based approaches as explained in Section 2.3.3; that is, speakers with more positive attitudes towards Māori may potentially activate a social concept 'Māori.' As a result, imported structure is also activated because it is cognitively linked with the social concept, and it is more likely to be produced. One of the anonymous reviewers pointed out another exemplar-based account for these attitude effects. The reviewer suggested that exemplars may be weighted in accordance with speakers' attitudes towards social groups. In the case of the NZE loanword phonology, speakers with positive attitudes towards Māori may favorably weight exemplars encoding imported structure, and the exemplars are more likely to be selected in speech because of the potential prominence. The current study cannot tease apart the two theoretical interpretations, and it will be worth testing which theoretical interpretation corresponds to reality in future study.

5.4. Words' association with the source language and its culture

We predicted that a loanword strongly associated with Māori is more likely to be produced with imported structure rather than adapted structure (see Prediction 4 in Section 2.3.4). This prediction is supported by the result of Experiment 2; that is, the effect of wordMaoriness is significant in the predicted direction ($p < 0.05$). Recall that this variable did not achieve significant levels in Experiment 1 ($p = 0.11$), although the direction was as predicted. The reason why this effect becomes statistically significant in Experiment 2 might be the number and type of loanwords employed in this experiment. The set of target loanwords in Experiment 2 is larger than that in Experiment 1, and it includes common nouns as well as place names whereas the set in Experiment 1 includes only place names. Consequently, Experiment 2 may allow us to explore a wider range of words' association with Māori, and this factor achieves a significant level.

This effect can be captured in the following way using exemplar-based approaches: A loanword strongly associated with Māori is more likely to be heard with imported structure, and consequently exemplars with imported structure have higher strength amongst exemplars belonging to the lexical category. As exemplars with higher strength are more likely to be chosen in production, imported structure is more likely to be produced for loanwords strongly associated with Māori.

It is worth commenting on the effect of wordPlace. This variable shows a trend ($p = 0.07$) in Experiment 1. This variable suggests that there is a tendency that place names referring to places in the North Island are more likely to be produced with imported structure. Although this effect is tentative, it could be given the same account as Prediction 4. That is, place names in the North Island are more likely to be produced in Māori community, because there are more Māori people living in the North Island, and consequently North Island place names are more likely to be stored with imported structure.

5.5. Social meanings carried by adapted structure and imported structure in Māori loanwords

Before concluding this paper, we would like to mention social meanings carried by adapted structure [ɹ] and imported structure [ɾ] in Māori loanwords. Our results indicate that the variation in the NZE loanword phonology is a type of inter-speaker variation, because the selection of a variant depends on speakers' attitudes towards Māori and may also depend on speakers' relationship with Māori. The results also suggest that the variation in the NZE loanword phonology is a type of intra-speaker variation, because speakers choose the variants (i.e., imported structure or adapted structure) in accordance with topics in speech. That is, this variation is used to style speech in accordance with speech situations. Previous literature also demonstrates that the variation in loanword phonology can be an inter-speaker variation (see Poplack et al., 1988; Friesner, 2009) and an intra-speaker variation (see Lev-Ari & Peperkamp, 2014; Lev-Ari et al., 2014).

According to Bell (2014), inter-speaker variation itself does not attest the existence of social meanings, but intra-speaker variation does. On the other hand, Eckert (2016) notes that variation is always socially meaningful. In either case, our results suggest that the variants in loanword phonology carry particular social meanings. The attitude effects reported in the current study may suggest that adapted structure carries a social meaning dissociated from Māori while imported structure carries a social meaning associated with Māori. Exploration of the exact social message may require perceptual studies as in Campbell-Kibler (2007), and it is left for future study.

Loanword phonology may provide an interesting test case to explore social meaning in linguistic variation. Hall-Lew, Starr, and Coppock (2012) demonstrate that the second vowel of a loanword *Iraq* can be realized as either /æ/ or /a:/, and that this variation is used by politicians to express their social identity. It is worth exploring what kind of social message, in general, can be expressed by choosing a variant of loanword pronunciation.

6. Conclusion

This study explored the effects of some sociolinguistic effects on the likelihood of choosing a variant in loanword phonology, that is, adapted structure versus imported structure. It was found that the selection depends on topics in speech, and speakers' and words' association with the source language and its culture. This strongly suggests that, rather than regarding loanword adaptation as being governed by strictly phonological properties (LaCharité & Pradis, 2005) or phonetic properties (Peperkamp & Dupoux, 2002), the behaviours of sociolinguistic variables need to be taken into consideration when discussing loanword phonology.

Addressing the research question in (1) develops our understanding of the mental representations of a variant in loanword phonology. The results reported throughout this paper can be encapsulated by exemplar-based approaches: They can accurately be predicted by positing that exemplars with imported structure are stored closely in relation to the social concept 'Māori,' and that the strength of imported structure is updated and determined in daily usage.

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Competing Interests

The author has no competing interests to declare.

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