# STUDIES ON SOUND STRUCTURES AND THEIR INTERACTIONS

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**Mémoire de l'Habilitation à Diriger des Recherches**

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# STUDIES ON SOUND STRUCTURES AND THEIR INTERACTIONS

**Part I.** *Exposé synthétique des recherches*

**Part II.** *Perspectives scientifiques*

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## Acknowledgements

Here I open a new paragraph to recount why I am still here in March instead of being in Miyako Island for my fieldwork as reported in the thesis, and instead, experiencing the threat of the virus spreading for the third time in a month. The chronicle starts in January 2020 when I started making phone calls to my potential informants of different dialects spoken on Miyako Island in southern Ryukyu in Japan. They had been introduced by my acquaintances in Tokyo and Okinawa. Five people accepted to participate in the recording and some of them were willing to introduce their friends to my colleague and me. In mid-February, two weeks

before my planned departure, several virus infection cases were reported in Japan, including one case in Okinawa: certain tourists from Wuhan infected taxi and bus drivers in the first place. During that week, no uncontrolled case was reported in Paris. If I carried out the fieldwork, the chance of bringing the virus through my journey to the Island seemed very low. I was thinking of protecting our elderly informants by disinfecting the materials and belongings I would bring into their places and by wearing gloves and a mask. During the last two weeks of February, when a few more cases were reported in Japan, all sorts of measures to slow down the spread of the virus were setting in: temperature screening, remote-working, time-lagged commuting, social distancing and ventilation in buildings and undergrounds. This move also proceeded in voluntary cancelling of not immediately necessary events such as linguistic meetings. For me, it implied awkward socialising with my friends or family members, no or little shopping or eating out in Tokyo on the way back from the Island to Paris planned in late March. In the meantime, there was a huge cluster outbreak in northern Italy. By the time I gave up my trip to Japan at the very end of February, the people who had spent their winter vacation in Italy were coming back to Paris. There were also other clusters formed in France. I thought about the same kind of constrained life as in Japan being ahead in Paris. But in fact, people around here kept living much in the same way. The usual scenes of close contacts taking place in front of my eyes were alarming. Not being totally sure about approaching epidemic outbreaks either here in France or there in Japan, I regretted for a while that I had not gone in the spring, during the period of cherry blossoms, but had to wait for autumn. Everyone here knows what happened after another two weeks, although it took a few more days to realise that the disaster was as serious as that in Wuhan and what we are experiencing now is confinement just like that in some of the Chinese cities seen on the YouTube in February: risking one's life for simple grocery shopping. This is the second threatening wave for me. However, it has not stopped there. At the time of this writing, the virus seems to have finally started spreading freely in Japan like anywhere else. This second crisis in Japan was apparently started in part by people coming back from Europe in the beginning of March and it has mostly spread among a population that night out – non-trackable cases. It will probably generalise to bigger disasters this time. This is the third threat for me. An expert in infectious disease says that a wave will repeat three times as in the case of the Spanish flu, thus, the situation will not be resolved even after this peak goes by. Also, as a consequence of the deep impact of the virus on society, social problems are emerging everywhere. Will there be any chance that we can visit the island in the near future?

<br>

Paris, 31 March 2020
SHINOHARA Shigeko

The defence took place on 5 June 2020. I thank the HDR office staff at the Université de Paris for arranging a visio conference. The final version of the thesis benefited from remarks made at the defence on facts about Ryukyuans and Tashlhyit Berber.

# STUDIES ON SOUND STRUCTURES AND THEIR INTERACTIONS

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# STUDIES ON SOUND STRUCTURES AND THEIR INTERACTIONS

## 1    Introductory remarks

The main research topics that interest me can be grouped as follows:

  1) Interaction between two sound systems

  2) Interaction between segmental and prosodic structures

My studies on interactions between two sound systems include loanword phonology and second language (L2) perception studies. Interaction between segmental and prosodic structures involves phonological, acoustic and articulatory studies of interlanguage phenomena or of a language. Thus, there is an overlap between the two areas where interlanguage phenomena are concerned.

Adult L2 perception is known to be conditioned by one's first language (L1) structure and categories. Perception patterns of L2 tested on naïve listeners often reveal aspects of L1 sound structure. For instance, Japanese listeners have difficulties identifying English approximants (Best and Strange 1992, Iverson *et al.* 2003) because Japanese language has fewer approximant categories. In L2 perception, some cues for a category difference are interpreted as being unused by listeners when correct identification has failed. The loanword adaptation process, on the other hand, necessarily neutralises most of the L2 contrasts inexistent in L1, since the inputs are treated by the L1 grammar, banning all illegal structures. English /l/ and /r/ are both adapted as /r/, the only liquid class in Japanese (e.g., *right/light* /raito/). Hence, L2 perception and loanword adaptation processes are similar in that the sound structure of L1 plays a major role in constraining the output patterns.

However, L2 perception does not always equate to loanword adaptation (*contra*. Peperkamp *et al.* 2008). One of the difficulties in loanword adaptation studies is that the input of the adaptation process varies depending on how well a particular adapter knows the L2 sound categorisation. In other words, the input structure retained for the process is not obvious. As a result, there is controversy over which input to take for the adaptation process (discussed in Sections 2.2.2.2; 2.2.2.3, see a summary on the issue in Kang (2011)). In my loanword studies, I assumed that inputs to loanword adaptation preserve L2 structures. This was necessary for allowing emergent patterns. One of the most interesting aspects of loanword phonology is where interaction emerges between L2 sound structure and L1 phonological grammar. In some cases, outputs of loanword processes present patterns that are rare or non-existent in L1 but common cross-linguistically (Shinohara 1997b; 2000; 2004a, reported

in Section 2.2).

The assumption about input structures becomes essential when considering the effect of saliency of certain sounds over others in a given sound string on phonological patterns. For example, the perceptual superiority of voiceless plosives over voiced ones in word-final position has been evidenced at low-level auditory functions (Sinex 1993), and its effect appears in many areas of cluster reduction patterns, including loanwords, historical change, synchronic alternations and language acquisition (Shinohara 2006). Importantly, the patterns appear in an implicational manner in loanwords. That is, some languages drop both types of plosives, some languages drop only voiced ones (i.e., in the opposite order of saliency), and yet others retain both of them. To give an example of the asymmetric case, the English word *weekend* is adapted as [wiken] without [d] but *punk* [pɔŋk] retaining [k] in Canadian French (Côté 2000). The variation among languages can be explained by grammar difference. It also presupposes that the inputs contain the whole string of consonants, without evidence of auditory ability difference among the populations. The grammar differentiating the treatment of final plosives is reflected in loanword adaptation and, more crucially, in synchronic alternation patterns. If acoustic structures and auditory mechanisms universally define which sounds are more salient than the others in a given context, they can predict possible grammars and typologies (cf. 'P-map hypothesis' by Steriade 2001; 2008). This hypothesis predicts for the case at hand that there will be no language that systematically deletes voiceless stops and retains all the voiced ones after a sonorant. Shinohara's (2006) results are reported in Section 2.3.

& have also encountered cases where there is a clear gap between perception and loanword patterns. Experimental studies have been carried out to document the current phonetic status of loanword inputs in Korean (Amino *et al.* 2007, Ooigawa and Shinohara 2009ab, Shinohara *et al.* 2009; 2011). They reveal that some parts of loanword patterns are not controlled by sound perception. A standardisation about how foreign words should be adapted overrides the perception. It appears that the standardisation persists even after phonetic correlates changed during the course of time (Kang 2010a, De Jong and Cho 2012). A subsequent study on Korean to Japanese adaptation also shows that a grammar of adaptation involves components not directly based on sound perception (Shinohara 2015).

Concerning the second group (Interaction between segmental and prosodic structures), interactions among different prosodic domains are found in both loanword adaptation processes and in synchronic and diachronic phonological patterns within a language. Some proposals in phonological theories have suggested that prosodic parsing is conditioned by segmental configurations. For example, 'Sonority sequencing principle' conditions syllable shapes, where sonority depends on the segment types categorised by their perceptual scales (Clements 1990). Another well-known principle, 'Weight-to-stress', compels the heavy

syllable to associate to stress (Prince 1990). Applying this type of association to segmental domain, Smith (2002) argues for the existence of constraints that allow perceptually prominent elements such as low vowels, long vowels, syllables with an optimal onset, and possibly high tone to occupy prosodically strong positions. In her study on vowel reduction, Crosswhite (1999) found that vowel contrasts tend to neutralise in unstressed syllables. Her findings imply that prosodically strong positions host more segmental contrasts. The idea can be extended to salience mapping between segmental and prosodic configurations. In interlanguage phenomena, epenthetic vowels employed to break up offensive consonant clusters often appear as a reduced or a short vowel and often do not associate themselves to a stress (see formal analyses in Aldrete 1999) or to a high tone (Kang 2010b, see Section 9.1 for examples), even when a lexical vowel of the same type does. As a result, epenthetic vowels do not stand out in output strings. Many examples indicate that languages favour these configurations. One of the driving forces for a grammar change can also be a perceptual salience mapping along with articulatory ease (see Blevins 2004 for roles of perception and articulation in diachronic changes without encoding phonetic influence directly into the grammar, Steriade 2001; 2008 for role of perceptual mapping encoded in the grammar). On this theme, in addition to the study of final cluster reduction patterns (Section 2.3), issues related to epenthetic vowel and syllable structure are discussed in Section 2.3.4, and the effect of salience mapping between segmental and prosodic configurations will be further explored in syncope and gemination in dialect variations in a future study.

More recent research activities involve studies of phonetic details necessary for understanding relationships between prosodic and segmental patterns in Japonic dialects (i.e., Japanese and Ryukyuan languages spoken in Japan). Some of the topics deal with phonological, articulatory and acoustic patterns of geminate consonants. As a continuation of interlanguage studies, I have conducted liquid perception research to better understand feature systems in languages. Some results will be reported in Section 2.6.

Part I *exposé synthétique des recherches* summarises the research results published after my doctoral dissertation and their significance. Its purpose is only to introduce each of those studies; hence, readers are referred to the original papers for details of analyses and discussions. However, some critical or related papers appeared after the publications of my works are discussed or mentioned in relevant sections (Sections 2.2.2.1, 2.2.2.2, 2.3.4 and elsewhere). The remainder of Part I is organised as follows. Chapter 2 addresses loanword phonology, interlanguage phenomena and studies related to L2 perception. Chapter 3 introduces phonological patterns of Japonic dialects, which are more thoroughly explored in Part II (*Perspectives scientifiques*). Chapter 4 summarises Part I. Part II starts with positions of my research in Section 5. Section 6 offers an overview of the research projects. Sections 7 to 10 successively report current results of new research projects and their perspectives. Section 11 concludes Parts I and II.

# Part I. *Exposé synthétique des recherches*

## 2   Loanword phonology

My studies in loanword phonology are the direct succession of my doctoral research. I begin by observing the evolution of this field as a branch of theoretical phonology. In the subsequent sections, I discuss phonological issues relevant to my studies, namely, the Emergence of the Unmarked (McCarthy and Prince 1994) in loanword data, the perceptual mapping hypothesis ('P-map', Steriade 2001; 2008) elaborated on the study of final cluster reduction patterns in various phonological domains and phonologically asymmetrical loanword patterns inviting a new direction in loanword phonology. The section is supplemented by my recent studies of L2 perception.

### 2.1   Loanword phonology in phonological theories

I have worked in the area of 'loanword phonology' since my doctoral research (Shinohara 1992, 1996, 1997ab). However, the field of loanword phonology began to gain ground only towards the end of 1990s. When I completed my doctoral dissertation in 1997, loanword phonology was still often classified as a marginal area of socio-linguistics. Since the late 1990's, it has become a research topic of many doctoral dissertations in phonology (Katayama 1998, Miao 2005, Uffmann 2007, Crawford 2009, Ahn 2011 among many others) and books on theoretical phonology (Calabrese and Wetzels eds. 2009, Irwin 2011), and recent phonology textbooks devote entire chapters to it (Lin 2007, Goldsmith *et al.* eds. 2011, van Oostendorp *et al.* eds. 2011, Honeybone and Salmons eds. 2015). In 2016, a Google search resulted in 159,000 hits for 'loanword phonology' (cf. 390,000 for 'phonology'), whereas before 1991, there were only 62 hits.[1] The evolution of the hit numbers of 'loanword phonology' during one-year periods of 1990, 1995, 2000, 2005, 2010 and 2015 is shown in Figure 1. A more constant increase of the word 'phonology' during the same period is given as a reference.

Loanword adaptation studies have become a major research topic owing to the development of constraint-based phonological models. The precursor of this trend was Silverman's (1992) analysis of Cantonese adaptations of English words in a basically derivational framework but using target constraints such as minimal word length. Yip (1993) re-analysed similar data within Optimality Theory (OT) (Prince and Smolensky 1993/2004, McCarthy and Prince 1995), which was apparently the first journal article within this theoretical framework. OT

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[1] Google, https://www.google.co.jp/#q=loanword+phonology, 26 July 2016.

was particularly interesting for loanword studies in that a segment inventory and structural forms are constrained by the same set of universal constraints in any language so that foreign segments can be directly fed as inputs. At the same time, another constraint-based theory, the Theory of Constraints and Repair Strategy (Paradis 1987 *et seq.*), extensively exploited loanword adaptation data as the basis for claiming that the (L2) input sequences are repaired to reach the target (L1) structure. In both theories, loanwords become interesting when the output forms are not quite the same as native (L1) words. For instance, many Japanese loanwords of Western origin have geminates in pre-final segment position (/ootomatikku/ *automatic*, /pikunikku/ *picnic*, /kitto/ *kit*), despite the fact that the output form does not pattern with native words. In OT, emerged patterns are considered as reflecting the hidden part of Universal Grammar (UG), known as the Emergence of the Unmarked. At the same time, however, the structure of inputs remains an issue of debate: whether they are just acoustic sounds or categorised L2 phones. This debate has incited L2 perception studies and online adaptation experiments, some aspects of which will be reported later in this thesis.
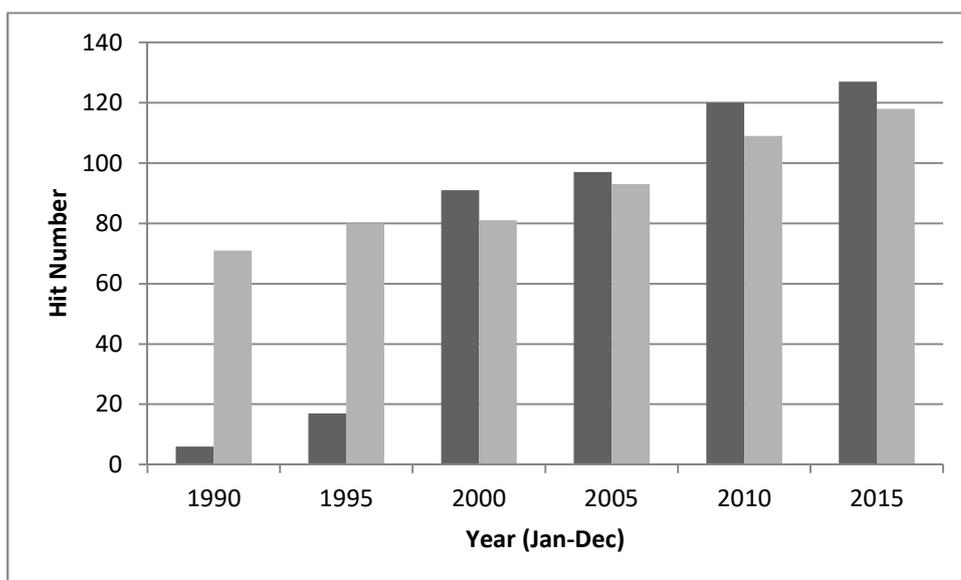


Figure 1 (Non-cumulative) Google hit number of 'loanword phonology' in dark and 'phonology' in clear bars

## 2.2 Loanword adaptation as a window through which to assess L1 grammar

Phonological analyses of loanwords, more precisely, forms of foreign words adapted by speakers fluent in those foreign languages were the focus of my doctoral research. I define foreign word adaptation as the process whereby native speakers of L1 adjust foreign words (L2) in such a way that the resulting forms are acceptable as L1 sound sequences. This type of adaptation is used in code-switching or by interpreters when an equivalent in L1 is not

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available (e.g., proper nouns). I assume that this type of adaptation is also the main source of loanwords. However, some loanwords in a dictionary have gone through histories, which can be diachronic change of the donor or the recipient language, social constraints, spelling-based integration and so on, which are difficult to trace. Therefore, I collected data directly from informants to focus on the mechanisms behind the loanword adaptation processes.

Data analyses in OT made it possible to reveal two aspects of phonological grammar in Japanese. First is the revelation of some unused portions of grammar, which presumably stayed intact since the initial state (see Section 2.2.1), that will be called as 'the emergent patterns'; the second is the confirmation of the grammar used only in the marginal part of the Japanese lexicon. A review of these two aspects and relations with subsequent projects will be presented below.

### 2.2.1   Emergence of Universal Grammar hidden in L1 grammar

The first of the two aspects introduced above, the emergent patterns observed in my dissertation (1997b), is reinterpreted in light of language acquisition theory in OT (Shinohara 2004a), namely the re-ranking of MARKEDNESS and FAITHFULNESS constraints (Hayes 2004, Prince and Tesar 2004). The acquisition theories in Generative Grammar, including OT, involve three phases: the initial state, the final state (i.e., the adult L1 grammar), and the learning phase. In the initial state, the phonological constraints are ranked in such a way that all the structurally marked forms are forbidden. During the learning period when a child acquires the phonology of an adult, the encountered marked forms heard in the ambient language allow the child's grammar to re-rank the FAITHFULNESS constraints over the corresponding MARKEDNESS constraints. This process repeats until the child's grammar is approximated to that of the adults. Based on the assumption that emergent patterns reflect UG, the patterns found in foreign word adaptation (below) are described with reference to cross-linguistic phonological patterns.

(1) Emergent patterns found in foreign word adaptation (Shinohara 1997b; 2004a):

1. Salience mapping between English stress and Japanese pitch accent
2. Avoidance of pitch accent placement in epenthetic vowels
3. Segmental markedness hierarchy of *[dz] > *[ts]
4. Alignment constraint between word boundary and syllable boundary


In the next section, I will briefly describe analyses and results presented in Shinohara (2004a). In doing so, I will connect the discussion to my current research.

***Emergent pattern 1: Salience mapping between English stress and Japanese pitch accent***

Tokyo Japanese is a pitch accent language. The accent is manifested by a falling pitch. The speakers of Tokyo Japanese place an accent when they utter any accented word. As in many languages, the accent position is not indicated in Japanese orthography. The accentedness (i.e., accented or unaccented) and the location of accent are determined through lexical specification, unless the words are verbs, adjectives or compound nouns, in which case the locations are predictable (if the word is accented). In the case that Tokyo Japanese speakers have to pronounce a word from a language without a pitch accent, they place a pitch accent somewhere in the words. For English words, they place pitch accents on the corresponding syllables of English words where they are primarily stressed.

Table 1 Pitch accent placement of the adapted forms of English words

English stress is indicated on the spelling, and pitch accent is indicated by ' after the accented mora

| Nouns | Adapted forms | Verbs | Adapted forms |
|---|---|---|---|
| pícnic | /pi'kunikku/ | mátter | /ma'taa/ |
| ínfluence | /i'NhurueNsu/ | órganise | /o'oganaizu/ |
| beháviour | /bihe'ibijaa/ | invéstigate | /iNbe'sutigeito/ |

<div align="right">(Shinohara 2004a: 303)</div>

Although it is unclear which acoustic cues of English stress are perceived as pitch accent by Tokyo Japanese speakers, they are equated to Japanese lexical accents, and the stressed syllables in English words are memorised through prominence, or salience mapping at an abstract phonological encoding level. The idea of allowing a grammar to map one type of acoustic or perceptual salience to another has had an important impact on my subsequent works as well as in other parts of loanword studies, presented in subsequent sections The idea is extended to a work on the perception of illegal L2 structures, where segment identification in such clusters was facilitated in salient prosodic position (Kamiyama and Shinohara 2010).

***Emergent patterns 2: Avoidance of pitch accent placement in epenthetic vowels***

In adapted forms from French words into Japanese, pitch accent is attributed to a certain predicted position according to a default rule, namely on the head of the non-final bimoraic foot, - (μμ)σ# (Section 2.2.2 presents how this position is determined).

(2)

       DEFAULT ACCENT: The head of the non-final bimoraic foot, - (μμ)σ#

Table 2 Pitch assignment in adapted forms of French words, regular patterns[2]

| French word | French form | Adapted form | Gloss |
|---|---|---|---|
| *mâchicoulis* | \|maʃikuli\| | /masi'kuri/ | 'machicolation' |
| *philatélie* | \|ɸilateli\| | /ɸira'teri/ | 'philately' |
| *alerte* | \|alɛʀt\| | /are'ruto/ | 'alert' |
| *travesti* | \|tʀavɛsti\| | /torabe'suti/ | 'travesty' |

<div align="right">(Shinohara 2000: 63)</div>

However, the pitch accent shifts from the default accent position when this position is occupied by an epenthetic vowel. In the table below, epenthetic vowels in the adapted forms are italicised.

Table 3 Pitch assignment in adapted forms of French words, shifted patterns

| *stylo* | \|stilo\| | /s*u*ti'ro/ | 'pen' |
|---|---|---|---|
| *abricot* | \|abʀiko\| | /ab*u*ri'ko/ | 'apricot' |
| *dactylo* | \|daktilo\| | /dak*u*ti'ro/ | 'typing' |
| *coquelicot* | \|kɔkliko\| | /kok*u*ri'ko/ | 'poppy' |

<div align="right">(Shinohara 2000: 66)</div>

The fact that epenthetic vowels in the adapted words from the input French string avoid accent is expressed by the constraint by Aldrete (1995).

(3)

HEAD-DEPENDENCE (HEAD-DEP): Every segment contained in a prosodic head in S2 has a correspondent in S1. If β is contained in a prosodic head in S2, then β ∈ Range(ℜ).

This is a FAITHFULNESS constraint referring to the input. Following the idea that prominence should match between two phonological units, the HEAD-DEP constraint can be interpreted in our case as follows: absence of syllable structure in the input should not have a prosodic prominence of pitch accent, as illustrated in Table 4. Other possible positions are ruled out by FOOT-FORM constraints and NON-FINALITY constraint, which are active in default patterns (see Shinohara 1997ab; 2000 for full analyses).

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[2]  Input phonemic sequences are presented between vertical lines, to be distinguished from adapted forms.

(4)

HEAD-DEPENDENCE (HEAD-Foot-DEP) >> DEFAULT ACCENT

Table 4 Adaptation of |abʀiko| → /aburi'ko/

| abʀiko | HEAD-Foot-DEP | DEFAULT ACCENT |
|---|---|---|
| ☞aburi'ko | | * |
| abu'riko | *! | |

(Adapted from Shinohara 2004a: 307)

### Emergent pattern 3: Segmental markedness hierarchy of *[dz] > *[ts]

In segmental adaptations, subdivision of a more general *AFFRICATE emerged in the adaptation patterns (Shinohara 2004a: 297-301 for the analysis). The avoidance of [dz] by means of lowering the following vowel was observed: /**tsuu**ruuzu/ < *Toulouse* versus /poNpi**doo**/ < *Pompidou*, where /t/ and /d/ are both subject to assibilate before /u/ by a Japanese phonotactic rule. This process is in line with universal hierarchy of segmental MARKEDNESS found in the study of cluster adaptation by Davidson *et al.* (2004). Adapted patterns of foreign inputs may be congruent with typological MARKEDNESS hierarchy. MARKEDNESS of voiced affricates was later more widely substantiated by Zygis *et al.* (2012).

### Emergent pattern 4: Alignment constraint between word boundary and syllable boundary

The fourth case is a problematic one in terms of Emergence of the Unmarked in that the analysis lends to a re-ranking going back from MARKEDNESS (M) >> FAITHFULNESS (F) to F >> M. The phenomenon concerns gemination in Japanese loanwords from Western languages, such as in /bura**dd**o pi**tt**o/ for *Brad Pitt*. Many attempts have been made to explain this mysterious phenomenon (Kawagoe 1995, Katayama 1997, Ito *et al.* 2017, among others). Morphological boundary and spelling sometimes blur generalisation in loanwords from English. Our generalisation on adaptations of French words is that it occurs in the pre-final syllable of the adapted words when the original word ends in a single consonant, unless the pre-final syllable is lengthened by other moraic segments. For example, if the pre-final syllable is heavy with a long vowel (/ruuʑu/ *rouge* 'red'), the gemination is suspended but the resultant syllable weight is always heavy. In the examples of Japanese adaptation of French words in (5) below, the word-final boundary is aligned with the syllable boundary in the output forms (5a-d). The gemination does not occur for word internal syllable boundary such that the alignment is not syllable to syllable (5e-f). The examples in (5) are drawn from

Shinohara (2004a).

(5)

| | | | | | |
|---|---|---|---|---|---|
| a | *nappe* | \|nap#\| | → /nap.pu/ | 'table cloth' |
| b | *patte* | \|pat#\| | → /pat.to/ | 'paw' |
| c | *lac* | \|lak#\| | → /rak.ku/ | 'lake' |
| d | *mèche* | \|mɛʃ#\| | → /mes.sju/ | 'lock' |
| e | *picnic* | \|pik.nik#\| | → /pikunik.ku/, */pik.ku.nik.ku/ | 'picnic' |
| f | *magma* | \|mag.ma\| | → /maguma/, */magguma/ | 'magma' |

This alignment can be formalised with a ranking of the two constraints in (6) and (7).

(6)

ALIGN R (STEM, R, SYLLABLE, R): The right edge of the stem in the input must be aligned with the right edge of the syllable in the output. (Tsuchida 1995: 17 (34))

(7)

DEP-µ: Do not insert a mora.

The pattern is yielded by the ranking in (8).

(8)

ALIGN R >> DEP-µ

Table 5 *pack* → /pakku/ (a loanword from English)

| pæk# | ALIGN R | DEP-µ |
|---|---|---|
| pa.ku | *! | |
| ☞pak.ku | | * |

The alignment between the right edge of the stem in the input and the right edge of the syllable in the output is absent in both native Japanese words and Sino-Japanese words (see Ito and Mester (1995) for structure of Japanese lexicon). Sino-Japanese words are the many Chinese words that the Japanese language has integrated since the 6th century and are an important part of Japanese lexicon. Sino-Japanese morphemes can end in a consonant, and the word-final consonants are pronounced with an epenthetic vowel without consonant gemination: /kjak/ [kjaku] *[kjakku] 'client'.

When we think that the Japanese grammar has changed to accommodate Sino-Japanese 'marked patterns', then, the first re-ranking is considered to have already taken place to yield F >> M. This issue is considered again in a more recent study on Japanese loanwords from Korean, where Sino-Japanese patterns have been preserved (Shinohara 2015). Korean stems have prosodic forms similar to Sino-Japanese stems: (C)V(X) (C = a consonant, V = a short vowel, X = a moraic element). Taken together, OT explains that Sino-Japanese stratum is constrained by a stronger prosodic minimality constraint, banning a stem form to equal to or to be less than two mora length. Geminating the consonant would exceed this length. Thus, this problem shed light on the structure of the Japanese lexicon as well as the grammar of each stratum.

### 2.2.2 Patterns confirming marginally employed grammar

Some of the other adapted patterns confirmed Japanese grammar used in marginal parts of the lexicon:

(9)

1. Default accent position in Japanese (similar to Classical Latin (Mester 1994)).
2. Bimoraic foot in Japanese (used also in 'prosodically derived' environments (Ito 1990, Ito and Mester 1992, Ito *et al*. 1996, Poser 1990, Tateishi 1991).

Shinohara (2000) discusses patterns confirming marginally employed grammar extensively. I shall present here how we can determine the default accentuation by using universally well-established prosodic parameters.

By analysing pitch accent patterns of Japanese adaptation of French and English words, I found that the positions where the adapters place accent on adapted forms are predictable. As mentioned, adapted forms from English words preserve the primary stress position as pitch accent locus (/pi'kunikku/ < *pícnic* versus /tekuni'iku/ < *technique*),[3] whereas those from French are accented on the basis of output syllable sequences. The prosody in French input does not play a role in pitch accent assignment. We have seen some examples with sequences of light syllables, such as /masi'kuri/ < *mâchicoulis* |maʃikuli| 'machicolation'. Those forms clearly define the default accent position as antepenultimate position. However, they do not tell us whether it is the antepenultimate 'syllable' or 'mora'. We shall supplement examples with other syllable types, namely with heavy syllables in various positions. Syllable

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[3] It should be reminded that these are adapted forms collected directly from Japanese speakers fluent in English as L2. Japanese language has been integrating many loanwords from English for over 100 years. Not all of the loanwords keep the original accentuation. But we assume that the preservation of stress position is a major source of loanword accent from languages with lexical accents.

boundaries are marked by a dot.

(10)

| | Adapted forms | French inputs | Gloss |
|---|---|---|---|
| a. | /oo.to.ma.ti'k.ku/ | *automatique* \|ɔtɔmatik\| | 'automatic' |
| b. | /po.wa'N.to/ | *pointe* \|pwɛ̃t\| | 'point' |
| c. | /po'.ti.roN/ | *potiron* \|potiRɔ̃\| | 'pumpkin' |
| d. | /sa'.ra.zaN/ | *sarrasin* \|saRazɛ̃\| | 'a type of wheat' |
| e. | /po.wa'N.soN/ | *poinçon* \|pwɛ̃sɔ̃\| | 'punch' |

(Data drawn from Shinohara 2004a)

The data (10a-b) represent the traditionally called 'antepenultimate accent' (McCawley 1968), or the accent on the syllable containing the antepenultimate mora. The accent position is more precisely characterised as the head of the bimoraic foot, excluding the final syllable in foot grouping from the end of the word. This generalisation can account for the data (10c-f) accented on the syllable containing the pre-antepenultimate mora. This characterisation is the same as Classical Latin accentuation recapitulated as follows:

(11)

-(μ'μ)σ# (the final syllable σ can be light or heavy)

The use of bimoraic foot was discovered in the formation of Japanese 'prosodically derived words': truncation of names (Poser 1990), abbreviated loanwords (Ito 1990), truncated compounds (Ito and Mester 1992) and Jazz musicians' argot (Ito *et al.* 1996).[4] Segments in base forms are moulded into the bimoraic template. The same bimoraic foot form has asserted itself as playing a major role in yielding the default accent patterns in Japanese pitch accent system along with universally common NON-FINALITY and ALIGNMENT constraints (Shinohara 1997ab; 2000). The bimoraic foot is known to be universally trochaic in accentuation (Hayes 1995). Depending on the input syllable weight sequences, several pitch patterns are yielded. Thus, the accent patterns are determined from the right edge of the output forms but excluding the final syllable.[5]

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[4] The references are not exhaustive. More references and examples are found in Shinohara (2000).

[5] Unaccented variants of a sequence of light syllables (LLLL) or four mora sequences starting from a heavy syllable (HLL or HH) might have a different foot structure. It is suspected that the default grouping for this sequences (μ(μ'μ)σ) is in conflict with a simpler and exhaustive foot parsing ((μμ)(μμ)) often found in compound words. Ito and Mester (2016) analyse such cases. They take the

### 2.2.2.1 Lexical specification for default accent

French inputs are unspecified for an accent, and they receive the default pitch accent when adapted into Japanese. Conversely, English words seem to carry over their primary stress positions into Japanese pitch accent assignment process. I turn now to a discussion on the specification of L2 words with regard to pitch accent. Kubozono (2006) focuses on the proportion and origin of accentuations in Japanese loanwords. In his data, three-mora loanwords taken from a dictionary overwhelmingly present initial accent (96%). And the majority of native nouns of the same length also presents initial accentuation (Initial accent 59%, Medial accent: 33%, Final accent: 9%). Kubozono's (2006) characterisation of the Classical Latin-type accentuation as the default accent in Japanese noun class is common with our analysis. However, the specifications in the words presenting this accent location, and, consequently, the reason why loanwords are accented by this rule, differs from our view.

As mentioned, we consider that Japanese regular nouns are lexically accented on any of the syllables so that the accent position is not constrained by the default accent. For example, three-mora words in (12) are accented on the initial (12)a, on the second (12)b, on the final syllable (12)c or unaccented (12)d:

(12)

|     |            |          |
| --- | ---------- | -------- |
| a.  | /i'noti/   | 'life    |
| b.  | /koko'ro/  | 'heart'  |
| c.  | /otoko'/   | 'man'    |
| d.  | /usagi/    | 'rabbit' |

One can derive the lexical accent positions in those words using undominated FAITH-ACCENT type constraint. We note that words with more than three syllables involve a morpheme boundary where compound accentuation may apply. Shinohara (2000) and Kubozono (2006) agree in that Japanese proper nouns and some prosodically derived words have no accent specification, and the default rule applies to yield the same accent patterns. However, interpretations of the accent locus specification of loanwords differ.

Kubozono (2006) calculated the rate of occurrence of accent in each position in Japanese words and in loanwords. He concludes that the default accent position is used in the majority of Japanese words and loanwords; thus, loanword accent originates in copying the most frequent accent patterns of Japanese vocabulary. He further claims that outputs of compound

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four-mora unaccented words as the base of analysis of the default accent, and consider (L(L'L)L) parsing as a variant yielded from an alternative grammar. Their analysis also excludes H'LH pattern; therefore, it might be incomplete.

accentuation are also constrained in part by the default rule, so that not all but many of the compounds have the similar accent locus to other Japanese words and loanwords. Another important difference is that he considers that all accent loci predicted by the default rule, including the ordinary noun class (cf. (12)), have no lexical accent specification other than [accentedness]. Thus, the accent type (12a) above has [accentedness] specification but no specification for the initial location. The items in (12b-c), on the other hand, have specification for their accent locations. *A priori*, there is no evidence for the origin of the initial accent position in (12a), nor for the others. It is merely an assumption that regular nouns in Japanese native words are specified for all accent locations. Based on this assumption, the traditional view of *n+1* possible accentuation for *n*-syllable words (McCawley 1968) treats all types, from (a.) through (d.) equally with regard to lexical accent specification. However, Kubonozo's account does not.

We note that there are also classes of vocabulary in which only [accentedness] is specified. Underived verbs and adjectives in the accented class are accented differently from the noun class, just like in English, where those two classes obey two distinct stress rules. The accent locations in these word classes in Japanese are predicted by the constraint ranking quite similar to the one above but without excluding the final syllable, i.e., NONFINALITY-σ is lower than ALIGN-RIGHT (Align right edge of every foot to right edge of a prosodic word). Thus, the accent shifts rightward compared to the noun class (see Shinohara 2000 for a detailed analysis). The compound accentuation also depends on the [accentedness] specification of the second morphemes. Furthermore, in the proper noun class, if a proper noun is accented, the accent falls on the location predicted by the default rule, thus, identical to adapted forms from French, or many integrated loanwords. Therefore, the accent location in the accented class of those words is not specified in the lexicon. Treating adapted forms from unstressed language as French, or any sequences of nonsense words as lexically unspecified for accent location, creates another symmetry. The basic components concerning the lexical specification of loanword accent in the two views are summarised in Table 6.

Table 6 Summary of the lexical specification of loanword accent

|  | **Domains of application of Default accentuation** | **Loanword accentuation** |
|---|---|---|
| **Kubozono (2006)** | All sectors of Japanese vocabulary | Copy the most frequent accentuation |
| **Shinohara (2000)** | Classes not specified for accent location | Go through default accentuation process |

Regarding loanword accentuation, Kubozono's analysis of the proportion of accented and unaccented words revealed that loanwords are more often accented than other Japanese words.

Although he does not give the number of English origin loanwords in his corpus, he assumes that the majority of loanwords are from English and are relatively old and established.[6] Given that more Japanese words are unaccented than accented, he claims that the accentedness in loanwords is rooted in the phonetic mapping of English pitch contour to the contour of Japanese pitch accent. However, we find that adapted forms from French words, where there is little reason for accent to be recognised, are also accented. Is accentedness from English preserved in loanwords? While adapted forms are the major origin of loanword form, loanwords can also nativise over time. In case of pitch accent, since the location of accent is not marked on the orthography, those who have not heard the loanwords (or the original words) have no access to the input forms. Consequently, once they are written down, loanwords are not different from any nonsense sequence segments. The loanwords for which the sound sources are unknown to the speaker can be accented according to the default accentuation. An additional remark in this case is that the distinction between epenthetic vowels and lexical vowels is not made so that the epenthetic vowels can be accented.

### 2.2.2.2  *Representation of illegal clusters*

The emergent pattern 3, the avoidance of pitch accent placement in epenthetic vowels, implicates how French consonant clusters, illegal to Japanese grammar, are perceived and represented in native Japanese listeners' minds. Many studies have been conducted on L2 sound perception by naïve listeners of L2 in psycholinguistics. Based on their experimental results showing insensitivity to inexistent clusters in the listeners L1 structures, the majority of studies seem to assume that the L2 listeners' perception and representation of clusters are constrained by L1 grammar (Hallé *et al.* 1998; 2003; to appear*, Dupoux *et al.* 1999; 2001, Dehaene-Lamberts *et al.* 2000, Hallé and Best 2007), as in the case of segmental contrasts. For presence or absence of a vowel between two consonants in Japanese monolingual speakers' representation, Dupoux's 'ebzo experiment' series is taken as evidence of the inability to represent consonant clusters in Japanese as Japanese lacks such a structure. This result seems to be endorsed by the non-behavioural study of Dehaene-Lambers *et al.* (2000) using electrocephalography (EEG) to demonstrate that insensitivity to the absence of vowel between consonants occurs at the very beginning of perception. On the other hand, Breen *et al.* (2013) present supporting veridical representations of phoneme sequences in illegal onset clusters /tl, dl/ by English listeners, also using EEG but different paradigms, and testing segmental contents rather than presence of consonant clusters. A gating experiment of /tl, dl/ by Hallé *et al.* (1998) also shows that perception of [tl] as /kl/ by French listeners shifts from the point when [l] starts, indicating that the representation was veridical at the beginning and

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[6]  He cites from Sibata (1994) [Eighty-four percent of loanwords used in contemporary Japanese are those that have been borrowed from English over the past 100 years or so].

reversed retroactively. Psycholinguistic studies are in general heavily dependent on their methods, and the results should be considered together with their experimental contexts. Recall that our adapters were native speakers of Japanese with an advanced competency in the L2, which was acquired during adulthood. In our study of online adaptation, it is clear that clusters and CVC sequences are distinctively processed, because prominence mapping between lack of lexical vowel in the input and avoidance of accent requires representation that distinguishes between presence and absence of vowel. In loanword adaptation, the contrasts absent in L1 structure are necessarily modified to conform to L1, but perception of contrasts is independent of loanword forms for the reasons given in the Sub-section 2.2.2.3.

### 2.2.2.3   Input in loanword studies

As we have seen, suppositions on the input forms as well as competence of adapters are important factors that influence the results of loanword phonology studies. Gaps between phonological analyses of loanwords and perception studies often derive from those factors. Perception studies very often involve naïve listeners of L2 (references in the preceding section), whereas loanwords are adapted by L1 speakers with knowledge of L2 at varying degrees (e.g., Paradis and LaCharité (1997) suppose 'bilingals'). Contrasts neutralised in native grammar can still be perceived by competent adapters. On the other hand, naïve listeners' perception might reflect the allophonic variation in L2 more faithfully, since they are not biased by how loanwords of that particular L2 are orthodoxly adapted. Loanwords may also go through nativisation and lexicalisation processes after adaptation. Consequently, a gap can reflect dialectal variability or phonological changes of a recipient language over time, or phonetic changes in a donner language. Loanword patterns treated in Section 2.4 reveal some aspects of those variabilities. Before moving onto this topic, I will provide a summary of one of my studies that is essential for relating perception and phonological grammar in Section 2.3.

## 2.3   Cross-language patterns of final cluster reduction

The role of perception in phonological grammar was investigated through word-final consonant cluster simplification patterns in loanword adaptations from English into several CV and CVC languages (Shinohara 2006). Distinct yet implicationally congruent reduction patterns in loanwords across languages indicated that perceptibility scales of segments in a given sound string are part of the grammatical components. This study was framed in the 'P-map hypothesis' by Steriade (2001; 2008).The basic idea underlying my study is quoted below from Shinohara (2006: 1047).

[My working hypothesis is that covert knowledge of the perceptibility of sounds in context, what

Steriade (2001a, 2001b)[7] refers to as the 'P-map', underlies loanword adaptation. In this study, the effects of several perceptibility scales are discerned in the deletion patterns of final clusters. The more general approach I am taking is to assume that markedness scales are naturally grounded in the sense that their origins are phonetically or cognitively based. In a recent volume on this issue, Hayes and Steriade (2004:1) note the following hypothesis:

> "the source of markedness laws . . . can be rooted in phonetic knowledge, the speakers' partial understanding of the physical conditions under which speech is produced and perceived. The sources of markedness constraints as components of grammar are this knowledge. The effect phonetic knowledge has on the typology of the world's sound systems stems from the fact that certain basic conditions governing speech perception and production are necessarily shared by all languages, experienced by all speakers, and implicitly known by all. This shared knowledge leads learners to postulate independently similar constraints. The activity of similar constraints is a source of systematic similarities among grammars and generates a structured phonological typology."

The study presented in this paper is an instantiation of such an effect. Mostly unrelated languages' common adaptation patterns can be explained by shared phonetic knowledge which must be presumably based on auditory experiences other than that acquired in L1. I shall show that the patterns of segmental deletion are derived from knowledge of the perceptibility of sound sequences. I shall analyse several similar patterns appearing in L1, in language evolution, and in L1 acquisition to support the idea that the emergent scales are based on general phonetic knowledge not specific to loanword adaptation.]

### 2.3.1   Prediction on asymmetric behaviour of post-sonorant obstruents

Vowel insertion is the most common strategy to repair surplus English consonants when they are adapted into foreign languages with a simpler syllable structure. Deletion occurs in a small number of languages and only in certain positions. For example, the most robust pattern found in my study, voiceless plosives (represented as T), is more retained than voiced ones (D) in the postnasal context (N_#) within a language and across languages. Similar output patterns of cluster reduction are found in synchronic alternations in African American Vernacular English (AAVE) and Quebec French, during language evolution of English and French, and in child acquisition data of English and Spanish. Let us illustrate the case of loanwords in Yoruba in (13). Yoruba syllable type is limited to CV(V), except that it has the syllabic nasal. Voicing distinction exists among plosives.

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[7]  These references correspond to Steriade (2001; 2008) in this thesis.

(13) Asymmetric English loanword patterns in Yoruba

(Transcription is phonemic. Tone indication seems inconsistent in the original transcription.)

Voiceless plosive retention

| | |
|---|---|
| *pump* > pɔ́mpù | *stamp* > sitampu |
| *account* > akɔ́ǹtì | *bank* > báǹkì |
| *consonant* > kɔ́nsónantì | *peppermint* > pɛpɛménti |

Voiced plosive deletion

| | |
|---|---|
| *bend* > bɛ́ɛ̀nì | *diamond* > dájámɔ́ɔ̀nù |
| *reverend* > rɛ́fúrɛ̀nì | *pound* > pɔnun |

(Shinohara 2006: 1057-1058, the original data source: Ojo (1977))

According to these patterns, deletion is not determined by syllabic position but by segmental context. These patterns are not readily accounted for by formal phonological treatments that disregard phonetic factors. The mixed pattern is difficult to express as a simple parametric choice between deletion and epenthesis as the repair. Syllable templates are not sufficient for predicting the non-uniform treatment of the input segments depending on the context. The deletion patterns are more naturally accounted for when the perceptual robustness of the segments in phonetic contexts is considered as the conditioning factor.

The asymmetric deletion patterns are predicted by the relative acoustic and auditory salience of the plosives in the post-sonorant context. A wide frequency range and relatively high amplitude of a vowel and a sonorant sound cause a relatively more difficult perception of consonantal sounds in sound strings during the low-level auditory encoding process. Among plosive consonants, voiceless plosives' release burst is expected to suffer less from perceptual masking than that of voiced plosives due to the relatively long silence that precedes it (Fastl 1977, Miller and Sachs 1983, Sinex 1993). We present an explicit piece of evidence from Sinex's study of cochleagram. Sinex (1993) examined discharge (i.e., neurons' response) patterns elicited by English syllables ending in /t/ and /d/ (/hid/, /hit/, /hud/, /hut/), as uttered by one speaker and presented at an overall level of 60 dB SPL (Figure 2).
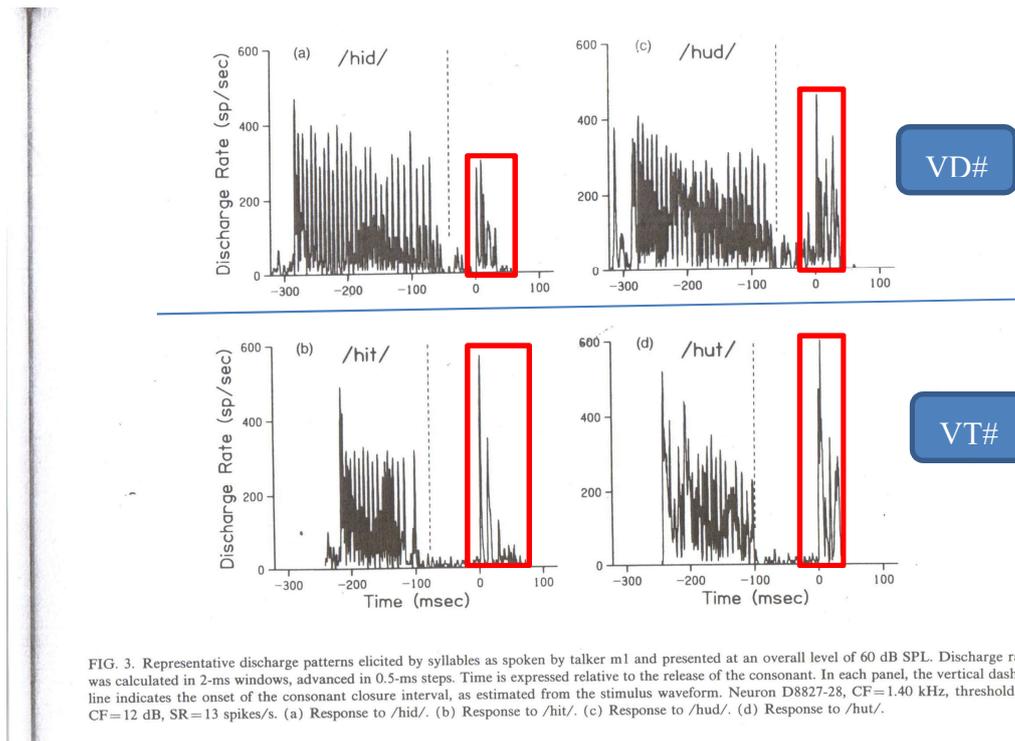
FIG. 3. Representative discharge patterns elicited by syllables as spoken by talker m1 and presented at an overall level of 60 dB SPL. Discharge rate was calculated in 2-ms windows, advanced in 0.5-ms steps. Time is expressed relative to the release of the consonant. In each panel, the vertical dashed line indicates the onset of the consonant closure interval, as estimated from the stimulus waveform. Neuron D8827-28, CF = 1.40 kHz, threshold at CF = 12 dB, SR = 13 spikes/s. (a) Response to /hid/. (b) Response to /hit/. (c) Response to /hud/. (d) Response to /hut/.

Figure 2 Auditory neurons' discharge patterns Sinex (1993:1355; FIG. 3). Coloured elements added by the author to highlight the relevant parts.

This empirical result proved an asymmetric perception between T and D in the relevant position. Discharge rates are greater for /t/-ending pairs (cf. the parts marked in red squares in Figure 2). In Sinex's (1993) stimuli, the mean closure intervals measured acoustically were 56 ms for syllables ending in /d/ and 114 ms for syllables ending in /t/. This closure duration difference is representative of English (Chen 1970: 144, among others). The study reports that the encoded closure interval was also longer for syllables ending in /t/. The patterns indicated higher and more stable discharge rates for the burst of /t/ than for /d/. This means that /t/ is perceptually more salient than /d/ in this position. It is important to note that there seems to be no significant difference in release rates of T versus D in postvocalic or post-sonorant positions (Byrd 1992). Another important assumption is that the saliency difference can also be encoded in the context VR_#, where V is a vowel, and R is a sonorant consonant. The above experimental data were obtained in V_ conditions, whereas the phonological cluster reduction data we present here concern VR_# contexts. Although we have not found any comparable experimental data in VR_# context, the effect of forward masking is expected, and perception of final consonants maybe even harder in the VR_# context. In fact, our preliminary perception experiment of French consonants in 2002 (unpublished) suggested that misperception of C in V_# context by native speakers (with normal hearing capacity) mostly occurs in noisy conditions. We used 'Speech Noise' to mask

the stimuli, otherwise every consonant identification would have reached the ceiling.

Relative auditory saliency of sound strings predicts that D is always deleted before T is in VR_# context. The study argued that the perceptibility scales are universally defined through auditory perception. However, it is important to emphasise that auditory perception alone does not directly determine phonological patterns. Instead, the perceptibility scales of sounds in their syntagmatic contexts are encoded into the grammar of each language. This is shown by distinct yet implicationally congruent reduction patterns in loanwords across languages.

### 2.3.2 More loanword patterns and interpretation

Below are Cantonese adaptation patterns, which delete both voiced and voiceless plosives after a sonorant. Sources are Silverman (1992) and Yip (1993).[8] Possible codas in Cantonese are glides, nasals and unreleased plosives.

(14) Deletion of plosives in Cantonese adaptation of English words

> *pump* > pam
> *account* > akaan
> *cement* > siman
> *sink* > siŋ
> *band* > pen

Cf. Sibilants in the same position are systematically retained through epenthesis in Cantonese, showing that vowel epenthesis is a possible recourse for integrating consonant sequences.

(15) Retention of sibilants

> *Benz* > pɛːnsi
> *chance* > tsʰaːnsiː
> *pence* > piːnsiː
> *ounce* > ɔːnsiː

As in Cantonese, Marshallese adaptation deletes both voiced and voiceless plosives in the same position. Fijian and Samoan exhibit intermediate cases where systematic variation occurs in the predicted direction. Fijian retains all voiceless plosives and deletes half of the voiced ones. Samoan retains part of the voiceless plosives and deletes all of the voiced ones. Otherwise, many languages retain most of the consonants in any position (e.g., Japanese, Korean and Finnish).

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[8] Number of examples is not given because the data are not from a random word list but phonologically classified ones. The total number of the corpus is not known, either.

Based on 'P-map hypothesis' (Steriade 2001; 2008), we assume that covert knowledge of perceptibility of each type of element in a given context underlies deletion phenomena. The data are analysed in the OT framework. We have seen that without assuming a fixed, universally scaled perceptibility of sounds in particular contexts, cross-linguistic patterns are difficult to explain by other markedness constraints such as the articulation-based *NC̥ constraint (Pater 1999) or the Sonority Dispersion Principle for (demi-)syllable well-formedness (Clements 1990).

A competing view for cluster reduction is to consider it an instance of misperception of perceptually weak elements (e.g., Ohala, 1981; 1992, an extensive discussion on diachronic change by misperception in Blevins (2004)). While this explanation is possible for some of the individual data sets, it cannot account for the observed patterns as a whole. What the misperception hypothesis fails to account for is, firstly, the implicational patterns across languages. In fact, many languages integrate perceptually weak elements into L1 structure to show that they are still recognised. Yet, some languages delete them in order of weakest segments to strongest segments using the knowledge of perceptibility. Assuming that auditory functions are common across human species, auditory perception should equally induce perceptibility scales across languages. One may also suspect that loanword adaptation can be based on written sources. While it could be true for some languages that never delete segments, it is not a plausible hypothesis for languages exhibiting asymmetric treatment according to segments types. Our idea is that some languages delete a consonant because their grammar requires it. The same relation is observed not only in loanwords but also in historical sound change, in synchronic grammars and in child phonological acquisition data. The scales of perceptibility of sounds in context are, therefore, universal. Here are some of the examples of cluster reduction in other domains than loanwords, drawn from Shinohara (2006).

### 2.3.3   Final cluster reduction patterns in other domains

*Historical change 1: French Creole*

According to Tinelli (1981), Standard French and Haitian both derive from a proto-language close to modern Southern French in which a vowel can be followed by a sequence of a nasal stop and a plosive. In this sequence, Standard French reduced the nasal stop, and Haitian reduced the following plosive but only the voiced ones.

(16) ND reduction: VND > ṼN

|  | French | Haitian |
|---|---|---|
| *jambe* | [ʒɑ̃b] | [ʒɑ̃m] 'leg' (cf. *jamber*, V. [ʒɑ̃be] 'to step over') |
| *bande* | [bɑ̃d] | [bɑ̃n] 'group' |
| *longue* | [lɔ̃g] | [lɔ̃ŋ] 'long, f.' |

(Examples drawn from Tinelli 1981: 159, phonetic symbols adjusted)

Voiceless stops were retained in both French and Haitian: VNT > ṼT

(17)

*pompe*    [pɔ̃p] 'pump, n.,'   *soixante* [swasɑ̃t] 'sixty',    *banque* [bɑ̃k] 'bank'.

### *Historical change 2: English Creoles*

In many English Creoles (Krio, Saramaccan, Sranan, Cameroons, Guyana, Gullah, Jamaican), voiced final stops following a homorganic nasal of Old English (OE) are truncated. The data are drawn from Tinelli (1981: 161). /-mb#/ in OE is regularly reduced to [m]. Truncation of OE/Middle English /-ŋg#/ is irregular. The final plosives in [mb] and [ŋg] are also dropped in many varieties of modern English: /b/-drop occurred by the end of 13C, /g/ dropped during 14C-16C depending on dialects. Interestingly, [nd] is also truncated in parallel with the other ND clusters in many Creoles.

### *Synchronic alternation 1: Canadian French*

In the cluster simplification patterns in Quebec French studied by Côté (2000), RT versus RD asymmetry appears mostly in English loanword contexts. However, Quebec French is distinct from loanword study to the extent that similar deletion processes occur in the native vocabulary as well. It is significant to find similar reduction patterns of final consonants in French because, unlike English, the final consonants (both voiceless and voiced ones) are usually released in French so that we can eliminate suspicion of lack of or unevenly distributed release between T and D as the factor influencing the weak perception of the final plosives in English.

### *Synchronic alternation 2: African American Vernacular English (AAVE)*

AAVE gives us an opportunity to verify if the perceptibility scale can be reflected in a synchronic grammar (in a larger context than in Canadian French). The knowledge of perceptibility scales is clearly a conditioning factor in the loanword adaptation process. Even so, in the loanword adaptation process, there is not always a means to tell that reduced consonants are present as a phonological input. AAVE may be a test case to see if a deleted

consonant of a cluster in a lexical form reappears after suffixation. The generalisation given by many authors is that the final plosive of the same voicing clusters has a tendency to delete (Wolfram and Fasold 1974, Green 2002). The deletion rates of the final consonants in RD# and RT# clusters clearly show an asymmetry between voiced and voiceless plosives:

(18) Percentage of final stop deletion from (Côté 2000) citing Shiels-Djouadi (1975)

/-ld/ 74% *killed, gold*
/-lt/ 0% *built, bolt*
/-nd/ 86% *send, find*
/-nt/ 13% *rent, pinte*


Among dialectal variation, at least in some dialects and in some styles, the final consonants are pronounced in suffixed forms: *colder*, *spending* (e.g., Green 2002). This indicates that deleted consonants are present in the lexical representation and that perceptually grounded constraints are active in synchronic alternation.

The synchronic aspect of perceptibility scale is further supported by L1 acquisition data. Shinohara (2006) reports data from English (Smith 1973) and Spanish (Barlow 2003) speaking child utterances at their stage of CVC production. In these data, we also observe asymmetric treatment of RT# and RD# clusters. Data from a child acquiring English shows the following pattern: *meant* [met], *mend* [men] (Smith 1973).

The grammar we reported in Section 2.3 is closely related to perception patterns. However, it is argued that the perceptibility scales themselves do not directly determine the loanword patterns, but they are encoded as part of grammar and interact with other aspects of individual grammars, yielding distinct loanword patterns across languages.

### 2.3.4 Prominence mapping between an epenthetic vowel and syllable structure

Related to the issue of representation of illegal consonant clusters discussed in Section 2.2.2.2, we shall discuss here the representation of final clusters in the context of prominence mapping.

There seems to be a restriction of syllable shape accommodating epenthetic vowels. We shall look at a few cases that prove that a syllable with an epenthesised vowel cannot be closed. Consider first the following observation in Yip (2006) (a footnote added by the author).

[Cantonese only allows one final consonant, and it must be a voiceless stop, nasal, or glide. Final clusters present a puzzle: In a final cluster, if C2 is a stop, then epenthesis of one vowel could create a new legal final closed syllable, and should also suffice, but deletion occurs instead.

|            |       |                    |                         |
|------------|-------|--------------------|-------------------------|
| Fric-stop  | cast  | *kʰaː.siːt         | kʰaː.siː                |
|            | shaft | *saː.fiːt          | sʌp                     |
|            | soft  | *sɔːfuːt           | sɔːfuː                  |
| Nas-stop   | sink  | *sɪŋ.kʰiː          | sɪŋ                     |
|            | band  | *pɛːn.tiː,*pɛː.niːt | pɛːn                    |
| Glide-stop | mike  | *maːj.kʰiː, *maː jiːk | maːj                  |
|            | loud  | *laːw.ti           | laːw [NB: HKE example: Hung ) |

Suppose these stops are perceived, but a low priority is placed on their retention, proportional to their perceptibility (Steriade, 2001; Wilson, 2001; Shinohara, 2004[9]). Then we encounter a problem: if they are perceived, no OT grammar can ever prefer [kaː.siː] to *[kaː.siːt], because the former will always incur one more violation of MAX, and they will tie on all other constraints [contra Yip, 2002]. Note that NOCODA cannot be appealed to here, since loans like Jack > [tsɪk] show that MAX >> NOCODA. We are thus forced to conclude that the final stops in CC clusters are not perceived.]

Yip's remark about the ranking between MAX and NOCODA is correct. But there seems something peculiar about epenthetic vowels in a closed syllable, and this must be independent of the MAX-CONSONANT ranking (i.e., MAX ranking depending on the perceptibility of the type of consonant in particular segmental sequences, a simple example is MAX-[s]/_# >> MAX-[d]/_#; see Steriade 2001; 2008, Shinohara 2006). There is a relationship between syllable structure and the prominence of the epenthetic vowels. That is, epenthetic vowels are constrained to have more structure that may amplify their presence. Epenthetic vowels in open syllables are more inconspicuous than ones with coda in the same sense as short epenthetic vowels are more inconspicuous than long vowels, or epenthetic vowel without accent is more unobtrusive than accented ones. All is by virtue of being associated to simpler structures. Thus, there should not be a coda for an epenthetic syllable.

It predicts that there is no consonant gemination after an epenthetic nucleus. We shall now instantiate lack of gemination where epenthetic vowels appear. Gemination is regularly observed in Japanese loanwords mostly from non-Sinitic languages. As presented in Section 2.2.1 as one of the emergent patterns in Japanese adaptation of French words, it occurs in the prefinal syllable of loanwords for source words ending in a short vowel closed with a single consonant. Here we give some examples from common Japanese loanwords from English below. A dot indicates a syllable boundary.

---

(19) Gemination for final simple coda (canonical patterns)[10]

**Source word Japanese loanword**

| | |
|---|---|
| *lip* | /rip.pu/ |
| *exit* | /e.gu.zit.to/ |
| *Bagdad* | /ba.gu.dad.do/ |
| *pack* | /pak.ku/ |
| *picnic* | /pi.ku.nik.ku/ |
| *Big Egg* | /big.gu eg.gu/ (Tokyo Dome) |

Note that similar gemination occurs in Finnish loanwords as well (*pop* → poppi, *hit* → hitti, *picnic* → piknikki, Simonović (2013)). As aforementioned (Section 2.2.1), one of the analyses for this interesting phenomenon is based on stem-final and syllable-final alignment (Tsuchida 1995), which occurs in natural languages (e.g., Axininca Campa, Bedouin Arabic: McCarthy and Prince (1993), Malay: Teoh (1987)). The particularity in loanword phonology is that the stem form is only recognisable in the source word. Consequently, the analysis should refer to the stem end in the input form.

(20) (Repeated from (9))

ALIGN RIGHT (Stem, R, Syllable, R): The right edge of the stem in the input must be aligned with the right edge of the syllable in the output.

This constraint dominates DEP-μ (= Do not insert a mora.) to yield a geminated output.

(21) *picnic* /pɪknɪk/ → /pikunikku/

| pɪknɪk# | ALIGN RIGHT | DEP-μ |
|---|---|---|
| pi.ku.ni.ku | *! | |
| ☞ pi.ku.nik.ku | | * |

The gemination does not occur in the prefinal syllable when there is a cluster in the final syllable in the original words (22a). The generalisation holds for loanwords from other source languages as well. Nevertheless, it can occur in the antepenultimate syllable in some type of clusters, namely those ending in /s/, /r/ and /l/ (22b) (more examples in Shinohara (1996)).

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[10] There is some variability in multi-morphemic words and source words ending with certain segments. The gemination only occurs variably in prefinal syllables ending with one of the following consonants: /s/, /r/, /l/ or a labial consonant (readers are referred to papers cited in Kubozono (2013)).

(22)

a. No gemination for final complex coda (canonical patterns)

**Source word Japanese loanword**

*act* /a.ku.to/, */ak.ku.to/, */a.kut.to/, */ak.kut.to/

*abstract* /a.bu.su.to.ra.ku.to/

*manifest* /ma.ni.ɸe.su.to/ */ma.ni. ɸes.su.to/, */ma.ni. ɸe.sut.to/

b. Gemination for final complex coda (exceptional patterns)

*deluxe* /de.rak.ku.su/

*litre* [litR] /rit.to.ru/ 'liter, Fr.'

*waffle* /waf.fu.ru/


In (22a), */ak.k*u*.to/ for *act* is ill-formed. Obviously, the form does not satisfy the stem-syllable alignment. The ill-formedness of */a.k*u*t.to/ must be explained since it can still satisfy ALIGN RIGHT. I claim that this is the case when the epenthetic vowel's prominence would be amplified by a coda.

Reason for the irregularity in (22b), on the other hand, is not clear. The final consonants must be somehow invisible to the prosodic structure in the adaptation process. I suspect that it is due to their status in Japanese internal phonology since all of them are related either to insertion or to deletion process in morpho-phonology or in historical change. Recognising the patterns in (22b) as exceptions, the canonical patterns are: 1) short vowel + single consonant resulting in gemination, as in (19); and 2) final clusters resulting in simple vowel epenthesis without gemination, as in (22a).

According the analyses presented in the preceding sections, epenthetic vowels should not appear prominent. If we apply this principle to the present case, a syllable with a coda is more prominent than one without. The basic principle is the following.

(23)

Do not amplify a sound lacking an input correspondent.


The above principle is achieved by placing the following constraint in a dominant position in the present case.

(24)

*STRUC-TO-Ø: Do not add any structure on an element absent in the input.

(25) /ækt/ → akuto

| | ækt# | *STRUC-TO- Ø | ALIGNRIGHT | DEP-μ |
|---|---|---|---|---|
| a.kut.to | | *! | | * |
| ☞ a.ku.to | | | * | |

This is a case where prominence is defined in terms of phonological structure. The vowel /u/ itself has the same sub-segmental features in /akuto/ and /akutto/, thus, they are phonetically equivalent. Note that the vowel duration is not necessarily shortened in the closed syllable in Japanese. It is known that the vowel duration in a syllable closed by a geminate consonant is even longer than the one in open syllables (e.g., Ofuka *et al*. 2005).

## 2.4 No phonetic mapping but matching patterns to existing loanwords

Long historical contacts between two languages can create a standard, or conventionalised loanword adaptation. Korean presents L2 phoneme to L1 phoneme mapping patterns, as seen in the English word adaptation examples in (26).

(26)

Korean adaptation of English voicing contrast:

| English | | Korean loanword | |
|---|---|---|---|
| |paɪp| | → | /pʰaipʰɯ/ | pipe |
| |spiːkə| | → | /sɯpʰikʰʌ/ | speaker |
| |gaɪd| | → | /kaitɯ/ | guide |

(Kim 2005, Shinohara *et al.* 2011: 1465)

In Korean adaptation of English voicing contrasts, regardless of the degree of aspiration, English voiceless stops are adapted into 'aspirated' category, and voiced stops are adapted as 'lenis' category in Korean. Phonetically speaking, the short lag of VOT in /p/ in *speaker* should correspond to 'lenis' in Korean. Thus, from these data, we understand that the allophonic variation is not involved in the adaptation process.

Puzzling loanword adaptation patterns were recognised in a series of studies on the adaptation between three-way Korean stop consonants (lenis /tal/ 'moon', aspirated /tʰal/ 'mask' and fortis /t'al/ 'daughter') and two-way systems (i.e., [+] or [–] voice as in French /pa/ *pas* 'step' versus /ba/ *bas* 'below'). The patterns were inexplicable with perceptual mappings between phonetic features of L1 and L2. In the data below, Japanese voiceless categories are adapted as 'lenis' in word-initial, and 'aspirated' or 'fortis' in intervocalic position. Tones on each mora are indicated by H(=high) and L(=low) to show that pitch in

Japanese inputs has no effect on the choice of consonants in Korean.

(27)

| Japanese | | Korean loanword | Gloss |
|---|---|---|---|
| |tanaka takeo| LHH LHH | → | /tanak'a tak'eo/ | 'personal name' |
| |tanaka kakuee| LHH HLLL | → | /tanakʰa kakʰuei/ | 'a former prime minister name' |
| |katoo kijomasa| HLL LHLL | → | /kat'o kijomasa/ | 'personal name' |
| |kami-kaze| LHLL | → | /kami katse/ | 'Divine wind' |

(Kim and Shinohara 2006, Shinohara *et al.* 2011: 1464)

A carefully designed perception test revealed that Japanese voiceless plosives are perceived as 'aspirated' in both initial and intervocalic positions in CVCV stimuli. This implies that these loanwords do not reflect perception. Perhaps deviation was achieved through standardised adaptation imposed on the grammar of loanwords. That is, loanwords follow the regularities found in previously integrated loanwords rather than reflecting perception of real L2 sounds. This pattern was also witnessed in Korean loanwords from French. French voiceless stops are often adapted as aspirated consonants in Korean (e.g., /pʰari/ 'Paris'); however, our experiment showed that they are mostly perceived as fortis consonants. In this case, aspirated adaptation is thought to mimic Korean adaptation of English words, whose voiceless plosives are always adapted to be aspirated. This kind of discrepancy was also found in other studies (e.g., de Jong and Cho 2012). As a result, phonology of loanword adaptation seems to have shifted its focus from a long-standing issue of phonetic versus phonological adaptation to sociolinguistic language evolution during a relatively short time span (Kang 2010 *et seq.*). We treated these discrepancies as the effect of Output-Output constraint in OT terms.

## 2.5   Learning a loanword adaptation grammar

The last study of the series, on the Japanese adaptation of Korean laryngeal contrasts, reached a similar conclusion in that standardisation plays an important role. Japanese renditions of Korean words and phrases introduced (mostly after the year 2000) into Japanese culture were studied with the Korean wave, *hanryuu*, as the background. Thus, data were mostly recent Korean personal names, product and place names from travel guidebooks and commonly used words. Shinohara (2015) demonstrated that not only is a Korean contrast referred to in the adaptation process but also a new grammar can be acquired for loanword adaptation.

The focus was on the laryngeal contrast. In Korean, unlike Japanese, the voicing of plosives and affricates is not contrastive; they are all voiceless on the surface except for lenis being voiced in the intersonorant environment. This Korean voicing alternation applied to Japanese adaptation of Korean phrases. For example, a protagonist given name |tsunsaŋ| *Kang*

*Joon-sang* in the Korean drama *Winter Sonata* is pronounced with a voiceless affricate in phrase-initial position [tɕunsaŋ] and with a voiced affricate [dʑunsaŋ] after the family name |kaŋ| in Korean. These forms are adapted as /tɕuNsaN/ (given name) and /kaN ʑuNsaN/ (full name) in the dubbed or subtitled Japanese version. Both given name forms, one with the voiceless prepalatal affricate /tɕ/ and the other with the voiced counterpart fricative /ʑ/ (i.e., [dʑ] is an allophone of /ʑ/), appear in phrase-initial position and after the surname |kaŋ|, respectively. Voicing alternates for a given name in this position. At first glance, it is not clear whether the given name has a single representation that alternates in voicing on the surface, as in Korean or whether the voicing patterns merely reflect the Korean realisations of lenis voicing on the phrasal level. However, importantly, other word sandhi phenomena (manner assimilation and resyllabification) are ignored in Japanese adaptation; only the voicing alternation is respected at the word boundary. These data are hard to reconcile with a model assuming a direct L1 influence in the categorisation of L2 sounds (Peperkamp and Dupoux 2003) as well as with a model of phonological mapping between L2 and L1 phonemes (Paradis and LaCharité 1997). Instead, we need a grammar specifically applied to Korean phrases.

To correctly realise the voicing rule, input specification for the lenis is essential. It follows from this that the adapters are aware of the underlying forms for each part of the phrase, and the two parts have independent representations. This is similar to the Korean adaptation of complex English words where the two parts have independent representations and when put together they undergo segmental alternation, while in mono-morphemic words such alternations are absent (Oh 2012). To support our case of alternation, I have provided some examples, which argue that non-native contrasts can be learned when they appear in varying contexts. The relationship with *Rendaku* (the sequential voicing in Japanese compound words) is also discussed in Shinohara (2015).

This phenomenon may depend on certain conditions characterising the contact between the two languages. Massive contact with the same foreign language inputs for a certain period of time may regulate the loanword outputs. Kang (2010a) argues that phonetically faithful adaptations and more variants are found in the early stage contact of Korean with English, but they may shift at a later stage to more regular patterns.

## 2.6   Listening to L2 segments

In this sub-section, I will present interlanguage perception studies developed with my collaborators.

A perception study of French consonant clusters by Japanese listeners tested the mapping between prosodic and segmental prominences (Kamiyama and Shinohara 2010). The avoidance of placing Japanese pitch accent on epenthetic vowels was systematically observed

in French word adaptation data (Section 2.2.1, Shinohara 1997b; 2000; 2004). The hypothesis of the perception study presented the opposite type of mapping: high-toned position is prosodically prominent in French phrase and it enhances segmental contrasts more than a low-toned position. As predicted, high-toned position reduced inaccurate perception of consonant clusters by the L2 listeners.

Another topic on interlanguage phenomena involved L2 segment perception of the four Punjabi liquids /ɾ ɽ l ɭ/ and two stops /d ɖ/. Well documented in perception studies, Japanese speakers present difficulty discriminating English r/l because Japanese has only one category of liquid sound (e.g., Yamada 1995). A hypothesis for low rates of correct categorisation is attributed to a lack of usage of the third formant frequency (F3) (e.g., Iverson *et al.* 2003). Is it then true that Japanese speakers do not make use of lower F3 as a cue? A study on perception of retroflex plosives, on the other hand, showed an advantage of Japanese speakers having the retroflex stop (as an allophone of /r/) over American listeners not having it (Pruitt *et al.* 2006). Punjabi retroflex segments were included in the study because they induce distinctively low F3 in the preceding vowel compared to alveolar rhotics. We first tested Japanese listeners to observe the role of retroflex sounds in the stimuli of discrimination task (Shinohara *et al.* 2015). The Japanese listeners showed a discrimination pattern: liquid-/d/ contrasts (easy) > liquid-/ɖ/ > /d/-/ɖ/ > liquid-liquid (difficult). After this study, we tested Mandarin listeners, possessing a two-way liquid contrast (/l/-/ɻ/), and a dental versus post-alveolar (traditionally referred to as 'retroflex') contrast for fricatives and affricates, but not for stops (Lin 2007). Mandarin Chinese listeners showed a gradual pattern within and between each of the following categories: lateral-stop > liquid-liquid > tap-stop > dental-retroflex. Overall, Mandarin Chinese listeners showed better perception than the Japanese listeners. Both Japanese and Mandarin Chinese listeners discriminated the lateral-stop contrasts very well. However, the Mandarin Chinese listeners performed better in discriminating the liquid-liquid contrasts, compared to the Japanese listeners. The laterality contrasts in Mandarin Chinese may have contributed to the sensitivity towards the Punjabi liquids. Furthermore, Japanese listeners showed better performance in /ɾ-d/ discrimination than the Mandarin Chinese listeners. This might be due to lack of [ɾ] as an allophone of any liquid in Mandarin Chinese. Usage of apical feature (i.e., retroflex) in fricatives and affricates did not help the perception of dental-retroflex contrasts. The results from the two populations cast doubt on the usage of individual cues in discrimination tasks. Rather, the existence of phonetically similar allophones helps listeners identify a sound in a pair.

An interlanguage production study in prosodic domain concerns moraic parsing of foreign input. A series of studies were devoted to examining the timing in Japanese production of French phrases compared to French speakers' production (Kondo and Shinohara 2003; 2006; 2009). We compared duration of utterances of French phrases where the phrases in each pair consisted of the same number of syllables, but the phrases could be potentially perceived by

Japanese speakers as having differing numbers of moras. For example, the French phrases, a) and b) have both six syllables: a) *les garçons dessinés* 'boys who were drawn' /le ɡaʀsɔ̃ desine/, b) *les gares sont dessinées* 'the stations are drawn' /le ɡaʀsɔ̃ desine/. However, in Japanese mora parsing, a) is parsed as /re, ɡja, ru, so, N, de, si, ne/ (8 moras), and b) /re, ɡja, a, ru, so, N, de, si, ne/ (9 moras) (a comma indicates a mora boundary). The results suggest that Japanese speakers parse sound sequences by the mora, and also use the mora rather than the syllable for durational control when they speak French. This tendency is clear in the experimental environments in which the French vowels were analysed as potentially bimoraic. Since Japanese phrase duration is proportional to the number of moras, the durations of French phrases uttered by Japanese speakers depended on how phrases were analysed in terms of the mora. Only when there was difference in the mora count, did the phrase duration differ. Previous studies have been unable to agree at which level in the prosodic hierarchy the timing compensation occurs for timing control in native French speech. In our study, the phrase durations of native French speakers was proportional to the number of syllables in each phrase. Hence, phrase-level compensation occurs according to the numbers of syllables present.

The theme of L2 perception concerns also several studies with graduate students of which the details will not be presented here. Summaries are found in *Liste des activités d'encadrement*.

## 3   Phonetics and phonology of Ryukyuan and Japanese dialects

While working at Sophia University in Tokyo, I began studying phonetics and phonology of Japonic (Japanese and Ryukyuan) dialects, which I will introduce in the context of my research and social interests. These topics continue to be my current research projects and will be also presented in *Perspectives scientifiques*.

### 3.1   Purposes and background

Topics on Japonic dialects are related to my long-term interests in phonological patterns formed by interaction between segmental features and prosodic positions. Gemination patterns (segmental and positional restrictions on gemination) are diverse across Japonic dialects and are of particular interest. As described in dialect studies and historical linguistics since the 1950's (e.g., Hattori 1959, Fujiwara 1964) after the earlier development of Japanese philology, cognate word forms evolved taking different paths over at least 1500 years (i.e., it is the time known from written sources, but it could be much longer). Old Japanese is known as an open syllable language, but it has developed various forms of consonant gemination across dialects. In Tokyo Japanese, gemination is restricted to nasal or voiceless consonants. There are also dialects where morphological concatenation yields the 'marked' voiced geminates. For instance, /sijor/ 'do-progressive' followed by /bai/ 'sentence ending particle'

gives /sijobbai/ with a voiced geminate in Chikugo Japanese. In some dialects, vowel devoicing and gemination seem to have occurred in similar segmental and prosodic contexts (Section 9.2). High vowel devoicing between two voiceless consonants is a common phonological alternation occurring in eastern and southern Japanese dialects, Ryukyuan dialects and also Canadian French. Where vowel devoicing is the precursor of gemination, only voiceless geminate obstruents are predicted. In another case, vowels and approximants might turn to consonantal sounds and create homorganic consonant sequences. This case will result in voiced geminates. For example, the first consonant of the form /zzu/ 'fish' in Karimata Miyako Ryukyuan is derived from a high vowel (/*ɿwu/ in Proto-Miyako Ryukyuan (Pellard and Hayashi 2012: 24)). The following questions therefore arise: What are the scenarios of gemination development? Are there phonetic driving forces?

Dialectologists have written down the forms with phonetic alphabets, however, it is only recently that we have been able to record audio and physiological data to do fine acoustic and articulatory analyses. Together with development in phonological theories, these methods allow us to study the synchronic sound system of a given dialect, along with comparisons among different systems. We can expect that phonetic patterns tell us about the direction of changes. By the time this technical development arrived, these dialects had already begun to die out. UNESCO recognises Amami, Kunigami, Miyako, Okinawan, Yaeyama and Yonaguni as (independent) Ryukyuan languages. All of them are considered to be endangered by UNESCO in 2009. Thus, there is an urgency to collecting and documenting data. I collected data on some aspects of two varieties of Ryukyuan (Tedumuni Yaeyama Ryukyuan and Ikema Miyako Ryukyuan), along with Kyushu (Yanagawa and Kumamoto) and Tokyo dialects of Japanese between 2010 and 2018.

Ryukyuan languages belong to the Japonic family and are related to Japanese. *Ryukyu* is the name of the kingdom that unified islands scattered in a vast area of the Pacific in the 15th century, which is currently the Okinawa prefecture and part of Kagoshima prefecture of Japan (for an overview on history and structure of Ryukyuans, see Shimoji 2010, Karimata 2015, Pellard 2015). In our study (Shinohara and Fujimoto 2011ab), the status of initial geminate consonants was examined in relation to prosodic structure in the Tedumuni dialect of Yaeyama Ryukyuan, an extremely endangered language (see Figure 4). This was part of the collaborative project with Masako Fujimoto and was sponsored by SOLIFIC (Sophia Linguistic Institute for International Communication, Sophia University). With the reinforced common language education in the beginning of 20th century, speakers of the dialect could also speak standard Japanese. However, the next generation no longer used the dialect. While there has been linguistic descriptions of this language (Kajiku 1996-2002, Makoto Kuno 1990, Mariko Kuno 1990, among others), our phonological study based on acoustic analyses is, to our knowledge, only the second one after Lawrence (1999), which observed formants and duration of central vowels of a single informant. At the time of our recordings in 2010,

there were over 20 speakers of which the most of them in their 80s. Even though the dialect has experienced movements of being revived on the island of a little over 300 inhabitants, at such events, the grandchildren of the native speakers sometimes make the native speakers laugh with their mispronunciation. Thus, although the language may still be understood by the younger generation, the need to record the sounds and study the sound structure with the native speakers is urgent. In response to the desire to preserve the identity of the inhabitants of the island, we used the term *Tedumuni* to designate the dialect. *Tedumuni* [tedumuɲi] is the name of the language in the dialect. The first time that this name was published in English was at the *International Congress of Phonetic Sciences* in 2011 when we presented our paper. The language used to be called the dialect of *Taketomi-jima* ('Taketomi Island' in Japanese). In the dialect, *muni* means language and *Tedun* [te:duN] (N denotes a placeless nasal glide) is derived from [taketomi].[11]



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Figure 3 Location of Taketomi Island

## 3.2   Summaries of my recent research on Ryukyuans

This section will outline the actions taken during the early stages of the project. Since there was an urgent need to record the sounds of this language, the first collaborative work was to transcribe the previously recorded data in 1996 by Fujimoto, with the aid of spectrograms at times (Fujimoto and Shinohara 2010; 2012). This was done to verify certain issues in our

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[11]  Tedumuni has three basic vowels /a i u/ and /e o/ derived from vowel hiatus, for instance, /ai/ → [e:]. (For discussion on reduced vowel /ə/ in Tedumuni, see Lawrence (1999) and references therein.) These mid-vowels are long but there is usually no contrast in length. /take/ must have been reduced to [te:] after the deletion or weakening of [k] and /tomi/ must have transformed to /duN/ with vowel raising and apocope, giving teduNmuni~tedumuni when suffixed with muni.

predecessors' descriptions, such as presence of glottalisation before voiceless stops or existence of the central vowel as described in earlier studies with a large amount of variation (Makoto Kuno 1990, Lawrence 1999). We did not recognise these sounds and decided to exclude them from transcription of our informants' pronunciation while keeping nasalised vowels in certain lexical items. The discrepancies might be due to generational and individual differences, as Lawrence notes that his informants were born in 1911 and 1912 whereas the five informants recorded in 1996 were born between 1928 and 1947.

While the first recording was to verify some of the characteristics described in the previous literature, the main focus of the project was to examine the nature of initial geminate consonants. The initial geminate consonants of Tedumuni were analysed in conjunction with pitch accent location. We embedded 85 existing words, including ones with initial geminates of different length and syllable structures, into test phrases. Unlike Tokyo Japanese, the pitch accent falls on a fixed position in Tedumuni nouns, namely, on the syllable containing the second mora from the beginning. Thus, in the accented class of words, the location of accent can tell us whether or not the first halves of initial geminates count as a unit for determining the pitch accent location. A moraic onset in Tedumuni was identified not only in the initial geminates but also in a variant pattern of word medial geminates. The analysis is presented in Section 7.

For the next SOLIFIC project in 2012, we recorded Ikema Miyako Ryukyuan on Miyako Islands. This dialect has a greater variety of initial geminate obstruents. It also has typologically rare voiceless nasal geminate consonants and a fricative vowel. After working on acoustic data, which indicated full voicing of voiced geminates, to better understand the articulation of geminate consonants, we conducted real-time magnetic resonance imaging (rt-MRI) of two speakers of Ikema Ryukyuan in 2014. There are several merits for using the rt-MRI. First, we can observe the consonant duration of otherwise silent initial geminate plosives. Second, the contact areas in the oral cavity of geminate and singleton consonants can be compared. The results may explain some of the acoustic differences other than duration between the two. Finally, it can visualise movements of tongue dorsum, velum, pharynx and larynx to explain the mechanism of full voicing during voiced geminate obstruent articulation. Pharynx expansion was found to enable full voicing during geminate obstruents in Ikema Ryukyuan, the results of which are presented in Section 8.1. To compare the articulation patterns of voiced geminates with mid-Kyushu Japanese, two speakers of Kumamoto dialect participated in rt-MRI recording in 2015, with the support of Sophia University Phonetics Laboratory. Although acoustic analysis did not indicate full voicing during voiced geminate articulation in Kumamoto Japanese, our preliminary analysis recognised pharyngeal expansion in rt-MRI in this dialect too. Thus, voicing gesture is present even when the sound wave does not indicate full voicing. We also recorded 5 speakers of Yanagawa Kyushu Japanese (a close dialect to Kumamoto) and 10 Tokyo

speakers in 2016. We used the same set of non-words containing voiceless and voiced obstruents in singleton and geminate contexts along with real words and phrases in each dialect. Partial results of the acoustic investigation are presented in Section 8. To supplement the analysis of voicing during geminate consonants, electroglottography (EGG) and airflow data were obtained for Ikema Ryukyuan and Tokyo Japanese in 2018 as a part of Labex-EFL project. A comparison of voicing patterns among dialects will be interpreted from the perspective of phonological contrast when analyses are completed.

In addition to the geminate consonants, the articulation and acoustics of four vowels /a, i, u, I/ in Ikema Ryukyuan were observed by rt-MRI. The vowel represented by /I/ has aroused phonological and phonetic debates: whether it is a vowel or consonant; and how it is articulated. This vowel has been variably described and transcribed as a 'central' vowel, /ï/ (Uchima 1984) and /ɨ/ (Hayashi 2010), or 'apical' vowel, /ɿ/ (Sakiyama 1963a, Sakiyama 1963b cited in Oono *et al.* 2000; Pellard and Hayashi 2012). Our study results posit that it is articulated at the further front part of the oral cavity than the hard palate with the front of the tongue, while at the same time it has a central acoustic quality on second formant axis without much friction noise (Fujimoto and Shinohara 2018b). This vowel occurs after a homorganic consonant onset /ts, s, z/ in Ikema. Other Miyako Ryukyuan dialects have radically distinct distribution of the similar type of vowel(s) (Oono *et al.* 2000, Karimata 2005, among others), which invite acoustic and articulatory as well as phonological studies across dialects.
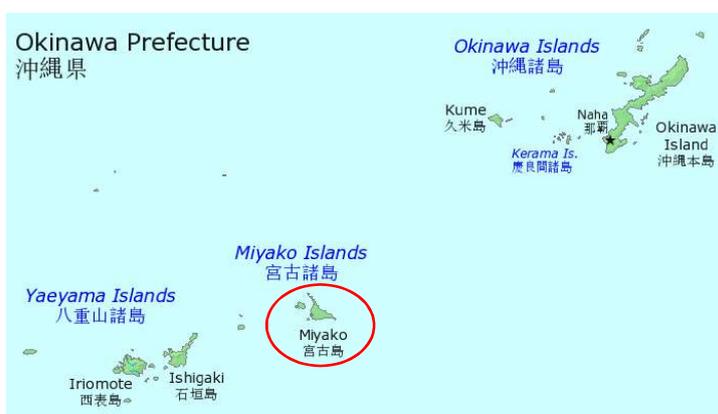


Figure 4 Location of Miyako Islands among Ryukyu Islands (https://en.wikipedia.org/wiki/Okinawa_Islands accessed on 2nd of August 2019). The red circle is added by the author.


## 4 Summary and conclusion of Part I

In Part I, I reviewed the topics and results of my past studies with a special focus on interlanguage studies and interaction between segmental and prosodic structures, namely,

perceptual salience mapping between the two. In Section 2 (Loanword phonology), we observed a number of cases where the phonological grammar leads a discreet segment to match a more unobtrusive prosodic position, and vice versa. We also observed instances where more discreet segments are less likely to be integrated into the surface forms. However, whether a given segment in a given string is retained or deleted on the surface form depends on the language. Implicational patterns across languages indicate that phonological patterns do not originate from misperception but are processed through phonological grammar based on universally fixed salience scales. Loanword phonology has developed as a field of research during the last few decades. My studies have largely contributed to this field since its early stage (e.g., Shinohara 1992; 1996; 1997ab; 2000; 2004; 2006). More of my recent studies involving Korean laryngeal adaptation (Amino *et al*. 2007, Shinohara *et al.* 2011, Shinohara 2015) have led the field of study, which have been concentrated in phonological and psycholinguistic areas in the last two decades, toward the direction of social and historical perspectives. Section 3 introduced the contexts for studying phonetics and phonology of Ryukyuan and Japanese dialects, of which the issues and first results are presented in Part II.

# Part II. *Perspectives scientifiques*

Study perspectives are broadly divided into two areas. One is phonetics and phonology of geminate consonants and other issues in Japonic dialects. Collaborative works with other researchers and aims of phonological analyses on this topic will be detailed in later sections. The second theme originates from past L2-related studies. Some remaining issues in those studies merit further investigation. It includes articulation of liquid segments.

Part II is organised as follows. Backgrounds of research themes in terms of my affiliation to laboratories, my research fields and theoretical attachment of my major studies are described in Section 5. An overview of research projects is presented in Section 6. Section 7 is devoted to presenting the results of a study of initial geminate in Tedumuni Ryukyuan dialect as an illustration of the phonetic and phonological approach. Section 8 provides another example of an extended collaboration with researchers in the field of physiological phonetics and that of acoustics. Section 9 introduces tracks to phonological analyses of geminate consonants. Section 10 presents the remaining topics.

## 5 Research locations

### 5.1 Research in the labs

While affiliated with the Laboratory of Experimental Psychology (UMR 8581, 2001-2006), I occupied a researcher position specified for the study of acquisition of first or second language. Consequently, themes related to L2 perception became the objects of study, and I continued my L2-related works during my service at Faculty of Foreign Studies at Sophia University in Japan (2006-2016). While working with students and researchers of the Sophia University Phonetics Laboratory on L2 research, I started studying the phonology and phonetics of Ryukyuans (spoken in Ryukyu Islands) and mid-Kyushu Japanese dialects. These languages exhibit gemination of various kinds. In my current laboratory (Laboratory of Phonetics and Phonology, UMR 7018 (LPP)), this topic has become my primary research theme and it is inscribed in one of the six research areas of LPP, '*Langues du monde : description et modélisation*'. The aims of this area are to document languages not previously well described, and, eventually, elaborate phonetic, phonological and typological modelisations and contribute to socio-linguistics and historical linguistics (cf. http://lpp.in2p3.fr/Langues-du-monde-description-et-modelisation). The topic is aligned with the Labex-EFL (The Laboratory of Excellence 'Empirical Foundations of Linguistics') project, Axe 1: Phonetic and phonological complexity (see

?lang=en), with which I am affiliated as a research member. My secondary theme of interlanguage phonetics and phonology has its place in '*Acquisition et multilinguisme*' of LPP. Aspects of perception and production of rhotic and retroflex obstruent sounds continue to be studied. L2 sound related themes have been popular subjects of my Master and Ph.D. students. Both themes are related to yet another research area '*Variation, organisation temporelle et traitement de la parole (Phénomènes de coordination dans la production et perception de la parole)*', as they both involve allophonic variation and prosodic aspects.

## 5.2 Research field

More generally, among diverse research fields of speech sounds, I would like to locate my main field of research of the next several years at the interface between phonetic properties of segments and their prosodic positions assigned by the grammar. The aim in a broader perspective is to provide empirical and analytical substances to the field of theoretical phonology, which defines possible human language structures. The topics concern dialectal variation of Japonic languages with a special focus on gemination. While the main purpose is to investigate the synchronic state of a language, when comparing the similar phenomena across dialects it will be inevitable to consult historical dimension at times. By examining phonetic details and how certain sequences have developed, I would like to consider typological aspects of segmental sequences in the languages.

## 5.3 Theoretical position

I will address broad theoretical matters in phonological grammar and phonetics. As demonstrated in Part I, I assume that mechanisms underlying speech sound production and perception participate in shaping abstract grammatical structures. The idea has largely gained ground in constraint-based phonological theories: MARKEDNESS constraints or MARKEDNESS scales are often backed by articulatory mechanisms (Hayes 1995, Prince and Smolensky 1993/2004, Hayes and Steriade 2004); perceptual properties of sounds are also reflected in phonological patterns (Flemming 1995/2002, Steriade 1997, Hume and Johnson 2001). Importantly, however, the impact of sound production and perception patterns on phonological grammar appears to be an indirect one, counter to the views of sound change by misperception (Ohala 1981; 1989; 1993, Blevins 2004). Extensive work by Ohala and his colleagues and students has supported the notion that listeners interpret phonologically ambiguous sound sequences in the way not intended by the speaker. Their work is very insightful in that certain segments and sound sequences are easily confused because of their acoustic properties, and it could well be the case that individual sound sequences propagate in listeners' misperceived versions of sound representation, to cause historical sound changes in the community. However, there are implicational patterns across languages that cannot be

explained solely by misperception. We witnessed in Part I that phonetically natural alternations of final cluster reductions do not occur in the same way across languages. Distinct deletion patterns in each language indicate that faithful retention of consonants (often with a vowel epenthesis) is required at a particular point within the universally defined salience scales, and this point is variable depending on the language. The view in which certain phonological rules are based on phonetics while at the same time fossilised in the grammar has invited criticism of 'duplication problem' (cf. Blevins 2004). As such, if an alternation is not learnable from native patterns, which is the case of emergent interlanguage phenomena, the alternation cannot be grammar-based. While such criticism may be justified when one only thinks about historical changes or phenomena within a single language, again, implicational phonological patterns in cross-linguistic data as well as synchronic alternations repel misperception hypotheses for our cluster reduction cases. Another aspect in sound transmission and change is that the impact of phonetics is admittedly incomplete: not all phonological patterns are constructed on phonetics.[12] Relatively recently, computational approaches to phonology have confirmed that certain alternations are regularised by existing patterns' frequency no matter if they are phonetically natural or not (Coleman and Pierrehumbert 1997, Hayes *et al.* 2009, among others). Loanword adaptation of English vowels into Korean found that the patterns are even controlled by a factor unrelated to input sounds: the orthography (Daland *et al.* 2015). Phonological alternation is also known to be governed by morphological paradigmatic uniformity, independently of phonetic motivation (cf. OUTPUT-OUTPUT FAITHFULNESS and BASE-REDUPLICANT IDENTITY by McCarthy and Prince 1995). Thus, grammar should contain components for treatment of input referring to their sound properties as well as for pattern-matching to the stored forms. The former can be substantiated in phonetics-phonology interface studies, while the latter can be pursued in frequency-based models. My projects concern the former.

## 6 An overview of perspectives

### 6.1 A brief introduction to geminates in Japonic languages

Tokyo Japanese is known as a moraic language, where the coda is restricted to the first half of a geminate, /hap.pa/ (a dot indicates a syllable boundary) [hap:a] 'leaf' or a placeless nasal, /paN/ [paŋ] 'bread.' Japanese introduced contrastive gemination to words through compounding, whereby underlying final consonants in /VC#/ sequences underwent gemination with an initial consonant of the second morpheme /#CV/ (e.g., /it#ɕo/ [iɕɕo]

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[12] This should not be understood as counter argument to Ohala's view. He admits that sound change can occur by the causes presented hereafter (Ohala 1993; 1998).

'together' versus /i#ɕo/ [iɕo] 'testament'). Acoustic timing of geminates of Tokyo Japanese is well studied (Han 1962; 1994, Homma 1981, Beckman 1982, Sagisaka and Tohkura 1984, Port *et al.* 1987, Idemaru and Guion 2008). Since Japanese developed from Old Japanese consisting only of CV syllables, geminates have developed through phonological processes. Types of geminate segments occurring in Japanese depend on lexical classes as well. Gemination of voiceless obstruents occurs mostly across morphemes in Native and Sino-Japanese classes, and within morphemes in Mimetic and Loanword classes (see Ito and Mester (1995) for stratification of Japanese lexicon). The inventory of segment types appearing as geminates varies across dialects. Geminate consonants in Tokyo Japanese are limited to voiceless obstruents and nasals, while many Japonic dialects have richer sets including typologically rarer voiced obstruent and word-initial geminates. Voiced geminates are used in the Chikugo and Kumamoto areas of Kyushu in the western part of Japan. It is unclear in certain Japanese dialects whether voiced geminates (e.g., /tɕik#go/ [tɕiggo], 'name of the mid-Kyushu varieties of Japanese') are post-lexically derived from the epenthesised forms (e.g., [tɕik-u-go]), or morpho-phonologically derived, and whether they differ phonetically from non-alternating geminates (i.e., /it#ɕo/ [iɕɕo] 'together' has no other way of pronunciation, but /tɕik#go/ can be pronounced [tɕiggo] or [tɕikugo]). The occurrence of word-initial geminates is characteristic of many Ryukyuan dialects. For instance, Tedumuni in the Western end of Ryukyu possesses initial voiceless geminate plosives with three places of articulation, while Miyako Ryukyuan has initial and medial voiced obstruent geminates with more asymmetric places and manners. We add another type of gemination, the 'phonetic geminate', presumably resulting from undershooting of vowels (i.e., not by morphological operation) to the inventory of geminates. This type is recognisable in the study of spontaneous speech of standard Japanese (Fujimoto and Maekawa 2014). We could compare this phonetic geminate with certain derived geminates in Chikugo and Kumamoto dialects to understand how certain types of geminates could have developed. More details will be given in subsequent sections.

## 6.2   Aims and issues in geminate studies

Cross-linguistic perception and production studies have shown that geminates are 'long' consonants that differ from their singleton counterparts in terms of duration (Abramson 1987, Lahiri and Hankamer 1988). Blevins (2004) argues that the geminate consonants can arise in a number of ways. As she rightly points out, we observe that lexical and morphologically conditioned geminates seem to originate from assimilation of consonant sequences and, less commonly, assimilation of a consonant and a vowel sequences, vowel syncope and enhancement/reinterpretation of voicing contrast by duration. In addition to these, moraic affixes are also realised as geminate consonants (explained in Section 9.2). From a phonological perspective, studies of geminates have two objectives. One is to define

functions of length contrast, and those of laryngeal contrast when relevant, within each language; the other is to consider origins of gemination across languages in terms of morpho-phonological alternations and phonetics in relation to interaction between segmental and prosodic prominence.

I have undertaken topics on phonological, acoustic and articulatory studies of gemination in Japanese and Ryukyuan dialects in collaboration with researchers at various institutions. The study involves fine phonetic examinations of geminate consonants in dialects of Japanese spoken in mid-parts of Kyushu (Shinohara *et al.* 2018) and dialects of southern Ryukyuans (Fujimoto and Shinohara 2011 *et seq.*). The study results will be compared to phenomena in related and unrelated languages in my future studies.

Since most Ryukyuan dialects are understudied, the documentation and verification of certain aspects reported in the literature will be the first goal. Unlike Japanese, Ryukyuans are not written languages. Transliteration of Ryukyuan dialects has not been standardised. The reason is, first of all, that there are many sounds particular to Ryukyuans which are not possible to faithfully represent with the Japanese *kana* writing system. Even using phonetic symbols, phonetic descriptions in the literature seem to vary not only by sound perception but also by particular phonological analyses. Especially, analysis of syllable structure may enormously depend on whether a theoretical framework taken by the researcher recognises a consonantal syllable nucleus or a moraic onset for initial geminates. Thus, the phonetic and phonological status of geminates (or long consonants, to be neutral) will be examined in light of current phonological theories. Furthermore, they will be compared with geminates in other languages such as Berber, Arabic or Indo-Aryan languages studied by one of the collaborators.

Focus will be put on the voicing patterns of obstruents. The distribution and realisation of voiced obstruents in geminates vary. Since voiced obstruents are considered to be marked because of physiological constraints, voiced initial geminate obstruents are multiply marked. Voicing patterns may require articulatory as well as functional explanations. We have started to collect and analyse articulatory data of Japanese and Ryukyuan dialects by MRI, EGG and airflow. The existence of voiced geminate obstruents may impact how voiceless counterparts are produced. If there are lexical contrasts of geminates due to voicing, which is clearly the case in Ikema Ryukyuan, an enhanced perceptual contrast is expected on the laryngeal dimension. If, on the contrary, lexical contrast by the voiced geminates is not evident in a language, such as Tokyo Japanese, the voicing pattern itself might be ambiguous (cf. 'intermediate contrast' by Hall 2013). We have begun comparing voicing patterns in terms of contrast in phonological system across languages. The study may enable us to predict possible phonological changes currently taking place in those and other dialects.

As a second step, I endeavour to determine if there is any phonetic difference among geminates created by different processes in mid-Kyushu dialects. Frequent gemination in

phrase formation in these dialects leads to ambiguity over whether they come from a phonological process or from a fast speech phenomenon as the one occurring in Tokyo Japanese (Fujimoto and Maekawa 2014). In certain languages, phonetic differences have been reported in derived geminates versus lexical geminates (e.g., Italian: Payne 2005, Tashlhiyt Berber: Ridouane 2007). In Japanese, since a timing characteristic of (phonological) geminate consonants manifests itself as lengthening of preceding vowel (Campbell 1999, Han 1994, Kawahara 2005; 2006, Fujimoto and Maekawa 2014), presence or absence of this lengthening may indicate whether gemination is phonologically induced. Such lengthening was not observed in geminates created through vowel deletion across a word boundary (i.e., phonetic and false geminates presumably caused by fast articulation) in spontaneous speech in Tokyo Japanese (Fujimoto and Maekawa 2014).

At the final stage of the series of geminate studies, I would like to consider processes that create geminates from theoretical and typological perspectives. This topic is most directly linked to the second theme presented in the very beginning of this thesis: Interaction between segmental and prosodic structures. It appears that the same structure, #CCV, of the initial voiceless geminates in Tedumuni and the initial voiced geminates in Miyako Ryukyuan, is formed through different processes. Different inventories of geminate consonants are related to respective historical change and phonological structure. The relation between vowel devoicing and gemination within and across dialects will be considered to understand how voiceless initial geminates were formed in Ryukyuans.

I mention two studies of my doctoral students that have a potential impact on my current research (my students' studies are summarised in the part '*les activités d'encadrement*'). For studies on dialects, generational sound change and language/dialect attrition are important issues. Currently, I advise a doctoral student's dissertation on pitch accent change among generations in South Kyunsang Korean. Better understanding the intricacy between sound change and variant sound patterns will be beneficial for Japonic dialect topics. Another student's study on perception and articulation of initial consonant clusters will provide some insight into processes of geminate formation in languages. In 2019, a former student at Sophia University finished her Ph.D. dissertation on initial consonant cluster perception. She conducted analyses on cue weighting in perception of Russian and Hebrew initial clusters (/tl, dl/) inexistent in listeners' L1. Feature trade-off in the cluster perception may consequently affect how clusters are reduced to geminates during language developments.

## 6.3    Data collection

Our data are collected through field works, but we may use, where relevant, recorded corpora available to us, such as the Corpus of Spontaneous Spoken Japanese (Furui *et al*. 2000) and ones in Speech Resources Consortium (http://research.nii.ac.jp/src/en/index.html, last

accessed on 14th October 2019). We collected audio and articulatory data on Ryukyu Islands, in Kyushu and in Tokyo. We studied the prosodic structure of initial geminates from the severely endangered Tedumuni dialect of Ryukyuan on the basis of acoustic study of a controlled corpus of five speakers in 2011 (funded by SOLIFIC, the results presented in Section 7). In the succeeding year, we made audio-recordings of the Ikema Miyako Ryukyuan dialect of five speakers. We also recorded the MRI of two speakers of Ikema and two speakers of Kumamoto (funded by SOLIFIC). Finally, to deepen knowledge on the articulatory aspect of voicing, we recorded audio, EGG and airflow data of 10 speakers of Ikema, 2 speakers of Kumamoto and 10 speakers of Tokyo in 2018 (funded by LPP and Labex-EFL). With regards to fricative vowel presented below and in Section 10.1, another data collection is planned for spring 2020 (aided by the Mitsubishi Foundation and Labex-EFL).

### 6.4    Other research topics

Apart from geminates, there is an interesting fricative vowel in Miyako Ryukyuan (Section 3.2). A front high vowel with some frication noise, /I/, is spread among Miyako Ryukyuan dialects, but its realisation and occurring contexts vary across dialects. Fricative sounds appearing in syllable nucleus position are rare but witnessed in several unrelated languages. The one in Miyako Ryukyuan is interesting in many aspects. There is controversy whether it is a consonant or a vowel, and whether it is a central or an apical articulation. We can ask questions about why the occurrence is variable across Miyako sub-dialects, how it occurred, and if there are typological tendencies of co-occurrence with the preceding consonant across languages. Some results and a study plan are presented in Section 10.1.

An issue was identified in interlanguage studies of Punjabi retroflex liquid perception presented in Section 2.6. The study concerned how liquid and retroflex sounds are perceived by Japanese and Mandarin Chinese speakers. In interpreting the perception study results, we realised that articulations of liquid variants in Japanese are not sufficiently studied to define their tongue tip and release features. If we have a better understanding of liquid realisations in single-liquid languages (Japanese, Korean and possibly Chinese), outcomes will contribute to studies of feature systems in phonology. It may also be applied to second-language teaching. Perspectives are summarised in Section 10.2.

## 7    A study on initial geminate in Tedumuni

To demonstrate an approach to studying geminates, I will present one of the first results of the series of studies on Ryukyuan geminates (extracted and revised from Shinohara and Fujimoto (2011ab)). These studies combine empirical and theoretical approaches. The audio recording of the Tedumuni dialect of Yaeyama Ryukyuan was done by researcher Masako

Fujimoto and the author (see Sections 3.1. and 3.2. for background of the language and recording). We studied moraic status of initial geminates in Tedumuni. This dialect has a two-way accent system: accented and unaccented types. The accented type has a fixed location. By examining the location of accents, syllable affiliation of geminates was determined. Onset affiliation of medial geminates was also found in one of the variant patterns. We also investigated word minimality and articulatory timing.

Tedumuni Ryukyuan has, typologically rare, word-initial geminate consonants in words such as /kkara/ 'strength', /ssa/ 'grass', /mmasaN/ 'delicious'. Not only their rarity calls attention but they are also interesting from both theoretical and empirical points of view. Prosodic affiliation of initial consonants is a problem in phonological theories. Since the mora is defined as an attribute to a nucleus or to a coda consonant leaving onsets aside in standard moraic theories (e.g., Hayes 1989), the initial geminates are problematic for moraic analysis. This problem has been discussed in previous studies. Davis (1999) argued that there are two types of initial geminates: those that count as a mora and those that do not. It has been also demonstrated that only underlying geminates bear moras (Topintzi 2010). In studies of syllable weight, the effect of onset has been reported in some languages such as Karo or Pirahã: certain types of onsets count for weight in terms of stress assignment while other types do not (Gordon 2005, Topintzi 2008; 2010). Underlying moraic onsets, of course, form heavy syllables.

With regard to syllable structure, even syllabicity of initial geminate has been reported. In Tashlhyit Berber, the first half of a geminate consonant is declared syllabic in its own right in metrical verses because initial geminates and the following nucleus align with a sequence of two light syllables in poetries (Dell and Elmedlaoui 2002: 96). An example is shown in (28). Dell and Elmedlaoui showed that a light syllable (L) consists of a nucleus with or without an onset. A heavy syllable consists of a nucleus and one or two coda(s). In Tashlhyit, a nucleus can be any type of segment, but the syllabification is strictly organised according to an algorithm conditioned by the sonority scale (see Dell and Elmedlaoui 1985 *et seq*.).

(28)

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|----|----|----|
|   | L | L | H | L | L | L | L | L | L | H | L | H |
| a. | a | ma | nad | ra | ru | rnk | ki | ns | ta | raj | za | ɣarn |
| b. | s~ | sr | miɣ | kul~ | lut~ | tl | ba | ns | sr | mij | gʷr~ | ramn |
| c. | k~ | ki | ɣlb | ħu | rs | ta | ra | ɣi | gn | wan | di | kaln |

Let us observe the first syllables of each line in (28). In line a. the first syllable is a vowel /a/ which counts as a light syllable. In lines b. and c. this light syllable slot is filled with first

halves of initial geminates. This fact indicates that the first part of the initial geminate in this language can count as an independent syllable while in other positions (see for instance 4th in line b. /kul/ which is a geminate across 4th and 5th syllables) first halves of a geminate can be not counted as a coda.

The initial geminates are problematic not only for phonological structure but also from the point of view of phonetics in some cases. The most prominent acoustic correlate of geminates is known to be their longer duration compared with their singleton counterparts. However, the duration of certain consonants in initial position is hard to perceive, especially that of the voiceless geminate plosives even though it is among the most frequent initial geminates.

As mentioned, our main data source was from recordings we conducted in 2010. These corpora for the recordings were constructed based upon that of a previous report by Mariko Kuno (1990). By close observation of her data, we drew some generalisations and constructed our own corpus to focus on the behaviour of geminate consonants in this dialect. Accent patterns give important information for syllable grouping of the segments.

We recorded twice in 2010 in each informant's house: once as a pre-test, a corpus of 39 sentences, with six speakers; and again as the main test with five speakers, four of whom took part in the two recordings. We resorted to the pre-test data for additional variant patterns at times. In the main test, native speakers aged between 80 and 89 read or translated a corpus of 85 sentences. All of the speakers were bilingual in Tedumuni and Standard Japanese. They have learnt Standard Japanese since primary school. None of them had major problems in hearing or speaking, although one of them has had a problem with her vision. To facilitate the reading and translating tasks, some of the utterances were orally incited by the investigators; others were read or translated from written materials. Test sentences were sometimes modified when speakers did not agree with a given form. Disagreements were partly due to inter-dialectal and ideolectal variation and partly to ignorance of Tedumuni by the investigators. Not all of them completed the task. Each session took about an hour.

The test sentences were recorded onto a Marantz PMD 660 through a RAMZA WM-S10 microphone at a sampling rate of 44.1kHz with 16bits resolution. The recordings were then transcribed with pitch marks by one of the authors, who is a speaker of Northern Kyushu and Tokyo Japanese with phonetic ear training. The rising point of certain items in the unaccented class was sometimes difficult to determine by listening. Pitch tracking and other acoustic measurements were carried out using Praat. Five of the pre-test sessions and two of the main test sessions were also recorded onto a Panasonic HDC-TM35 digital high vision video camera. Video recording was used for observing lip closure duration (audio and video data are available at https://www.internationalphoneticassociation.org/icphs-proceedings/ICPhS2011/index.htm#S last accessed on 15 October 2019).

## 7.1 Phonological description

We shall first assess the moraicity of the initial geminate by considering the prosodic minimality of word length. In the description by Mariko Kuno (1990) and elsewhere (Kajiku 1996 *et seq.*, Fujimoto and Shinohara 2010), there is an opposition of vowel and consonant lengths in words, and there is no word consisting of only a single short consonant and a single short vowel (when embedded in a phrase). As in many other Ryukyu dialects, corresponding monomoraic words in Tokyo dialect are pronounced with a long vowel in Tedumuni.

(29)

| Tedumuni | Gloss | Corresponding Tokyo |
|----------|--------|---------------------|
| su: | 'nest' | [su] |
| du: | 'oar' | [ro] |
| ni: | 'root' | [ne] |
| pa: | 'tooth' | [ha] |

Mariko Kuno notes that when a word is pronounced in isolation there is tendency to shorten these words (1990:89).

(30)

a. ʃi                    'blood'
b. ʃi:nu ndʒi'tta        'blood came out'

In a. the word /ʃi/ is pronounced in isolation with a short vowel. When the word is followed by the subject marker /nu/ it is pronounced with a long vowel. We shall call the latter an accentual phrase, i.e., the noun followed by another word. We interpret this phenomenon as a lengthening of monomoraic items in a phrase, rather than a shortening in isolation. This indicates that monomoraic words are required to have at least bimoraic length in the accentual phrase. Bimoraic word minimality is a norm in all types of phrase in Kyoto Japanese. In contrast, in Tedumuni it does not occur in words in isolation but it does occur in accentual phrases. We have heard instances of this lengthening in such items as /i'/ 'stomach', /mi'/ 'eye', /pa'/ 'tooth', /ja'/ 'house', /pa/ 'leaf'. For example, [i i: nudu jamu] 'Stomach, I have a stomach ache'. By contrast, such lengthening did not occur in initially geminated words as /ssa'/ 'grass', /ppi'/ 'sepia', /ppa'/ 'saddle', or /tta'/ 'tongue', and they were pronounced in the same rhythmic length in isolation and in the accentual phrase.

## 7.2 Vowel length measurement

To provide evidence for the lack of lengthening for initially geminated words, we made acoustic measurements of the pair /pa'/ 'tooth' vs. /ppa'/ 'saddle' as an isolated phrase (I),

and also embedded in longer phrases (Ph) such as /pa nudu jamu/ 'The tooth is aching.' and /ppa nudu aru/ 'There is a saddle'. Five - eight tokens of each target were measured. Below is the average duration of the tokens across speakers.

Table 7 Interval between release of [p] and offset of the following vowel /a/ in milliseconds in /pa'/ [pa:] vs. /ppa'/ [p:a].

| pa (I) | pa: (Ph) | ppa (I) | ppa (Ph) |
|--------|----------|---------|----------|
| 194.8  | 246.3    | 109     | 104.8    |

The durations of /ppa/ in Table 7 are both shorter than those of /pa/. The reason is that the longer geminate portion is in the closure duration, which was not included in the measurement. By the effect of phrasal rhythmic compensation (Kaiki *et al*. 1990), it is expected that the same portion will be shorter when embedded in a longer sequence than when uttered in isolation. However, /pa/ is longer in (Ph). This indicates that, in proportion, it is lengthened even more than the ratio [pa]:[pa:] seen in Table 7 ). The initially geminated /ppa/, on the other hand, does not show such a difference. This preliminary acoustic comparison indicates that the vowel portion of /ppa/ is not subject to bimoraic lengthening, because the word is underlyingly bimoraic.

## 7.3    General pitch accent patterns of Tedumuni

Let us turn now to the accentual patterns. We shall first present the general accent patterns and their acoustic characteristics before accent patterns of geminates.

The pitch accent patterns of the nouns in a phrase in Tedumuni are summarised as having only two classes:

1. Accented class: a sharp pitch-fall at a fixed location in an accentual phrase (i.e., a noun followed by a grammatical particle).

2. Unaccented class: a flat pitch with some rise after the first syllable with no fall within an accentual phrase.

(31) Two accent classes (Transcription is roughly phonetic. ' indicates the pitch rising point; ' indicates the beginning of the pitch fall.)

| Accented word | Gloss | Unaccented word | Gloss |
|---------------|-------|-----------------|-------|
| a'mi'         | rain  | ami             | candy |
| 'paa'         | tooth | paa             | leaf  |
| 'mii'doo      | woman | biidoo          | man   |

When a noun is accented, the first mora is low-pitched unless the word consists of only one syllable. The pitch starts falling from the accent location, and keeps falling to the end of an accentual phrase ([a'mi'-nu] in Figure 5).
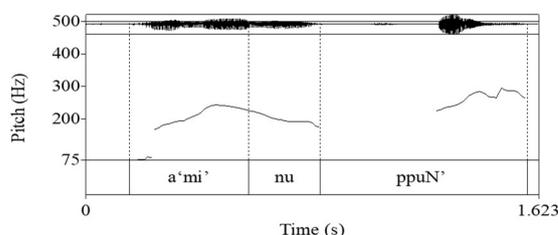


Figure 5 Pitch contour of an accented phrase [a'mi' nu (ppuN')] 'The rain is (falling)'. Speaker: A.

In case of the unaccented phrases, the pitch rises more or less from the beginning and formed a plateau throughout the accentual phrase (Figure 6).
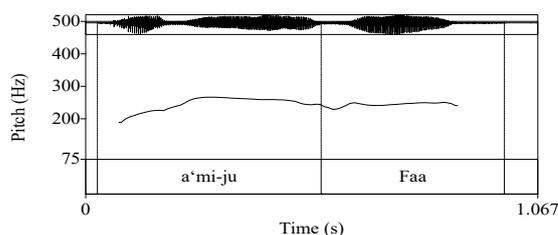


Figure 6 Pitch contour of an unaccented phrase [a'mi ju (ɸaa)] '(Eat) a candy'. Speaker: A.

The location of the pitch accent is determined by the following data:

(32) Accent location in the accented class

|     | Word | Gloss |     |     | Word | Gloss |
| --- | --- | --- | --- | --- | --- | --- |
| a. | a'mi' | rain | | d. | çi'mu'gukuru | heart |
| b. | ka'ta'na | knife | | e. | 'suu'ru | head |
| c. | mu'ra'saki | mauve | | f. | u'jaN'tçu | mouse |

The sequences of light syllables a.-d. in (32) are accented on the second syllable from the beginning of the word. However, the forms in e.-f. require rectification of the counting unit. The accent location is the syllable containing the second mora from the beginning. e. shows

that a heavy initial syllable omits the low tone at the left edge, as in Tokyo Japanese. Unlike Tokyo, where the fall within a heavy syllable occurs only after the first mora, the fall in Tedumuni occurs at the end of the heavy syllable, as in e.-f. (with a few variant forms of, presumably, the Tokyo type: e.g., [u.ʻje'N.tɕu] 'mouse' by one speaker. A dot indicates a syllable boundary.).

The basic accent patterns are compared with those in words starting with a geminate consonant and those with a medial geminate.

## 7.4 Word initial geminate

We have defined the accent location as the syllable containing the second mora from the beginning. The forms below make it clear that the initial syllables starting with a geminate consonant consist of two moras, otherwise a.-d. should carry the pitch fall at the end of the word.

(33) Accent location in the accented class

|     | Word    | Gloss          |     | Word  | Gloss   |
| --- | ------- | -------------- | --- | ----- | ------- |
| a.  | ssu'ru  | medicine       | e.  | ssa'  | grass   |
| b.  | kka'sa  | public officer | f.  | ppa'  | saddle  |
| c.  | tta'ti  | soy source     | g.  | ppi'  | sepia   |
| d.  | kku'bi  | belt           |     |       |         |

In (33), each of the examples e.-g. consists of a single heavy syllable with two moras. In these, the pitch falls after the words before a grammatical particle. The utterance below shows a pitch contour similar to that in Figure 5.
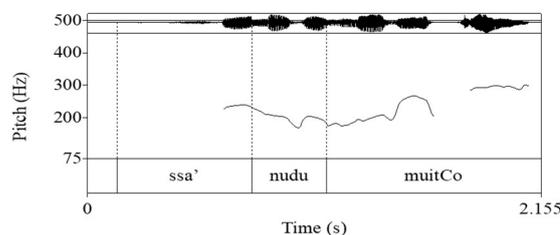


Figure 7 Pitch contour of an accented phrase starting with a geminate [ssa' nudu (muiʻtɕo)] 'The grass is (grown)'. Speaker: A.

In summary, it is clear from the pitch patterns that the initial geminates bears a counting unit.

## 7.5    Word medial geminate

In the analysis of pitch patterns, we encountered instances where the medial geminates behave just like the initial geminates. That is, the whole geminate affiliates with the onset position instead of straddling two syllable positions, resulting in cross-linguistically rare, and thus unstable syllabification pattern (Topintzi 2010). As seen below there are two accent patterns for medial geminate words.

(34) Accent location in medially geminated words. Variants are noted after ~. Rising
     points are omitted (see below).

|   | Word | Gloss |   | Word | Gloss |
|---|------|-------|---|------|-------|
| a. | nap'pa | pillow | e. | ҫitta'~ҫitta'(~tta'~ҫita') | tongue |
| b. | mit'tҫi | thunder | f. | ҫikka' | stick |
| c. | toҫ'ҫi | guava | g. | nukka' (~nuka') | rice bran |
| d. | gakko'~gak'ko | school | h. | ҫippa'sa (~ppa'sa) | darkness |

All of the above examples can be analysed as accented on the syllable containing the second mora from the left edge, conforming to the regular accentuation pattern. But this occurs only if we allow a medial geminate to affiliate with the onset.

In moraic theories (e.g., Hayes 1989), it is assumed that the first half of a medial geminate is attached to the coda and the second half to the onset of the following syllable, as in /kit.te/ [kit:e] (35a.).

(35)

| | a. | b. | c. |
|---|---|---|---|

syllable       σ   σ        σ   σ        * σ    σ

mora          μ  μ μ       μ   μ   μ      μ  μ   μ

Segmental tier k   i   t   e       k   i   t   e   k   i   t   e

Realisation        [kit.te]        [ki.tte]        *[kitt.e]
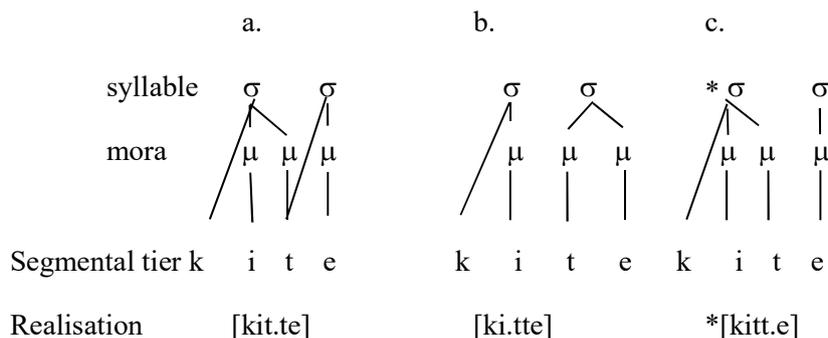
However, as proposed by Topintzi (2010), another possibility is that the whole geminate affiliates only with the onset of the following syllable, forming a moraic onset as in (35b.). Topintzi finds such cases in Marshallese and in some other languages. She argues that another logical possibility, the type [kitt.e] (35c.), where a geminate exclusively belongs to the coda, is excluded because of ONSET constraint (In OT terms, a form such as [kitt.e] violates both NOCODA and ONSET so that it always loses against candidates with an onset or without a

coda). She notes that medial moraic onset of the type [ki.tte] (35b.) is typologically rarer than the 'flopping structure' of the type [kit.te] (35a.) (i.e., *MORAIC ONSET >> NOCODA is more frequent across languages than the opposite ranking).

In our data, the exact location of pitch change within a geminate is not clear, however, in (34a.-c.) the pitch is heard high on the initial vowel whereas in d.-g., it is high on the second vowel. This difference depends on the affiliation of the first half of the geminate: either with the coda on its left or with the onset on its right syllable. If the syllable boundary is as in [nap.pa], the first half of the geminate belongs to the coda of the initial syllable, which is a canonical case of mora affiliation (35a.). When the affiliation is with the onset as in the initial geminates [ga.kko], the accent pattern in [gakko'] is explained by anchoring of the accent on the first part of [kk], which is the second mora from the left edge, and the high pitch is realised on the whole syllable [kko]. This pattern does not seem completely stable, often appearing with other variants (cf. d.-h.). It remains to be investigated whether the variation is free or lexically determined for a given speaker.

## 7.6 Perspectives

The study thus confirmed the moraicity of the initial geminates through phonetics and phonological analyses. However, issues remain in other domains. Tedumuni allows only voiceless obstruent geminates apart from nasal ones, as in Tokyo Japanese. The closure durations of initial geminate plosives are reported as being difficult for native speakers to perceive in Swiss German, (Kraehenmann 2001) and Tashlyit Berber (Ridouane and Hallé 2017). While a perception test is not an option for Tedumuni because of the advanced age of the speakers, a more acoustic investigation might reveal cues other than closure duration that distinguish between singleton and geminate plosives. Such quality differences were observed in the Ikema dialect of Miyako Ryukyuan (Fujimoto and Shinohara 2017b, Shinohara and Fujimoto 2018). Cross-dialectal studies of laryngeal contrast involving geminates are greatly needed. Part of the results of laryngeal contrast in initial plosives of Ikema Miyako Ryukyuan is included in the study project presented in the next section.

## 8 Voicing in geminates

Cross-linguistic studies indicate that voiced geminates are rarer than voiceless ones (Kirchner 2000, Blevins 2004). From an articulatory perspective, maintaining voicing and long closure duration in voiced geminates is challenging due to the aerodynamic constraints (Ohala 1983). Therefore, devoicing is widespread across languages (Jaeger 1978, Ohala 1983; 1997). We have pointed out that voicing patterns of voiced geminates are variable among Japonic dialects (Kawahara 2006, Matsuura 2012, Fujimoto and Funatsu 2018, Hussain and Shinohara 2019). Along with studies of individual languages, our project involves analysis of

the cross-linguistic voicing patterns in relation to contrast systems of the languages. To achieve this goal, collaborations with a specialist in physiology of speech and an expert in acoustic analyses are being conducted. As mentioned in Section 6, one phonological issue is the relationship between lexical contrasts and the voicing status of voiced geminate obstruents, and the other is how the language internal phonological contrast is achieved by phonetic realisations of its segments. So far, we have investigated voicing patterns and mechanisms in Ikema Ryukyuan and Kumamoto Japanese. Both of them showed articulatory gesture supporting full voicing of voiced geminates. Acoustic analyses, on the other hand, indicated full voicing in most tokens in Ikema (real words) (Fujimoto and Shinohara 2017, Shinohara and Fujimoto 2018) and in only part of the words in Kumamoto (Fujimoto and Shinohara 2018a). No voicing during closure was found in most speakers of Tokyo Japanese (Hussain and Shinohara 2019). In the sub-sections below, our recent findings about geminate voicing and remaining issues are summarised.

## 8.1   Ikema Miyako Ryukyuan

The Ikema dialect of Miyako Ryukyuan is spoken on Miyako Islands located between Okinawa and Yaeyama Islands (Figure 4). The dialect allows more variety of segments in initial geminate position than Tedumuni. So far, we have conducted two types of studies in Ikema: acoustics and articulatory observation by rt-MRI.
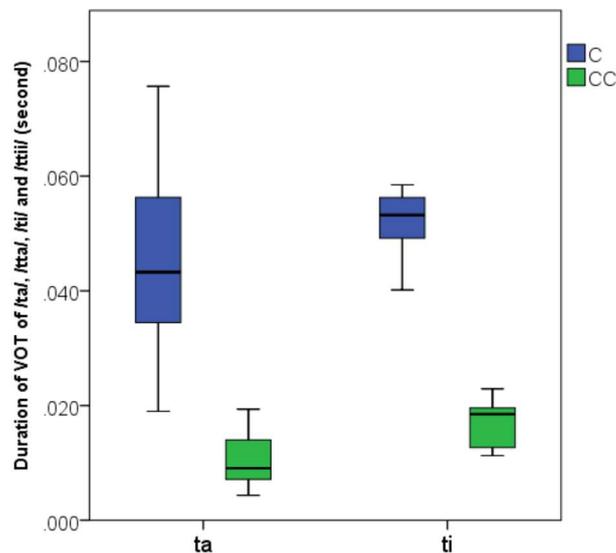


Figure 8 Boxplots of VOT of singleton and geminate /ta/ [ta:] and /tta/ [tta] and /ti/ [ti:] and /ttii/ [tti:] (from Shinohara and Fujimoto 2018)

The first audio recording was obtained in Nishihara District of Miyako Main Island. The segmental duration measurements revealed moraic timing in this dialect, since the mora count predicted word duration more accurately than syllable count (Fujimoto and Shinohara 2017,

Shinohara and Fujimoto 2018). Apart from segmental timing difference between singleton and geminate consonants, the VOT of /t/ was found to be longer than that of /tt/ (the alveolar is the only voiceless plosive geminate place in initial position) (Figure 8). Such difference is not present in medial geminates of Tokyo Japanese (Beckman 1982, Hirata and Whiton 2005), those of Bernese Swiss German (Ham 2001) or Bengali (Lahiri and Hankamer 1988).

Ikema dialect has typologically rare word-initial and voiced geminate obstruents (e.g., /vva/ 'you', /ffa/ 'child', /tta/ 'tongue', /badda/ 'side'). Full voicing during closure for medial geminates and also prevoicing for initial voiced obstruents were observed (Figure 9).
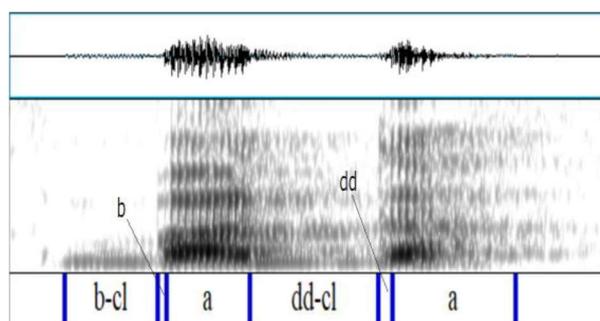


Figure 9 Voicing during closure of /dd/ in Ikema/badda/ [badda] 'side'. Frame length is 700 ms., 'cl' denotes 'closure'. (from Shinohara and Fujimoto 2018)

We have used rt-MRI to investigate the types of articulatory settings that allow Ikema speakers to maintain contrasts between singleton and geminate obstruents. Our analyses of two male speakers' utterances showed the following main characteristics: 1) Geminate obstruents in Ikema have longer duration of articulatory constrictions regardless of position and consonant types; 2) Alveolar voiceless plosives /t/ and /tt/ have a greater degree of linguopalatal contact than their voiced counterparts /d/ and /dd/, respectively; 3) Voiced geminate obstruents are accompanied by pharyngeal expansion for both speakers and by lowering the larynx for one speaker, but not by lowering of velum for either speaker. Different behaviours between plosives and fricatives with regard to linguopalatal contact were observed. Affrication of voiced fricative phonemes /z/, /zz/ and /vv/ as well as the place of articulation of /f/, /ff/ and /vv/ called for further confirmation by other means of investigation (see Fujimoto and Shinohara (to appear) for the details).

Related to voicing in geminates, Ikema dialect also has initial nasal stop geminates involving typologically rare voiceless nasals in their beginning, such as [n̥nu] 'horn' or [m̥mu] 'cloud'. They seem to historically derive from a sequence of a voiceless stop followed by a high vowel. Following an investigation of their timing patterns (Shinohara and Fujimoto 2018), the acoustics showed that voiceless part is shorter than voiced part and the whole geminate duration is shorter than a CV mora (i.e., [na] in /nada/) (Figure 10). Articulation of these

phones merits further investigation. We recorded audio and airflow data of another 10 speakers of Ikema dialect in Ikema Island in 2018 for this purpose.
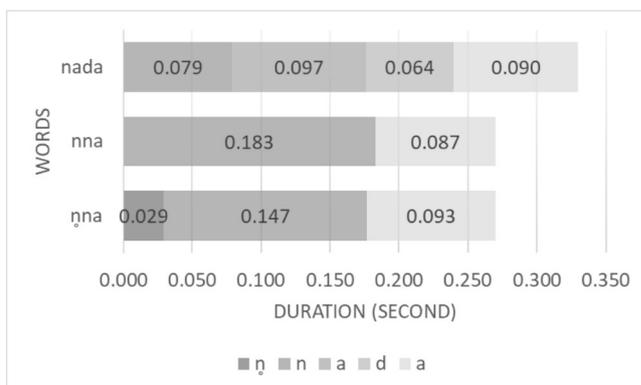


Figure 10 Segment durations of /nada/ 'tears', /nna/ 'spiral shell' and /n̥na/ 'rope' by five speakers, 11 tokens in total (from Shinohara and Fujimoto 2018)

## 8.2 Yanagawa mid-Kyushu Japanese

Yanagawa Japanese is a Chikugo dialect spoken in Yanagawa City in Kyushu (see Figure 11). It uses voiced geminate obstruents, as in other neighbouring mid-Kyushu dialects such as Kumamoto. So far, we have only investigated durational aspects with non-words in Yanagawa (Shinohara *et al.* 2018).
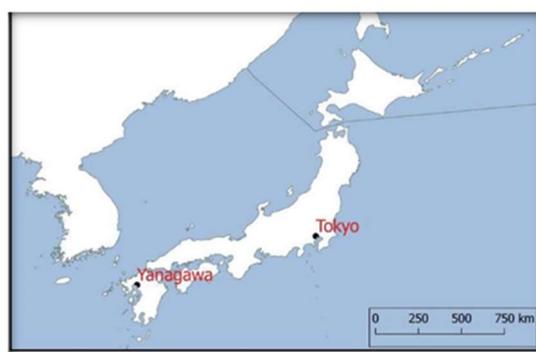


Figure 11 Map of Japan indicating locations of Yanagawa and Tokyo

There seems to be a handful of words clearly containing lexical voiced geminate (e.g., /miɾogge/ [miɾogge] 'ark shell'). Otherwise, the lexical status of geminates is not crystal clear, as one can often find corresponding non-geminate forms (e.g., [koggo] corresponds to /kokugo/ [kokugo] 'national language'). Five speakers' duration patterns were investigated acoustically. The recording corpus included non-words common with those used for Tokyo speakers (Table 8) (Total tokens: 215 (Yanagawa) and 246 (Tokyo)).

Table 8 Non-words for singleton versus geminate recording

| Place | | Voiceless | Voiced |
|---|---|---|---|
| Alveolar | Singleton. | /tata/ タタ | /tada/ タダ |
| | Geminate | /tatta/ タッタ | /tadda/ タッダ |
| Velar | Singleton. | /kaka/ カカ | /kaga/ カガ |
| | Geminate. | /kakka/ カッカ | /kagga/ カッガ |

Comparisons between the two dialects of Japanese indicated that they both have similar timing patterns of vowels and consonants, except that the preceding vowel (V1) was more influenced (lengthened) by gemination in Yanagawa. V1 was longer before voiced geminates than before voiceless ones in Tokyo, but no difference was found between voiced and voiceless geminates in Yanagawa (Figure 12).
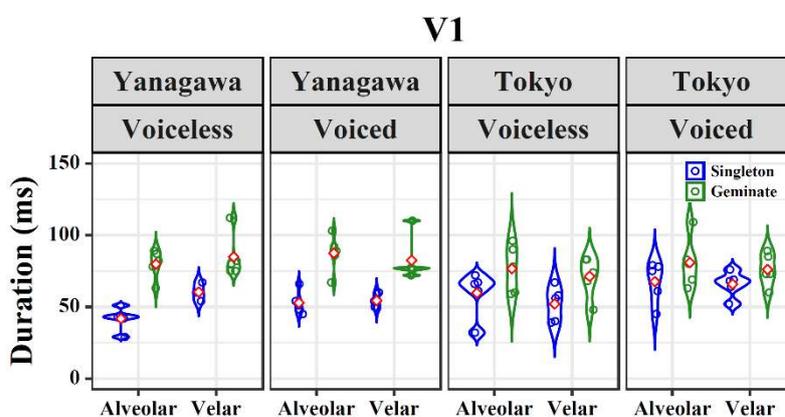


Figure 12 V1 duration patterns in Yanagawa and Tokyo Japanese (from Shinohara *et al*. 2018)

Other acoustic features have yet to be investigated. We would like to consider two things in this dialect for future research: similar acoustic measurements and comparison with Tokyo Japanese presented in the next section; and if there is any acoustic difference between clearly lexical and clearly derived geminate contexts. We plan to continue acoustic studies of lexical, derived and spontaneous (occurred by undershooting of intervening vowels between two consonants) geminates in Yanagawa and Tokyo Japanese (see Section 9).

### 8.3 Tokyo Japanese

Only a handful of loanwords in Tokyo Japanese contain voiced geminates (e.g, /sunobbu/ 'snob', /goddo/ 'God', and /eggu/ 'egg'). Full voicing of voiced geminates has been denied in past studies (Kawahara 2006, Hirose and Ashby 2007). In addition to the abovementioned timing, we investigated indications of voicing in acoustic signals of voiced geminate in Tokyo Japanese with a more extended corpus including labial consonants. However, closure voicing was not observed in four out of five speakers' tokens (examples in Figure 13).

Moreover, we did not observe any significant differences in non-durational acoustic measures of stop release bursts, like the first four spectral moments (spectral centre of gravity, spectral standard deviation, spectral skewness, and spectral kurtosis) to separate the voiceless and voiced geminate plosives (Hussain and Shinohara 2019). The only V1 duration difference between voiceless and voiced geminates indicated the contrast between the two. Whether or not this difference is perceived, speakers differentiated between them in their production. Note that whole word duration was not longer in voiced geminates, so the unfamiliarity of voiced geminates by Tokyo speakers as a factor of V1 lengthening can be rejected.
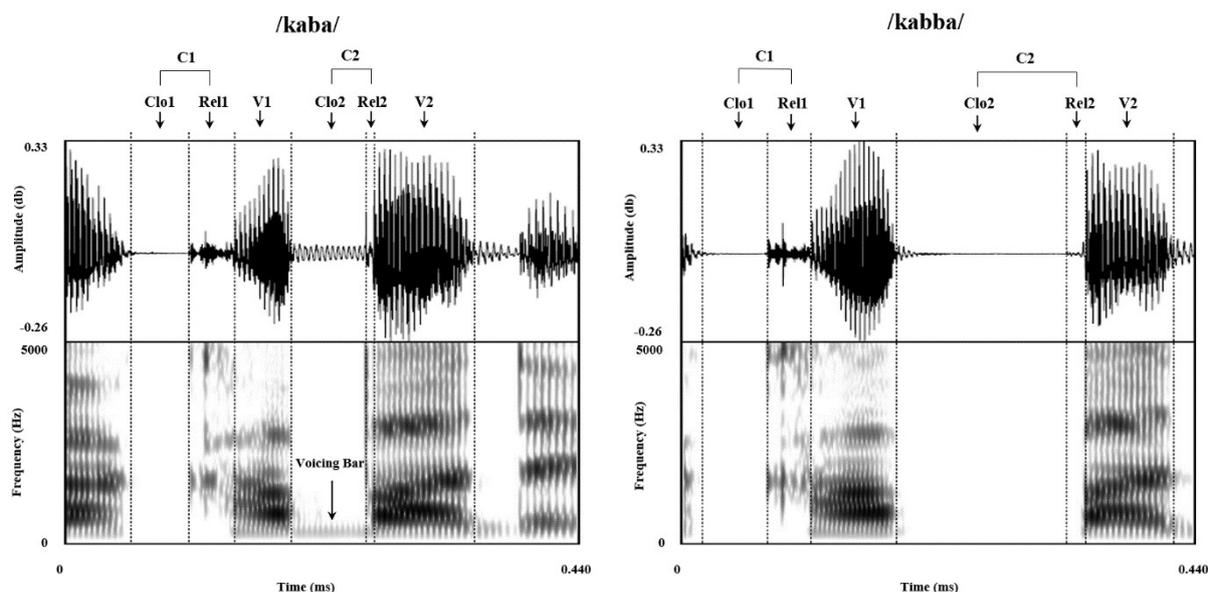


Figure 13 Spectrograms: Voiced singleton /kaba/ and geminate /kabba/ in Tokyo Japanese (from Hussain and Shinohara 2019)

## 8.4    Perspectives

One purpose of geminate studies is to draw a typological generalisation based on the function of geminates in a language. Relationships between phonological function and phonetic realisation of voiced geminates are to be compared across languages. A study on voiced geminate in Punjabi, an Indo-Aryan language spoken in Pakistan and India showed that Punjabi has a lexical contrast in voicing in geminate obstruents, and voiced ones are acoustically fully voiced (Hussain 2015). The findings of this study align with Ikema Ryukyuan. Based on the facts gathered so far, we could summarise the lexical status of voiced geminates and their phonetic voicing, and draw a preliminary typological hypothesis that there is a correlation between contrast of voicing and degrees of voicing in obstruent geminates.

Table 9 Typology of lexical status of voiced geminate obstruents and acoustic voicing

| Language | Punjabi Ikema Ryukyuan | Kumamoto Japanese | Tokyo Japanese |
|---|---|---|---|
| **Contrast status** | Lexical contrast | Morphologically derived contexts | Marginal area of the lexicon |
| **Phonetic characteristics** | Full closure voicing | Variable closure voicing and pharyngeal expansion | No closure voicing but V1 lengthening |

We need to deepen the study of morphological structures of geminates in Kyushu dialects to determine if there are any phonetic differences among the derivation types (some issues are presented in the next section). In addition, acoustic studies of voicing patterns of Yanagawa dialect (a neighbour dialect of Kumamoto) should be conducted. Since V1 difference before voiceless and voiced geminates was not observed contrary to Tokyo Japanese, other acoustic differences between voiceless and voiced geminate obstruents are expected. The data of Kumamoto dialect in the previous study (Fujimoto and Shinohara 2018a) were small and it could have been a familiarity difference of the tested words that induced the variable voicing. In 2018, more acoustic and physiological data were obtained for Yanagawa/Kumamoto area; however, additional data collection is desired for a better comparison. Currently, acoustic examination of Ikema dialect is being carried out. Fine acoustic cues of voicing can be found between initial and medial and singleton and geminate pairs. Following these analyses, we plan to proceed to the analyses of EGG and airflow data. To directly compare three types of dialects (i.e., Ikema Ryukyuan, Yanagawa/Kumamoto Japanese, Tokyo Japanese), we have also recorded common loanword pairs (patto versus paddo, batto versus baddo) that will be analysed along with other recorded words.

## 9    Phonological relationship of prominence and gemination

During the last stage of the project on geminate consonants in Japonic dialects, phonological analyses from cross-linguistic perspectives are planned. This section presents options for pursuing more formal analyses and challenges to be overcome. A blueprint is to be developed after studies of some of the dialects on the points included below and elsewhere.

### 9.1    Typologies of prominence mapping

Pitch accent avoidance on the epenthetic vowel was witnessed in the loanword study (Section 2.2.1), and a high tone enhancing correct perception of presence or absence of a vowel between two consonants was shown in the perception study in Section 2.6. Clearly, the lack

of prominence in epenthetic vowels has its origin in their absence in the input. In many languages, epenthetic vowels and lexical vowels are identical on the surface except that only lexical vowels are entitled to certain prosodic prominences. The complex behaviours of epenthetic vowels in stress assignment such as the case of Winnebago attracted attention in autosegmental phonology (Hayes 1995, and references therein). Alderete (1999) gives an account on such interactions in the OT approach. The first type is Swahili where there is no interaction: epenthetic vowels behave in the same way as lexical vowels. The epenthetic vowels in Swahili count as a constituent of stress feet and they can be stressed themselves. In this case, structural constraints override and no particular property of epenthetic vowels is to be detected on the surface. However, epenthetic vowels behave differently in many languages. In Dakota, the iambic stress avoids epenthetic vowels. The second syllable is stressed according to iambic foot form in canonical cases ([čʰikté] 'I kill you', [mayákte] 'you kill me'), but it shifts to the preceding syllable in case the second syllable is occupied by an epenthetic vowel (/ček/ [čéka̱] 'stagger', the epenthetic vowels are underlined in the examples.).[13] A slightly more complex case is found in Yimas. Its canonical stress pattern is the syllabic trochee with non-finality ([áwak] 'star', [wárkapwi] 'wallaby', [wánkanàwi] 'insect'). However, the stress avoids epenthetic vowels and it shifts forward from the canonical position (/tmi/ [ti̱mí] 'say') unless the second syllable is filled with another epenthetic vowel (/tkt/ [ti̱ki̱t] 'chair')[14].

In addition to stress avoidance, it is attested that epenthetic vowels carry Low tone. Here are a few examples of loanwords (drawn from Kang 2010b, Low tone=L, High tone=H).

(36)

| **English** | **Twi** (Devonish 2002) | |
| --- | --- | --- |
| *bucket* | bu$^H$ki$^L$ti$^L$ | |
| *cigarette* | si$^L$ga$^L$rɛː$^{HL}$ti$^L$ | |
| **Portuguese** | **Kongo** (Devonish 2002) | |
| *papél* | pa$^L$peː$^{HL}$le$^L$ | 'paper' |

In English loanwords in Twi and Portuguese loanwords in Kongo, coda consonants in the source languages are adapted through epenthesis. In both cases, the tone assigned to these positions is presumably less prominent Low tone. Kang (2010b) observes in these and in other languages that stresses in the original languages are realised with 'a variant of High

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[13]  Phonetic symbols remain as in his original paper.

[14]  Yimas data here are supplemented with those employed in Peng (2013). Alderete (1999) and Peng (2013) both rely on the original description by Foley (1991).

tones'. Thus, it is fair to assume that syllables with stress receive prominent High tone and those with an epenthetic vowel receive one of the less prominent tones.

An interesting case comparable to epenthesis is the deletion conditioned by vowel quality in Lushootseed (a Salish language) reported in Gouskova (2003). Below, RED denotes a reduplicant morpheme.

(37)
> Stress pattern: default left ([jə́səd] 'foot', [ʔítut] 'sleep')
>
> Avoid stressed ə ([təyíl] 'to go upstream')
>
> Avoid unstressed a ([biɫáʔ] 'have more than enough' *[bíɫaʔ], [yuwáɫ] 'the very' *[yúwaɫ])
>
> Delete a from unstressed positions (/RED-walis/ [wáwlis] 'little frog' *[wáwalis]), keep i (/RED-wiliq'wid/ [wíwiliq'wid] 'quiz someone')
>
> When syncope is blocked by cluster condition, reduce a to ə (/RED-tabəc/ [taʔtəbəc] *[taʔtbəc] 'slowly, softly')

The basic generalisations are given below.

(38) Lushootseed stress and syncope generalisations (Gouskova 2003: 263):

a. Default leftmost stress moves onto the next full vowel to avoid stressed ə.
b. When a cannot be stressed, it syncopates.
c. If the resulting cluster has rising sonority, a reduces to ə instead of deleting.

To account for these data, sonority-sensitive stress constraints are at work. They are in conflict with trochaic foot parsing and IDENT constraints. Gouskova summarises these phenomena as follows (p.265):

> [the distribution of vowels in Lushootseed is to a large extent determined by the sonority-sensitive stress system: low and high vowels are preferred in stressed positions, while ə is preferred in unstressed positions. Syncope, reduction, and overwriting are the strategies used to ensure these output goals.]

In Lushootseed, the prominence matching between vowel quality and stress is assured to the extent that it leads to vowel deletion.

We have observed interactions between vowel features and prosodic positions: weak vowel features match to a weak prosodic position. A similar idea is found in Smith (2002) (see Section 1).

## 9.2 Types of geminates and related phenomena

I shall present the final step of a long-term project. We will consider vowel syncope and vowel assimilation to a consonant, both resulting in gemination in Japonic dialects. The issue will be to determine the contexts that condition a vowel to delete and form a geminate. This topic will involve studies in phonology, morphology and phonetics of gemination and vowel devoicing of several dialects.

The current phonetic literature has revealed differences in the articulatory timing of lexical (or underlying), assimilated and concatenated geminates in certain languages. Tashlhyit Berber not only has lexical geminates (/ttutt/ [ttutt] 'forget her'), but geminates can also occur through assimilation of two consonants across morpheme boundaries (/rad tut/ → [rattut] 'she will hit') or concatenation (/tut tins/ → [tuttins] 'she hits hers') (Ridouane 2010). Ridouane (2007) posits that the consonant durations of lexical, assimilated, and concatenated geminates are similar but the amplitude of burst is greater only for lexical and assimilated geminates, compared to concatenated ones in Tashlhiyt Berber. Lahiri and Hankamer (1988) did not find differences in closure and VOT durations among underlying, concatenated and assimilated geminate stops in Bengali. Payne (2005) found that lexical geminates are longer than post-lexical geminates in Italian, which may be due to the fact that only lexical geminates are contrastive with singletons. Thus, the lexical and the post-lexically derived ones do not share the same functional load. She also found that false geminates have distinct durational patterns, either fused and short or long with an epenthetic vowel. In Moroccan Arabic, the articulatory gesture of an assimilated word-initial geminate (/l+duda/ → [dduda] 'the earthworm') showed longer closure than that of a singleton onset consonant (/duda/ [duda] 'an earthworm'), but there were no statistically significant differences in tongue height and amplitude between an assimilated geminate [dd] and a singleton [d]. Zeroual *et al.* (2012) argue that these geminates are merely clusters of two identical consonants. Hence, 'assimilation' here means manner feature assimilation, while in terms of segmental slot there must remain two of them. In this case, it looks distinct from a 'true' geminate, which has only one segment for two prosodic positions (McCarthy 1986). It follows from the above-mentioned studies that the two types of distinct phonological representations of geminates manifest themselves in articulation and acoustics although the manifestations might differ across languages.

Let us observe the status of geminates in Japanese by giving a more detailed description. Gemination of voiceless obstruents occurs across morphemes in Yamato (i.e., native) and Sino-Japanese and within morphemes in Mimetics and Loanwords. A study of productive gemination in Sino-Japanese vocabulary by Ito and Mester (1996) involves the issue of representation of morpheme final consonants. In their analysis, the final /t/ is a default consonant for a placeless consonantal position in Sino-Japanese stems, which I represent as

/C/ in examples in (39). This featurally empty position, /C/, undergoes systematic gemination when the initial consonant of the following stem starts with a voiceless obstruent:

(39)

/seC+haN/ [seppaN] 'halve divide'

/seC+teN/ [setteN] 'point of contact'

/seC+kiN/ /sekkiN/ 'approaching'

/seC+sjok/ [seɕɕoku] 'physical contact'


/k/-final stems are also geminated with another following /k/ to form a compound (40a) but not with another type of consonant (40b-c):

(40)

a  /sjok+ki/→[ɕokki] 'dishes'

b  /sjok+hi/ [ɕokuçi] 'food expense'

c  /sjok+tak/ [ɕokutaku] 'table'


In Yamato vocabulary, gemination also occurs through the concatenation of grammatical morphemes. In this case, stem-final consonants undergoing gemination are not limited to /t/ and /k/: /ik-te/ [itte] 'go, participle', /ir-te/ [itte] 'roast, participle', /iw-te/ [itte] 'say, participle'. However, in this type of gemination, historical changes are involved, and the consonant-ending stems do not all result in the geminate outputs when affixed with the same morpheme /te/: /kak-te/ [kaite] 'write, participle', /kag-te/ [kaide] 'smell, participle' (cf. /kaw-te/ [katte] 'buy, participle'). Thus, there must be lexical specifications for each type of alternation. In some non-alternating compounds such as /kir+te/ [kitte] 'stamp', or familiar compound words in general, the lexical status of geminates (i.e., whether it is /tt/ in the lexical form or derived from /rt/) may be an issue. But there is no such issue in the input representation for loanwords such as /esupuresso/ 'espresso'. Another type of geminate derivation is the insertion of moraic affix. Emphatic affixes can create voiceless obstruent gemination in Yamato (e.g., prefix /maμ-/, as presented in (41a-c)) and Mimetic (infix /-μ-/, (41d-g)) vocabulary. The moraic position in these affixes are segmentally empty, but it is realised as a first half of geminates before a voiceless obstruent and is realised as a moraic nasal before other consonants:

(41)

a  /maμ+ kuro/ 'black' [makkuɾo]

b   /maμ+ siɾo/ 'white' [maɕɕiɾo]

c   /maμ+ maɾu/ 'round' [maNmaɾu]

d   /pitaɾi/ 'just' [pittaɾi]

e   /pokiɾi/ 'breaking noise of hard and long objects' [pokkiɾi]

f   /huwaɾi/ 'floating' [ɸuNwaɾi]

g   /bojaɾi/ 'unfocused' [boNjaɾi]

Despite possible representational differences, the above cases of geminates have been treated equally and regarded as they are articulated as a long consonant with a single articulatory gesture in the past production studies (Ofuka *et al*. 2005, among others), unless non-words were used (Otaki 2011, among others).

The phonetic manifestation of geminates is not uniform across languages and can involve various acoustic cues within consonants as well as duration of adjacent segments. Regarding duration of segments in words involving geminate consonants, Japanese lengthens the preceding vowels when the following consonant is a geminate (Han 1994), whereas Italian (Esposito and Benedetto 1999), Hindi (Ohala 2007) and Tashlhiyt Berber (Ridouane 2007) shorten the preceding vowels. Others show no differences in the preceding vowels whether the following consonant is a singleton or a geminate (Punjabi: Hussain 2015, Lebanese Arabic: Khattab and Al-Tamimi 2014 (no difference in VC(C)V context but shortens long V: in V:CCV)). The duration of the vowel following a geminate, on the other hand, is shortened in Tokyo Japanese (Han 1994, Campbell 1999, Idemaru and Guion 2008).

Among geminates in Japanese, there is at least one case of apparent gemination with different articulatory characteristics. A study of geminate formation in connected speech observed in the Corpus of Spontaneous Japanese (Furui *et al*. 2000) reveals that a deletion of a vowel resulting in gemination occurs across morphemes and in contexts independent of vowel devoicing (Fujimoto and Kagomiya 2005).[15] Since a geminate is formed after deleting a vowel between $C_1$ and $C_2$, the release of the consonants is economised from two to one. Thus, this occurrence facilitates the articulation. Unlike high vowel devoicing in Tokyo Japanese (see below), this gemination might be regarded as undershooting the vowel, because it occurs more frequently between homorganic consonants. But importantly, resultant form is at least perceptually a phonologically well-formed voiceless geminate. That is to say, heterorganic

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[15] The corpus consists of recordings of academic/business meetings and public speeches termed 'Common Japanese'. Common Japanese has segmental and syntactic characteristics similar to those of Tokyo but prosodic features reflect the dialectal varieties of each speaker (Furui *et al*. 2000).

clusters, inhibited in Japanese phonology, are not formed from this process. Gemination (or vowel syncope) occurs most frequently in the context /k/_/k/, and the deleted vowel is /u/ in over 70% of the cases: /ugoku#ka/ [ugokka] 'if it moves', /hossoku#kara/ [hossokkara] 'from flotation'. Vowel devoicing is known to occur in the same context (Vance 1987); but it is not limited to between /k/s and occurs for both /u/ and /i/. What is more distinct in the case of gemination is that the second most frequent $C_1$ after /k/ is /r/: /suru#toki/ [suttoki] 'when I do'. /r/ does not provide a context for vowel devoicing. The high frequency of /r/ in this result must be due to its frequent phonological occurrence in the final syllable of a morpheme (Labrune 2014). However, the fact that /r/'s identity is totally taken over by that of the following consonant must be due to its phonological status. /r/ is considered the unmarked consonant used for filling a consonantal position in Japanese morpho-phonology (Labrune 2014, *contra.* Pellard 2016). There are also more variable cases of spontaneous gemination, but the proportion of each case is negligibly small. Among the examples given in their article, the geminations only occur when $C_1V_1$ is not accented, at least when considered in Tokyo Japanese. The accent patterns were not considered in the original article by Fujimoto and Kagomiya (2005). It might appear that the productive gemination in spontaneous speech does not frequently occur by deleting the accented vowels. This would indicate that the patterns are largely governed by phonetic prominence mapping, which should be investigated further.

The Chikugo dialect of Japanese is not pitch-accented, and there is systematic vowel devoicing, as in Tokyo. In Chikugo, the (surface) high vowels delete between plosives to form geminates. In our pilot study of nonsense word reading by a Yanagawa (one of the Chikugo varieties) speaker, both voiceless and voiced obstruents tended to provide environments for deleting high vowels to give rise to gemination: /kakika/ [kakka], /kakiga/ [kagga], /tɕitsutɕi/ [tɕittɕi], /tɕitsuʑi/ [tɕiddʑi], whereas /tatɕita/ was pronounced as [tatɕita]. Two research questions thus arose: Does the deletion of the vowel produce the same acoustic patterns or articulation as the clearly phonological geminates produced with a single hold stage such as /kakka/ written as カッカ or /tɕittɕi/ チッチ, where the small letter ッ denotes the gemination of the following consonant? Do the same articulation patterns occur in voiced obstruents as in voiceless ones? In some instances in the former, the post-lexically derived gemination, the geminate consonants sounded like undershooting of the intervening vowel. That is, while the consonantal release is not audible, the articulatory timing sounded as if there was a gesture for a vowel. Thus, the phonological status of the geminate consonants and the skipped vowels are in question. Some lexical compound words showed the same tendency: /kaku-go/ [kaggo] 'resolve', /koku-go/ [koggo] 'national language'. One issue of dialects is that there are two ways to pronounce words with voiced geminates: one variant is without gemination, as in [kokugo] /koku-go/ 'national language', and the other is with gemination [koggo]. The form without gemination could be the standard Japanese form permeated into the dialect, or it could be an underived variant. This situation renders the

lexical status of the geminate in such words ambiguous. Gemination could be either the one processed through a phonological operation or a phonetic undershooting of the type reported in Fujimoto and Kagomiya (2005) for standard Japanese. In addition, when a preceding morpheme ends with a syllable /ru/, the gemination occurs just like in spontaneous Tokyo speech, but this time it also occurs with a following voiced obstruent. /aru-gena/ 'exist, they say' can form a geminate [aggena]. Clearly, there was no alveolar contact in this utterance, whereas in /aku-gena/ 'open, they say' also pronounced as [aggena] it was difficult to assert that the gemination is with or without undershooting of the underlying /u/ vowel. Acoustic and physiological data might give an answer in a future study.

Let us turn to a clearer case in terms of the lexical status of the geminates and accent location. In Tedumuni Ryukyuan, initial geminates are the results of deletion of the contents of the initial syllable leaving its prosodic position behind. In the examples below, underlying representations of the corresponding words in Tokyo Japanese and their surface forms with pitch accent marks, if any, are given along with Tedumuni forms.

(42)

| **Tedumuni** | | **Tokyo Japanese cognate** |
|---|---|---|
| kkara | 'strength' | tikara [tɕikara']（力） |
| ttati | 'soy source' | sita-ti [ɕitazi]（下地）'base' |
| ssa | 'grass' | kusa [kusa']（草） |

As mentioned, the gemination is limited to voiceless obstruents and nasals in Tedumuni. Gemination of voiceless consonants occur where vowel devoicing should have been present in unaccented position. In the words that have clear etymological cognates in Japanese, their positions coincide with syllables with a high vowel between voiceless consonants. An interaction between syncope and (absence of) pitch accent is therefore suspected.

Many other Ryukyuan dialects also have lexical geminates but their origins vary. One such case is the vowel turning into a consonant to form a geminate with the following consonant in Miyako Ryukyuan, as described in Section 10.1. These cases will be considered in phonological analyses of geminates with regard to prominence mapping.

Finally, let us consider the relation between vowel devoicing and accent. In Tokyo Japanese, the high vowels /i/ and /u/ systematically devoice between voiceless consonants. A fiberscope and palatoglottography study of glottal opening by Fujimoto *et al.* (2002) shows that vowel devoicing in Tokyo is not caused by undershooting but is a phonological rule. In contrast, more variable devoicing in Osaka Japanese is a result of undershooting because a closing gesture of vocal folds is still observed when the vowel is devoiced (Fujimoto *et al.* 2002).

Vowel devoicing can be regarded as a weakening process, since the vowels lose their voicing feature. Even though the vowels are devoiced, pitch accent can fall on them. Pitch accent displacement from a devoiced vowel to an adjacent one was reported in Tokyo Japanese by Haraguchi (1977), although no phonetic data were provided to verify the patterns, and it is furthermore no longer a rule in present-day Tokyo Japanese. Vowel devoicing is not constrained by pitch accent and vice versa.

## 9.3 Perspectives

Let us summarise the found facts and hypotheses with regard to interactions between segmental and prosodic prominences. We have observed that pitch accent does not interact with vowel devoicing. But devoiced vowels can delete, perhaps when they are not pitch-accented. The lack of pitch accent in gemination in spontaneous Tokyo speech is probably not coincidental. Lack of pitch accent in the initial geminate in Tedumuni may be a consequence of these processes. The prominence mapping patterns are summarised below. Examples 1-5 in (43) are attested or negated. Example 6 is to be explored.

(43) Summary of interactions between types of prominence

| Type of association | |
|---|---|
| 1.  Absence of vowel feature - No stress/No pitch accent | Attested |
| 2.  Absence of vowel feature - No High tone | Attested |
| 3.  Absence of vowel feature - No heavy syllable | Attested |
| 4.  Absence of voicing feature in a vowel - Gemination/syncope | Attested |
| 5.  Absence of voicing feature in a vowel - Absence of pitch accent | Denied |
| 6.  Absence of pitch accent/stress - No gemination/No syncope | To be explored |

Obviously, experimental studies may offer new insight into completing this typology.

## 10  Other topics

The 'fricative vowel' of Miyako Ryukyuan is also related to the main focus of study and is most directly related to the study of geminates in Miyako, as it is one of the origins of fricative geminates in the dialect. This topic has also gained interest from cross-linguistic perspectives. The second study on liquids originated from interlanguage studies with colleagues and students.

## 10.1 Phonetics and phonology of 'fricative vowel'

Miyako Ryukyuan and a part of Yaeyama Ryukyuan dialects have developed an alveolar fricative vowel (which we symbolise as /I/), and possibly a labio-dental fricative vowel, the latter being more variably described and in need of verification. Their distributions are distinct in each dialect. For example, /I/ with strong friction noise ([z] or [s] depending on adjacent consonants) occurs after /p, b, t, d, k, g/ in Karimata Miyako dialect (Oono *et al.* 2000), while Ikema limits its occurrence to after /ts, s, z/ with weak and short frication noise. Ikema has developed a fricative vowel, often described as an apical vowel, and the vowel transcription was used in the beginning of words such as /Izu/ (/zzu/ in our transcription) by early studies (e.g., Hirayama 1983). According to our analysis of rt-MRI of Ikema vowels, the vowel /I/ shares the same place of articulation with the preceding alveolar consonants, at least as seen in the midsagittal dimension. As abovementioned, the linguopalatal contact is made at the very front of the cavity, further forward than /i/. Nevertheless, the resonant frequencies indicated a central quality: the second formant (F2) value is located between those of /i/ and /u/. A more precise measurement of the back part of the cavity might find tongue dorsum raising, which may explain a lower F2 value despite the front articulation. Since its articulation was unknown, this vowel has been described in the literature by many different names: 'central', 'apical' or 'special' vowel. Our articulatory and acoustic study (Fujimoto and Shinohara 2018b) made a stunning contribution to this long-term dispute by determining its place of articulation with the acoustic correlates of the vowel of the same speakers.

The fricative vowel is fascinating, not only because of its ambiguity but also from cross-linguistic perspectives. I am interested to see if there is any regularity in the distribution of similar type of vowels and preceding consonants in other languages, in particular, whether the consonants preceding the vowel can have exclusively the same place of articulation or exclusively a different place of articulation. The former favours articulatory ease and the latter makes for a more ideal contrast of consonant and vowel identities. Thus, from a phonetic point of view, either patterns can be predicted. As a similar case to Ikema, only /s, ts, tsʰ/ are followed by an apical vowel in Mandarin Chinese (Lin 2007). The vowel is described by Wells (2007) as [an alveolar approximant articulation, and transcribed with IPA symbols [z] with, subscript, the lowering diacritic [˕], and a following superscript [ɯ] to show the accompanying close back unrounded colouration]. We could characterise these cases as an occurrence of fricative vowel in the assimilative context with the preceding onset consonant. There are comparative cases with a labiodental fricative vowel in Bai, a language spoken in southern China (Dell 1981), and in the Lanzhou and Loufan dialects of northern Chinese, where /u/ is realised as [v] after labiodental fricatives and affricates, creating a prolongation of friction noise (Dell 1994). In the description of Hirara Miyako Ryukyuan, Karimata (2005) notes /f/ as a moraic consonant appearing in words such as /fmu/ 'cloud' and /fkuru/ 'bag'.

He argues that there is no lip rounding after /f/ to prove that it is not a devoiced variant of /u/ vowel. This might arguably be another case of a fricative vowel with a labiodental quality occurring in an assimilative context. However, the assimilative cases are not the only ones that occur. Len in Mambila, a language group spoken in Cameroon, has two phonetic fricative vowels contrasting with /i/ or /u/ (Connell 2007): alveolopalatal fricative vowel [z͎i] occurring after [b, ʃ], and labiodental fricative vowel [v͡ɯ] after [t, d, k, f]. Hence, the fricative vowels appear in both dissimilar and assimilative contexts. The mixed pattern is also observed in Jixi dialect of Huizhou Chinese, where fricative vowel [z] occurs after /p, pʰ, m, n, s, ts, tsʰ/. This vowel contrasts with other high vowels after the same set of consonants (Shao and Ridouane 2018). Thus, it is still hard to define a typology of occurrence of this type of vowel. Historical aspects of Ryukyuan dialects might indicate changing direction in such mixed cases. A typological comparison will be conducted after Miyako Ryukyuan dialects are recorded. A project on this issue with Masako Fujimoto has been approved by the Mitsubishi Foundation for Research Grants in the Humanities (September 2019-September 2020) and by Labex-EFL Axe1.

## 10.2 Liquid perception and variation

Japanese listeners are known for their limited perception capacity of more than one liquid categories in L2 (Goto 1971, MacKain *et al.* 1981, Yamada and Tohkura 1992, Zhang *et al.* 2005). Japanese has a single-liquid category /r/. However, its articulation is hard to define due to many contextual and free variants. One variant is a voiced stop [d], which is contrastive with the alveolar voiced plosive /d/ [d] (Labrune 2012, Arai 2013). Korean also has a single-liquid category where a tap and a lateral alternate. Some Chinese dialects only use laterals, although rhotacised vowels are also used (Lin 2007). There have been a number of perception studies of English /r/ versus /l/ by Japanese, Korean or Chinese listeners (Gillette 1980, Smith and Kochetov 2009). Some of them argue that F3 cue is unused by the Japanese consonant system, so that English /r/ cued by F3 is not perceived (Iverson *et al.* 2003). However, an independent study indicates that Japanese listeners outperformed American English listeners in discrimination of Hindi dental and retroflex stops, typically displaying F3 locus difference (Pruitt *et al*. 2006). This implies that Japanese listeners are able to exploit some cues characterising retroflex sounds, and American English listeners are not.

We have carried out perception experiments on Punjabi liquids (tap/lateral and dental/retroflex) and voiced stops (dental/retroflex) to test to what extent the retroflex cue is exploited by Japanese and Mandarin Chinese listeners (reported in Section 2.6). Japanese listeners seem to categorise the retroflex stop as a Japanese liquid, since liquid-stop pairs were less accurately discriminated when the stop was a retroflex (Shinohara *et al*. 2015). Mandarin listeners, on the other hand, showed some difficulty in distinguishing between the members of the pairs involving the tap (Shinohara *et al.* 2016).

Classifying some of the single-liquid languages into rhotic or lateral may not be valid. For instance, Japanese /r/ can either be tap or lateral, but a commonality across variants seems the usage of tongue tip. Mandarin Chinese may define its liquid articulation and perceptual cues differently. The difference may be observed in the way each listener population interprets a two-way (as in many of European languages) or four-way liquid system (as in Punjabi) in L2. The first step we would like to take is determining the tongue tip shapes of variants of Japanese /r/ in motion. The results will enable us to interpret perception study results on one hand, and will allow us to consider more adequate feature systems on the other.

## 11 General conclusion

In this thesis, the achievements since my doctoral studies and current research projects have been presented. The main achievement can be summarised as a contribution to the development of the field of loanword phonology. Results of formal phonological analyses illuminated the role of unused portions of grammar and the role of phonetics in phonology. The generative framework, especially the acquisition theory in OT (Hayes 2004, Prince and Tesar 2004), made it possible to assume that portions of the grammar unused by the native words remain accessible when fed by new inputs. By studying loanword adaptation, mapping between two sound systems has involved multi-layered prosodic levels. That is, sounds are not simply adapted at segmental level but prosodic features also play important roles during sound mapping process to make best matches. Salience scales are required to achieve predictions for phonological patterns (cf. Steriade 2001; 2008). All segments are not treated equally either. Grammar is able to evaluate which types of segments in which prosodic positions can be integrated. This aspect also motivated my interests in the direction of more general sound mappings of different prosodic levels in synchronic grammar and dialectal variation.

My current research subjects involve phonetic and phonological studies of Chikugo Yanagawa and Kumamoto Japanese spoken in Kyushu, and endangered Yaeyama and Miyako Ryukyuan languages spoken in Ryukyu Islands of Japan. These dialects present an extensive variety of geminate consonants, including initial and voiced ones. Some possess typologically interesting voiceless nasals or fricative vowels. Even though not being wide spread, similar sounds exist in some unrelated languages. The sounds of Ryukyuans are greatly understudied, and instrumental studies have been barely conducted by our predecessors. I would like to study the phonetic details of these sounds and identify conditions that allow marked segmental outputs.

More work with colleagues and students has been realised after an intense period of teaching and directing a phonetics lab (2006-2016). Ryukyuan and Japanese dialects are being studied collaboratively and from larger perspectives. We have recorded audio, EGG and airflow in

the fields. MRI was also filmed for two dialects. Articulatory data are analysed with a specialist in physiology of speech, and detailed acoustic investigation (duration, F0, intensity, and voice qualities) is led by a researcher who studied in Indo-Aryan dialects for similar aspects of obstruents. I hope to continue working collaboratively within and outside the lab, taking advantage of being a member of a lab for the study of phonetics and phonology.

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