LEXICAL ENCODING OF LENGTH CONTRASTS IN LEARNERS OF JAPANESE AS A SECOND LANGUAGE

Chisato Kojima

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Doctoral Committee:

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Isabelle Darcy, Ph. D

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Stuart Davis, Ph. D

____

Kenneth J. de Jong, Ph. D

____

Steven Lulich, Ph. D

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To my late father Hiroshi Kojima and my mother Eiko Kojima

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LEXICAL ENCODING OF LENGTH CONTRASTS IN LEARNERS OF JAPANESE

AS A SECOND LANGUAGE

Some contrasts in the second language (L2) impose difficulty in processing for learners, especially when these contrasts are not used phonemically in a learner's first language (L1). This thesis is to examine how American English speakers learning Japanese discriminate and store information regarding the L2 contrasts as a part of their lexicon (i.e. lexical encoding). The central discussion is on how length contrasts, both consonantal and vocalic (e.g. *shita* "under", *shitta* "came to know" and *shiita* "theta") are perceived and processed by learners. In addition, a relationship between geminate and long vowel were examined (e.g. *shitta* "came to know" and *shiita* "theta").

Three experiments were conducted to test the learner's ability to discriminate and lexically encode (a) singleton vs. geminate consonant, (b) short vs. long vowel, and (c) geminate and long vowel. The first experiment was a discrimination task (ABX) to see whether learners can discriminate between these contrasts. The other two tasks were lexical decision and forced lexical choice (FLeC). These tasks implicitly require full lexical processing. The FLeC task is an innovative experimental paradigm that was introduced in this thesis in order to supplement the lexical decision task.

The results from the ABX and lexical decision tasks indicated that there is a distinction between discriminating length contrasts and successfully encoding length contrasts as a part of Japanese words. The results from the lexical decision and FLeC tasks suggested that learners refer to the closest or most familiar L1 phoneme (i.e. singleton/short vowel) to process a new L2 phoneme. Thus, results exhibited an asymmetric lexical encoding pattern: lower accuracy rates were observed in test words with geminate or long vowel when compared to test words with singleton or short vowel. In contrast, higher accuracy rate was observed in test non-words with geminate or long vowel in comparison to the ones with singleton or short vowel. The results suggest that learners' representations for geminates and long vowels are less accurate than those for singleton consonants and short vowels, while also showing that learners are successfully maintaining L2 contrasts.

Isabelle Darcy, Ph. D

Stuart Davis, Ph. D

Kenneth J. de Jong, Ph. D

Steven Lulich, Ph. D

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Chapter I
Introduction

Honest mistakes in second language classrooms happen when a student tries to make a request, converse with peers and so on. Causes of the mistakes vary but some of the most frequent mistakes are from mispronunciation of words that are close in pronunciation but drastically different in meaning. For instance, when an instructor says *Kite kudasai,* "please come," and some students stand up and come to the instructors while others remain seated quietly ready to listen to the instructor. This is likely due to misunderstanding the instructions if students do not process a length contrast in Japanese correctly. In this specific instance, students who remained in their seats may have perceived the instructions as *Kiite kudasai*, "Please listen," which differs from the first form through the presence of a long vowel [i:] in *kiite*. Though students can in most cases understand the meaning of a sentence through the context, in this particular case, the sentence uttered by the instructor could even have a further potential meaning for students to perceive it as *Kitte kudasai*, "please cut (it out)." Length contrasts are some of the most frequent causes of mispronunciation, misunderstanding and misspelling by learners of Japanese.

As illustrated above, the perceptual ability of second language learners (L2 learners) is critical in understanding and recognizing words in order to successfully communicate through their L2. Yet, confusable L2 contrasts, such as the Japanese length contrast, leads to less efficient word recognition and imprecise lexical representations (Broersma, 2012; Ota et al., 2009). In recent approaches to L2 perception, there is a debate on where exactly learners' misperception stems from, or rather, whether difficulties linked to segmental contrasts are only due to inaccurate perception, or whether difficulties can also take place at the level of the lexical representations that learners establish for the words of their L2 (Darcy, Daidone, & Kojima, 2013, 2015). In one scenario, difficulties emerge during phonetic perception that is not target-like. That is, learners have difficulty categorizing L2 contrasts at the phonetic level. In this perspective, learners cannot perceive the physical difference between two contrasting sounds. For instance, learners cannot perceive or robustly categorize the difference between a short or long vowel ("*kite*" vs "*kiite*" in above example). The other perspective proposes that the difficulty is not contained exclusively at the level of phonetic perception (see also Melnik & Peperkamp, 2019). Instead, learners *can* detect the physical difference between the sounds but have difficulty storing it in the mental lexicon (i.e. lexical encoding), that is, committing this difference to long-term memory.

In this thesis, we explore how learners of Japanese perceive length contrasts, focusing on the source of inefficient word recognition. To this end, three experiments were conducted, and are presented and discussed in Chapters 3 to 5. Before moving on to these experimental results, we will briefly review Japanese phonology for the remainder of this chapter, and examine previous studies on L2 perception in relation to length contrasts in Chapter 2.

1.1 Japanese Phonology and Length Contrast

In Japanese, length is phonemic. There are consonantal length contrasts such as *saka* "slope" vs. *sakka* "writer." In addition, Japanese exhibits vocalic length contrasts such as *hito* "person" vs. *hiito* "heat." Thus, triplets such as *shita* "below, under", *shitta* "came to know" and *shiita* “theta” would impose difficulty to L2 learners with inefficient word recognition. Japanese consonantal length contrasts have been extensively studied in phonetics (Han, 1962; Idemaru & Guion, 2008), phonology (Davis, 2011; Ito & Mester (1995); Kubozono (1999) among many others), and L2 acquisition (Toda, 2003; Harada, 2006; Hirata, 1990b).

Kubozono (1989b) demonstrated the importance of mora as a subcategory of a syllable in order to account for pitch accent patterns, speech errors and word blending phenomena in Japanese. It is phonemic (e.g. *ko* “individual” vs. *koo* “incense”) and its physical existence is also established in phonetic research conducted in the language (Han, 1962). Thus, the mora plays an important role in Japanese as a unit for timing and syllable weight. It is the smallest building block of Japanese prosody. It is noteworthy that there are 4 different types of morae called special mora: (a) first part of geminate (i.e. *ka<u>t</u>ta* “bought”), (b) second part of long vowel (i.e. *so<u>o</u>* “layer”), (c) second part of diphthong (i.e. *da<u>i</u>gaku,* “university”) and (d) moraic nasal (i.e. *ka.ba<u>N</u>* “bag”). In this study, we will exclude the moraic nasal from the scope of our research.

In addition to the segmental contrasts, (e.g. *kata* “shoulder” vs. *kita* “north”) and length contrast (*kata* “shoulder” vs. *katta* “bought”, *shita* “under” vs. *shiita* “theta“) we have discussed so far, pitch accent is also phonemic in Japanese. For instance, *hashi* with low-high pitch accent means “chop sticks” while and *hashi* with high-low pitch accent means “edge”. The following Table 1.1 shows length contrast in Japanese in relation to pitch accent. The examples are cited from Toda (2003).

Table 1.1: Length contrast in relation to pitch accent (Taken from Toda, 2003, p.5)

	Sentence	Pitch Accent Pattern H = High L= Low	Gross
1	Kite kudasai	HL	Please come
2	Kite kudasai	LH	Please wear
3	Kitte kudasai	HL	Please cut
4	Kitte kudasai	LH	Please give me a stamp
5	Kiite kudasai	LH	Please listen

If all these sentences above were given as oral instructions, it is likely that learners of Japanese would have serious difficulties distinguishing them in terms of meaning, if they are not sensitive to pitch accent. In addition, if learners are not sensitive to the length distinction, examples 1 and 3 and examples 2 and 4 in Table 1.1 would sound all the same to them. In the following section, we explore how visual cues in Japanese orthography can help to differentiate the above examples.

1.2 Japanese Orthography

Aside from the phonological inventory, the Japanese language makes use of three different orthographies that are visually very different from the Roman alphabet: Hiragana and Katakana syllabaries and Kanji (i.e. Japanized/nativized usage of Chinese characters). The first two orthographies are glottographic (i.e. each symbol corresponds to a phoneme or syllable) whereas Kanji is logographic (i.e. each character represents a word or phrase). All the special morae mentioned above will be spelled differently in Hiragana and Katakana syllabary and Kanji helps visually recognize the difference in meaning when a word in question is semantically ambiguous due to the existence of homophones.

In the following examples, singleton vs. geminate is visually distinguishable by hiragana syllabary and kanji usage that will help further assist to visually clarify semantic ambiguity. For instance, the horizontal hook-like character in (1a) [っ] alerts readers that there is a geminate consonant. In addition, the use of different kanji characters in (1a) – (1b) will notify readers that there are different meanings. Example in (1a) and (1b) are otherwise spelled exactly the same in the hiragana syllabary. Native speakers take copious advantage of this kind of visual help when recognizing or distinguishing words. However, in most classroom settings, at least in beginner to intermediate levels at college, vocabulary lists and spoken words come first (i.e. listening to lecture or engage in conversation in pair/group). In addition, it takes some time to master and feel comfortable to use all these different types of orthography.

(1)	a. きって	*kitte*	切って	"to cut"
		kitte	切手	"postal stamp"
	b. きて	*kite*	着て	"to wear"
		kite	来て	"to come"

1.3 Pedagogical Needs for the Current Study

As mentioned in section 1.1, the special morae are phonemic and play a crucial role in proper word recognition and understanding grammatical structures. In particular, geminates are an essential part of verb conjugations (i.e. plain form of past tense). Thus, it is critical for learners of Japanese to detect and process those special morae properly.

Yet, these two aspects of Japanese phonology in particular (length and pitch accent) cause many difficulties for L2 Japanese learners in the classroom, as shown by the numerous errors that appear in students' writing, and which may signal a lack of awareness, a misperception, uncertainty about the exact form of the word even if its meaning is known, or a more generalized listening comprehension issue (Han, 2009). The following examples in (2) and (3) are recurring mistakes from students that the author has observed over the years.

Ungrammatical forms, that is, non-existing words, are marked with asterisks in the following examples. In (2a), students were supposed to spell a word for "watch" or "see," which does not contain a long consonant or vowel. However, students tend to spell the word with a geminate. In contrast, student were supposed to write hiragana corresponding to the first part of geminate for the word for school (2b), but the geminate tends to be omitted in their writings. Example (2c) shows how a student misspells "homework" with a long vowel instead of a short vowel. Similarly to (2c), a short vowel was written instead of a long vowel in (2d). We can see students struggle with the distinction between short vs. long sounds.

(2) Short – Long

a. *mite*	みて	"to see, watch"	vs. みって	**mitte*
b. *gakkou*	がっこう	"school"	vs. がこう	**gakou*
c. *shukudai*	しゅくだい	"homework"	vs. しゅうくだい	**shuukudai*
d. *oosaka*	おおさか	"Osaka (place name)"	vs. おさか	**osaka*

Of note, such substitutions of a long for a short sound and vice-versa also happen when students are asked to repeat a word; thus, the effect is not limited to the written form of words. In addition, the examples in (3a) show that students spelled a word for "to listen" with a geminate where they were supposed to spell with a long vowel. Conversely, students spell "yokka" with a long vowel in (3b) where native speakers spell it with a geminate consonant. The examples in (3) demonstrate that students were not only confused about short vs. long contrasts, such as replacing a long with a short consonant, they were also confused about the quality of a long sound – that is, whether a word contains a long consonant/geminate or a long vowel/diphthong. Therefore, even if they are aware that a word contains a long sound, it is not immediately clear whether it is a vowel or a consonant that is long, and confusions across the whole word are common.

(3) Long (consonant) - Long (vowel)

a. *kiite* 聞いて 'to listen' **kitte* 聞って

b. *yokka* 四日 '4th (of the month)' *youka* 八日 '8th (of the month)'

According to Kozasa (2005) the ratio of the duration of long to short vowels and consonants varies by segment, speech rate, speaker, and elicitation technique, but ranges from approximately 1.8:1 to 3:1 (Kawahara, 2015). Thus, phonetically the “long” sounds are very different in physical length. Yet students often will confuse long consonants with long vowels and vice versa. The question naturally arises about the extent to which students are confused between categories (i.e. short vs. long) and within a long category (i.e. geminates vs. long vowels), and whether one type of confusion is more prevalent than another. Similarly, the question arises as to where these confusions take place during processing: at the level of basic perception or when memorizing the form of words, or both.

In the next chapter, we start with a discussion of how previous studies dealt with phonemic contrasts in general in the realm of the second language studies. Then moving on to review previous research examining length contrasts specifically, and describing how this specific topic contributes to our understanding of second language phonological patterns.

Chapter II
Literature Review

2.1 Phonemic Contrast and Speech Perception

Recognition and discrimination of phonemes has been considered one of the critical building blocks in speech perception. Thus, perception and discrimination of phonemic contrasts has understandably drawn a lot of attention in the field of auditory, visual or audiovisual speech perception. It is also essential for listeners' ability to recognize and discriminate a contrast in a given language, and to decide whether a string of sounds convey meaning or not. Hence, early research on speech perception mainly focused on the discrimination of various speech sounds, and how categories are built during first language acquisition (i.e. how infants acquire their mother tongue). In the same vein, pathological approaches centered on problems with sound confusions.

In the last two decades, there have been active discussions and exchanges of thoughts among researchers regarding second language (L2) perception. Compared to the first language (L1) perception, L2 perception tends to be less accurate, especially when a person started to learn the L2 in their adulthood (i.e. late learners). It is inevitable to take the L1 into consideration when L2 acquisition of phonology is concerned. To pursue the nature of auditory perception, there have been studies on naïve/non-native listeners in comparison with native ones. Among the most influential models in speech perception, the Speech Language Model (SLM) proposed by Flege (1995) and the Perceptual Assimilation Model (PAM) L2 proposed by Best and Tyler (2007) are prevalent in the field.

As implied by Flege's SLM, L2 learners would face difficulty in acquiring a contrast between L2 categories when a learner's first language does not have the contrast, meaning that it is not used phonemically. The basic mechanism behind both models state that, depending on how sounds in the L2 map onto L1 categories, perception and discrimination between sounds in the L2 may range from easy to difficult. The most difficult case is expected to emerge when two phonemes in the L2 map onto the same phonemic category in the L1. One of the most typical examples for this case is L1 Japanese learners of English. The English /r/ and /l/ phonemes will be mapped onto the same category for Japanese L1 learners of English. More specifically, this effect is strongest when the contrast is in medial or onset position of a word (Sheldon & Strange, 1982; Iverson et al., 2003). In the case of length contrasts, the issue is slightly different from purely segmental categories in that one possible contrast involves a comparison between vocalic and consonantal quality in *kiite* vs *kitte,* for example. Segmentally, no model predicts confusion between /i/ and /t/, but length may be different. Length distinctions are considered as belonging to the prosodic dimension, or being a suprasegmental distinction (McAllister, Flege & Piske, 2002). However, one can also consider that a long vowel /iː/ vs. a short vowel /i/, if phonemic, function like categories, at least in L1 Japanese. Hence, Japanese speakers may build a phonemic category for a long /iː/ and another for a short /i/. If we treat short segment and long segment as phonemic contrast, then Japanese length contrasts would be predicted by SLM or PAM-L2 as the most difficult contrasts to acquire. It is because American English does not have phonemic length contrasts. Actually, Nishi (2008) suggested that both /iː/ and /i/ would map onto the one /i/ category in the phonemic vowel inventory of English speakers. That is, both long and short vowels of the same vowel quality will map onto the same vowel for these learners. A similar phenomenon is expected for consonantal length contrasts. As described in McAllister et al. (2002), listeners whose L1 does not distinguish vocalic or consonantal length phonemically (Spanish, English) also had more difficulties distinguishing words differing in length compared to listeners whose L1 had phonemic length categories (like Estonians). Thus, learners would map /t/ and /tt/ to /t/.

Though length contrasts in American English are not phonemic, there are phonetically short and long consonants and vowels. The minimal pair *sit* and *seat* contrasts a phonetically shorter and longer phoneme, respectively. These pairs are abundant in American English. Studies have shown that vowel quality is the primary cue to distinguish these phonemes (e.g. McAllister et al., 2002). Thus, the vowel duration is not used as a primary cue. As for geminates, in American English, they do not occur within a root. However, there are examples that are phonetically geminates (e.g. lamp post [ˈlæmp.poʊst], misspell [ˌmɪsˈspɛl]). These geminates occur between morpheme boundaries and are not phonemic. The occurrence of phonetic geminate cases are less common than phonetically long sounds in American English. Thus, this difference in frequency might lead to a situation where native speakers of American English perceive long vowels better than geminates.

An important consequence of inaccurate phoneme discrimination is that it may lead to inaccurate lexical representations. Pallier and colleagues (2001) conducted a lexical decision task with Catalan and Spanish listeners, and used word pairs in Catalan that use a phonemic contrast (/e/ - /ɛ/ and /o/-/ɔ/), such as /pera/ 'pear' vs. /pɛra/ 'Peter'. Both phonemic contrasts are difficult to distinguish for Spanish-dominant bilinguals, because it is not phonemic in Spanish. The researchers observed that the Spanish bilinguals made more errors in a discrimination task between the two vowel pairs (Pallier, Bosch, & Sebastián- Gallés, 1997). They also observed difficulties in lexically distinguishing the word pairs, and concluded that they had used the same vowel to lexically represent the word pairs, effectively resulting in homophones. They concluded that inaccurate perception yields confusable or ambiguous lexical representations (Pallier, Colomé & Sebastián Gallés, 2001). That is, two different words will have the same lexical representation as a result of a lack of perceptual discrimination of the contrast. In other studies, the same kind of difficulty in phonemic discrimination yields spurious lexical activation, where the lexical representation is imprecise. For instance, a near-word such as */lɛmp/ for 'lamp' /læmp/could lead to activation of 'lamp', that is, it could function as a word via spurious lexical access (Broesma & Cutler, 2008; Dupoux, Sebastián-Gallés, Navarrete & Peperkamp, 2008; Sebastián-Gallés, Echeverría, & Bosch, 2005). These effects are also evidenced in L2 learners as repetition priming effects (Pallier et al., 2001; Darcy et al., 2012) with minimal pairs. In these studies, L2 learners, but not native speakers, experienced a repetition priming effect for minimal pairs, and not only for the same items, indicating that the two words in the minimal pair activate each other as if they were repetitions of themselves. The researchers interpreted this effect to mean that the lexical representations of the words do not exclude phonologically confusable segments.

2.2 Learners Discriminatory Ability and Lexical Representations

The idea that misperceptions of learners can lead to inaccurate lexical representations is now prevalently accepted in the field. However, other researchers show that learners can actually be trained or learned new contrasts and perform better (Tajima et al., 2008; Hayes-Harb & Masuda, 2008). A further issue is that L2 contrasts are not all equally easy to distinguish (Altmann, Berger, & Braun, 2012): some of the contrasts are relatively easier to perceive than the others. We will come back to the issue of difference in difficulty in encoding L2 contrasts later in this chapter.

It is very important to recall that the ability to perceive and produce segmental contrasts alone does not guarantee that learners store the form of L2 words correctly in their lexicon (i.e. lexical encoding). Several studies have shown that there is a dissociation between discriminatory ability and lexical activation or lexical encoding (e.g. Dupoux et al., 2008). To put it differently, maintaining a robust phonetic difference and storing separate lexical representations for words involving that phonetic difference are separate issues.

Weber and Cutler (2004) and Cutler, Weber, and Otake (2006) indicated that L2 learners can sometimes lexically encode a contrast which is not in their L1, despite difficulties distinguishing the contrast. The evidence that learners can have different (even if non-target-like) representations comes from the following phenomenon: if two L2 categories are completely merged in lexical representations, for instance /r/ and /l/ for Japanese learners of English, upon hearing *rock*, both the words ‘rock’ and ‘lock’ will be activated for L1 Japanese listeners who are learning English. Conversely, upon hearing *lock*, again ‘rock’ and ‘lock’ would be activated for those learners – the two would be fully homophonous. However, Cutler, Weber, and Otake (2006) show that is not true. While hearing *lock*, it activates both *rock* and *lock* whereas *rock* elicits less activation. This asymmetric activation of L2 phonemes was demonstrated in the length of subjects' gaze to a target and competitor. In eye-tracking experiments, longer fixation to an object indicates more confusable in recognition. For instance, for Dutch listeners, *pen* and *pan* are confusable as /æ/ is not in the Dutch phonological inventory. Moreover, even if the stimuli are not a minimal pair, such as "pencil" and "panda", hearing 'pan…' [pæn…] (the first syllable of *panda*), will yield longer looks to both an object depicting a pencil and an image of a panda, indicating that the first syllable activated both lexical entries. However, the same subjects will not give the extended gaze to *panda* when they hear 'pen…' [pɛn], the first syllable of *pencil* suggesting /ɛ/ did not evoke /æ/, and that this syllable did not activate the /æ/-containing words. Not only did Weber and Cutler (2004) and Cutler, Weber, and Otake (2006) demonstrate the asymmetric perception, they also demonstrated that learners treat /ɛ/ and /æ/ differently in lexical representations, though the way they are stored are not the same way as native speakers. Namely, learners' lexical encoding process refers to the nearest L1 category as dominant/familiar category (/ɛ/ in Dutch case), and these words are stored "faithfully" or target-like. The other, non-dominant category is categorized as "not /ɛ/" (i.e. new category), and thus, not exactly target-like. More specifically, one member of the contrast is dominant, whereas the other is encoded separately as "different from the dominant category." The authors postulated that *phonetic proximity* determines what the dominant category would be (Cutler, Weber, & Otake, 2006). Mapping L2 sounds to the closest sound in the L1 as *dominant* (old/familiar) category could be very selective, and lead to a precise lexical representation, whereas the non-dominant (new) category will be result in a more ambiguous or imprecise lexical representation, or less efficient activation and/or selection.

Darcy, Daidone, and Kojima (2013, 2015) corroborated the findings from Weber and Cutler (2004) and Cutler, Weber, and Otake (2006) with a method other than eye-tracking paradigm. They used an ABX discrimination task and lexical decision task: the ABX tasks were used to see whether L2 learners can distinguish L2 categories phonetically and the lexical decision task was used to see whether learners can encode perceived input accurately as L2 sounds. Note that they used two different languages (Japanese for a consonantal length contrast and German for vowel contrast) with different proficiency levels (i.e. beginners and advanced learners). The results indicated that L2 learners can distinguish relevant L2 contrasts with high accuracy, and yet, showed an asymmetrical lexical activation parallel to the one observed in Cutler et al. (2006). Darcy and colleagues concluded that it is specifically at the level of lexical representation that learners face difficulty, with coding the correctly perceived input of L2 sounds. They specifically designed to examine whether the less efficient word recognition often observed in L2 learners is due to inaccurate input perception or due to fuzzy lexical representations, and concluded the latter. (Darcy et al., 2013, p. 373).

Most importantly, asymmetrical lexical encoding was taking a form where learners make reference to the dominant category (i.e. L1 phoneme, which they called "old"). That, in turn, leads to a specific order of accuracy in lexical decision. As mentioned in 1.1, the length of a consonant and a vowel are phonemic in Japanese. (i.e. *kite* "to come" vs. *kitte* "postal stamp", *shiru* "liquid, soup" *shiiru* "sticker"). In the following example, two Japanese words are used to illustrate the asymmetric lexical encoding in terms of order of accuracy: *akeru* "to open" and *kippu* “ticket”. Given that subjects can discriminate singleton and geminate well, their perception is fine, but they have ambiguous or fuzzy lexical representations for geminates.

The results of lexical decision task indicate the type of stimuli which acquired highest accuracy were real words with singleton/single consonant. In other words, a word containing the dominant/old category, which also is present in English phonological inventory, is the easiest to accept. Then an existing word with new category, such as a geminate (e.g. *kippu* “ticket”), comes second best, and is relatively easy to accept as real word. When it comes to rejecting the non-words, the ones with geminates (the new category) will be less accurate than real word acceptance, but still better than rejecting non-words with singletons (the old category), which will be the least accurate. It is easier to reject **akkeru* than **kipu*, since subjects can refer to an existing word *akeru* with a singleton which is encoded precisely because it contains a familiar category). Inversely, the subjects have to refer to *kippu* to correctly reject **kipu*. If the lexical representation for geminate is imprecisely represented (because it is a less familiar category), then it may not exclude singleton productions and the non-word will be very hard to reject. Table 2.1 represents this asymmetry through the predicted ordinal accuracy for each of the four cases. Of note, this table indicates that perception is accurate: there is no change from input to percept (see Darcy et al., 2013, 2015 for details).

Table 2.1: Ordinal Accuracy in Lexical Decision Task

Lexical Representation	/akeru/		/ki?u/	
	match	mismatch	no mismatch	no mismatch
Percept	[akeru]	*[akkeru]	[kippu]	*[kipu]
Input	[akeru]	*[akkeru]	[kippu]	*[kipu]
Expected Response	yes	no	yes	no
Accuracy Rank	1	3	2	4

? = imprecisely represented

As mentioned earlier, Darcy, Daidone, and Kojima (2013, 2015) replicated the asymmetric lexical encoding for L2 contrast in Japanese consonantal length and German vowel distinctions. Moreover, since they conducted experiments with different proficiency levels, their data indicated learners' proficiency for lexical decision has an impact on accuracy on the lexical decision task: the accuracy progressively gets higher as learners' proficiency advanced. In their German results, the results from advanced learners indicate that they overcome the asymmetric lexical encoding and behave essentially like native speakers. There was an asymmetric pattern in accuracy for the beginning learners in German data just like results from Japanese subjects, but there was no such pattern in advanced learners suggesting that accuracy and lexical encoding patterns may change over the course of learning the language.

In addition to this peculiar L2 encoding pattern, some researchers indicated that there is a difference in perceptual difficulty depending on contrasts. That is, some distinctions are easier to encode than others. It may be partly because L2 learners use different cues compared to native speakers. Specifically, Altmann, Berger, and Braun (2012) examined the effects of L1 in both vocalic and consonantal length contrasts. Ten German native speakers who had no exposure to Italian, 10 proficient Italian learners whose L1 are German, and 10 Italian native speakers who had no exposure to German.

(4) German vocalic length contrast and Italian consonantal length contrast

German-vocalic length contrast (e.g. /ban/ “ban” vs. /ba:n/ “train”)
Italian consonantal length contrast (e.g. /fato/ “fate” vs. /fat:o/ “fact”)

The intriguing perspective in this study is whether learners can make use of their (implicit and/or explicit) knowledge of consonantal length contrasts in their L2 when they process an unfamiliar consonantal length contrast. That is, whether learners of Italian whose L1 is German take advantage of knowing consonantal length contrasts from their experience in the Italian language (i.e. L2): the learners’ group should show higher accuracy in consonantal length discrimination task when compared with the results of German native speakers who had no exposure to the Italian.

The results of a consonantal length discrimination task indicated that non-native listeners (i.e. both native speakers of German with and without exposure to Italian) had difficulty compared to the native speakers of Italian. However, the learners were more accurate than non-learners. That in turn indicates that their L2 knowledge may have helped to improve their discrimination of consonantal length contrasts. Interestingly though, there was no difference (i.e. no effect of groups or type of contrast) in the accuracy for the discrimination for the vowel contrasts in all groups, not only those for whom it is part of the L1. Thus, the authors concluded there is a generalized asymmetry in L2 perception between vocalic and consonantal length contrasts. To be more precise, they claim that overall, the vowel length contrast was easier to perceive across all groups than the consonantal length contrast.

This is somewhat contradictory to the results from Darcy, Daidone, and Kojima (2013, 2015), who found that even beginning learners can discriminate consonantal length in Japanese with high accuracy (i.e. above 85% accuracy rate). However, the study for Japanese only dealt with the shot vs. long consonantal length contrast. It did not include a direct comparison with vocalic length. Hence, the vowel length contrast in comparison with consonantal length contrast is missing, and in this dissertation, both vocalic and consonantal length contrasts are considered. Three different experiments were designed to obtain a more holistic picture of how length contrasts in Japanese are perceived and encoded by L2 learners. These experiments aimed to examine how learners discriminate, process, and lexically encode length contrasts as L2 phonemes.

The first part of this study (Chapter 3) will be devoted to replicating and expanding the discrimination task (i.e. ABX) reported in our previous study (Darcy, Daidone, & Kojima, 2013, 2015) including the vocalic length contrast. In this way, it is possible to see whether subjects can discriminate vowel and consonantal length contrasts in one language. In this chapter, we also examine whether the vowel length contrast is easier to discriminate than the consonantal length contrast based on Altmann, Berger, and Braun (2012).

The second part of this study (Chapter 4) will be devoted to replicating the lexical decision task from Darcy, Daidone, and Kojima (2013, 2015) and Kojima and Darcy (2014), also including vocalic length contrast. To date, no study has examined both vowel vs. consonant asymmetries in lexical encoding in one single language. Previous research (Cutler, Sebastián-Gallés, Soler-Vilagelie, & Van Ooijen, 2000) indicates that vowels and consonants do not have the same status during lexical access: consonants constrain lexical access more than vowels (i.e.

during word recognition, listeners are more tolerant of vowel differences than that of consonant differences). Thus, it is a crucial question to examine, since it may provide critical insights into how lexical encoding in the L2 unfolds, and whether encoding difficult contrasts on vowels is harder or easier than on consonants.

The third part of this study (Chapter 5) will be devoted to reinforcing the observation of Darcy, Daidone, and Kojima (2013, 2015) and Kojima and Darcy (2014), by introducing a new method to examine lexical behavior, in the form of a forced-choice binary lexical decision task to see subjects' L2 processing at the time of lexical decision task. This additional experiment is designed to give a limited choice (i.e. only the two most relevant ones) out of a possibly huge activated cohort that might be activated upon hearing a stimulus, and which might cloud L2 learners' decision process. The general discussions will be made in chapter 5 followed by concluding remarks and future directions in chapter 6.

2.3 Research Questions and Predictions

Putting all the previous evidence mentioned above together, the research questions we specifically pursue in this thesis fall into three main points as follows:

a) Does a Perceptual Advantage in Vowel over Consonant Length Contrasts Exist in L2 Japanese?
b) Do we observe a dissociation between phonetic discrimination and lexical encoding for vocalic length contrasts?
c) Is this dissociation similar for both vowel and consonants?

Following Darcy, Daidone, and Kojima (2013, 2015), different proficiency levels will be included (i.e. beginners and advanced). The aim to include different proficiency level is to take learnability of lexical encoding process into consideration. As mentioned in earlier sections, the study indicated that learners could overcome asymmetric lexical encoding in the case of a German vowel length contrast.

We assume both vowel and consonantal length contrasts will exhibit perceptual asymmetries in learners' responses but not in native speakers: advanced learners' response would be more accurate than beginners if this study replicates Darcy, Daidone, and Kojima (2013, 2015). In addition, learners exhibit higher accuracy for the discrimination of the vowel contrasts than consonantal length contrasts if the results replicate Altmann, Berger, and Braun (2012).

Chapter III

Categorical Discrimination Task (ABX)

3.1 Introduction

ABX tasks have been widely used in psychology for testing participants' ability of discrimination. In an ABX task, participants are presented a triplet of stimuli—A, B, and X—and asked whether the last one (i.e. X) is more similar to the first one (i.e. A) or the second one (i.e. B). Short-term auditory memory in which participants upon hearing stimuli lasts approximately 200-300ms (Gerrits & Schouten, 2004). Due to time intervals between each stimulus, participant's auditory memory of A and B might have faded away and they have to rely solely on their knowledge of phonetic/phonemic category stored in memory. Therefore, the ABX task has been extensively used to test categorical discrimination for consonants (Casserly & Pisoni, 2010) in language studies, including in L2 phonology. The ABX task has also been applied for vowel contrasts as well. A known disadvantage of this task is that participant responses tend to have a strong bias towards B = X (Schouten, Gerrits, & Van Hessen, 2003).

Other discrimination tasks include AX, 2AFC, and so on. An AX task asks participants whether the first stimulus (i.e. A) was the same as or different from the second stimulus (i.e. X). The task imposes less cognitive load in comparison with the ABX task in that there is less time lag from the stimuli presentation to the moment in which participants making decision. It reduces participant's cognitive load in auditory memory. As Gerrits and Schouten (2004) point out, the disadvantage of this task is that participants tend to respond "different" only when they are sure that A and X are different. 2AFC stands for *two-alternative forced-choice*. In this paradigm, a pair of stimuli is presented, and they are always “different”. Then, participants have to determine the order of stimuli such as AB or BA. As Schouten and Van Hessen (1992) point out, this task has a potential risk of encouraging labelling behavior. That is, participants are influenced by the category used to describe the stimuli in question. Both AX and 2AFC tasks have advantages over ABX in that they have less response bias. However, neither the AX nor 2AFC task would tap participant’s phonetic/phonemic knowledge in the mental lexicon. Thus, many researchers make use of ABX tasks in second language research where researchers investigate the content or composition of learners mental lexicons.

In the discrimination task mentioned above, response time, along with accuracy rate, will be measured to examine processing difficulty. That is, if the response time is slower, it indicates that the task is more difficult for participants to process.

Darcy, Daidone, and Kojima (2013, 2015) examined the discriminability of consonantal length contrasts by L2 learners of Japanese. They used ABX tasks and examined two different proficiency levels: beginners and advanced learners. The study showed that high accuracy was observed in both advanced learners (average 94%) and beginners (average 93%). In addition, there was no statistically significant difference in accuracy rate between beginners and advanced learners, nor between native speakers and advanced learners. Thus, they concluded that learners can discriminate geminate and non-geminate even at the beginning level.

As mentioned in Chapter 1, Japanese exhibits both vocalic and consonantal length contrasts within the language. Aside of the length contrast itself (i.e. singleton vs. geminate, short vowel vs. long vowel), L2 learners of Japanese seem to be confused with geminate and long vowel (see Chapter 1 example (2), p. 5). Both geminate and long vowels are “long” sounds to learners and they are confused in terms of the type of length. Along this line, Altmann, Berger, and Braun (2012) observed vowel advantage over consonants among non-native listeners in the speeded same-different perceptual discrimination task (i.e. AX task).

Participants of the study were 10 German native speakers, 10 German native speakers learning Italian, and 10 Italian native speakers. Note that German has vowel length contrasts (e.g. *ban* “ban” vs. *ba:n* “train”) while Italian has consonantal length contrasts (e.g. *fato* “fate” vs. *fat:o* “fact”). Thus, testing native speakers of both languages and German native speakers learning Italian give the ideal testing environment to observe L1 influence holistically.

The study measured *d’* scores which reflects participant’s sensitivity for difference in stimuli in terms of hits and false alarms (Macmillan & Creelman, 2005). A higher *d’* score indicates that a participant can easily detect the difference; that is, they have a high sensitivity to the contrast. The study found that *d’* score for consonantal length contrasts depends on the participants’ L1 and/or experience of learning the Italian language. That is, when discriminating consonantal length contrasts, the *d’* score of the Italians was higher than German native speakers learning Italian (average *d’* for Italian was 3.04, whereas average *d’* of German native speakers learning Italian was 1.95; the difference between them was significant at $p < .001$). In addition, the sensitivity of German learners of Italian was higher than German non-learners (average *d’* score of German non-learners: 1.31, $p = .05$).

With respect to the vocalic length contrast, the average *d’* score for the Italians was 3.04, for the German native speakers learning Italian, it was 2.75, and for the German non-learners, it was 2.87. Corresponding statistical result show that there was no effect of group ($p > .05$). Recall here that only Italian language exhibits consonantal length contrast while the

German exhibits vocalic length contrasts. The results indicate that all three groups were equally sensitive to the vocalic length contrast despite these differences in L1 or L2 learning experience. Therefore, the authors concluded that non-native vowel length contrasts are easier to perceive than consonantal length contrasts. The Italians were apparently able to use the vocalic length cue and apply it to vocalic length discrimination, whereas the reverse was not true for the Germans when discriminating consonants.

The results from Altmann, Berger, and Braun (2012) suggest that there is an advantage in perception of vowel length contrast over consonantal length contrasts by non-native speakers. If this perceptual advantage holds in Japanese length contrasts, the vocalic length contrast should be easier for anyone to perceive while the consonantal length contrast is harder to perceive. What makes the current study and Altmann, Berger, and Braun's (2012) study different is that Altmann, Berger and Braun (2012) made use of two different languages that exhibit consonantal (i.e. Italian) and vocalic length contrasts (i.e. German). Japanese exhibits both consonantal and vocalic length contrasts together in one language. Thus, our study contributes to the discussion of how the perceptual advantage plays a role for learners of Japanese.

In addition, Altmann, Berger, and Braun (2012) targeted German native speakers learning Italian who had learned the language for at least 11 months. The learners' length of study varied from a learner who studied one year at university to the one who learned a total of 7 years (5 years at school in Italy (at age of 15) then 2 years at university). Darcy, Daidone, and Kojima (2013, 2015) demonstrated that learner accuracy rates are greatly influenced by their proficiency level. Therefore, learner groups in the current study are divided into two based on their length of formal education at university. Those who were taking the second semester of introductory Japanese courses were recruited as members of the beginner group in the following experiments. Those who had completed third-year Japanese courses or those who further completed 4th-year Japanese were recruited as advanced learners. In addition to these learner groups, native speakers were recruited so that the native speaker group plays a role as a control group.

In the current study, all the participants in learner groups are native speakers of American English. This is simply due to the fact that the dominant student population for college-level Japanese language classes in the United States is native English speakers. However, we acknowledge a rapidly growing international student population in the classroom in a last decade. Note that some English phonemes are also phonetically longer or shorter than others, but length itself is not lexically contrastive. The minimal pair *sit* and *seat* contrasts a phonetically shorter and longer phoneme, respectively. However, studies have shown that vowel quality is the primary cue used to distinguish these phonemes in native English, and that lengthening the short phoneme or shortening the longer phoneme has minimal impact on native listener categorization (Grenon, 2010). We might represent the word *sit* in the International Phonetic Alphabet (IPA) as [sɪt], whereas *seat* could be represented as [si:t], but in terms of how it is phonologically encoded in memory, Grenon (2010) has shown that *seat* could not be encoded as /si:t/. That is because specification for length implies that listeners would be able to reject shortened non-words like */sit/, when in fact, they readily accept short pronunciations, and phonetically long [sɪ:t] as *sit*, as well.

As introduced in 2.1, phonetic geminates can occur in American. However, these geminates occur between morpheme boundaries and are not phonemic. The occurrence of phonetically geminate cases are less common than phonetically long sounds in American English.

In the following section, the experimental design for details will be described. As mentioned in Chapter 1, students seem to be confused not only short-long distinctions (e.g. *shita* vs. *shitta* and *shita* vs. *shiita*) but also confused between geminates (e.g. *shitta*) and long vowels (e.g. *shiita*). Thus we explore whether learners can discriminate (a) a singleton and geminate (e.g. *shita* "under, below" vs. *shitta* "knew"), (b) short vowel and long vowel (e.g. *shita* "under, below", under" vs. *shiita* "theta"), and (c) geminate and long vowel (e.g. *shitta* "knew" vs. *shiita* "theta").

In pursuit of replication of Darcy, Daidone, and Kojima (2013, 2015), an ABX task was chosen, rather than an AX task that Altmann, Berger, and Braun (2012) used. As mentioned in 3.1 (p.21), participants have to rely solely on their knowledge of phonetic/phonemic category stored in memory in ABX task. It is due to time intervals between each stimulus.

In Darcy, Daidone, and Kojima (2013, 2015), only singletons and geminates were used as length contrasts for the ABX discrimination task and lexical decision task. In this study, a crucial addition was made to explore learners' perception and processing of length contrast in Japanese in a more holistic way. Thus, the two additional contrasts were: short vowel and long vowel, as well as geminate and long vowels. To date, this study will be the first to include three contrasts of length contrasts (i.e. singleton vs. geminate, short vs. long vowel and geminate vs. long vowel) in one task.

In this task, we expect high accuracy rate in general regardless of proficiency level and type of stimuli based on Darcy, Daidone, and Kojima (2013, 2015). The results of the study suggested that learners score high accuracy (above 90%) for an ABX discrimination task even at the beginning level. According to their study, proficiency plays a crucial role in accuracy rates on the lexical decision task but not for the ABX task.

As for the prediction in terms of discriminability, it is expected that vocalic length contrast will be easier than consonantal length contrast based on Altmann, Berger, and Braun (2012). This advantage of vocalic contrasts over consonantal contrast is also predicted by the phonetic realization of long vowel and geminate in American English. Although duration is not a primary cue in perception, there are more phonetically long vowel than geminates (see 3.1, p. 22). It is likely that listeners are more accurate at discriminating when they have more exposure to some phonetic feature directly or indirectly related to the L2 contrast in question. Hence, we predict higher accuracy in the vocalic length contrast than in consonantal length contrast.

With respect to the contrast between geminate and long vowel, there are at least two different interpretations and predictions in discriminability. Despite of the perceptible acoustic duration of a geminate or a long vowel itself, they are both “long” (e.g. two morae). Thus, participants have to discriminate the *type* of length (i.e. geminate/long vowel) while the length is perceptually equal between the two items. In this respect, discriminating a geminate from a long vowel could be harder than discriminating a short from a long segment (e.g. singleton vs. geminate, or short vs. long vowel). Another possibility is that it could be easier for participants to discriminate a geminate from a long vowel, because they could make use of the inherent phonetic cues pertaining to the geminate vs. the vowel over a longer period of time (because they are long segments).

3.2 Experimental Conditions and Stimuli

Disyllabic sets of non-word were used. Since learners' L1 is English, none of the stimuli were real Japanese or English words. As mentioned in 3.1, there were three targeted types: (i) singleton (e.g. *mete*), (ii) geminate (e.g. *mette*) and (iii) long vowel (e.g. *meete*).

The design of the ABX task in the current study compares participants' performance in three test conditions (see Table 3.1): singleton vs. geminate, single vs. long vowel and geminate vs. long vowel.

Table 3.1: Experimental Conditions and Sample Trials for ABX

Condition	Sub-conditions	Sample trial (A – B – X)	Expected answer
Baseline	Baseline	goka - kogga – goka	A
Test	Geminate Condition (GC)	mette - mete – mete	B
	Long Vowel Condition (LV)	mete - meete – mete	A
	Quality of Length (GC/LV)	mette - meete – meete	B

All the stimuli were non-words, and learners were required to detect either the difference between a short and long sound or the quality of the long sound. Test triplets consist of one of the following sub-conditions: (a) Geminate (GC) (e.g. *mette* vs. *mete*), (b) Long Vowel (LV) (e.g. *meete* vs. *mete*) and (c) Quality of Length (e.g. *mette* vs. *meete*). The comprehensive list of non-word pairs is presented in Appendix B. There was no control condition per se (see

Dupoux et al., 1997, Experiment 1). Instead, we used the first block of practice trials as a baseline measure (see below) for analysis.

Stimuli were recorded multiple times by two female Japanese native speakers. This was to reduce the effect of familiarity with one specific voice. Both speakers were trained linguists. One speaker was a Tokyo dialect speaker while the other was a phonetician who is very familiar with the Tokyo dialect. The recordings were made in a sound-proof room with a portable microphone at a private university in the Tokyo region. Stimuli were recorded onto a computer and later divided into separate sound files for presentation in the experiment. There was no cross-splicing or manipulations to the sound files. The sampling rate was 22000 Hz and stimuli were elicited by reading isolated non-words multiple times at a normal speed. Non-words were written in roman alphabets (e.g. *mete*, *mette* etc.). The same native speakers of Japanese also recorded the stimuli for the Lexical Decision task and for the Forced Lexical Choice (FLeC) in the following chapters. In the ABX task, the trained phonetician's recording was used for the first and the second items in a triplet (i. e. A and B) and the Tokyo dialect speaker's recoding was used for the last item of a triplet (i.e. X).

3.3 Procedure

Each trial consisted of a triplet of non-words (i.e. A, B and X) where X is similar to either A or B. Participants were asked to decide whether X was similar to A or B as quickly and accurately as possible. For instance, if the test triplet was A - *mete*, B- *mette*, X - *mete*, the correct answer for X was "A". In half of the trials, X was equal to A, and in the other half, X was equal to B. All the counterbalanced combinations of presentation orders (i.e. ABA, ABB, BAA and BAB), conditions (singleton, geminate and long vowel) and voice type (i.e. female 1 and female 2) yielded a total of 144 test triplets (4*3*2 = 144).

The actual test session was always preceded by a practice session. The practice session utilized 8 trials, used to make sure participants understood and executed the ABX task properly. Thus, the practice session was specifically designed to have A and B differ in length *and* other segments (e.g. k vs. g in this example: A = *koga*, B = *gokka*, X = *koga*). The extra cue (i.e. a segmental difference) was expected to facilitate participants' distinction of A and B while familiarizing them with the task involving length contrasts. We used performance on this first block as a baseline to evaluate outliers in this task.

Participants were seated in front of a laptop computer, equipped with high-quality headphones in a sound-isolated room, and gave their answers by pressing keys on the computer keyboard. Keys were labeled "1" or "2". The 144 triplets along with 8 practice triplets were presented in four randomized blocks separated by breaks. Experimental stimulus presentation was controlled by the software DMDX (Forster & Forster, 2003). Randomization was executed both among and within blocks. Accuracy and Response Time (RT) were measured. Participants had 2500 ms to make their response before the next trial was initiated. Inter stimulus interval was 500 ms. Response times were measured from the onset of the third item in a trial. The participants were allowed to take breaks between the blocks as needed. The total duration of this task was about 10-15 minutes.

This task was administered as the first in a series of 3 speech perception tasks: after the subject completed the ABX task they move on to the Lexical Decision Task followed by the Forced Lexical Choice (FLeC). The subjects filled out the demographic survey and language background questionnaire before or after all the experiments depending on waiting time for their turn. Most of the participants filled in the survey and questionnaire before the experiments.

3.4 Participants

The recruitment was done at a large university in the Midwest area in the United States. Participants' demographics and language/linguistic background were screened with two separate questionnaires (see Appendix A). Two groups of late learners of Japanese (advanced learners; n = 15, 5 males and 10 females), mean age = 24.6, beginning learners; n = 19, 11 males and 8 females, mean age 19) and one group of native speakers of Japanese (n = 16, 5 males and 11 females, mean age = 30.5) were tested.

All the learners in this study were native speakers of American English. None of the learners reported having had formal education in or exposure to the Japanese language before the age of 14 or 15 depending on which age they started to study Japanese in high school. For learners, second languages that they were exposed other than Japanese were as follows: Spanish (19), French (11), Chinese (4), German (2), Korean (2), Italian (1), Norwegian (1), Hebrew (1), and ASL (1).

Advanced learners were either enrolled in 4th year Japanese (J401) or were teaching or had taught Japanese as associate instructors at the time of recruitment. Average length of time in Japan for advanced learners was 13.6 months (SD = 21.9). All the beginning learners were enrolled in first semester of beginning Japanese (J101) at the time of recruitment. None of them reported having lived in Japan. Some of the learners had traveled to Japan. However, the length of stay during the trip was no more than two weeks.

Native speakers of Japanese were recruited at the same university mentioned above and most of them were enrolled as students who had taught/were teaching Japanese as associate instructors. They were living in the US at the time of testing. Their average (self-reported) proficiency in English was 5.2 out of 7.

No participants reported any history of hearing or speech disorder. Participants received a small compensation of $10 for their participation in the study. All procedures used in this and the following experiment were approved by the Indiana University Institutional Review Board for Human Subjects (IRB# 1310570064).

3.5 Sample Characteristics and Data Screening

Mean accuracy rate and mean response time (RT) were measured on each condition (baseline vs. test) for each participant and each item. First, accuracy on all items was screened for outliers in the native speaker group. Five items obtained accuracy rates that were below 2.5 SD from the mean accuracy for this group and were removed from the analysis. Subsequently, once these items were removed, individual accuracy in each condition was obtained for all participants, and those who scored below 50% (i.e. lower than chance level) accuracy on the baseline items were removed from further analysis since we cannot assume that they understood the task. After this elimination 15 advanced learners, 13 beginners and 16 native speakers were retained for the statistical analysis below.

3.6 Accuracy Rate

3.6.1 Global Analysis

The following Table 3.2 shows the results of accuracy rate and response time between native speakers (NS) and non-native speakers (Learners) to see the overall results and tendencies. Note that we have not shown the results split by different learner groups (i.e. beginners and advanced learners) in the following table.

Table 3.2: Mean Accuracy and RT According to Response for Each Group and Each Condition

Test Cond	Group	Response	Mean Accuracy	SE	Mean RT	SE
Base	Learners	First (X = A)	.84	.04	1159.4	50.3
		Second (X = B)	.79	.04	1149.2	55.6.
		Mean	.81	.03	1154.3	43.9
	NS	First (X = A)	.88	.05	1144.8.	64.2
		Second (X = B)	.96	.05	1151	68.5
		Mean	90	.04	1147.9	56.7
Test	Learners	First (X = A)	.83	.02	1110.3	33.6
		Second (X = B)	.92	.02	1050.6	33.5
		Mean	.87	.02	1080.5	32.9
	NS	First (X = A)	.96	.03	962.4	46.2
		Second (X = B)	.98	.03	904.5	46.1
		Mean	.94	.03	933.5	45.5

As can be seen, all the participants had very high accuracy regardless of group or condition. All the mean accuracy rates are around or above 80%. In terms of response time (RT), native speakers and non-native speakers do not seem different from the baseline condition. However, native speakers' response time seems faster than that of non-native speakers in the test condition.

A linear mixed effects model was executed in SPSS 21 on accuracy rate. Group (i.e. native speakers (NS) vs. learners (NNS)), Condition (i.e. baseline vs. test) and Response (i.e. First - A = X vs. Second - B = X) were entered as fixed effects. Items and Subjects were entered as random effects.

The type III tests of fixed effects revealed significant main effects of Group (F (1, 59.2) = 6.9, p = .011) and Condition (F (1, 159.7) = 5.4, p = .021). However, there was no effect of Response (F (1, 159.7) = 2.3, p = .13). In addition, none of the interaction between fixed effects was significant: Group and Condition (F (1, 6232) = .005, p = .94), Group and Response (F (1, 6232) = .98, p = .32) and Condition and Response (F (1, 159.7) = 1.1, p = .29). However, the three-way interaction among fixed effects was significant: Group, Condition and Response (F (1, 6232) = 7.5, p = .006). Namely, native speakers are always more accurate than non-native speakers regardless of Condition and Response, which is what led to the three-way interaction.

Note that mean accuracy in both the native speaker group and the combined learner group showed that baseline performance was less accurate than the test condition. Baseline data was collected through the training session. In the training session, *koga, goka, kogga* and *gokka* were used. Eight triplets from these non-words were used (e.g. *koga-gokka-koga*, *goka-kogga-kogga*). Segmental cues other than length contrasts were added to these stimuli, expecting to facilitate participants' distinction of A and B. It might be the case that additional cue did not help to ease participants' discrimination.

3.6.2 Accuracy Rate by Group and Conditions

Next, a mixed effects model was run on the test condition only, to examine effects of proficiency within the learners, as well as specific differences between subconditions. This model specified Group (native speakers (NS), advanced learners (EA) and beginners (EB)) and non-word condition (C-C:, V-V: and C:-V) as fixed effects. These three types of conditions are (i) comparing singleton and geminate (i.e. C-C:), (ii) comparing singleton and long vowel (i.e. V-V:) and (iii) comparing geminate and long vowel (i.e. C:-V:). Note that we did not include Response from the fixed effects as its effect was not significant in the global analysis. Subjects and items were entered as random effects.

Type III test of fixed effects revealed significant main effects of Group (F (2, 41) = 7.3, p = .002) and Condition (F (2, 136.9) = 7.7, p = .001). In addition, there was a significant interaction between Group and Condition (F (4, 5930) = 3.8, p = .004).

For the overall effect of condition across groups, C-C: is the least accurate one (87.2%) followed by C:-V: (90.8%) and V-V: is the most accurate (92.2%). Namely, we can see the tendency that discriminating singleton from geminate is the hardest (i.e. lowest accuracy) and discriminating singleton from the long vowel is the easiest (i.e. highest accuracy). A post-hoc pairwise comparison with Sidak correction confirmed that above differences corresponds to the statistical significance. Pairwise comparison between C-C: and V-V: was significant (p < .001). Namely, the contrast between a long vowel and short vowel yielded better accuracy than discriminating geminates from singletons. In addition, the pairwise comparison between C-C: and C:-V: was significant (p = .02). That is, discriminating geminate from long vowel yielded better accuracy than discriminating geminate from singleton. However, there was no statistical significance in the pairwise comparison between V-V: and C:-V: (p = .61). That is, discriminating short and long vowels was as accurate as discriminating long vowels from geminates.

With respect to the effect of group, mean accuracy rate for each group showed that accuracy rates for native speakers were the highest (97%), followed by the advanced learners (91.6%) and the beginner's accuracy rate was the least accurate (81.7%). Post-hoc pairwise comparison with Sidak correction revealed that the native speakers are significantly more accurate than beginners (p = .001). On the contrary, advanced learners were only marginally more accurate than beginners (p = .051). In addition, there was no significant difference when native speakers and advance learners were compared (p = .42). Thus, beginners were less accurate than the native speakers while advanced learners were not significantly less accurate than the native speakers. Despite the difference between the learner groups in comparison with the native speakers, all three groups were overall highly accurate on this task (over 80% correct).

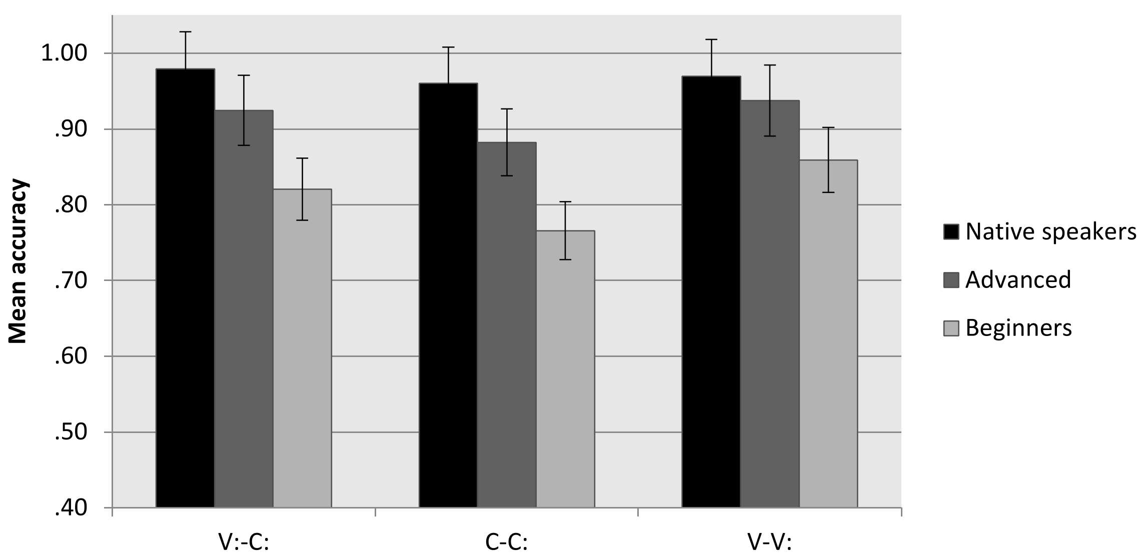

Figure 3.1: Accuracy Rate in Each Condition for Each Group. Error Bars Represent the 95% CI

Table 3.3 shown below is the summary of accuracy rate by each group. The accuracy rates for specific conditions are listed in order from the highest to the lowest accuracy rate. For both learner groups, V-V: scored the highest accuracy rate followed by C:-V: and C-C: scored the lowest accuracy. It is critical to point out that these results are compatible with Altmann, Berger, and Braun (2012): discriminating long vowel from singletons (i.e. V-V:) is more accurate than discriminating geminate consonants from singletons. Unlike the learners, the native speakers do not follow this pattern.

Table 3.3: Accuracy Rate in Order by Conditions

	Beginners (EB)	Advanced Learners (EA)	Native Speakers (NS)
Most accurate	V-V: (85.9%)	V-V: (93.8%)	C:-V: (97.9%)
↓	C:-V: (82.1%)	C:-V: (92.4%)	V-V: (96.9%)
Least accurate	C-C: (77.1%)	C-C: (88.5%)	C-C: (96.1%)

Post-hoc pairwise comparisons with Sidak correction each group were then used to compare these sub-conditions. For the advanced learners, C-C: was marginally less accurate than C:-V: (88.5% vs. 92.4%, p = .061), whereas C-C: was significantly less accurate than V-V: (88.5% vs. 93.8%, p = .006). Although advanced learners were as accurate as native speakers overall, these comparisons confirm that processing the singleton vs. geminate consonant contrast is the most challenging.

Similar post-hoc pairwise comparisons with Sidak correction within the beginner group revealed that C-C: was significantly less accurate than C:-V: (77.1% VS. 82.1%, p = .02) and C-C: was also less accurate than V-V: (77.1% vs. 85.9%, $p < .001$). This pattern parallels exactly the difficulties of the advanced learners but appear here more pronounced in the beginner group.

We conclude that the order of accuracy represents an order of difficulty in processing the length contrasts in L2: differentiating singleton from geminate consonants is the most difficult task; learners experience relative ease in differentiating geminate consonants from long vowels (C:-V:); Finally, differentiating short from long vowels is the easiest.

When it comes to the native speakers, none of the comparisons were statistically significantly different as they are highly accurate on all the conditions in the range of 96.1 - 97.9% indicating a ceiling effect, which was expected for this group.

Other sets of pairwise comparisons with Sidak correction within each condition revealed that the beginners were statistically less accurate than native speakers on all three conditions: C-C: (p = .001), V-V: (p = .034) and C:-V: (p = .001). That is, the native speakers were more accurate in all three different conditions.

Contrary to the beginner group, none of the comparisons showed significant differences when comparing native speakers to advanced learners (C-C: (p = .18), V-V: (p = .81) and C:-V: (p = .44)). Namely, the advanced learners were as accurate as native speakers regardless of condition.

With respect to the comparison between advanced learners and beginners C-C: (p = .026) and C:-V: (p = .046) are significant but not for V-V: (p = .18). That is, advanced learners are more accurate than beginners in both C-C: and C:-V: conditions. However, comparing single and long vowel (V-V:), the relatively high accuracy rates for advanced and beginning learners were not significantly different (advanced learners: 93.8% vs. beginners: beginners: 85.9%). This may be because the groups are approaching a ceiling effect, as this condition is the most accurate out of the three conditions for both learner groups.

In summary, advanced learners have succeeded in performing at native speaker levels in this task overall, which suggests that some degree of perceptual acuity for length contrasts can be acquired. In addition, advanced learners were more accurate than beginners in most of the conditions except for the V-V: condition. In the V-V: condition, beginners were as accurate as advanced learners. From these observations, we can conclude that gains in proficiency level correspond to higher accuracy rates in the task.

Though advanced learners were as accurate as the native speakers, the advanced learners follow the same accuracy order with beginners (i.e. V-V: > C:-V: > C-C:). we assume that this accuracy order reflects the order of difficulty.

More importantly, the fact that V-V: was the most accurate and C-C: was the least accurate in both beginner and advanced learner groups clearly corroborate the asymmetric perception of non-native vowels and consonants that Altmann, Berger, and Braun (2012) observed. That is, the vocalic length contrast appears easier to discriminate and the consonantal length contrast is harder to discriminate.

3.7 Response Time

3.7.1 Global Analysis

The following statistical analysis is for response times on the discrimination task. It complements statistical analysis for the accuracy rate. Therefore, we begin with the global analysis to see overall results between native speakers (NS) and non-native speakers (NNS). Namely, the results of non-native speakers include both beginners and advanced learners. Then we will move on to more detailed analysis by each group and condition in the following sections.

Table 3.4 shows the results of response time between native speakers (NS) and non-native speakers (NNS) for the overall results and tendencies. A linear mixed effects model was executed in SPSS 21 on response time (RT). Mean response times were computed over correct responses. group (i.e. native speakers (NS) vs. learners (NNS)), condition (i.e. baseline vs. test) and response (first vs. second) were declared as fixed effects. Items and Subjects were declared as random effects. Type III test of fixed effects revealed that there is an effect of Condition (Baseline: 1151.1 ms vs. Test 1006.9 ms: F (1, 155.2) = 26.7, p < .001) but no significant effect of Group (NS: 1040.7 ms vs. NNS: 1117.3 ms: F (1, 49.2) = 1.7, p = .19) and Response (First: 1094.2 ms vs. Second: 1063 ms: F (1, 155.2) = 1.2, p = .28).

Table 3.4: Overall Mean Response Time by Condition for Non-Native Speakers (NNS) and Native Speakers (NS)

Condition	Group	Mean RT	Sig.
Base	NNS	1154.3	F [(1, 77.3) = .91] p = .79
	NS	1147.9	
Test	NNS	1080.4	F [(1, 43) = 4.9]. p = .012
	NS	933.4	

Although there was no effect of group, there was a significant interaction between effect of Group and Condition (F (1, 5613.6) = 15.8, p < .001). However, none of the other interactions including the three-way interaction were significant: Condition*Response (p = .31), and Group*Response (p = .80), Condition*Group*Response (p = .84).

Univariate tests further revealed that effect of interaction between Group and Condition stems from the difference in response time for the test condition. Namely, native speakers and non-native speakers are equally fast for the Baseline (p = .79) but native speakers are significantly faster than non-native speakers in the test condition (p = .012).

3.7.2 Response Time by Group and Conditions

Next, a mixed effects model was run on the test condition only to examine the effects of proficiency and sub-conditions. This model declares Group (native speakers (NS), advanced learners (EA) and beginners (EB)) and Condition (C-C:, V-V: and C:-V:) as fixed effects. Again, response (first vs. second) was excluded from fixed variable in the analysis below. Subjects and items were declared as random effects.

The results revealed that there was a main effect of condition (F (2, 137.3) = 7.7, p < .001)) and of group (F (2, 41) = 4.4, p = .018)). However, the interaction of condition and group was marginally significant (F (4, 5363.9) = 2.4, p = .052). Regarding the main effect of condition, V-V: was the fastest in response time (mean RT: 996.7 ms). C:-V: is the second fastest (mean RT: 1034 ms). C-C: is the slowest (mean RT: 1054.2 ms).

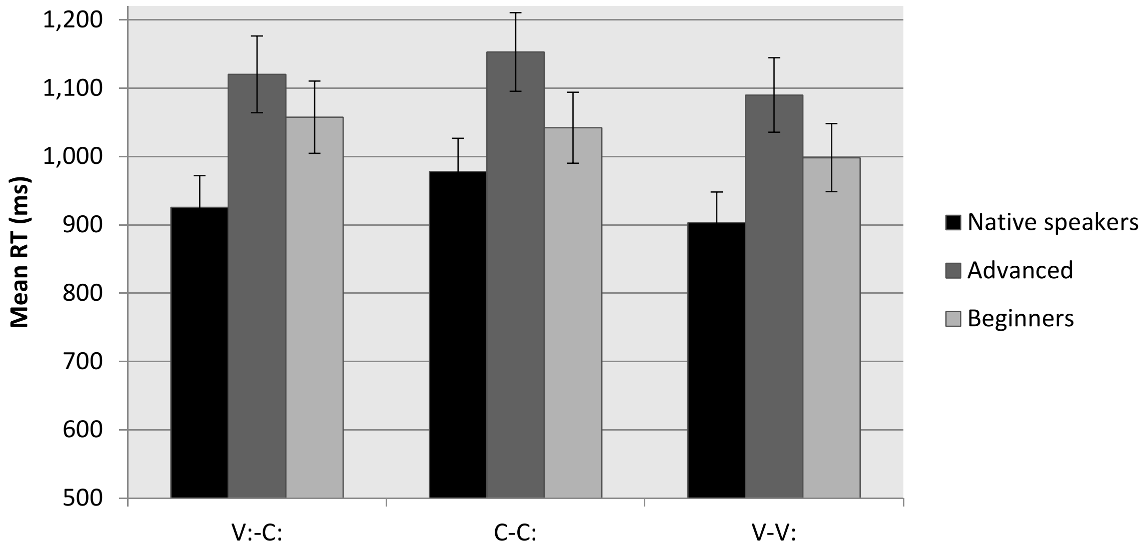

Figure 3.2: Mean RT for Each Group and Condition (Error Bars represent 95%CI)

Corresponding post-hoc pairwise comparisons with Sidak correction revealed that V-V: (mean RT: 996.7 ms) yields significantly faster responses than V:-C: (mean RT: 1034 ms, p = .034) and C-C: (mean RT: 1054.2 ms, p = .001). However, there is no statistical significance when C-C: and V:-C: are compared (p = .45).

With respect to the effect of group, the results revealed that the native speakers' recorded the fastest mean response times (mean RT: 934.2 ms). The beginners recorded the second fastest response time (mean RT: 1031.1 ms) and the advanced learners' mean response time was the slowest (1119.6 ms).

Corresponding post-hoc pairwise comparisons with Sidak correction further revealed that advanced learners were significantly slower than the native speakers in all three conditions (C-C: (p = .025), V-V: (p = .015) and C:-V: (p = .011)). However, none of the comparison between beginners and native speakers is significant (C-C: (p = .71), V-V: (p = .41), and C:-V: (p = .16)). In addition, there was no statistically significant difference when the advanced learners and beginners are compared (C-C: p = .28, V-V: p = .42, and C:-V: p = .72).

In summary, native speakers were faster than the advanced learners in all three conditions. However, the beginners and native speakers were equally fast. The results also indicate that the beginners and advanced learners were equally fast. These results contribute to the marginal interaction of Group and Condition.

The Table 3-5 in the following shows that the latency order of advanced learners and native speakers match: V-V: is the fastest, followed by C:-V:, and C-C: is the slowest. Beginners do not follow the pattern, but response speed was as fast as native speakers.

Pairwise comparisons with Sidak correction within group revealed that C-C: vs. C:-V: (p = .028) and C-C: vs. V-V: (p = .001) were significantly different for native speakers. That means processing long vowel and geminate (i.e. C:-V:) is faster than processing singleton and geminate (i.e. C-C:). In addition, processing singleton and long vowel (i.e. V-V:) is faster than processing singleton and geminate (i.e. C-C:).

For advanced learners, only C-C: vs. V-V: was significant (p = .005). Namely, V-V: is faster than C-C:. Put differently, there was a statistical significance between the fastest condition (V-V:) and the slowest condition (C-C:).

As for beginners, only the Pairwise Comparison between V-V: and C:-V: was significant (p = .009). Again, the results showed that there was a statistically significant difference between the fastest (V-V:) and the slowest (C:-V:) conditions.

Table 3.5: RT Order by Conditions

	Beginners (EB)	Advanced Learners (EA)	Native Speakers (NS)
Fastest	V-V: (997.4 ms)	V-V: (1089 ms)	V-V:(903 ms)
↓	C-C: (1039 ms)	C:-V: (1120 ms)	C:-V:(925 ms)
Slowest	C:-V: (1056 ms)	C-C: (1149 ms)	C-C: (974 ms)

Unlike the accuracy rate, above results showed that beginners were as fast as native speakers. On the contrary, advanced learners were slower than the native speakers. Recall that advanced learners were comparable to native speakers regarding accuracy rate. Thus, we speculate the slower latency is a trade-off of accuracy against response time.

3.8 Discussion

Overall, all three groups including the beginner group, performed with high accuracy. As can be seen in the Table 3.6, all three groups were least accurate in the C-C: condition. However, native speakers did not show any significant effect among the conditions as they seemed to reach ceiling effect (96% or above for all the conditions). On the contrary, learner groups followed a specific accuracy order (i.e. V-V: > C:-V: > C-C:). Statistically, the advanced learners were not less accurate than native speakers. However, results of the advanced learners showed statistical significance in most of the comparisons among conditions. Thus, we assume that this accuracy order corresponds to the difficulty of discriminating length contrast and quality of length. The results from the beginners enhanced this point as all the pairwise comparisons among condition were significant.

In summary, the results indicate that discriminating singletons from geminates is harder than discriminating single vowels from long vowels. That is, the vocalic length contrast is easier to process, corroborating the results from Altmann, Berger, and Braun (2012). Moreover, the above accuracy order also demonstrates relative processing difficulty of Japanese length contrasts: discriminating long vowels from geminates is easier than singletons vs. geminates but more difficult than single vs. long vowels. Last but not least, it is worthy to point out that proficiency matters despite the high accuracy across the ABX task.

Table 3.6: Accuracy Rate by Conditions

	Beginners (EB)	Advanced Learners (EA)	Native Speakers (NS)
Most accurate	V-V: (85.9%)	V-V: (93.8%)	C:-V: (97.9%)
↓	C:-V:(82.1%)	C:-V: (92.4%)	V-V: (96.9%)
Least accurate	C-C: (77.1%)	C-C: (88.5%)	C-C: (96.1%)

Table 3.7: RT Order by Conditions

	Beginners (EB)	Advanced Learners (EA)	Native Speakers (NS)
Fastest	V-V:(997.4 ms)	V-V: (1089 ms)	V-V: (903 ms)
↓	C-C: (1039 ms)	C:-V: (1120 ms)	C:-V: (925 ms)
Slowest	C:-V:(1056 ms)	C-C: (1149 ms)	C-C: (974 ms)

As for the response time, there were statistical significance in all comparisons among conditions for native speakers. That is, their latency is sensitive to the type of condition. Interestingly, the order of the response time by condition is exactly the same with the accuracy rate that learners demonstrated (i.e. V-V: > C:-V: > C-C:). We assume that native speakers' accuracy was too high to have the order emerge in the accuracy rate. Indeed, only advanced learners follow this order for both accuracy and response time. We can say that advanced learners' accuracy and response time are bound to the order of the processing difficulty: the easier, the faster.

That said, recall that advanced learners were as accurate as native speakers when accuracy rate was compared. However, the advanced learners were significantly slower than the native speakers when the response time was compared. We assume that the advanced learners' response speed was not as fast as native speakers because the slower latency was a result of compensation for accuracy.

Beginners were somewhat different in comparison with the advanced learners. When it comes to the response time, they were as fast as native speakers and advanced learners. In addition, their response time order by condition is not compatible with the order that advanced learners and native speakers followed (V-V: > C:-V: > C-C:). All the pairwise comparisons by conditions for beginners was significant for the accuracy rate ranging from 77.1 % to 85.9 %. That is, their accuracy rate depends on the condition. Thus, we assume beginners' latency order does not attribute to the order of processing difficulty. Rather, it attributes to their proficiency: there was some uncertainty in processing (i.e. less accuracy in comparison with advanced learners and native speakers) and unlike advanced learners, processing speed does not correlate with processing difficulty.

3.9 Summary

In this chapter, we examined the difference between consonantal and vocalic length contrasts, and the perception of quality of length (geminate vs. long vowel) along with the effect of learners' proficiency. We observed that both advanced and beginning learners can discriminate length with high accuracy on an ABX task. Additionally, we confirmed that proficiency and type of length matter. In particular, vowel contrasts were better discriminated than consoanatal length contrasts as predicted. Of particular interst, both advanced and beginning learners' discrimination of geminate and long vowel was more accurate than that of consonantal length contrast. However, it was less accurate overall than vowel length contrasts. Our prediction was such that discriminating content of "long" is either more difficult or easier than short and long contrast. The results indicate difficulty by learners was placed in the middle: it was easier than consonantal length contrast since length was not a feature in comparison. At the same time, it was more difficult than vocalic length contrast since the "long" category is not monolithic and vowel contrast will be better perceived than consonantal contrasts.

From the viewpoint of prevalent models of L2 phonological acquisition (i.e. SLM and PAM-L2), the length contrasts are predicted as the most difficult contrast since American English does not have length contrasts in a contrastive way. Contrary to the expectation generated from these models however, learners' accuracy on ABX task was very high.

In the next chapter, we address the issue as to whether learners can lexically encode the length contrasts in Japanese. Darcy, Daidone, and Kojima (2013, 2015) suggested that there is a discrepancy between discriminability and accuracy in lexically encoding. Lexical encoding refers to a state where learners stored L2 contrast to their mental lexicon. While a discrimination task requires participants to make use of short-term memory, the lexical encoding task taps into learners' L2 contrasts in the lexicon: it requires long-term memory. We explorer this issue through a lexical decision task.

Chapter IV
Lexical Decision

4.1 Introduction

As was seen in the last chapter, the ABX task revealed that even at the beginning level, learners had high accuracy in all the test conditions. The results corroborate those of previous studies, especially by Darcy, Daidone, and Kojima (2013, 2015) in that even beginners scored high accuracy rate. In this chapter, we report the results of the lexical decision task designed to observe the learners' ability to encode the L2 contrast (i.e. short vs. long contrast in Japanese) in lexical representations. As was the case in the ABX task, vocalic length contrasts, and comparison of geminate and long vowel were examined along with consonantal contrasts.

Lexical decision tasks are a commonly employed type of behavioral task in psychological and psycholinguistic experiments (Rubenstein, Garfield, & Millikan, 1970; McCusker, Holly-Willcox, & Hilinger, 1979, and many others). The task asks subjects to classify stimuli as a word or a non-word in a given language while measuring accuracy and response speed. Hence, the task implicitly requires full lexical processing. In other words, deciding whether something is a word or not demonstrates successful word recognition as it involves a match between incoming acoustic signals (i.e. stimuli) and stored forms. The task has been used to examine the nature of lexical representations but is not limited to it. For instance, the task has been used to examine the effects of word frequency (MacCusker et al., 1979; Marslen-Wilson, 1990), repetition priming (Slowiaczek & Pisoni, 1986), facilitatory phonological priming, and so on (Goldinger, Luce, Pisoni & Marcario, 1992, among others). See Goldinger (1996) for an extensive review on the lexical decision task in speech perception.

In the field of perception in the second language, learner accuracy and response speed (i.e. latency) in comparison with native speakers is assessed. Traditionally, either ABX tasks (see Chapter 2 and 3 for details) or lexical decision tasks are used in previous studies. As mentioned in the last chapter, researchers use ABX tasks to assess learner's ability to discriminate L2 contrasts, while a lexical decision task typically assesses how precisely learners made connection between what they perceived and what they store in the mental lexicon (i.e. lexical encoding). Unlike the traditional approach, Darcy, Daidone, and Kojima (2013, 2015) made use of both ABX and lexical decision to evaluate discriminatory ability and precision of lexical encoding in one study (i.e. same experimental groups for both tasks). By combining the two tasks, the research investigated whether there is a discrepancy between discriminatory ability and precision of lexical encoding ability. The results of the study cast a new light on a discrepancy between L2 learner's discriminatory ability and precision of lexical coding. That is, learners can detect physical difference of short and long consonant in Japanese (e.g. *mete* vs. *mette)*, but were still inaccurate in lexical decision. The study conducted ABX task using non-words along with the Lexical Decision task using word and non-words (Darcy, Daidone, and Kojima, 2013, 2015).

Not only did the study suggest the discrepancy, the study corroborated previous findings on asymmetric lexical encoding specific to the second language acquisition through the auditory lexical decision task. Asymmetric lexical encoding was originally suggested by Weber and Cutler (2004) and Cutler, Weber, and Otake (2006), using eye-tracking methodology (see also Escudero, Hayes-Harb, & Mitterer, 2008, for a word learning study showing the same asymmetry when orthographic information is provided).

The core idea of asymmetric lexical encoding is that learners refer to the closest L1 category (i.e. old) when evaluating an L2 category in question (i.e. new), particularly, when L2 learners have to deal with an L2 category that is not in their L1. To take an example from the current experiment, Japanese singleton and geminate can be defined as follows: the closest L1 category for this contrast is a singleton segment in English. When learners have to process an L2 new category, say *sakka* "writer", they refer to the old category (i.e. singleton). In fact, there is a word *saka* "slope" in Japanese. Thus, learners need to encode *saka* and *sakka* precisely to distinguish those two words. There are also cases involving an L2 word that features a new category—a long vowel as in *apaato* "apartment"—but its short vowel counterpart is not a word in Japanese (i.e. **apato*).

Unlike the ABX task, Darcy, Daidone, and Kojima (2013, 2015) reported that accuracy rates differed by proficiency level in their lexical decision task. That is, the accuracy rate in the advanced learner group was higher than the one for the beginners overall. Since the task asks participants to decide whether stimuli are words or not, the results of their study suggested that the size of vocabulary matters for the lexical decision task.

Furthermore, the results indicated that there is an interaction between condition (control vs. test) and lexical status (word vs. non-word). The authors suggested the asymmetric lexical encoding embodied a specific order in accuracy through these interactions: (1) control word, (2) test word (old), (3) test word (new), (4) control non-word, (5) test non-word (new) and (6) test non-word (old). In general, researchers assume control stimuli are more accurate than test stimuli. In addition, it is well known that words are always more accurate than non-words (Forster and Chambers, 1973). Weber and Cutler (2004) and Cutler, Weber, and Otake

(2006) showed that a L1 like category (i.e. dominant) is better perceived than a new L2 category (non-dominant). If the old category always placed higher than the new category, the last two orders (i.e test non-word (new) > test non-word (old)) do not comform to the order predicted. Darcy, Daidone, and Kojima suggested that this is due to a peculiarlity of L2 lexical processing. The study suggested that this very order is evidence for asymmetric lexical encoding. In the case of test-words, knowledge of the L2 vocabulary helps learners process even words using a new category. In the case of non-words, L2 learners cannot make use of the knowledge of L2 vocabluary. Hence, learners' L2 processing relies on a strategy that enables them to use old and new categories. On the reverse order of the test non-word, Darcy, Daidone, and Kojima explained that a non-word with a new category is more accurate since the learner can refer to the old category to determine that the incoming input is not a word. For instance, upon hearing **akkeru*, learners can easily reject it by referring to a word containing an old category *akeru* "to open". However, when it comes to processing a non-word with an old category (e.g. **kipu*), learners need to refer to a word with the new category (e.g. *kippu* "ticket"). The authors came to the conclusion that learners' representation for the new category is somewhat imprecise ("fuzzy") and it contributes more to erroneous lexical activation compared to the old category. The study reinforced asymmetric L2 lexical encoding in a modality (i.e. auditory perception) other than visual perception (i.e. the eye-tracking) as used by Weber and Cutler (2004) and Cutler, Weber, and Otake (2006).

4.2 Rationale and Predictions

What needs to be examined now, other than replicating the previous study, is to investigate the relationship between geminates and long vowels as a new L2 category. The learners' mistakes (Chapter 1, p. 6) imply possible confusions within a "long" category, along with the short vs. long contrast. Therefore, the current experimental paradigm incorporated stimuli with long vowels (e.g. *apaato* "apartment") in addition to the ones with singletons and geminates. In this way, one is able to examine how learners process singleton vs. geminate (e.g. *akeru* "to open" vs. **akkeru*, short vowel vs. long vowel (*****apato vs. apaato "apartment") and long consonant vs. long vowel (e.g. *hikkosu* "to move" vs. **hiikosu* "sort"). In combination with ABX task results (Chapter 3), this enables us to capture a more holistic picture of the L2 length contrast processing and lexical encoding in L2 learners of Japanese.

ABX examines L2 learners' discriminability while lexical decision examines their ability to store L2 contrasts in long-term memory (i.e. lexical encoding). In ABX, we observed high accuracy regardless of group (i.e. above 85%). Thus, if there is a discrepancy between these abilities, there will be a difference in performance (i.e. accuracy rate) between ABX and lexical decision tasks.

With respect to the difference between vocalic and consonantal length contrasts, if there is a perceptual advantage (see ABX results in Chapter 3), we expect vocalic length contrasts elicit higer accuracy rate than consonantal length contrasts. In addition, the comparative accuracy between geminte and long consonant will be more accurate than consonantal length contrast but less accurate than vocalic length contrast.

As a task-specific prediction for lexical decision task, a higher accuracy rate overall is expected for advanced learners than for beginners (Darcy, Daidone, and Kojima, 2013, 2015). If learners process stimuli by way of asymmetric lexical encoding, we expect an interaction between lexical status and condition. Hence, we expect to replicate the specific order of accuracy shown in 4.1: (1) control word, (2) test word (old), (3) test word (new), (4) control non-word, (5) test non-word (new) and (6) test non-word (old). If there is the intereaction from vocalic length contrasts, this would be a new finding. This contributes to a better understanding of length contrasts in L2 Japanese.

4.3. Method

4.3.1 Experimental Conditions and Stimuli

Thirty-six Japanese words (12 with singletons, 12 with long vowels, 12 with geminates) were selected as test words from the textbook used by the first-year and second-year students at the institution where the current research project was executed. The textbooks are called *Genki* I and II (Banno et. al., 1999). The textbooks were used to enhance the level of familiarity with the lexical items among all learners. 45 filler words as distractors were also selected from the same textbooks (see the comprehensive lists of test words, test-non-words and fillers in Appendix A).

Two female native speakers of Japanese recorded all of the stimuli in a noise-isolated recording room: one is a Tokyo dialect speaker and the other one is a trained phonetician from Niigata Prefecture. Half of the stimuli were chosen from the recording made by the Tokyo dialect speaker and the other half was chosen from the recordings by the trained phonetician, in an effort to avoid familiarity to one voice so that it does not affect the experimental results. When balancing as to which voice to be used, all the conditions were considered and meticulously split in half. For instance, if there were 4 geminate non-words, we used two from the Tokyo dialect speaker, the other two from the trained phonetician, and the same is true for the rest of the stimuli.

For the test words with singleton (henceforth "Origin S"), 12 words containing a singleton were selected as test items (e.g. *akeru* "to open"). For the test words with geminate (henceforth "Origin G"), 12 words containing a geminate were selected as test items (e.g. *hikkosu* "to move"), and finally, for the test words with long vowel (henceforth "Origin L"), 12 words with a long vowel were selected as test items (e.g. *apaato* "apartment").

For each test word mentioned above, two corresponding non-word conditions were created, resulting in a total of 108 test stimuli (i.e. 36 words + 72 corresponding non-words). Those non-word conditions function as non-word test items in the experiment. For instance, *akeru* "to open" is one of the test words with singleton (i.e. Origin S). We created one test non-word with geminate (Condition G) by altering the singleton consonant to a *geminate (e.g. akeru "to open"* → **akkeru*). Then, another non-word with long vowel (Condition L) was created by elongating the first vowel to create a long vowel (e.g. *akeru* → **aakeru).* Likewise, test for words with geminate such as *hikkosu* "to move", (i.e. Origin G), one non-word (Condition S) was created by altering the geminate into a singleton consonant (e.g. *hikkosu* "to move" → **hikosu*). Then, another non-word (Condition L) was created by switching the length from the geminate to a long vowel (e.g. *hikkosu* → **hiikosu*). Similarly, for test for words in the Origin L, one non-word with singleton (Condition S) was created by shortening a long vowel (e.g. *apaato* “apartment” → **apato*) and another non-word (Condition G) was created by switching the length from the long vowel to a geminate (e.g. *apaato* → **apatto*). Note that the original status with respect to the length and its quality (i.e. singleton, geminate/long consonant or long vowel) is expressed as Origin from now on. Those test non-words with singleton are referred as Condition S, the non-words with geminate will be referred to as Condition G, and the non-words with long vowel will be referred to as Condition L, respectively. Table 4.1 shows an overview of the word and non-words conditions (test) for this experiment.

Table 4.1: Overview of the Conditions for the Test Words and Test non-Words (marked by *), Distinguishing Origin and Condition. A double-letter indicates a long vowel or a long consonant

Origin	**Word**	**Non-word (singleton)** **Condition S**	**Non-word (geminate)** **Condition G**	**Non-word (long vowel)** **Condition L**
S	*akeru* “to open”	N/A	**akkeru* *Origin S* *Condition G*	**aakeru* *Origin S* *Condition L*
G	*hikkosu* “to move”	**hikosu* *Origin G* *Condition S*	N/A	**hiikosu* *Origin G* *Condition L*
L	*repooto* *“report”*	**repoto* *Origin L* *Condition S*	**repotto* *Origin L* *Condition G*	N/A

For the control condition, 45 words were selected from the textbooks and included as fillers in the experiment. Each filler word was modified to create a corresponding non-words just like the test words. However, the non-word fillers were made by altering one feature or a segment (e.g. *tenki “weather”* → **tengi*) so that those filler non-words did not involve any length contrasts.

In summary, a total of 198 stimuli were used in the experiment: 108 test items (i.e. 36 Japanese words, 24 non-words with singleton, 24 non-words with geminate, and 24 non-words with long vowel) and 90 fillers (i.e. 45 word and 45 non-word fillers). The overall proportion of words and non-words in the experiment was 81 words (41%) for 117 non-words (59%).

4.3.2 Procedure

The 198 items mentioned above were divided into three blocks consisting of 66 items (i.e. 36 test items and 30 fillers), such that members of a triplet (e.g. *akeru* “to open”- *akkeru*- **aakeru*) were placed in a different block. The presentation of stimuli was controlled by the DMDX software (Forster & Forster, 2003). The stimuli were presented in a randomized order: the three blocks were randomized among blocks and within each block. Each participant thus had a different presentation order of blocks (i.e. Block1 -Block2-Block3, Block3-Block1-Block2 etc.) and a different presentation order of stimuli within a given block.

The participants were seated in a sound-isolated or very quiet room in front of a laptop wearing high-quality headphones (Sennheiser HD515). They were able to self-select a comfortable listening level. The instructions were displayed on the screen, and asked participants to answer whether a stimulus was a real Japanese word or not. They were also told to answer as quick and accurately as possible. The left Control key was assigned for a non-word response and the right Control key was assigned to a word response. Hence, when participant thought the sound sequence he/she heard is a Japanese word, they hit the right Control key whereas when they thought it was a non-word, they hit the left Control key.

The keys were colored and indicated *yes* (i.e. the stimulus was a Japanese word) and *no* (i.e. the stimulus was not a Japanese word) respectively. All the instructions were given in English for the learner groups and in Japanese for the native speaker group. For the advanced learner group, 1 participant reported being left-handed, 13 participants were right handed, and 1 reported being ambidextrous. For the beginner group, 1 participant reported being left-handed, 17 participants were right handed, and 1 reported being ambidextrous. For the native speaker group, 1 participant reported being left-handed and 15 participants were right handed.

Participants were first asked to adjust the sound volume and placement of the headsets then move on to the practice session to get used to the task. There was a short practice session with 9 trials prior to the test session. Each practice trial was followed by feedback ("correct" or "wrong") as soon as the participant hit the left (no) or right (yes) key. For the practice session, the items were either a word or a non-word (e.g. *migi "right", *nigi, sakana "fish", *sagana*). However, none of the practice trials contained a geminate or a long vowel. After the practice, participants were offered the chance to clarify any questions they had, and then were told that there will be three blocks to complete the task. The participants were allowed to take a break for as long as they wished between those trial blocks. For details on the stimuli, see Appendix B and for the instructions for the task, see Appendix C.

During each trial, one word or non-word was presented through the headphones. The participant had 2200 ms to make an answer before the next trial started. The Inter-trial interval was 2600 ms. Accuracy and response times were collected. Response times were measured from the beginning of each item.

4.3.3 Participants

The three groups who participated in the ABX task (i.e. native speakers, N = 16, advanced learners, N = 15, and beginners, N = 19) also took part in this task (see Chapter 3, page 30).

4.4 Results

4.4.1 Sample Characteristics and Data Screening

Mean accuracy scores were computed for each subject, and were screened for outliers, if any. One subject from advanced learner group whose overall accuracy score was beyond 2 SD from the group mean was considered an outlier. Then, we examined item accuracy. We looked at the native speakers' accuracy rate separately for words and non-words. Native speakers' mean accuracy for the words was 96% (SD = 8) while mean accuracy for the non-words was 93% (SD = 1.7). Then those items with mean accuracy beyond ± 2 SD were excluded from further analysis: 4 words and 5 non-words were excluded according to this criterion. Finally, subjects' mean accuracy scores were again screened after exclusion of the outlier items, to exclude outliers with a mean accuracy beyond ± 2 SD from their group mean. The same outlier subject from the advanced group was again considered an outlier following this criterion and excluded from further analysis.

After excluding outliers, overall accuracy and Response Time (RT) were examined by lexical status (word vs. non-word) and by condition (test vs. control), in each group. Later we examine the specific types of test items by sub conditions (i.e. Condition S, L and G and Origin S, G and L).

4.4.2 Accuracy Rate - Global Analysis

Table 4.2 shows the overall accuracy rate and RT means by lexical status and condition. When looking at accuracy, the native speakers were very accurate in all conditions for both words and non-words. With respect to the learner groups, accuracy rates are higher for words than for non-words in both groups. We also see a difference in the two conditions (test vs. control), whereby items in the control condition (i.e. distractors) were overall responded to more accurately than the items in the test condition.

A mixed effects model was conducted in SPSS 21 on the accuracy rates, declaring the factors “group” (i.e. native speakers (NS), advanced learners (EA) and beginners (EB)), “lexical status (i.e. word vs. non-word), and “condition” (i.e. test vs. control) as fixed effects. Participants and items were declared as random effects.

Table 4.2: Mean Accuracy (%), mean RT (ms) and Standard Error (SE) in the Control vs. Test Conditions in Lexical Decison for Japanese Words and Non-Words, for Each Group

	Lexical status	**Condition**	**NS**		**Advanced**		**Beginning**	
			Mean	*SE*	Mean	*SE*	Mean	*SE*
Accuracy	word	Control	97.5	*.023*	92.9	*.024*	66.1	*.022*
	non-word	Control	97.6	*.032*	86.7	*.033*	55.8	*.032*
	word	Test	97.1	*.028*	90.5	*.028*	63.7	*.026*
	non-word	Test	96.7	*.022*	75.6	*.023*	37.1	*.021*
RT	word	control	1019	*39.6*	1180	*55.3*	1271	*36.9*
	non-word	control	1123	*44*	1342	*45.5*	1388	*42.4*
	word	test	1156	*41.7*	1298	*43*	1339	*39.3*
	non-word	test	1183	*39.2*	1469	*40.7*	1461	*37.2*

Note: mean RT is computed over correct responses only

When looking at the Type III tests of fixed effects, the F-tests revealed that there was a main effect of group on accuracy (native speakers, 97.2%, advanced, 86.4%, beginners, 55.7%, $F[2, 47.4] = 181.1$, $p < .001$). Performance for words was more accurate than for non-words (lexical status: $F[1, 185.7] = 28.3$, $p < .001$). Accuracy rate was also higher in the control condition compared to the test condition (condition: $F[1, 185.7] = 10.6$, $p < .001$). All interactions were significant (all $p < .01$), including the triple interaction among group, lexical status and condition ($F[2, 8631.9] = 8.2$, $p < .001$).

When looking at interaction between group and condition, learner groups were more accurate in the control condition compare to the test condition (both advanced and beginning learner groups, $p < .001$). Additionally, a significant interaction of group and lexical status was found: learner groups were significantly more accurate for words than non-words (both $p < .001$).

The interaction between condition and lexical status was also statistically significant $F[1, 186] = 5.4$, $p < .02$). However, condition had no effect on the native speaker performance ($p = .77$). In fact, both lexical status and condition do not affect native speakers' accuracy as well: their accuracy rate is above 95% for all cases ($p > .96$). Therefore, the interactions mentioned above are mainly due to learners' performance. More specifically, both advanced learner and beginner groups followed an accuracy order as follows: control word > test word > control non-word > test non-word. This indicates that lexical status for learners is a primary factor to perform better on the lexical decision task. Then, the condition is the secondary factor to yield higher accuracy rate.

4.4.3 Learners' Accuracy Rate as a Function of Origin

As was seen in the last section, the accuracy rate of the native speakers is not affected by lexical status (i.e. word vs. non-word) or condition (test vs. control). However, learner's accuracy is greatly influenced by both lexical status and condition. In order to explore more in depth regarding the effect of length manipulations, we consider only the test items, eliminating items in the control condition for the following analysis (i.e. control words and control non-word).

When analyzing the test items, we incorporated *origin* as an additional fixed variable. Origin refers to the original status regarding the length of a phoneme before modification to make a test non-word. For instance, a word *akeru* "to open" is an example of origin S since the word has no geminate or long vowel. On the contrary, *hikkosu* "to move" is an example of origin G as it has a geminate in it. Finally, *apaato* "apartment" is an example of origin L.

Table 4.3: Mean Accuracy (%) and Standard Error (SE) in the Test Condition in Lexical Decision for Japanese Words and Non-Words, for Each Group by Origin

	Origin	NS		Advanced		Beginning	
		Mean	*SE*	Mean	*SE*	Mean	*SE*
Word	S	96.1	*.043*	90.5	*.044*	75.5	*.04*
	G	97.2	*.043*	93.5	*.044*	63.4	*.04*
	L	98	*.046*	87.1	*.047*	50	*.043*
Non-Word	S	96.1	*.034*	85.1	*.035*	30.4	*.032*
	G	95.5	*.034*	69.3	*.035*	31.3	*.032*
	L	98.6	*.034*	72.3	*.035*	49.8	*.032*

Note: mean RT is computed over correct responses only

Table 4.3 shows the overall accuracy rate of test word and test non-words for each group separated by Origin. Native speakers' accuracy rate is above 96% regardless of the origin and condition. Advanced learners' accuracy rate varies from 72% to over 90% depending on the origin and/or lexical status. For instance, we can see that their accuracy is higher when accepting a word with singleton/short vowel 90.5 % (e.g. *akeru*, Origin S) than when rejecting a non-word with a singleton/short vowel, 85.1% (e.g. **akkeru*/**aakeru*, Origin S). Beginners' accuracy rates also vary. In addition, the accuracy rate is low overall. Note that all of the results of beginners for test non-words are below chance level (i.e. 50%).

In order to evaluate the effect of origin on each group's accuracy, a linear mixed effect model was executed in SPSS 21 on the accuracy means. It declared the factor *group* (i.e. beginners, advanced learners and native speakers) as a fixed effect and the factors *lexical status* (i.e. word, non-word) and *origin* (i.e. S, G and L) as repeated effects within subjects. Participant and item were declared as random effects.

When looking at the type III tests of fixed effects, the F-tests revealed a main effect of group (F (2, 45.9 = 107), $p < .001$), and lexical status (F (1, 100.6 = 42.9), $p < .001$). However, there was no significant main effect of origin (*F* (2, 100.6 = 1.3), *p* = .3). Despite the fact that origin was not significant, all the possible interactions including the triple interactions of group, lexical status an origin, were significant: the interaction between group and lexical status (*F*(2, 4814 = 48.2), *p* < .001), group and origin (*F*(4, 4814 = 2.6, p = .032), lexical status and origin (*F*(2, 100.1 = 4.4, *p* = .014) and a triple interaction between group, lexical status and origin (*F* 4, 4814 = 21.6, (*p* < .001).

Given that the triple interaction was significant in the global model, it is appropriate to take a closer look by group to evaluate whether the interaction of origin and lexical status is significant. As a reminder, a significant interaction might indicate difficulties in lexical encoding. A linear mixed effect model was executed in SPSS 21 on the accuracy means, for each group separately. It declared the factors lexical status (i.e. word, non-word) and origin (i.e. S, G and L) as repeated effects within subjects. Participant and item were declared as random effects.

For native speakers, lexical status (*F* (1, 100 = .11), *p* = .8) and origin (*F* (2, 100 = 1.6), *p* = .2) did not have an effect on their accuracy rate for the lexical decision task. Just like the one we observed in the global analysis, accuracy rate is very high regardless of the lexical status or origin of the stimuli (lexical status: word 97.1%; non-word 96.8%; origin: G 96.4%; L 98.3%; S 96.1%). The interaction between lexical status and origin was not significant, suggesting that the native speakers encode both long and short sounds equally accurately in their mental lexicon.

For advanced learners, there was a significant effect of lexical status (*F* (1, 100 = 26.3), *p* < .001), such that words were more accurate than non-words. There was no significant effect of origin (*F* (2, 100 = 2.9), *p* = .057). However, the interaction between lexical status and origin *F* (2, 100.6 = 3.7), *p* = .028) was statistically significant. That is, origin itself does not crucially play a role unless lexical status is not taken into consideration (mean accuracy: origin S, 87.8%, origin G, 81.4%, and origin L, 79.7%).

For beginners, there was a significant effect of lexical status (F (1, 100 = 35.8), $p < .001$) such that words were more accurate than non-words. However, there was no significant effect of origin (F (2, 100 = .57), $p = .6$). As in the case of advanced learners, the interaction between lexical status and origin was statistically significant F (1, 100 = 9.2), $p < .001$). As in advanced learners' results , origin as a whole does not crucially play a role unless lexical status is not taken into consideration(mean accuracy: origin S, 52.9%, origin G, 47.4%, and origin L, 49.9%) .

For advanced learners, there was no significant effect of origin on test words (F (2, 100 = .57, $p = .57$). Accuracy rate for test words on origin G was 93.5%, origin L (87.1%) and origin S (90.5%). Origin only influenced accuracy for test non-words (F (2, 100 = 8.9, $p < .001$)) such that origin S (85.1%) yielded better accuracy than origin G (69.3%) and L (72.3%). Corresponding post-hoc pairwise comparisons with Sidak correction of test non-words for the advanced learners revealed that the comparisons between origin S and G ($p < .001$), origin S and L ($p = .005$) were significant. However, the comparison between origin G and L was not significant ($p = .84$). The results indicate that there is an asymmetric result in accuracy rate between origin S and other origins (i.e. origin G and L). That is, origin S yields always better accuracy rate than origin G and L. However, origin G and L are not different in terms of its contribution to the accuracy rate. We will discuss this further in 4.8.

When looking at simple main effect of origin for each level of lexical status (i.e. the Univariate tests), beginners' accuracy on word (F(2, 100 = 4.1, $p = .019$)) and non-word (F(2, 100 = 6.7, $p = .002$)), it was significantly impacted by origin, such that origin S (75%) yields better accuracy than origin G (63.4%) and L (50%) for test words. Post-hoc pairwise comparisons with Sidak correction for test words revealed that the difference between origin S and G was not significant (p = .4) while the difference between origin S and L was significant (p = .015). In addition, the difference between origin G and L was also not significant (p = .35). The results indicate that though origin S yields better accuracy than origin G and L for test words, origin S (75%) and G (63.4%) are not different while origin S (75%) and L (50%) are different in how origin has impact on accuracy rate in response to test words. When origin G (63.4%) and L (50%) were compared, the contribution of each origin to accuracy rate does not differ.

As for the test non-word condition, origin L (49.7%) yields better accuracy than origin S (30.3%) and G (31.3%). Corresponding Pairwise Comparison revealed that origin S and G were not significantly different (p = 1) while origin S and L (49.7%) were significantly different (p = .005). In addition, origin G (31.3%) and L (49.7%) were significantly different (p = .008). Contrary to the test words, origin L corresponded to better accuracy than other origins in beginners' non-test words.

In summary, while lexical status and origin do not affect the accuracy of native speakers, learners were greatly affected by lexical status. Namely, words always lead better accuracy for both beginners and advanced learners. Although origin itself was not statistically significant for both beginners and advanced learners, both learner group had significant interactions with lexical status. The interaction between lexical status in advanced learners took a form in which only test non-words were affected by origins. In contrast, both test words and test non-words were influenced by types of origin for beginners. For instance, the mean accuracy rate of test word for beginners with origin S was 76% whereas the one with origin L scored 50%. In the case of test non-words, the accuracy rate of non-words with origin L is 50%. However, the mean accuracy of non-words with origin S was 30%.

Notably, the univariate test showed that there is no difference between native speaker and advanced learner groups when it comes to the accuracy rate for the test words (p = .3). While lexical status was a critical factor for accuracy rate in both advanced and beginning learners, origin critically differenciates from native speakers to the advanced learners if and only if the stimuli were test non-words. Therefore, we further report another statistical result focusing specifically on test non-words for the learner groups in the next section.

4.4.4 Learners' Accuracy Rate as a Function of Word Origin and Non-word Condition

As seen in the previous section, origin interacted with lexical status to affect accuracy rates only for learners. Specifically, for beginners, the accuracy rate by different origins influenced accuracy rates for both test words and non-words, whereas for the advanced learners origin played a crucial role in accuracy rate when the stimuli were non-words. For instance, in advanced learners a non-word with origin G (69.3%) triggered more errors than a non-word with origin S (85.1%).

However, considering origin alone is not sufficient to reveal what contributes the errors. For instance, those that are labeled as origin G non-words can surface in two forms (i.e. sub-conditions). It can either become a non-word with singleton (origin G becomes non-word conditions S, henceforth G → S), or it can become a non-word with a long vowel (G → L). Therefore, it is important to know how origin relates to these non-word conditions. In what follows, we thus examine this interaction for test non-words, in the learner groups, and declaring the fixed effect of origin and non-word condition.

Non-word condition is a subcategory coding the phoneme change occurring in the test non-words. Each test non-word in this study can be classified by the subcategory. There are three sub-categories: non-word condition S, G and L. non-word condition S is a test non-word that contains a singleton/short vowel. A test non-word with a geminate is called non-word condition G, and a test non-word with a long vowel is called non-word condition L. Each test non-word can have two different origins.

To demonstrate the relationship between the non-word condition (i.e. 3 sub-categories) and origin, let us take *akeru* "to open" as an example. It is a test word and labeled as origin S. Then **akkeru and* **aakeru* (which are both derived from the word *akeru*) will be categorized as test non-words. The first one belongs to non-word condition G whereas the second one belongs to non-word condition L. See Table 4.1 in section 4.3.1 for an overview of the stimuli types.

We performed an analysis that is parallel to what was done in the last section. As seen above, we split results of test non-words by group and execute a linear mixed model for each group in SPSS 21 on the accuracy means. It declared origin (S, G, L) and non-word condition (S, G, L) as fixed effects within subjects. Table 4.4 provides an overview of the descriptive mean scores for this analysis.

Table 4.4: Accuracy Means (%) for Each Group and Origin as a Function of Non-Word Condition

GROUP	ORIGIN	NONWORD CONDITION			Overall Mean by Origin
		S	**G**	**L**	
NS	**S**		96	97	96
	G	97		94	96
	L	98	99		99
	Overall mean by non-word condition	97	98	96	97
ADV	**S**		81	89	85
	G	63		76	69
	L	79	66		72
	Overall mean by non-word condition	71	74	82	76
BEG	**S**		25	36	30
	G	27		36	31
	L	48	52		50
	Overall mean by non-word condition	37	38	36	37

When looking at the type III tests of fixed effects on the native speakers, the F-tests revealed that there was no overall effect of origin (F (2, 66.2 = 1.3), p = .28) or non-word condition (F (2, 66.2 = .66), p = .94). In addition, there was no interaction between origin and non-word condition (F (1, 66.2 = 1.7), p = .2). As was in the case in the previous sections, native speakers' performance is solid and accurate regardless of origin and non-word condition. (See Table 4.6).

For advanced learners, the F-tests revealed that there was a significant effect of origin (*F* (2, 66 = 8.6), *p* < .001) as well as of non-word condition (*F* (2, 66 = 4.48), *p* = .015). With respect to the interaction between origin and condition, it was not significant (*F* (1, 66 = 2.87), *p* = .095) (see Table 4.4).

For beginners the F-test revealed that there is a significant effect of origin (*F* (2, 66 = 9.99), *p* < .001) but no effect of non-word condition (*F* (2, 66 = 1.74), *p* = .18). The interaction between origin and non-word condition was not statistically significant (*F* (1, 66 = .2), *p* < .65). Although the beginners' accuracy rate was consistently low on test non-words, origin crucially affects their accuracy rate (see Table 4.4).

Given that the native speakers accuracy rate was not affected by origin and condition, and origin crucially affects both advanced and beginning learner groups, we will specifically look at learner groups' accuracy rate by each origin. As for test non-word condition, it was significant only in advanced learners, so the results of advanced learners will be reported in the following.

4.4.5 Analysis of Origin for Learner Groups

Starting with overall effects of origin, for advanced learners, the mean accuracy of test non-words for origin S is 85%, origin G was 69%, and origin L was 72% and respectively (see Table 4.4). That is, when the origin is S, that elicits the highest accuracy compared to origin G and L. Put differently, when the participants refer to a word with singleton to reject the perceived stimuli as a non-word, they have higher accuracy compared to when they have to refer to words with geminates or with a long vowel to reject a perceived non-word. This point was reinforced by the statistical analysis: the post-hoc pairwise comparison with Sidak correction between origin S and

G was significant (p = .001) so is S and L (p = .02). Regarding origin G and L, when the subjects refer to the word with long vowel (i.e. origin L: 72%) to determine whether the stimuli they heard is word or not, participants are more accurate than when they have to refer to the word with geminate (origin G: 69%). Statistically, however, there is no difference between those “long” items. Pairwise comparison between origin G and L is not statistically significant (p = .8). In short, the above results indicate that there might be an overall difference between the category “short” and “long” (i.e. origin S vs. L and origin S vs. G) but no difference within a “long” category (origin G vs. L).

For beginners, the mean accuracy for test non-words for origin S was 30%, for origin G, it was 31%, and for origin L, it was 50%. Post-hoc pairwise comparisons with Sidak correction revealed that there was no statistically significant difference between origin S and origin G (p = 1). However, there was a difference between origin S and origin L (p = .005). In addition, origin G was overall less accurate than origin L (p = .008).

Unlike the advanced learners, referring to a word with singleton (i.e. origin S) does not seem to make non-word rejection easier for beginners. The difference between origin G and L was what we have not observed in advanced learners’ result. Since the accuracy rate for each origin in this group was at or below chance level, making a clear interpretation of the data is difficult. We assume that the difference between origin G and L might not be a reflection of a difference within a potential “long” category. We will come back to this point and discuss for details in the discussion section in this chapter and in the next chapter.

4.4.6 Analysis of Non-word Condition for Learner Groups

Now, we take a look at the results focusing on the non-word condition. Here we report advanced learners' results only, since this factor was not significantly affecting accuracy rates in both native speakers and beginners. For the advanced, the mean accuracy for non-word condition S was 71%, for non-word condition G was 73%, and for non-word condition L was 82% respectively (see Table 4.4).

The post-hoc pairwise comparison with Sidak correction between non-word condition S and G was not significant (p = .88). However, non-word condition S was significantly less accurate than non-word condition L (p = .016). The difference in accuracy between non-word conditions G and L was not significant (p = .086).

According to these results, non-words that pertain to non-word condition S are the hardest to reject and trigger the lowest accuracy rate among all the conditions. Note that the Condition S is where participants are required to refer to a word with either a long vowel or a long consonant, that is, a sound from the long category, in order to correctly reject the stimulus as a non-word (i.e. geminate/Origin G or long vowel/Origin L). This is the exact mirror-image of the accuracy obtained for origin S: referring to a word that originally contains a singleton triggers the highest accuracy. Accordingly, referring to a word originally containing a "long" category yields the lowest accuracy rate. Likewise, among non-word conditions, the non-word condition L (where a stimulus is either Origin S or G) triggered the highest accuracy rates.

4.4.7 Interplay of Origin and Non-Word Condition

Finally, we now turn to the statistical analysis of the combination of origin and non-word condition. We first take a look at how a specific origin affects accuracy rates when combined with a specific non-word condition. To this end, we will take a look at bidirectional effects: we start with specific pairwise comparison based on origin (i.e. Origin X → Condition Y). Then we move on to pairwise comparisons based on non-word condition (i.e. Condition X → Origin Y). This bidirectional observation gives us overall perspective as to how accuracy rate varies.

As was in the previous section, we limit our reports on advanced learners. Recall that the Origin S in general yields the highest accuracy rate among all the origins. When considering origin S and non-word condition together, there are two possible changes for a word with origin S: (i) into a non-word with geminate (i.e. non-word condition G: 81%) and (ii) into a non-word with long vowel (i.e. non-word condition L: 89%). Pairwise comparisons indicate that this difference of 8% points between non-word condition G and L was not significant (p = .147), suggesting that when referring to words with a singleton in order to reject a G or L non-word, the specific non-word type doesn't matter. Combined with the previous results, we can say that stimuli with Origin S contribute to higher accuracy rates than the other origins regardless of the non-word conditions. We can interpret the results to mean that it is easier when subjects can refer to a word with a singleton in order to reject a non-word containing some long sound category. It is possible to infer that this facilitation stems from participants' more precise lexical encoding of words with singletons, since this category is the one that is most familiar to them from their L1 English.

When it comes to the origins G and L, there are also two types of changes involved for each origin: (i) G → S, (ii) G → L, (iii) L → S and (iv) L → G. With respect to origin G, pairwise comparisons reveal that the difference between non-word condition S and L was significant (p = .031). Namely, items in the non-word condition L (G → L: 76%) yielded higher accuracy rates than items in the non-word condition S (G → S: 63%). That is, when the original reference words contain a geminate consonant (origin G), it appears easier to reject a non-word that contains another long sound (a long vowel, in this case) than to reject a non-word that contains a singleton sound. This could again be explained by the possibility that participants have a more precise lexical encoding for singleton sounds, compared to "long sounds." Here, the higher accuracy seen in the case of L nonwords could be due to a bias to reject items containing a long sound – thus yielding higher accuracy in non-word rejection (S nonwords are 13% points less accurate than L non-words).

Regarding the origin L, pairwise comparisons indicate that the difference between Condition S and G was significant (p = .031). Non-words with singletons (L → S: 78.6%) were rejected more accurately than those with geminates (L → G: 66%), when the reference word contains a long vowel. In this case, and unlike the origin G situation, comparing a word containing a long vowel to a non-word with a singleton leads to higher accuracy when the non-word contains a geminate. This may suggest that participants may have a more precise encoding of words with long vowels overall, compared to words with geminates, but less precise still than words with singleton.

The pairwise comparisons further revealed that no other relevant comparisons were statistically significant. Although, there was a rather large difference between G → S vs. L → S in accuracy rates per se (i.e. 63% vs. 79%), statistically there was no difference. Similarly, the directionality of G and L (e.g. Origin G → Condition L vs. Origin L → Condition G) was also not statistically significantly different.

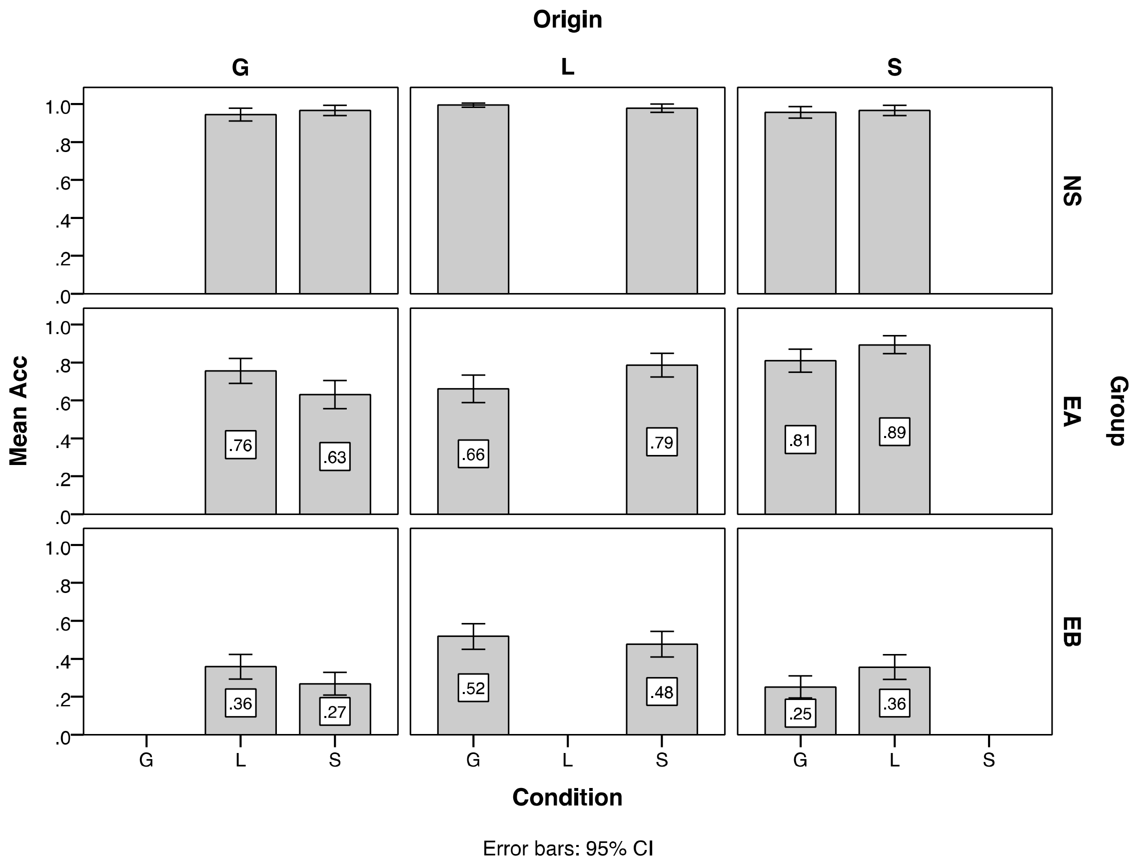

Figure 4.1: Mean Accuracy on Non-Word Test Items for Each Group, Separated by Origin as a Fucntion of Non-Word Condition.

Now, we reverse the way we consider the relationship between the words' origin and the non-word conditions: we look at how different origins bring changes in accuracy rates for a specific non-word condition. The Figure 4.2 below corresponds to the following statistical analysis.

Figure 4.1 shows accuracy rates by non-word condition as a function of origin. For instance, we can see how test items in the non-word condition G are split up into two bars in terms of origin. For the advanced learner group, we can see the test non-words containing geminates (G) yield 66% accurate responses when their origin is L whereas accuracy rates climb to 81% when the G non-words' origin is S.

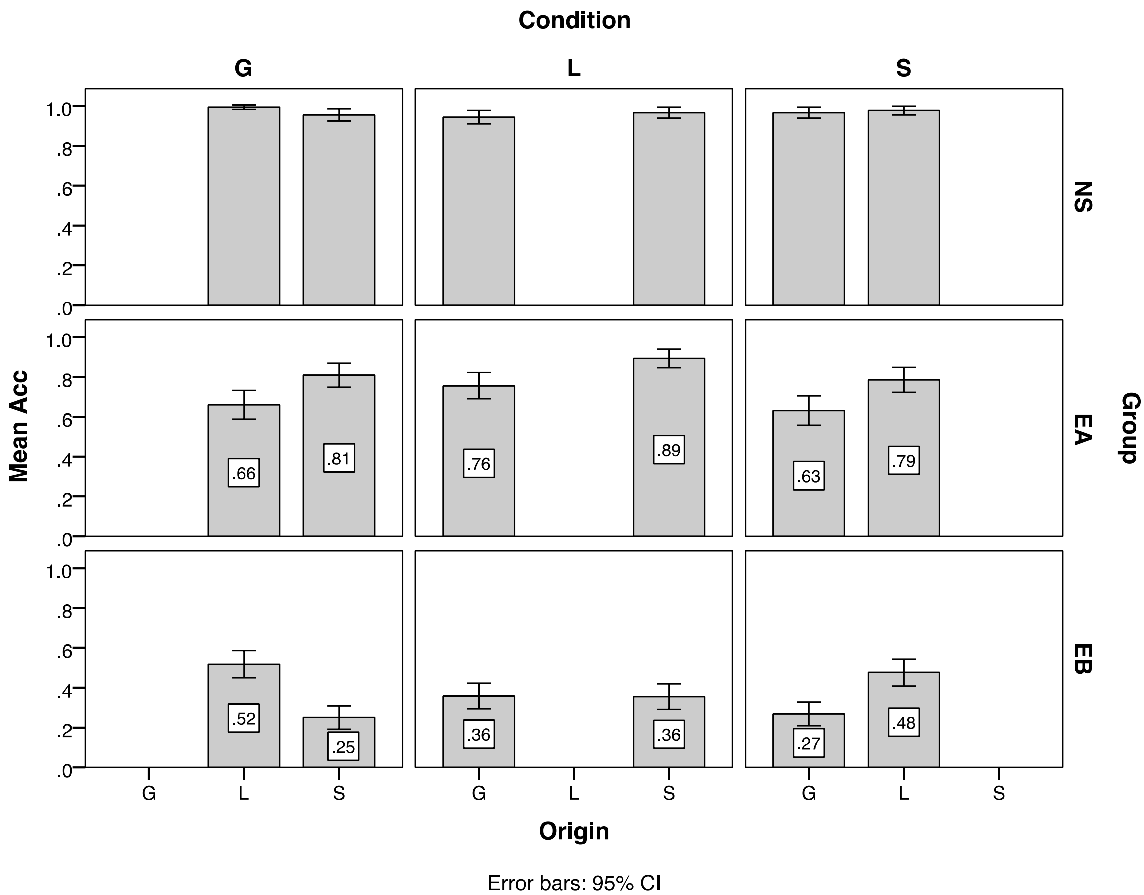

Figure 4.2: Mean Accuracy on Non-Word Test Items Only for Each Group, Separated by Non-Word Condition as a Function of Origin.

Non-word condition S comprises items of two origins: (i) a word with a geminate becomes a singleton non-word (i.e. origin G: 63%) and (ii) a word with a long vowel becomes a singleton non-word (origin L: 79%). The pairwise comparison indicates that the difference between origin G and L for S non-words was significant (p = .008). In the comparison of Origin G and L in general (i.e. including test words), there was no difference between the two. However when it comes to the test non-words with singleton (i.e. non-word condition S), there was a clearer difference between the two origins, where L origin yielded higher accuracy than G origin. That is, within the "long" category, Origin L yielded higher accuracy rates than origin G.

With respect to the non-word condition G, the pairwise comparisons show that the difference between Origin S (81%) and L (66%) was significant (*p* = .011). Namely, the Origin S brings better accuracy rate than the Origin L. This suggests that it is easier for participants to reject G non-words when these refer to a singleton word (which they probably have encoded precisely) than when the non-word refers to a long-vowel word (which is likely more fuzzily encoded).

Regarding non-word condition L, the pairwise comparison between origin S (89%) and G (76%) is significant (*p* = .019). Again, the Origin S brings higher accuracy rates than the Origin G when listening to L non-words. The following Tables 4.5 and 4.6 show all the results of the combinations of origin and conditions that we have presented so far.

Table 4.5: Advanced Learners' Accuracy Rate on Non-Word Conditions for Different Origins

	Non-word condition	Accuracy Rate	*p*-value
Origin S	G	81%	*p* = .147
	L	89%	
Origin G	S	63%	*p* = .031
	L	76%	
Origin L	S	79%	*p* = .031
	G	66%	

Table 4.6: Advanced Learners' Accuracy Rate by Origin, for Different Non-Word Conditions

	Origin	Accuracy Rate	*p*-value
Non-word condition S	G	63%	p = .008
	L	79%	
Non-word condition G	S	81%	p = .011
	L	66%	
Non-word condition L	S	89%	p = .019
	G	76%	

In Table 4.6, we can see when non-word stimuli are considered, origin S contributes to higher accuracy rates regardless of the non-word conditions. This is statistically reinforced by our prior statistical analysis where origin S yields higher accuracy than origin G and L. Conversely, when non-words contain S (i.e. non-word condition S, see Table 4.6), it is hardest to reject them if they refer to word with geminate (63% accuracy in advanced learners). Taken together, these results suggest that words containing singleton sounds are encoded most precisely, those containing geminates are encoded the least precisely, with words containing a long vowel comes in-between. Recall that when the effect of origin in general was considered, there was no difference between Origin G and L (p = .8, see also section 4.5). However, in its interaction with specific non-word conditions, namely, non-words containing S, origin L yields higher accuracy rates than origin G (p = .008, see Table 4.6).

Data from non-words containing a geminate (i.e. non-word condition G) also indicate that rejecting non-words with geminate by referring to words containing another long sound (i.e. condition L) is more difficult (66%) than referring to a word containing a singleton (81%). A parallel pattern is found in for non-words containing L, which are harder to reject when they refer to words containing the other long sound (G, 76%) than when they refer to words with singletons (S, 89%).

4.4.8 Response Time (RT)

The analysis of RT was executed in the same manner as accuracy rates. As can be seen in the Table 4.2 above (p. 57), participants responded to words faster than to non-words, and this difference was visible across both test and control conditions in all three groups.

Type III tests of fixed effects, the F-tests showed that there was a main effect of group on mean RT; native speakers = 1120 ms, advanced learners = 1322 ms, and beginners = 1365 ms, $F[2, 44.2]$ =, $p < .001$). Performance for words was more faster than for non-words (lexical status $F[1, 186] = 49.9$, $p < .001$; mean RT for words = 1211 ms and for non-words = 1328 ms) Also, RT was faster in the control condition compared to the test condition (condition $F[1, 185.2] = 34.4$, $p < .001$; mean RT for control = 1221 ms and for test = 1318 ms,).

Speaking of interactions of these independent variables, all three groups exhibited faster responses for words than for non-words (all p <. 001). Similarly, all three groups were faster on control items than test items (all $p < .001$). Thus, the pattern of response time was the same across groups. However, the actual response time differed in each group. Therefore, there were significant interactions of group and lexical status $F[2, 6622.7] = 22.9$, $p < .001$ and group and test condition $F[2, 6616.5] = 4.9$, $p < .008$). However, the interaction between lexical status and condition was not statistically significant ($F[1, 186] = 4$, $p = .52$). Most importantly, there was a significant triple interaction of group, condition and lexical status ($F[2, 6621] = 5$, $p < .006$). To understand the triple interaction, we looked into the results in each group. For native speakers, there was no significant effect of lexical status in native speakers' test items ($p > .2$). However, in the control condition, there was a main effect of lexical status for control items; words were faster than non-words.

On the contrary, learners' response times are different from the native speakers' and showed consistent patterns across beginners and advanced learners; control words obtained the fastest response in both learner groups followed by test word items. For non-word, similarly, control items were faster than non-word test items, which received the slowest response times in both groups. As was seen in the accuracy rate, this triple interaction indicates that learner's response time depends on the lexical status and condition of the stimulus whereas native speakers' RT, especially on test items, were not affected by neither lexical status nor types of stimuli.

4.5 Discussion

In this chapter, we reported the results of a lexical decision task focusing on how learners respond to stimuli. Participants were asked to decide whether a stimulus was a Japanese word or not. In this respect, learners were required to make use of their knowledge of Japanese words or make use of their lexically encoded length contrast, even if that contrast was still emergent. Now, we discuss our results focusing on four points: overall performance in ABX and lexical decision, difference between vowel and consonant, asymmetric lexical encoding pattern, and accuracy rate and response time.

First, we observed an overall difference in performance between native speakers and learners. The native speakers' performance was very high and was not affected by any factors such as lexical status, origin, or non-word condition. In contrast, the learner group exhibited a variety of patterns that differed from the native speaker group. This point is clearly different from the performance pattern in the ABX task where all the groups scored high accuracy. Thus, the result suggests a difference between discriminability and storing L2 contrasts.

Moreover, not only did we observe different performance between native speakers and learners, learner's proficiency level seems to play a crucial role in this task: the more proficient, the more accurate overall (i.e. advanced learners > beginners). Overall, though, accuracy scores were quite low considering the high proficiency level of the advanced group. Especially for test non-words, some conditions triggered accuracy rates as low as 63%. However, given the difficulty of the task overall, their performance remains well in the range of what has been observed elsewhere (e.g. Simonchyk & Darcy, 2017).

In terms of asymmetric encoding, the triple interaction between group, lexical status and test-non word condition was found statistically significant ($p. < .001$). The interaction implies what imposes difficulty for learners when processing Japanese length contrasts. As the native speakers' performance was not affected by any of these factors, there is no doubt that there is a difference between native speakers and learners in terms of how they access lexical representations. This is most likely because of a differential precision in L2 lexical encoding.

We predicted that the learners' accuracy rate would exhibit the following order, if there is an interaction between lexical status and test non-word condition: control word > test word (old) > test word (new) > control non-word > test non-word (new) > test non-word (old).

Whether we could observe the following order is a key to discussing asymmetric lexical encoding since control words were better than test words in this task: test word (old) > test word (new) > test non-word (new) > test non-word (old).

In the current study, according to Darcy, Daidone, and Kojima's classification, singleton and short vowel are the old category while geminate and long vowel are the new category. Thus, the test word stimuli with geminate or long vowel are classified as a new category. With respect the non-word test stimuli, the ones labeled origin S are non-word (old): origin S represent non-words with geminate or long vowel corresponding to a word with singleton.

For test words, origin S in beginners elicited the highest accuracy rate (beginners: 75.5%) among other origins. In addition, there was no statistical significance when origin G and L were compared. Thus, we could say word (old) > word (new) from these results. However, advanced learners' accuracy for words was not influenced by origin (p. = .57) due to the high accuracy rate (above 87%). Of note, there was no statistically significant difference between advanced learners and native speakers in accuracy rates (p = .3) for the test words. That is, when stimuli were Japanese words, advanced learners were comparable to native speakers. Thus, aforementioned order was not observed in advanced learners.

For the test non-words, advanced learners' accuracy rate was generally much lower than test words and affected by both word origin and non-word condition. If asymmetric lexical encoding is at work for processing test non-words, we expect that origin S would outperform origin G and L. That is exactly what we found in the advanced learner group: while there was no difference between origin G and L, test non-words with origin S overall resulted in the highest accuracy for the advanced learners. These results from the analysis on origin verified that referring to singleton/short vowel elicits higher accuracy rates than referring to words with geminates or long vowel.

We looked into test non-word conditions as additional evidence of asymmetric lexical encoding. Contrary to origin S, test non-word condition S elicited the lowest accuracy rate. This means non-word test stimuli with singleton (i.e. old) are the hardest to reject. This could be interpret as test non-word (new) > test non-word (old). However, these statistical analysis confirmed only a comparison between test non-word condition S (71%) and L (82%) was significant (see table 4.7). That is, test non-word condition S is less accurate than test non-word condition L. Pairwise comparisons of test non-word condition S (71%) and G (73%) and comparison between condition G (73%) and L (82%) were not significant (see table 4.7). Thus, statistically, we verified the order non-word (new) > test non-word (old) as valid through the comparision between test non-word condition S and condition L being statistically significant.

Table 4.7: Pairwise Comparison by Test Non-Word Condition (Advanced Learners Only)

	Non-Word Condition	*p*-value
Non-word condition S	G	$p = .88$
	L	$p = .016$
Non-word condition G	S	$p = .88$
	L	$p = .086$
Non-word condition L	S	$p = .016$
	G	$p = .086$

As for beginners' result of test non-word, the old category superiority that beginners showed in test words (origin S > origin G & L) was not observed. In fact, origin L elicited the higest accuracy for the test non-words. However, these results may be difficult to interpret due to the low accuracy overall observed in their performance (i.e. most conditions remained below chance level). Further analysis is required for future study.

Systematically, the above results replicate the ordinal accuracy that Darcy, Daidone and Kojima (2013, 2015) suggested. Learners showed parts of asymmetric pattern by different proficiency. For instance, the beginners' result demonstrated the following order: word (old) > word (new), whereas advanced learners' results showed: non-word (new) > non-word (old). Word (old) > word (new) was not observed by advanced learners due to advanced learners' high accuracy. It was comparable to the native speakers' performance. On the contrary, non-word (new) > non-word (old) was not observed by beginners since their accuracy was at or below chance level.

Additional issues to be discussed here is the difference between geminate and long vowel in terms of the difficulty of encoding as L2 phoneme. In the previous chapter, we observed a superiority of long vowels over geminates in the discrimination task. The results in the ABX task corroborated the findings of Altman, Berger and Braun (2002) that vocalic length contrasts seem to yield higher accuracy than consonantal length contrast in discrimination tasks.

In the current task, there are two possibilities that we can observe vowel superiority over consonants: (i) when origin G and L are compared, and (ii) when G and L under certain test non-word conditions are compared.

The first one comes from the Pairwise Comparison of origin G and L for beginners' test non-word. For the sake of convenience, the following Tables 4.8 and 4.9 summerize the results.

As can be seen, there was a significant effect when origin G (31%) and L (50%) were compared. However, test non-word elicited at or below the chance level for the beginners. Thus, futher tests will be required to investigate vowel superiority over consonant. The second case appears in advanced learners' results when looking at the comparison between origin G and L under the test non-word condition S (see table 4.10). This might suggest a vowel superiority over consonant in lexical decision task.

Table 4.8: Summary of the Accuracy Rate by Origin

	Origin S		Origin G		Origin L	
	Word	Non-Word	Word	Non-Word	Word	Non-Word
ADV	90%	85%	94%	69%	87%	72%
BEG	76%	30%	63%	31%	50%	50%

Table 4.9: Summary of Pairwise Comparison between Origins by Lexical Status

	Origin S vs. G		Origin S vs. L		Origin G vs. L	
	Word	Non-Word	Word	Non-Word	Word	Non-Word
ADV	n.s	✓	n.s	✓	n.s	n.s
BEG	n.s	n.s	✓	✓	n.s	✓

Table 4.10: Pairwise Comparison on Non-Word Condition S with Different Origins

	Condition S (Origin G)	Condition S (Origin L)	*p* value
ADV	63%	79%	$p = .008$
BEG	27%	48%	$p = .008$

As for the relation between accuracy rate and response time, native speakers were fast and accurate whereas advanced learners were slower than native speakers and beginners, but accuracy was comparable to the native speakers. Thus, we assume there was a trade off between response time and accuracy rate: advanced learners took more time to be accurate. What is puzzling is the beginners' result. They were as fast as native speakers, but they were the least accurate. Based on this data, we assume that there were actually no difficulty imposed for beginners. That is, they had strong bias towards positive responses meaning that they confused non-words as words. There was a confusion between old and new categories, since they perceived non-words with the new category as words with the old category.

An additional issue related to the interpretability of data in the case of beginners, as well as with the overall high difficulty of the lexical decision task itself, needs to be addressed as well. Recall that in this task, learners hear either words or non-words, one by one, and have to decide whether it is a real Japanese word or not. In our view, the only way to make this decision is to compare the perceived input to stored representations for words. That is, one needs to refer to the "corresponding words" in order to reject the non-word. The interpretation of our data relies on this assumption being correct, as well as on the listeners being able to perceive the length manipulation of the stimuli in the input. While we have ascertained that listeners can indeed perceive the length distinctions in our ABX task, one might wonder here whether participants really in fact refer to the 'corresponding words' that the researchers determined for the manipulation of the length. While this is likely the case for native speakers, it is perhaps not such a straightforward situation in the case of the learners. In particular, the overall below-chance accuracy level of the beginning learners suggests that the task may be too cognitively demanding for them, or that they answered by focusing on dimensions other than the length manipulation.

The major goal of the question investigated in the next chapter is to evaluate whether learners are in fact really activating the most plausible and closest lexical candidate such as the ones we used as reference words for the non-word stimuli in the lexical decision task. We therefore attempt to replicate these findings by reducing the cognitive load of the task and focusing learners' attention on the length manipulation of the stimuli. We call the following task a "Forced Lexical Choice", which uses only a choice between two alternatives, rather than an open-ended type of decision such as the one employed in a typical lexical decision tasks.

4.6 Summary

In this chapter, we reported the results of the lexical decision task mainly focusing on learner groups. Unlike the ABX task, the accuracy rate varied by group, lexical stauts and origin. There was a clear difference in accuracy rate by proficiency level: native speakers were the most accurate, and advanced learners were the second most accurate and beginners were the least accurate. This is a different pattern in comparison with ABX task where any group scored 80% correct or above. Thus, we concluded that there is a discrepancy between discriminability and storing L2 contrasts as a part of words (i.e. lexical encoding).

From the viewpoint of prevalent models of L2 phonological acquisition (i.e. SLM and PAM-L2), the length contrasts are predicted as the most difficult contrast as American English does not have length contrasts. In this respect, superiority in accuracy of origin S and asymmetric lexical encoding discussed in 4.5 demonstrated that referring to a familiar category (singleton/short vowel) elicits higher accuracy. Hence, these results verified the relative difficulty of length contrasts. However, our results are not decisive as to which length contrasts (i.e. vocalic or consonantal) are better encoded in the learners' mental lexicon. Careful examinations should be done to see whether there is vocalic length contrast superiority in another experimental paradigm (e.g. priming, eye-tracking).

Chapter V
Forced Lexical Choice Task (FLeC)

5.1 Introduction

As seen in the previous chapter, we observed the asymmetric lexical encoding in learner groups. The asymmetric lexical processing is different from native speakers lexical processing: it is a unique way for learners to maintain the L2 contrasts. It has been said that processing L2 involve more competitions or neighborhood density than native speakers (Broersma and Cutler, 2011). This complex competition slows their processing speed. For instance, upon hearing a word *rock*, Japanese native speakers learning English would activate *lock* (Cutler, Weber, & Otake, 2006). Less degree of activation for *lock was* observed when processing *rock* when native speakers of English heard *rock*. Likewise, upon hearing *depaato* “department store”, learners of Japanese would activate near-words such as **depato* or **depatto* if their encoding of long vowel is fuzzy.

Researchers always assume that what we use as stimuli are the one that learners actually activate. More specifically, we assume **akkeru* and **aakeru* in relation to *akeru* “to open” are the most relevant stimuli for the lexical decision task. However, the voluminous literature in the Neighborhood Activation Model (Luce and Pisoni, 1998, and others) had shown that learners activate much more than what we think learners activate.

In this chapter, we evaluate these assumptions by narrowing plausible competitors down to two. We use the two stimuli that we think the most relevant for a given competition. After listening to a pair of stimuli, the participants were asked to determine whether the first or the second one is a Japanese word. Recall that the Lexical Decision task requires participants to decide if the sound sequence they heard was a Japanese word or not. Thus, in the Lexical Decision task, there is only one stimulus presented to participants. Even though they hear only one stimulus, to accept the stimulus as a word or to reject it as a non-word, participants might activate more competitors than two. For instance, upon hearing *kippu* "ticket", learners might activate **kipu*, **kiipu*, *koppu* "cup" and so on before they make a decision that *kippu* is a Japanese word. Analogically, the lexical decision task is an open-ended question, while in the current experimental paradigm we ask participants to choose from one of two competitors. In the remainder of this study, we call it as the Forced Lexical Choice, henceforth, FLeC.

We posit this FLeC task to complement the lexical decision task reported in the preceding chapter. We assume the FLeC task would reduce participants' cognitive load by presenting two options to choose from. Hence, we expect higher accuracy overall. Both learner groups in particular should show higher accuracy in this task than in the lexical decision task. For advanced learners, the accuracy rate for test words in the lexical decision task was high and comparable to the native speaker's. However, when it comes to test non-words, we will see asymmetric encoding. That is, non-words with geminates and long vowels will be more accurately rejected than non-words with singletons. This is because learners can refer to the old category (i.e. singleton/short vowel) when processing test non-words with geminate or long vowels. This is what we expect to see for both advanced and beginning learner groups for test non-words. In addition, test words are better than test non-words in accuracy rate. Among the test words, a word with an old category (i.e. singleton/short vowel) will usually yield a higher accuracy rate than a word with a new category (i.e. geminate/long vowel). We expect to see accuracy order (i.e. test word (old) > test word (new) > test non-word (new) > test non-word (old)) with better accuracy rate in beginner group. Their accuracy rate was very low in the lexical decision task, especially for test-non-words.

5.2 Method

5.2.1 Participants

The same participants who took part in the previous experiments took part in the current experiment as well (see Chapter 3, page 30).

5.2.2 Stimuli

Unlike for the Lexical Decision task, there were no distractors. Therefore, the total number of stimuli was 144: 36 Japanese words consisting of 12 with singletons, 12 with long vowels and 12 with geminates. These words were the same as the ones from the Lexical Decision task. We also used 72 non-words from the Lexical Decision that were made based on the 36 Japanese words. The test pair in FLeC consists of one of the 36 Japanese words and one of the corresponding near words. If the original word is the one with singleton (i.e. *shigoto* "work"), there were two corresponding near words. For instance, a word with singleton *akeru* "to open" has 2 corresponding non-words such as **akkeru* and **aakeru*. Thus, there was a pair like *shigoto* vs. **shigotto* or *shigoto* vs. **shigooto*. When the original word contains a geminate, the possible pairs in the task will be *hikkosu* "moving" vs. *hikosu* or *hikkosu* vs. **hiikosu.* Upon hearing *hikkosu* "moving" followed by **hikosu*, the participants were asked to determine whether *hikkosu* or **hikosu* is a Japanese word. In this example, the participant should answer *hikkosu* (i.e. first one) as a Japanese word. To use the 72 non-words exhaustively, there were 2 experimental blocks ((36 pairs in each block)* 2 = 144 stimuli). Subjects were allowed take a break between those blocks as much as they needed.

The presentation of stimuli was controlled by the DMDX software (Forster & Forster, 2003). Within the experimental block, the presentation of the order for lexical type (word vs. non-word) and length (i.e. short, geminate and long vowel) were randomized so that participants' performance was not affected by those factors. In addition, presentation order of the blocks was randomized via the DMDX software. Since we use the same stimuli from the Lexical Decision task, there were two speakers and stimuli which were split half and half to avoid participants' familiarity to one of the voices.

The left shift key was marked 1 and right shift key was marked 2. Participants were asked to hit "1" when they think the first one in a given pair is the Japanese word. In contrast, they were asked to hit "2" when they think the second one in the pair was a Japanese word. All the instructions were given in English for the learner groups and in Japanese for the native speaker group.

Prior to the test session, there was a trial session. There were 5 pairs with feedback. The participants saw ○ when their response is correct while they saw × when their response was wrong as feedback. In this trial session, none of the pairs contained the short vs. long contrast.

As we have done for the lexical decision task, accuracy on all items by native speakers was screened to see if non-words were perceived as words and vice versa. To be consistent with the lexical decision task, those items with the accuracy below 2 *SD* of the mean for the native speaker group were excluded for later analysis. Thus, after this screening process no stimuli were excluded but one subject in the advanced learner group was excluded from further analysis. Total number of participants analyzed were 16 for native speakers, 14 for advanced learners and 19 for the beginner group.

5.3 Global Analysis on Accuracy Rate

Since this experiment is a follow-up to the lexical decision task, and its aim was to examine whether we could observe asymmetric lexical encoding in beginners, we only focus on accuracy rate for the following statistical analyses. Table 5.1 shows the accuracy rate by group for non-word test stimuli in lexical decision and in FLeC. As can be seen, the accuracy rate is not that different in two different experiments for native speakers but there is a great difference in accuracy between Lexical Decision and FLeC in advanced learners (96.8% vs. 75.6%) and in beginners (66.1% vs. 37.1%) respectively. In general, a reduced cognitive load elicited higher accuracy rates for the current task. Keeping this in mind, we will move on to the statistical analysis.

Table 5.1: Learners' Mean Accuracy (%) and Standard Error (SE) in the Non-Word Test Condition for Lexical Decision and FLeC

	Native Speakers		Advanced Learners		Beginners	
	Mean	SE	Mean	SE	Mean	SE
Lexical Decision	96.7	.027	75.6	.028	37.1	.025
FLeC	99.5	.013	96.8	.014	66.1	.012

A linear mixed effects model was executed in SPSS 21 on mean accuracy. The factor word position (First, Last), group (advanced learners (EA), beginners (EB) and native speakers (NS)), origin (S, G and L) and non-word condition (S, G and L) were declared as independent variables. The independent variables were entered as repeated effects within participants. In this trial, the F-Tests showed word position and all the possible interactions (i.e. word position*condition, word position*origin*condition) were not significant (all $p > .1$). Thus, the same model in SPSS 21 was re-ran without the variable word position.

A linear mixed effects model was executed again in SPSS 21 on mean accuracy. As mentioned, word position was excluded this time. Thus, group, origin and non-word condition were declared as independent variables. The independent variables were entered as repeated effects within participants. The following Table 5.2 shows the possible combinations of origin and non-word condition that appeared as a pair in stimuli presentations. These are critical when we talk about accuracy rate later in this chapter.

Table 5.2: Possible Pairs in FLeC

Origin (Word)	Non-word Condition	Label
S *akeru* “to open”	G (e.g. *akkeru*)	GS
	L (e.g. *aakeru*)	LS
G *hikkosu* “to move”	S (e.g. *hikosu*)	SG
	L (e.g. *hiikosu*)	LG
L *apaato* “apartment”	S (e.g. *apato*)	SL
	G (e.g. *apatto*)	GL

The F-tests revealed that there were main effects of group (F [2, 46] = 233.8, p < .001), origin (F [2, 66.8] = 3.3, p = .045), but there was no effect of non-word condition (F [2, 66.8] = 1.5, p = .23). In addition, there were significant effects in the interaction between group and origin (F [4, 3394.2] = 4.9, p = .001), and the interaction between group and non-word condition F [4, 3394.2] = 4.3, p = .002). However, the interaction between origin and non-word condition F [1, 66.8] = 1.4, p = .23) was not significant. The triple interaction among group, origin and non-word condition was not significant, either (F [2, 3394.2] = 1.5, p = .22).

For the effect of group, post-hoc pairwise comparison with Sidak correction on group effect revealed that the comparison between native speakers (mean accuracy: 99.5%) and advanced learners (mean accuracy: 96.8%) was not significant (p = .32). Put differently, degree of accuracy rate of advanced learners is comparable. However, the comparison between beginners (mean accuracy: 69.2 %) vs. native speakers (p < .001) and beginners vs. advanced learners (p < .001) showed significant differences. Therefore, the lower accuracy rate of beginners in contrast with native speakers and advanced learners greatly contributes to the effect of group.

With respect to the effect of origin, post-hoc pairwise comparisons with Sidak correction revealed that the comparison between Origin G (87.4%) and L (86.3%) was not significantly different (p = .93). However, the comparison between Origin S (91.9%) vs. G (87.4%) and Origin S (91.9%) vs. L (86.3%) were significant. Thus, in general, not only did origin S elicits better accuracy than origin G and L, a word with a singleton (Origin S) yielded the highest accuracy.

Regarding the interaction between Group and Origin, Pairwise Comparison on Group at each Origin revealed all the comparisons between native speakers vs. beginners (Origin G, L and

S, p <. 001) and advanced learners vs. beginners were significant at each Origin (G, L and S, p <.001). However, there were no significant effects in comparison of native speakers and advanced learners for each origin (G: p = .38, L: p = .68 and S: p = .83). That is, advanced learners are not less accurate than native speakers and they are always more accurate than the beginners regardless of the origin.

These results so far also tell us that the type of word contained in the trials (i.e. origin) mattered for overall accuracy. What's more important is that origin interacted with group, indicating that while word type in the trial mattered for the beginner group, it did not affect accuracy for native speaker and advanced learner groups.

Another post-hoc pairwise comparison with Sidak correction on origin within each group revealed that there was no significant effect for native speaker and advanced learner groups in any comparison (all p > .9). In the beginner group, there were significant effects for the comparison between origin S and G (p <. 001) and S and L (p < .001). In these cases, origin S (78.5%) is more accurate than either origin G (66.2%) or origin L (63%). However, there was no significant effect on the comparison between origin G and L (p = .48). These results indicate that when the beginners could refer to a word with singleton, their accuracy would be better than the cases where they refer to a word with geminate or long vowel. Speaking of difference between origin G and L, there is no difference in terms of contribution to accuracy rate.

Now, we turn to the effect of the non-word condition (i.e. types of non-word test words). As found in the interaction of group and origin, post-hoc pairwise comparison with Sidak correction on group at each condition revealed all the comparison between beginners vs. advanced learners and beginners vs. native speakers were significant at each condition (non-word condition S, G and L, $p < .001$). However, there were no significant effects between native speakers and advanced learners for any condition (G: $p = .42$, L: $p = .447$ and S: $p = .94$). The results show that advanced learners were as accurate as native speakers regardless of non-word conditions.

In addition, a post-hoc pairwise comparison with Sidak correction of non-word condition by group revealed that there was no significant effect in any comparisons within native speakers (G vs. L: $p = 1$, G vs. S: $p = 1$, and S vs. L: $p = 1$) and advanced learner groups (G vs. L: $p = 1$, G vs. S: $p = .78$, and S vs. L: $p = .89$). Thus, any condition or type of non-word would not affect the participants' performance in these two groups. Contrary to the native speakers and advanced learners, there were significant effects in beginners for the comparison between non-word condition S (62.7%) vs. L (77.2%) ($p < .001$) and Condition G (67.8%) vs. L (77.2%) ($p = .001$). However, Condition S (62.7%) vs. G (67.8%) was not significant ($p = .127$). Thus, unlike the native speakers and advanced learners, beginners were affected by a certain non-word condition: condition L elicits better accuracy while condition S contributes to the lowest accuracy.

5.4 Results of Beginners from FLeC in Comparison with Results of Advanced Learners from Lexical Decision

In the previous section, we observed that the advanced learners' accuracy rate was very high: in fact, there was no statistical difference when compared with the native speakers. In addition, the beginners' accuracy rate was also higher compared to the Lexical Decision task (see Table 5.1 for details). In this section, we would like to look further into the beginners' results in comparison with results of advanced learners in the lexical decision. Recall that advanced learners showed asymmetrical lexical encoding for test-non-words in lexical decision task, but it was not observed in beginner group due to the low accuracy rate in the task. Here, we would like to examine whether the asymmetric lexical encoding is at work for beginners in the current task.

In the lexical decision task, we observed that the accuracy of advanced learners for test words was high to the point that it was comparable to the ones with the native speakers. Yet the intriguing fact was that the asymmetric lexical encoding was at work for test non-words. Namely, test non-words with geminate and long vowel yielded higher accuracy rate than the ones with singleton.

Now, extensive focus will be on beginner's results in FLeC in comparison with the advanced learners' results of lexical decision. We start with the results focusing on origin. Figure 5.1 shows the results of accuracy rate in lexical decision task whereas Figure 5.2 shows the results of accuracy rate for FLeC. Now, paying attention to the marked areas in the lexical decision task and in FLeC. By comparing two different groups in Figures 5.1 and 5.2 show that origin S yields higher accuracy than origin L for non-word condition G. In addition, origin S yields higher accuracy than origin G for non-word condition L. As in Table 5.3, the pairwise comparison in lexical decision for advanced learners and FleC for beginners, the pattern is exactly the same. What is shown from results of advanced learners from the lexical decision task is that origin S elicited better accuracy than origin G and L. However, origin G and L were not different. What is shown from results of beginners in FLeC is that origin S also elicits better accuracy than oirigin G and L. However, origin G and L were not different. These results clearly demonstrate that despite lexical decision and FLec are different tasks, origin S elicits higher accuracy. Put differently, referring to a singleton (i.e. old category, origin S) yields higher accuracy when compared with origin G or L (i.e. referring to geminates or singleton (new category)). The results also indicate that there is no difference between origin G and L in terms of the ease/difficulty of processing.

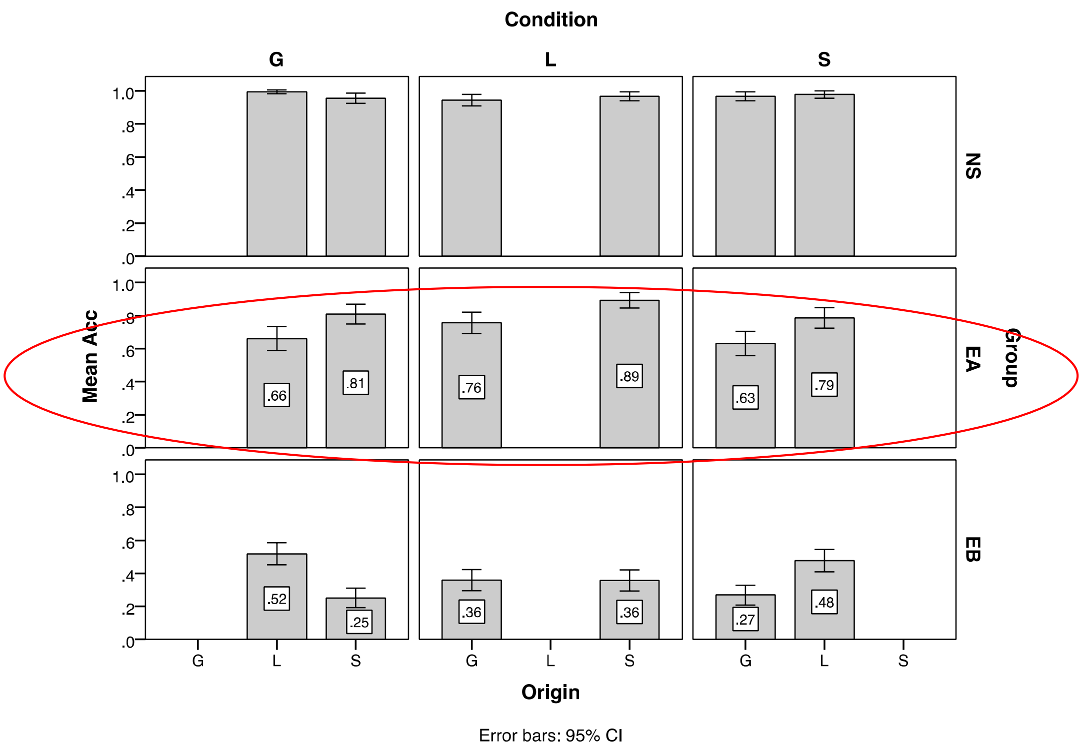

Figure 5.1: Results of Non-Word Test Stimuli in Lexical Decision Task Focusing on Origin

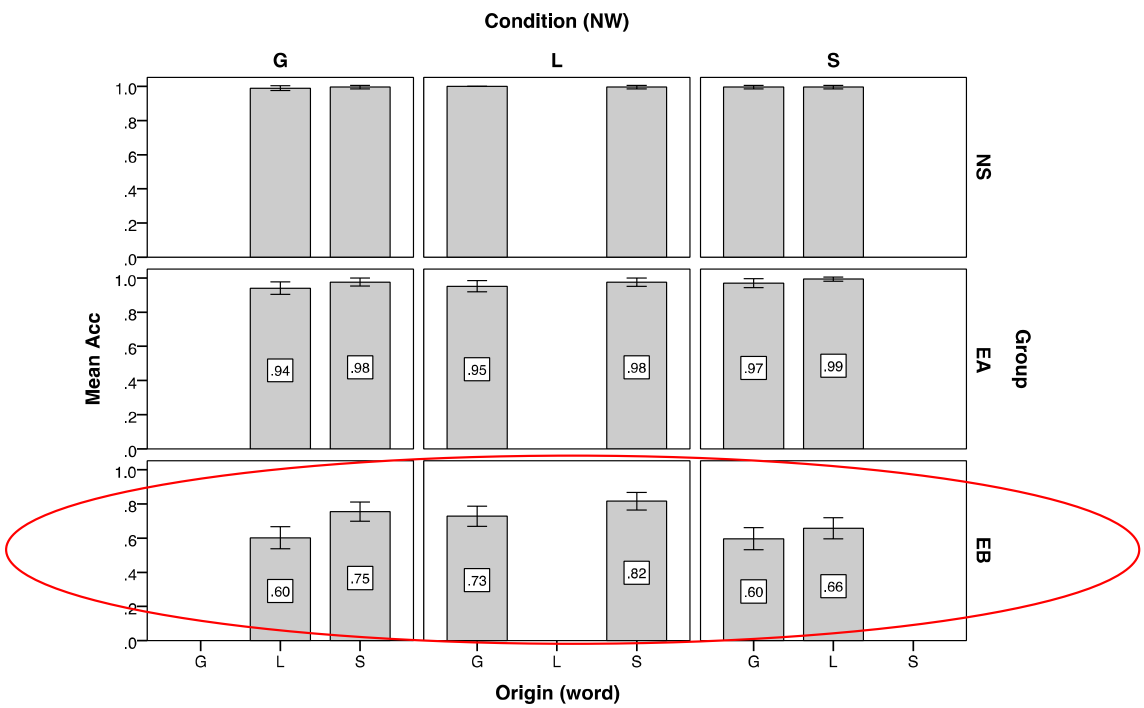

Figure 5.2: Results of Non-Word Test Stimuli in FLeC Focusing on Origin

Table 5.3: Statistical Results of Lexical Decision for Advanced Learners and Results of FLeC for Beginners

	Lexical Decision (Advanced Learners)	*p*-Value	FLeC (Beginners)	*p*-Value
Origin S & G	*	$p = .001$	*	$p < .001$
Origin S & L	*	$p = .02$	*	$p < .001$
Origin G & L	n.s.	$p = .8$	n.s.	$p = .48$

Note that these asymmetric results were not observed in the advanced learner group for the FLeC task due to the extremely high accuracy regardless of the origin. Now, beginners' asymmetric lexical encoding was revealed with the reduced cognitive load. Most importantly, the asymmetric pattern observed in this task is comparable to what we observed from the advanced learners in the Lexical Decision task.

Moving now on to the comparison between advanced learners and beginners focusing on the test non-word condition. As can be seen in Figure 5. 3 and 5.4, these are the general results of the Lexical Decision and FLeC respectively. Again, we highlight the red circled portions in Figures 5.3 and 5.4.

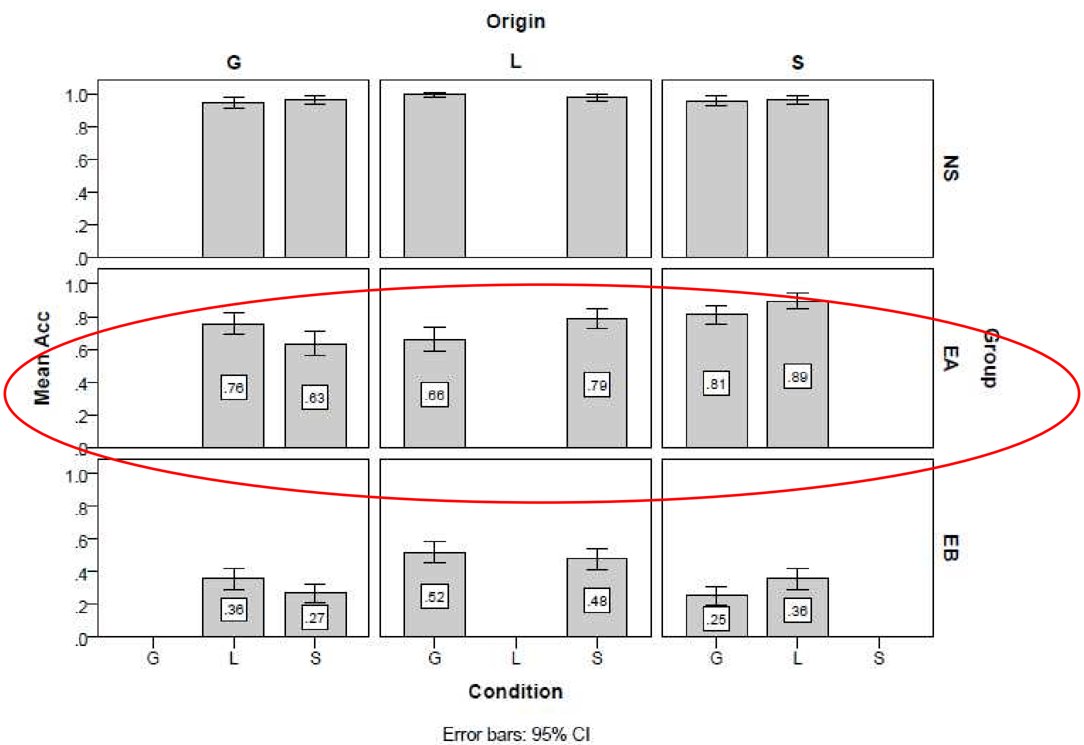

Figure 5.3: Results on the Non-Word Condition in the Lexical Decision Task

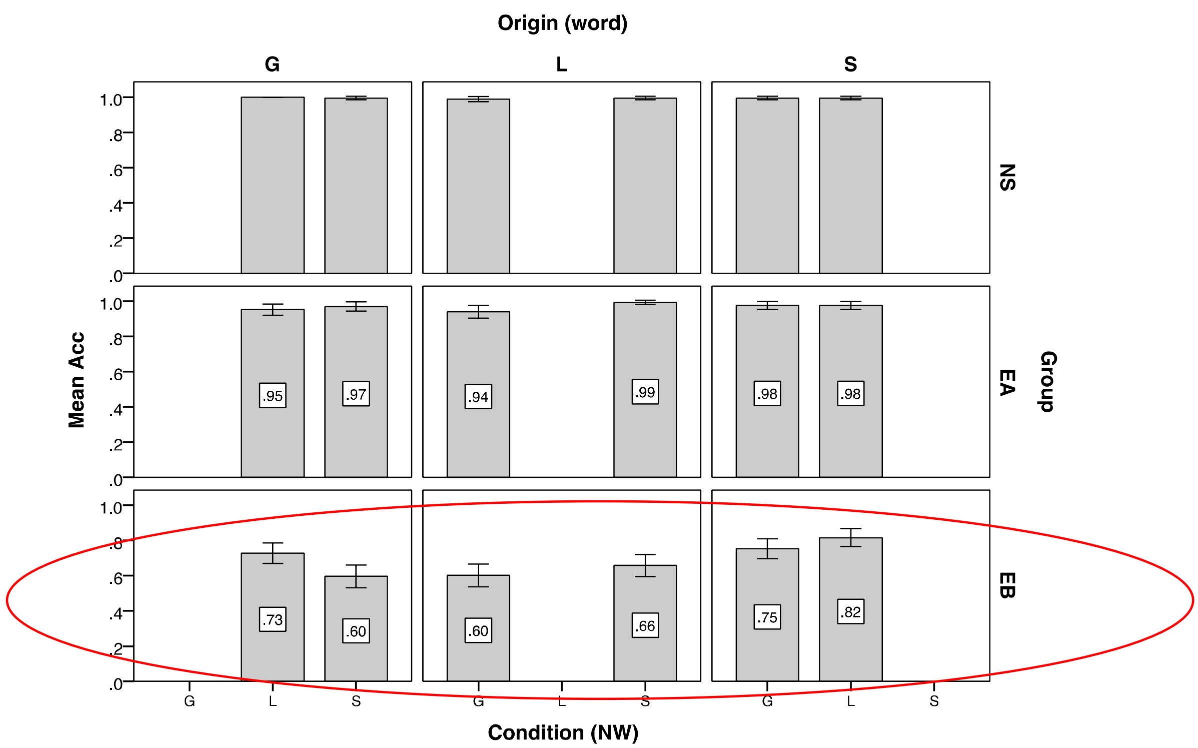

Figure 5.4: Results on Non-Word Condition in the FLeC

Looking at row accuracy rate, advanced learners in lexical decision (Figure 5.3) shows that test non-word condition L is higher than condition S. For origin L, accuracy rate for condition S is better than condition G. For origin S, accuracy rate for condition L is better than G. Corresponding post-hoc pairwise comparison with Sidak correction that all of these comparisons were statistically significant (see table 5.4). From these results, we observe origin L elicits higher accuracy rate than origin G and origin S contributes higher accuracy rate.

Table 5.4: Statistical Results of Lexical Decision for Advanced Learners

Condition	Origin	Accuracy	Sig.
S	G	63%	p = .008
	L	78.6%	
G	S	81%	p = .011
	L	66.1%	
L	S	89.3%	p = .019
	G	75.6%	

What can be seen from the raw accuracy rate of beginners in FLeC (Figure 5.4) is that accuracy rate of test non-word condition L is higher than condition S. For origin L, accuracy rate for condition S is better than condigtion G. For origin S, accuracy rate for condition L is better than G. Corresponding post-hoc pairwise comparison with Sidak correction showed there was a statistical significance between origin G and L under condition S. This means origin L elicits better accuracy than origin G under condition S. However, there were no statistical significance for the comparison between origin S and L under condition G, origin S and G under condition L (see table 5.5). From these results, we observed that vowel length is easier to process than the consonantal length contrast under the non-word condition S.

Table 5.5: Statistical Results of FLeC for Beginners

Condition	Origin	Accuracy	Sig.
S (62.7%)	G	60 %	*p* = .027
	L	66 %	
G (67.8%)	S	75 %	*p* = .368
	L	60 %	
L (77.2%)	S	82 %	*p* = .272
	G	73 %	

Table 5.6 shows the post-hoc pairwise comparison with Sidak correction of test non-word condition with Sidak correction. Note that these are comparisons among test non-word for each condition in general, and not a comparison within the condition. In the left column in Table 5.6, the results of lexical decision for advanced learners are shown. Statistical analysis shows that while the comparison between test non-word condition S and G and condition G and L were not statistically significant, the comparison between condition S and L was significant. Thus, condition L scored higher accuracy rate than condition. Since this is a result of test non-word condition, higher accuracy rate in condition L than condition S means that test

non-word with singleton scored lower than test non-word with long vowel. This is exactly what we would expect if learners process L2 contrasts asymmetrically: test non-word (new) > non-word (old). The current results indicate long vowel was more correctly rejected than consonantal length within the “new” category. However, when it comes to consonantal length (i.e. condition G) and test non-word with singleton, we cannot tell the difference. That is, they are equally difficult to reject.

On the right columns in table 5.6, results of FLeC for beginners are shown. Statistical analysis show that while there was no statistical significance between test non-word condition S (62.7%) and G (67.8%), there were statistical significance between condition S (62.7%) and L (77.2%), and condition G (67.8%) and L (77.2%). That is, rejecting non-word with singleton and the one with geminates are equally difficult. However, rejecting non-word with long vowel is easier than rejecting non-word with singleton. In addition, rejecting non-word with long vowel is easier than rejecting the ones with geminate. These results indicate that test non-word with long category, hence new category, will be rejected more accurately than test non-word with singleton/short vowel. In addition, among the long category, non-word with long vowel would be more accurately rejected. Not only these results showed non-word (new) > non-word (old) order, the results unfolded vowel length contrast superiority over consonantal length contrasts in lexical decision task.

Table 5.6: Statistical Results of Lexical Decision for Advanced Learners and Results of FLeC for Beginners

	Lexical decision (Advanced Learners)	p-Value	FLeC (Beginners)	p-Value
Condition S & G	n.s.	$p = .88$	n.s.	$p = .127$
Condition S & L	*	$p = .016$	*	$p < .001$
Condition G & L	n.s.	$p = .086$	*	$p < .001$

To summarize, we observed almost the same pattern between beginners and advanced learners not only through mere accuracy rate but through the statistical analysis on specific variables (i.e. origin and non-word condition) and corresponding pairwise comparison.

Beginners show the statistical significance between Condition G and L (i.e. L brings higher accuracy). We speculate the statistical significance shown between non-word condition G and L could be a reflection of perceptual ease on long vowels over geminates.

5.5 Discussion

In this chapter, our goal was to test the validity of our assumptions for lexical activation among learners, as implemented in the lexical decision task. To this end, we designed a forced binary choice that should result in a lower cognitive load while highlighting the phonological manipulation. This enables us to examine beginners' results focusing on whether asymmetric lexical encoding is at work. In comparison with the lexical decision task, we observed higher accuracy rates for learner groups in the current task. That indicates FLeC indeed reduced learners' cognitive load. These enhancements in accuracy rate also indicate that the forms we usually assume as "the most relevant competition" are indeed most likely the ones strongly associated with target words in the L2 lexical activation. Hence, the results help validate the pattern of results obtained in the lexical decision more generally.

The enhanced accuracy in both learner groups further reveals the disappearance of the asymmetric lexical encoding patterns for advanced learners, and in parallel, the emergence of such a pattern of lexical encoding for beginners. The advanced learners' accuracy reached a ceiling effect with above 95% mean accuracy: they were as accurate as native speakers in this lower cognitive load situation. Gaining such a high accuracy rate, compared to the lexical decision task, also reduced or eliminated traces of learner-specific asymmetric lexical encoding processes for this group of advanced learners.

On the contrary, the enhanced accuracy in beginners brought asymmetric lexical encoding to surface. Having statistical significance between origin S and other two origins or having no significance when Origin G and L are compared coincide with what we observed in advanced learners from the lexical decision task.

All of these results indicate that proficiency level relates to how precisely a learner can activate and process the words they have stored in the L2 mental lexicon. The more they progress in L2 proficiency, the more precisely they are also able to process, encode, and activate L2 distinctions. As for the way of processing, the primary driver of behavior is lexical status. In addition to the knowledge of the lexical status, learners make use of their L1 knowledge of phonemes. Hence, if an L2 word contains phonemes similar to the ones present in the L1, it is easy to process. That is, processing difficulty for learners has something to do with their L1 lexicon. In the current study, a word with a singleton is easy to process, encode, retrieve and activate, possibly because its representation is accurate, precise, and robust. When a non-word with a geminate or long vowel is encountered, learners can reject it based on their knowledge of a word with a singleton. On the contrary, when learners encounter a non-word with a singleton, they experience increased difficulty as they need to make use of the knowledge of a word with geminate or long vowel. Indirectly, therefore, our findings show that the corresponding representations are likely to be less precise, since specifically in this case, difficulties arise. However, this peculiar difficulty in processing and encoding L2 contrasts is likely to be mitigated or even to fully disappear when proficiency increases. The actual reasons for this development are still unclear, however. Recent approaches (e.g. Darcy & Holliday, 2018; Darcy & Thomas, 2019) surmise that improvements in perception over time, combined with an increasing number of words that are encoded with accurate phonolexical representations, can snowball and lead to gradually more wide-spread corrections in the mental lexicon. The exact processes by which these developments occur need to be further explored.

5.6 Summary

In this chapter, validity of lexical decision task was confirmed. In addition, giving binary choice to learner groups enhanced accuracy rate in both advanced learners and beginners. That in turn, brought into sharp focus the contrast between advanced learners and beginners. Asymmetrc lexical encoding which relies on familiar L1 category to store L2 contrast, disappeared due to the high accuracy in advanced learners while we observed asymmetric lexical encoding in beginners with enhancement of accuracy rate.

From the viewpoint of prevalent models of L2 phonological acquisition (i.e. SLM and PAM-L2), these models do not predict these dynamics in terms of proficiency levels. In addition, as seen in ABX task and other two tasks in this thesis (i.e. lexical decision and FLeC), neither of the models make predictions of relative difficulty in terms the level of word recognition (i.e. phonetic discrimination vs. lexical encoding). The models need to address what kind of difficulty in what level a specific L2 contrast imposes.

Chapter VI
Conclusion

6. 1 Returning to the Research Questions

So far, we reported three experiments and their results in turn. In this chapter, we apply our results to our research questions and conclude what this research as a whole indicates, contributes and addresses further directions.

6.1.1 Does Perceptual Advantage in Vowel over Consonant Length Contrasts Exist in L2 Japanese?

Altmann, Berger, and Braun (2012) demonstrated that learners perceive the vowel length contrast better than the consonantal length contrast in a discrimination task regardless of learner's L1 experience. In our ABX task (i.e. Chapter 3) the accuracy rate overall was high regardless of the proficiency level. Even beginners scored more than 80% mean accuracy. Most importantly, ABX task results on singleton vs. long vowel yielded the highest accuracy in both beginners and advanced learners. On the contrary, the results on singleton vs. geminate yielded the lowest accuracy rate in both learner groups. The results on long vowel vs. geminate were the second highest in accuracy for both learner groups. Our results corroborated Altmann, Berger, and Braun (2012) in that the vowel length contrast was better discriminated than the consonantal length contrast.

6.1.2 Vowel Superiority Over Consonant

As for proficiency with respect to research question, both beginners and advanced learners were able to discriminate short and long vowel contrasts. In addition, they could discriminate singleton and geminate contrasts and geminate and long vowel contrasts. All these results indicate that learners can detect the physical difference between short and long contrasts and type of long category (i.e. geminate and long vowel). Accuracy rates for these contrasts were higher than the one for singleton and geminate contrasts. Overall, origin S contributed highest accuracy across Lexical Decision and FLeC tasks.

As for the lexical decision and FLeC tasks, the accuracy rate was greatly influenced by combinations of lexical status (word or non-word) and type of stimuli (control or test). With respect to origin, while origin S elicits higher accuracy rates than origin G and L, there was no statistical difference between origin G and L. The only exception was found from advanced learners' results in the pairwise comparison between origin G and L under the test non-word condition S in the Lexical Decision task (p = .008). In this case, origin L scored higher accuracy rate than origin G.

Regarding test non-word condition, condition S elicits the lowest accuracy. In contrast, condition L yiels better accuracy rate than condition G. In FLeC, this superiority of vowel length contrasts over consonantal length contrasts from beginners results from findings that pairwise comparison between S and L and between G and L were statistically significant. The superiority of vowel length contrast was confirmed from lexical decision task in advanced learners as well. There was a statistical significance when condition S and L were compared. Our results are in line with discrimination task and would be the first to report vowel superiority in length contrast other than discrimination task.

6.1.3 Do We Observe Dissociation Between Phonetic Discrimination and Lexical Encoding for Length Contrast?

When it comes to the lexical decision task (see Chapter 4), accuracy rates were low for the beginner group (test-word mean 63.7%, test non-word mean 37.1%) whereas the accuracy of the advanced learners was comparable to the native speakers for the test words. Unlike the ABX task, this task requires participants to associate lexical status (i.e. word or non-word) when processing incoming stimuli. For advanced and beginning learner groups, the accuracy rate for the test non-word was greatly affected by the original status of a stimuli regarding length (i.e. origin). More specifically, when the advanced learners can refer to a word with singleton (origin S stimuli such as *akeru* “to open”), they reached the highest accuracy (advanced learner mean accuracy for origin S, 85.1%). Although there was a significant effect of origin for beginners, accuracy rates for the test non-words were low. In fact, it was around chance level. The fact that origin L yielded the highest accuracy (50%) and that Pairwise Comparison between origin L and S (30%) and origin L and G (31%) were significant (origin L vs. S: p = .005, origin L vs. G, p= .008) did not coincide with results from advanced learners. We assume this is due to overall low accuracy rates. High accuracy rates for both the advanced and beginning learner groups on the ABX task and varying accuracy rates depending on proficiency level and origin on the lexical decision task show sharp contrasts in terms of distribution of accuracy rates in learners groups. In addition, proficiency level clearly comes into play when a task requires learners’ implicit/explicit knowledge of lexical status. To discuss dissociation between discriminability and lexical encoding, it is necessary to discuss asymmetric lexical encoding.

6.2 Asymmetric Lexical Encoding

With respect to asymmetric lexical encoding, it was only visible for non-word test words processing for advanced learners in lexical decision task (see Chapter 4).

The pattern was not shown in the test words due to the extremely high accuracy rate. In fact, advanced learners were comparable to the native speakers for the accuracy rate in test words. Unlike the advanced learners, beginner's accuracy rates on test non-words were around chance level or lower and asymmetric lexical encoding was not visible. These results suggest that knowledge of L2 vocabulary or vocabulary size in L2 is a critical factor to store L2 contrasts as a part of the lexicon.

Asymmetric lexical processing took the form of higher accuracy in test non-words with a geminate or long vowel when compared with the ones with a singleton. This was observed in the beginners in the FLeC task. These results were found as superiority of origin S in comparison with origin G and L, higher accuracy in test non-word condition G and L over condition S. All these results conincide with the accuracy order of non-word (new) > non-word (old) that Darcy, Daidone and Kojima (2013. 2015) suggested. That is, referring to a familiar L1 category elicits higher accuracy while referring to L2 category such as geminate or long vowel result in lower accuracy.

On the contrary, asymmetric lexical encoding was not observed among advanced learners at all in the FLeC task. This indicates less cognitive load enhanced the accuracy in both beginners and advanced learners.

The vigorous enhancement in accuracy in both learner groups further indicate that the most relevant competitors that researchers assume are actually the ones that learners activate during the lexical decision task.

In conclusion, our contribution to L2 perception in general is that we confirmed that there is a discrepancy between learner's ability to discriminate and encoding as L2 sounds. In addition, we reported an asymmetric processing pattern that is unique to learners and it becomes less asymmetrical as learner proficiency level progresses. Finally, we examined the lexical decision task and its validity through an additional experimental paradigm called the Forced Lexical Decision (FLeC).

6.3 Conclusions

6.3.1 Summary

The difference between discriminatory ability and storing contrasts to the lexicon were evident in the high accuracy for both learners in the ABX and varied accuracy rates depending on proficiency level in the lexical decision task. The varied accuracy rate in lexical decision and FLeC tasks were due to interactions between lexical status (word vs. non-word), condition (control vs. test) and proficiency level. The intractions of these factors embody specific accuracy orders in lexical decision and FLeC tasks: word (old) > word (new) > non-word (new) > non-word (old). This specific order is due to the fact that a word with a singleton is easy to process than the ones with geminate or long vowel. On the contrary, a non-word with a geminate or long vowel is encountered, learners can reject it based on knowledge of a word with a singleton. Hence, a non-word with geminate or long vowel elicits higher accuracy than a non-word with singleton or short vowel. When it comes to a non-word with a singleton, learners need to refer to a L2 category (geminate/long vowel) to successfully reject that it is not a Japanese word. Our results showed that this processing difficulty for learners arises since they refer to a familiar L1 or old category to maintain L2 (new) contrast. The reason that learners need to rely on L1 (old) category is due to their L2 representation is inaccurate, inprecise, and fuzzy. In contrast, L1-like category must be encoded, retrieved and activated properly. The asymmetric lexical encoding pattern was observed both in lexical decision and FLeC tasks. In ABX task, there was no such systematic processing pattern found. The difference in accuracy distributions and this systematic lexical encoding pattern in lexical decision and FLeC made us conclude that there is a discrepancy between learners' discriminating ability and storing of L2 contrasts. In fact, Darcy, Daidone, and Kojima (2013, 2015) demonstrated that there is a discrepancy between ability of discrimination and lexical encoding in German vowel contrasts. Further investigations are required in different L2 contrasts to examine the idea that this dissociation is common to L2 perception in general.

Our results also showed that proficiency level is closely relted to the ability to process, encode, and activate L2 distinctions. However, this peculiar difficulty in processing and encoding L2 contrasts is likely to be mitigated or even to fully disappear when proficiency increases. The actual reasons for this development are still unclear, however. Previous studies found that vocabulary size is one of the contributing factors to accurate performance on naming and lexical retrieval tasks (Bialystok, Craik & Luk, 2008a). Although the study is focused on native speakers and bilinguals, and other studies did not show a difference in accuracy for a lexical decision task between native speakers and early bilinguals (Randsell & Fischler, 1987), it suggests that at least a related factor could be what differentiates learners of different proficiency levels: surely, L2 vocabulary size matters in some way. Thus, when considering learner ability to encode L2 contrasts, we should consider how vocabulary size expands over the course of learning. Recent approaches (e.g. Darcy & Holliday, 2018; Darcy & Thomas, 2019) surmise that improvements in perception over time, combined with an increasing number of words that are encoded with accurate phonolexical representations, can snowball and lead to gradually more wide-spread corrections in the mental lexicon. The exact processes by which these developments occur need to be further explored.

With respect to perceptual advantage, vowel length was more easily discriminated compared to consonant length on the discrimination task. The results corroborated Altmann, Berger and Braun (2012). In addition, our results suggested test non-word with long vowel will be more precisely rejected than the ones with geminate in lexical decision and FLeC tasks. This indirectly imply that not only would vowel contrasts be discriminated, they would be more accurately encoded and activated than consonantal length contrast. Our results are first to report the vowel contrast advantage over consionantal length contrast other than discrimination task. We speculate this is due to more prevalent phonetic (not phonemic) vowel length contrasts than consonantal length contrasts in American English. Further research is required as to why vowel contasts were discriminated or lexically encoded better than consonantal contrasts.

6.3.2 Implications for L2 Acquisition Models

The most prevalent models of L2 acquisition such as SLM (Flege, 1995) and PAM-L2 (Best and Tyler, 1997) predict the length contrast will be the most difficult one for native speakers of American English because the contrast is not in their L1. However, these models do not posit different processing levels in L2 perception. Namely, our results indicate that there should be a realm that is associated with phonetic level processing. In addition, there will be a realm that is associated with lexical encoding. Our results suggest that learners do not show difficulty at phonetic level processing. The high accuracy observed in ABX task regardless groups was not predicted by neither SLM nor PAM-L2. Thus, these models should be updated to capture different levels of L2 perception.

As for the results of lexical decision and FLeC coincide with the predictions from SLM and PAM-L2 in that learners processing pattern is based on L1-like category. The processing difficulty is also related to whether an input contains old category or not. Along this line, our results revealed that proficiency levels play a crucial role for more accurate lexical encoding. Proficiency levels are not vigorously discussed in SLM and PAM-L2. Thus, the models should incorporate proficiency as well as levels of perceptual processing.

Finally, our research is based on perceptual experiments from an L2 acquisition point of view. However, perception is only one of the faculties of language. Thus, L2 production, in association with L2 perception must also be pursued. According to the Speech Learning Model (SLM, Flege, 1995), better production ability is contingent upon increasing ability in perception. However, recent studies have questioned the connection between perception and production for L2 vowel contrasts (e.g. Peperkamp & Bouchon, 2011). Thus, one of the extensions of this study will be to incorporate production task along with different types of perceptual tasks such as an ABX task and lexical decision task, which should give a more holistic view of how L2 contrasts will be perceived, processed, and executed for learners.

6.3.3 From Research to Practice

Given that our research indicated that even beginning learners can discriminate length contrasts with high accuracy, classroom activities in which students are simply asked to discriminate short vs. long sounds would not be helpful. Recall that lexical decision does not require full association of meaning and sound: they need to answer whether the sound sequence is a word or not. Nonetheless, our results indicate that accuracy on the lexical decision task would increase as student proficiency progresses. For advanced learners, their accuracy on test words were comparable to the native speakers. That being said, what students need is instruction during which we could encourage learners to make an association between meaning and L2 contrasts. That, in turn, would help to develop better lexical encoding ability, or to put it differently, help learners to store L2 contrasts in the lexicon. Careful examination of existing classroom activities is critical to evaluate what brings the most efficient learning in terms of making the association possible. For instance, there are classroom activities where students are required to demonstrate receptive vocabulary ability: students will see a set of pictures and the instructor will name one of them. Then the student will indicate the named image. On the other hand, there is a naming task where students are shown pictures and name them accordingly. Both of the activities make use of association of meaning and corresponding vocabulary.

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Appendices

Appendix A. Copy of Demographic Questionnaires

(1) English

Subject's ID ____________

Nb - Group ____________

Language Background Questionnaire

This questionnaire is designed to learn about your language history. In addition, we are required to collect demographic information by government funding agencies. Information collected will be stored in a secured laboratory. No identifying information will be made available unless you specifically give permission in writing to do so. All answers are strictly confidential. Any information you provide will not be distributed to outside parties. Thank you!

1. **Date of experiment:______________ [session ______]** **2. Sex : M F**

3. **Date of birth:** .... **4. Are you left or right-handed?** L R Both

5. **Place of birth:** a. City: .... b. State/Province & Country : ....

6. **Your native language(s) – please be specific (e.g. British English)?** ....

7. **Father's Birthplace:** a) City/Town and State/Province: .... b) Country: ....

8. Father's native language: .... If he speaks his native language with an accent, specify the type (e.g., regional dialect): ....

   Does he speak another language ***fluently***? Which one(s)? ....

9. **Mother's Birthplace:** a) City/Town and State/Province: .... b) Country: ....

10. Mother's native language: .... If she speaks her native language with an accent, specify the type (e.g., regional dialect): ....

    Does she speak another language ***fluently***? Which one(s)? ....

11. **As a child, what languages were spoken in your home and by whom** (e.g., by parents, guardians, grandparents, or relatives)? For example, these can be languages that you frequently heard but didn't understand or speak, languages that you understood but did not speak, or languages that you both understood and spoke. Please indicate whether you spoke and/or understood any of these languages.

....

....

12. **Do you have an "accent" in your native language (e.g., Southern accent)?** YES NO

    If "YES", which regional area is your accent from? ....

    Do you sound like other people from your region? YES NO

    Can you describe characteristics of your accent? ....

....

....

13. **As a child, what languages were spoken outside your home** (e.g., kindergarten or school)? These can be languages that you frequently heard but didn't speak, languages that you understood but did not speak, or languages that you both understood and spoke. Please indicate whether you spoke and/or understood any of these languages.

....

....

14. Your **age of arrival** in the U.S.: ....

15. Years & months you have **lived in the U.S.** (e.g., 1 year and 4 months): ....

16. Do you feel that your **English pronunciation** has become more American since your arrival in the U.S? Please rate your change on a scale from "1" (*Not changed at all*) to "11" (*Definitely changed, and I speak with an American accent*).

    (*Not changed at all*) 1 2 3 4 5 6 7 8 9 10 11 (*Definitely changed*)

17. Number of **years of formal education** in your native country ________ and in the U.S. __________.

    If you had formal education in other countries, which countries are they and how many years?

1

Country: ____________ Years: ____________ Country: ____________ Years: __________

Country: ____________ Years: ____________ Country: ____________ Years: __________

If you need more space, please use the backside of the questionnaire.

What do (or did) you study in college? ....

What is (or was/were) your occupation? ....

Are you a Graduate/Undergraduate Student at IU? G U [in my __________ year of study]

18. If you know **any languages other than your native language**, list the language(s) and estimate your ability to speak, understand, read and write the language(s) on a scale from "1" (i.e., your ability is very poor) to "7" (i.e., your ability is very good). Please include English if it is not your native language.

Language																							
Ability	1	2	3	4	5	6	7		1	2	3	4	5	6	7		1	2	3	4	5	6	7
Speaking																							
Understanding																							
Reading																							
Writing																							

If you need more space, please use the backside of the questionnaire.

19. Please circle your race (optional):

a. American Indian or Alaskan Native b. Asian

c. Native Hawaiian or Other Pacific Islander d. Black or African American

e. White f. More than one race

g. Other h. Do no wish to report

20. Please circle your ethnicity (optional):

a. Hispanic or Latino b. Not Hispanic or Latino c. Do not wish to report

21. Have you ever had any kind of a speech or hearing disorder? Yes No

If "Yes", please explain: ....

....

22. Please list the places you have lived more than 6 months in chronological order:

- Where I have lived (earliest to most recent): From (year) to (year):

1 ....

2 ....

3 ....

4 ....

5 ....

6 ....

If you need more space for this question, you may write on the back of this questionnaire.

23. a Do you take part in any musical activities? Yes No
(for example, do you play an instrument, sing in a choir, etc.) ....

b. Do you smoke? Yes No

c. Do you exercise a lot? Yes No

The following questions are only for non-native speakers of English.

24. How did you learn English? (e.g., home, guest family, school, friends, business, etc.) ....

....

25. What variety or varieties of English pronunciation did you learn? (e.g., American English, British English, or Australian English) ....

....

26. Can you describe characteristics of your accent in English?

a) Please rate your degree of accent in **American** English on a scale from 1 (*very heavy accent*) to 11 (*no accent at all, like a native speaker of American English*).

(*very heavy accent*) 1 2 3 4 5 6 7 8 9 10 11 (*no accent at all*)

b) If you indicated above that you **did not learn American English**, please rate your degree of accent in the variety of English that you learned (or in other languages that you speak other than your native language). Indicate the variety / language for each rating.

________________ (*very heavy accent*) 1 2 3 4 5 6 7 8 9 10 11 (*no accent at all*)

________________ (*very heavy accent*) 1 2 3 4 5 6 7 8 9 10 11 (*no accent at all*)

________________ (*very heavy accent*) 1 2 3 4 5 6 7 8 9 10 11 (*no accent at all*)

27. Can you describe **characteristics** of your accent in English?

....

....

....

....

28. Please estimate **how much you currently (e.g. in the past five weeks) speak** any kind of English in these places or situations. Place an 'X' in the appropriate box.

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
While at home (including TV/radio)											
At work/school											
With friends											
On the telephone											
While shopping											
At parties & social gathering											

29. In sum, in your current everyday life, you use

English: % **your first language:** %

If the total above is not 100%, do you speak other languages in the remaining time?

Language : .... at % Language : .... at %

30.a. How much English did you use in the past five months?

In the past 5 months, in your everyday life, you used

English : [%] your first language: [%]

If the total above is not 100%, did you speak other languages in the remaining time?

Language : .... at %	Language : .... at %

30.b. How much English did you use in the past five years?

In the past 5 years, in your everyday life, you used

English : [%] your first language: [%]

If the total above is not 100%, did you speak other languages in the remaining time?

Language : .... at %	Language :................................ at %

31. Please indicate what you think about the following statements on a seven-point scale

(1 = strongly disagree; 11 = strongly agree)

a. **It is important to speak English grammatically**

1 2 3 4 5 6 7 8 9 10 11

b. **I enjoy learning new words and new ways of saying things in English**

1 2 3 4 5 6 7 8 9 10 11

c. **It is important to pronounce English correctly**

1 2 3 4 5 6 7 8 9 10 11

d. **I want to improve my pronunciation of English**

1 2 3 4 5 6 7 8 9 10 11

e. **I try to have as many American friends as possible**

1 2 3 4 5 6 7 8 9 10 11

f. **I believe that Americans will respect me more if I use correct English grammar and vocabulary**

1 2 3 4 5 6 7 8 9 10 11

g. **I believe that Americans will respect me more if I pronounce English well**

1 2 3 4 5 6 7 8 9 10 11

h. **I believe that English is important for my success at work/school**

1 2 3 4 5 6 7 8 9 10 11

(2) Japanese

被験者番号 ____________

言語に関するアンケート

このアンケートはあなたの言語に関する情報についてお聞きするためのものです。このアンケートによって集められた情報は厳重に保管されます。あなたの身元が判別するような情報はあなたが特別に許可しない限り公開されることはありません。すべての回答は極秘情報として扱われます。いかなる情報も外部の第三者に口外されることはありません。

1. **実験日**:________________ **2. 性別**: **男** **女**

3. **生年月日**: .... 4.利き腕 左 右 両方

5. **出生地**: a.都道府県: .... b.市町村: ....

6. **母国語** ....

7. **父親の出生地**: a) 都道府県: .... b) 市町村 Country: ....

8. **父親の母国語**: ....

父親が東京方言以外の方言を使う........................

日本語以外の言語を流暢に話すことができる........................

9. **母親の出生地**: a) 都道府県: .... b) 市町村 Country: ....

10. **母親の母国語**: ....

母親が東京方言以外の方言を使う........................

日本語以外の言語を流暢に話すことができる........................

11. **子供の頃、家庭で使用されていた言語は何ですか。また、だれがその言語を話していましたか**(例: 両親、保護者、祖父母、親戚など)。家庭で使用されていた、自分では話せない、あるいは理解できなかった言語も含めてお答えください。日本語以外の言語をお答えになる場合現在その言語を話したり理解したりできるかについても言及してください。

....

....

12. **あなたはどの方言を話しますか。(例: 東京方言、大阪方言など)**

....

あなたの話す方言の特徴を描写してください(任意)

....

....

13. 子供の頃、家の外(例: 幼稚園、小学校など)で使用されていた言語は何ですか。**自分では話さなかった、あるいは理解できなかった言語も含めてお答えください。日本語以外の言語をお答えになる場合現在その言語を話したり理解したりできるかについても言及してください。**

....

....

14. **あなたの第二外国語いついてリストし、スピーキング、リスニング、リーディング、ライティングの各技能について 1 から 7 で評価してください**(1 はとても苦手である、7 はとても得意であることを示します)。

1

言語																							
能力の種類	1	2	3	4	5	6	7		1	2	3	4	5	6	7		1	2	3	4	5	6	7
スピーキング																							
リスニング																							
リーディング																							
ライティング																							

※書ききれない場合このアンケートの裏に記入してください。

15. これまでに言語または 聴覚障害と診断されたことがありますか。 はい　　　いいえ

「はい」とお答えの場合どのような診断をされたか簡単にご記入ください: ....

....

16.これまでに 6 ヶ月以上住んだことのある場所を時系列にそってご記入ください:

- 期間:　　　　　　　　　　　　地名:

1 ....
2 ....
3 ....
4 ....
5 ....
6 ....

※書ききれない場合このアンケートの裏に記入してください。

ご協力ありがとうございました。

Appendix B. List of Stimuli

(1) ABX - Test Stimuli

Non-Word without Long Sound	Non-Word with Geminate	Non-Word with Long Vowel
besa	bessa	beesa
gepo	geppo	geepo
kose	kosse	koose
mete	mette	meete
mopa	moppa	moopa
neka	nekka	neeka
nesa	nessa	neesa
pota	potta	poota
puki	pukki	puuki
pute	putte	puute
suke	sukke	suuke
tepa	teppa	teepa

(2) ABX - Training Session

Non-word without long sound	Non-word with geminate
koga	kogga
goka	gokka

(3) Lexical Decision – Test Stimuli

Word without Long sound	Corresponding Non-Word	Gloss
akeru	akkeru aakeru	To open
akirameru	akkirameru aakirameru	To give up
chikaku	chikkaku chikaaku	Close/Nearby
daigaku	daigakku daigaaku	University/College
itsu	ittsu iitsu	when
kongetsu	kongettsu kongeetsu	This month
naku	nakku naaku	To cry
sake	sakke saake	Japanese sake (alcoholic beverage)
shigoto	shigotto shigooto	job/work
tatsu	tattsu taatsu	To stand
wakaru	wakkaru waakaru	To understand
watashi	wattashi wataashi	I

Word with geminate	Corresponding Non-word	Gloss
bukka	buka	consumer price
	buuka	
chotto	choto	a little
	chooto	
gakkou	gakou	school
	gaakou	
hikkoshi	hikoshi	To move
	hiikoshi	
jyaketto	jyaketo	jacket
	jyakeeto	
kippu	kipu	ticket
	kiipu	
kissaten	kisaten	cafe
	kiisaten	
petto	peto	pet
	peeto	
yottsu	yotsu	four small things
	yootsu	
yukkuri	yukuri	slowly
	yuukuri	
zasshi	zashi	magazine
	zaashi	
zutto	zuto	for a long time
	zutto	

Word with Long Vowel	Correspoding Non-Word	Gloss
Apaato	apato apatto	apartment
Chokoreeto	chokoreto chokoretto	chocolate
Depaato	depato depatto	Department store
Kaaten	katen katten	curtain
Konsaato	konsato konsatto	concert
Peeji	peji pejji	page
Repooto	repoto repotto	report, term paper
Saafin	safin saffin	surfing
Saakuru	sakuru sakkuru	club activity
Supiichi	supichi supicchi	speech
Supootsu	supotsu supottsu	sports
Suupu	supu suppu	soup

(4) Lexical Decision – Control Stimuli (Words)

Word	Gloss	Word	Gloss
akai	red	omiyage	souvenir
ashi	foot	ongaku	music - repeated
atama	head	otera	temple
batsu	sign for not good	oto	sound
byouki	sick	otoko	male
dakara	because	rekishi	history
dasu	To turn in, exit	ringo	apple
densha	train	rishi	interest
donna	what kind of	ryokou	Travel/trip
eiga	movie	sakana	fish
esa	feed	shashin	picture
gohan	rice, meal	shigoto	job, occipation
hanasu	to speak	shiken	exam
hayaku	quickly	soshite	and then
hidari	left	suwaru	to sit
honya	book store	tabemono	food
imi	meaning	taberu	to eat
isu	chair	tada	free of charge
kazoku	family	takusan	many
kisetsu	season	tango	vocabulary
kowai	scary	tegami	letter
kuru	to come	tenki	weather
kuruma	car	tobu	to fly
megane	glasses	tokoya	barbar

migi	right	totemo	extremely
mochi	rice cake	tsukue	desk
mune	chest	wakai	young
nanika	something	wakaru	to understand
nodo	throat	yaku	to grill
odoru	to dance - repeated	yasumi	to rest
okashi	sweets	yoyaku	reservation
omise	stores		

(5) Lexical Decision – Control Stimuli (Non-Words)

Non-Word	Note
agai	Made from a real word akai "red"
achi	Made from a real word ashi "foot"
ami	Made from a real word imi "meaning"
bonya	Made from a real word honya "book store"
dagara	Made from a real word dakaraa "because"
eza	Made from a real word esa "feed"
hitari	Made from a real word hidari "left"
ishu	Made from a real word isu "chair"
manika	Made from a real word nanika "something"
megame	Made from a real word megane "glasses"
muru	Made from a real word kuru "to come"
nadama	Made from a real word atama "head"
nigi	Made from a real word migi "right"
nochi	Made from a real word mocha "rice cake"
nune	Made from a real word mune "chest"

odera	Made from a real word otera “temple”
odoko	Made from a real word otoko “male”
omize	Made from a real word omise “store”
oniyage	Made from a real word omiyage “souvenir”
rushi	Made from a real word rishi “interest”
sagana	Made from a real word sakana “fish”
soshute	Made from a real word “and then”
takuzan	Made from a real word takusan “many”
tengi	Made from a real word tenki “weather”
yagu	Made from a real word yaku “to grill”

(6) Lexical Decision – Training Session

Word	Gloss
migi	left
sakana	fish
wasureru	to forget
tsuku	to arrive
odo	sound
shugoto	job, occupation
gankoku	Non-word made from a real word kankoku “Korea”
zanposuru	to take a walk
gowai	Non-word made from a real word kowai “scary”

(7) Forced Lexical Choice (FLeC) - Test Stimuli (Pairs)

Word	Paired Non-word	Gloss
akeru	*akkeru	To open
akeru	*aakeru	
apaato	*apato	apartment
apaato	*apatto	
bukka	*buka	price
bukka	*buuka	
chikaku	*chikakku	nearby
chikaku	*chiikaku	
chokoreeto	*chokoreto	chocolate
chokoreeto	*chokoretto	
chotto	*choto	a little
chotto	*chooto	
daigaku	*daigakku	university, college
daigaku	*daigaaku	
depaato	*depato	department store
depaato	*depatto	
gakkou	*gakou	school
gakkou	*gaakou	
hikkosu	*hikosu	To move
hikkosu	*hiikosu	
itsu	*ittsu	when
itsu	*iitsu	
jyaketto	*jyaketo	jacket
jyaketto	*jyakeeto	

kaaten	*katen	curtain
kaaten	*katten	
kippu	*kipu	ticket
kippu	*kiipu	
kissaten	*kisaten	cafe
kissaten	*kiisaten	
kongetsu	*kongettsu	this month
kongetsu	*kongeetsu	
konsaato	*konsato	concert
konsaato	*konsatto	
naku	*naaku	to cry
naku	*nakku	
peeji	*peji	page
peeji	*pejji	
petto	*peto	pet
petto	*peeto	
repooto	*repoto	report, term paper
repooto	*repotto	
saafin	*safin	surfing
saafin	*saffin	
saakuru	*sakuru	club activity
saakuru	*sakkuru	
sake	*sakke	Japanese alcoholic beverages
sake	*saake	
shigoto	*shigotto	job, occupation
shigoto	*shigooto	

supiichi	*supichi	speech
supiichi	*supicchi	
supootsu	*supotsu	sports
supootsu	*supottsu	
suupu	*supu	soup
suupu	*suppu	
tatsu	*tattsu	to stand
tatsu	*taatsu	
wakaru	*wakkaru	To know, understand
wakaru	*waakaru	
watashi	*wattachi	I
watashi	*waatachi	
yottsu	*yotsu	4 small things/objects
yottsu	*yootsu	
yukkuri	*yukuri	slowly
yukkuri	*yuukuri	
zasshi	*zashi	magazine
zasshi	*zaashi	
zutto	*zuto	for a long time
zutto	*zuuto	

Appendix C. List of Experimental Scripts

(1) ABX Task

```
<ep> <azk> <NumberOfItems 144> <scramble 36> <ContinuousRun> <fd 30> <Delay 118> <Timeout 2500> <id "Keyboard"> <mr +Space> <MapNegativeResponse "+Right Alt"> <MapPositiveResponse "+Left Alt"> <vm 640,480,480,8,0> <eop>
```

```
$

0 <line -8> "ABX Instructions",<line -6> "You will hear 3 pseudo words in a row.", <line -4> "You have to decide whether the third one is similar to", <line -3> " the first or the second one. ",<line -2> "Please press the LEFT Alt or the RIGHT Alt B button as quickly as possible,",<line 0> "Press LEFT Alt if you think that the last one is the same as the first ",<line 2> "and Press the RIGHT Alt if you think that the last one is the same as second word",<line 4> "Press SPACEBAR to start with a short practice.";


0 <line -10> "はじめに",<line -6> "このタスクは連続して3つの無意味語を聞いていただいた後、",<line -4> "最後に聞いたものが最初に聞いたものに類似しているか",<line -2> "2番目に聞いたものに類似しているか判断していただくものです。", <line 2> "もし最後に聞いた音声が最初のものと同じだと思ったら左ALTキーを、",<line 4> "2番目の音声と同じだと思ったら右ALTキーをできるだけ早く押してください。", <line 8> "スペースバーを押すと短い練習セクションが始まります。";


999 <ms% 2000> "+"  /;
$
```

```
+41221001 <cfb "○"> <wfb "✕"> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / <wav 2> "koga" / <ms% 500> / <wav 2> "gokka" / <ms% 500> / <wav 2> "koga" * /;

-41212001 <cfb "○"> <wfb "✕"> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / <wav 2> "goka" / <ms% 500> / <wav 2> "kogga" / <ms% 500> / <wav 2> "kogga" * /;

-42121001 <cfb "○"> <wfb "✕"> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / <wav 2> "gokka" / <ms% 500> / <wav 2> "koga" / <ms% 500> / <wav 2> "koga" * /;

+42112001 <cfb "○"> <wfb "✕"> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / <wav 2> "kogga" / <ms% 500> / <wav 2> "goka" / <ms% 500> / <wav 2> "kogga" * /;

+41221002 <cfb "○"> <wfb "✕"> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / <wav 2> "goka" / <ms% 500> / <wav 2> "kogga" / <ms% 500> / <wav 2> "goka" * /;
```

```
-41212002 <cfb "〇"> <wfb " ✕ "> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / <wav 2> "koga" / <ms% 500> / <wav 2> "gokka" / <ms% 500> / <wav 2> "gokka" * /;

-42121002  <cfb "〇"> <wfb " ✕ "> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / <wav 2> "kogga" / <ms% 500> / <wav 2> "goka" / <ms% 500> / <wav 2> "goka" *

/;

+42112002 <cfb "〇"> <wfb " ✕ "> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / <wav 2> "gokka" / <ms% 500> / <wav 2> "koga" / <ms% 500> / <wav 2> "gokka" * /;


$

0 <line -8> "Ready for the real experiment?", <line -6> "The feedback is now turned off  but otherwise it will be almost the same.", <line -4> "Respond as fast as you can without making mistakes.", <line -2> "If you make a mistake, don't worry and keep going! Good luck！", <line 0> "ここから実験がはじまります。", <line 1> "ここから先は正解、不正解などのフィードバックはありません。", <line 2> "フィードバックがないという点以外は形式は同じです。", <line 4> "できるだけ早く正確に答えてください。", <line 6> "間違えたと思っても気にせず先に進んでください。", <line 8> "スペースバーを押すと実験が始まります。";


999 <nfb> <ms% 2000> /;

$


\


+11211120 <ms% 250> "+" / <wav 2> "sg-20-p" / <ms% 500> / <wav 2> "lv-20-p" / <ms% 500> / <wav 2> "sg-20-c" * /;

-21223120 <ms% 250> "+" / <wav 2> "gc-20-p" / <ms% 500> / <wav 2> "lv-20-p" / <ms% 500> / <wav 2> "lv-20-c" * /;

-22112120 <ms% 250> "+" / <wav 2> "gc-20-p" / <ms% 500> / <wav 2> "sg-20-p" / <ms% 500> / <wav 2> "sg-20-c" * /;

+11213123 <ms% 250> "+" / <wav 2> "gc-23-p" / <ms% 500> / <wav 2> "lv-23-p" / <ms% 500> / <wav 2> "gc-23-c" * /;

-21222123 <ms% 250> "+" / <wav 2> "sg-23-p" / <ms% 500> / <wav 2> "gc-23-p" / <ms% 500> / <wav 2> "gc-23-c" * /;
```

```
+12121123 <ms% 250> "+" / <wav 2> "lv-23-p" / <ms% 500> / <wav
2> "sg-23-p" / <ms% 500> / <wav 2> "lv-23-c" * /;

+11213127 <ms% 250> "+" / <wav 2> "gc-27-p" / <ms% 500> / <wav
2> "lv-27-p" / <ms% 500> / <wav 2> "gc-27-c" * /;

-21222127 <ms% 250> "+" / <wav 2> "sg-27-p" / <ms% 500> / <wav
2> "gc-27-p" / <ms% 500> / <wav 2> "gc-27-c" * /;

-22111127 <ms% 250> "+" / <wav 2> "lv-27-p" / <ms% 500> / <wav
2> "sg-27-p" / <ms% 500> / <wav 2> "sg-27-c" * /;

-21221128 <ms% 250> "+" / <wav 2> "sg-28-p" / <ms% 500> / <wav
2> "lv-28-p" / <ms% 500> / <wav 2> "lv-28-c" * /;

-22113128 <ms% 250> "+" / <wav 2> "lv-28-p" / <ms% 500> / <wav
2> "gc-28-p" / <ms% 500> / <wav 2> "gc-28-c" * /;

+12122128 <ms% 250> "+" / <wav 2> "gc-28-p" / <ms% 500> / <wav
2> "sg-28-p" / <ms% 500> / <wav 2> "gc-28-c" * /;

+11212130 <ms% 250> "+" / <wav 2> "sg-30-p" / <ms% 500> / <wav
2> "gc-30-p" / <ms% 500> / <wav 2> "sg-30-c" * /;

+12121130 <ms% 250> "+" / <wav 2> "lv-30-p" / <ms% 500> / <wav
2> "sg-30-p" / <ms% 500> / <wav 2> "lv-30-c" * /;

+12123130 <ms% 250> "+" / <wav 2> "lv-30-p" / <ms% 500> / <wav
2> "gc-30-p" / <ms% 500> / <wav 2> "lv-30-c" * /;

-22111132 <ms% 250> "+" / <wav 2> "lv-32-p" / <ms% 500> / <wav
2> "sg-32-p" / <ms% 500> / <wav 2> "sg-32-c" * /;

-22113132 <ms% 250> "+" / <wav 2> "lv-32-p" / <ms% 500> / <wav
2> "gc-32-p" / <ms% 500> / <wav 2> "gc-32-c" * /;

+12122132 <ms% 250> "+" / <wav 2> "gc-32-p" / <ms% 500> / <wav
2> "sg-32-p" / <ms% 500> / <wav 2> "gc-32-c" * /;

+11212133 <ms% 250> "+" / <wav 2> "sg-33-p" / <ms% 500> / <wav
2> "gc-33-p" / <ms% 500> / <wav 2> "sg-33-c" * /;

-21221133 <ms% 250> "+" / <wav 2> "sg-33-p" / <ms% 500> / <wav
2> "lv-33-p" / <ms% 500> / <wav 2> "lv-33-c" * /;

+12123133 <ms% 250> "+" / <wav 2> "lv-33-p" / <ms% 500> / <wav
2> "gc-33-p" / <ms% 500> / <wav 2> "lv-33-c" * /;

+11211135 <ms% 250> "+" / <wav 2> "sg-35-p" / <ms% 500> / <wav
2> "lv-35-p" / <ms% 500> / <wav 2> "sg-35-c" * /;
```

```
-21223135 <ms% 250> "+" / <wav 2> "gc-35-p" / <ms% 500> / <wav 2> "lv-35-p" / <ms% 500> / <wav 2> "lv-35-c" * /;

-22112135 <ms% 250> "+" / <wav 2> "gc-35-p" / <ms% 500> / <wav 2> "sg-35-p" / <ms% 500> / <wav 2> "sg-35-c" * /;

-21223136 <ms% 250> "+" / <wav 2> "gc-36-p" / <ms% 500> / <wav 2> "lv-36-p" / <ms% 500> / <wav 2> "lv-36-c" * /;

-22112136 <ms% 250> "+" / <wav 2> "gc-36-p" / <ms% 500> / <wav 2> "sg-36-p" / <ms% 500> / <wav 2> "sg-36-c" * /;

+12121136 <ms% 250> "+" / <wav 2> "lv-36-p" / <ms% 500> / <wav 2> "sg-36-p" / <ms% 500> / <wav 2> "lv-36-c" * /;

+11213137 <ms% 250> "+" / <wav 2> "gc-37-p" / <ms% 500> / <wav 2> "lv-37-p" / <ms% 500> / <wav 2> "gc-37-c" * /;

-21222137 <ms% 250> "+" / <wav 2> "sg-37-p" / <ms% 500> / <wav 2> "gc-37-p" / <ms% 500> / <wav 2> "gc-37-c" * /;

-22111137 <ms% 250> "+" / <wav 2> "lv-37-p" / <ms% 500> / <wav 2> "sg-37-p" / <ms% 500> / <wav 2> "sg-37-c" * /;

+11211139 <ms% 250> "+" / <wav 2> "sg-39-p" / <ms% 500> / <wav 2> "lv-39-p" / <ms% 500> / <wav 2> "sg-39-c" * /;

+11212139 <ms% 250> "+" / <wav 2> "sg-39-p" / <ms% 500> / <wav 2> "gc-39-p" / <ms% 500> / <wav 2> "sg-39-c" * /;

+12123139 <ms% 250> "+" / <wav 2> "lv-39-p" / <ms% 500> / <wav 2> "gc-39-p" / <ms% 500> / <wav 2> "lv-39-c" * /;

-21221142 <ms% 250> "+" / <wav 2> "sg-42-p" / <ms% 500> / <wav 2> "lv-42-p" / <ms% 500> / <wav 2> "lv-42-c" * /;

-22113142 <ms% 250> "+" / <wav 2> "lv-42-p" / <ms% 500> / <wav 2> "gc-42-p" / <ms% 500> / <wav 2> "gc-42-c" * /;

+12122142 <ms% 250> "+" / <wav 2> "gc-42-p" / <ms% 500> / <wav 2> "sg-42-p" / <ms% 500> / <wav 2> "gc-42-c" * /;


$

0 <line -2> "Take a break…press SPACEBAR when ready.", <line 0> "ここで休憩してください。次のセクションへ進む準備ができたらスペースバーを押してください。";

$


-21221220 <ms% 250> "+" / <wav 2> "sg-20-p" / <ms% 500> / <wav
```

```
2> "lv-20-p" / <ms% 500> / <wav 2> "lv-20-c" * /;

-22113220 <ms% 250> "+" / <wav 2> "lv-20-p" / <ms% 500> / <wav
2> "gc-20-p" / <ms% 500> / <wav 2> "gc-20-c" * /;

+12122220 <ms% 250> "+" / <wav 2> "gc-20-p" / <ms% 500> / <wav
2> "sg-20-p" / <ms% 500> / <wav 2> "gc-20-c" * /;

+11211223 <ms% 250> "+" / <wav 2> "sg-23-p" / <ms% 500> / <wav
2> "lv-23-p" / <ms% 500> / <wav 2> "sg-23-c" * /;

-21223223 <ms% 250> "+" / <wav 2> "gc-23-p" / <ms% 500> / <wav
2> "lv-23-p" / <ms% 500> / <wav 2> "lv-23-c" * /;

-22112223 <ms% 250> "+" / <wav 2> "gc-23-p" / <ms% 500> / <wav
2> "sg-23-p" / <ms% 500> / <wav 2> "sg-23-c" * /;

-21223227 <ms% 250> "+" / <wav 2> "gc-27-p" / <ms% 500> / <wav
2> "lv-27-p" / <ms% 500> / <wav 2> "lv-27-c" * /;

-22112227 <ms% 250> "+" / <wav 2> "gc-27-p" / <ms% 500> / <wav
2> "sg-27-p" / <ms% 500> / <wav 2> "sg-27-c" * /;

+12121227 <ms% 250> "+" / <wav 2> "lv-27-p" / <ms% 500> / <wav
2> "sg-27-p" / <ms% 500> / <wav 2> "lv-27-c" * /;

+11212228 <ms% 250> "+" / <wav 2> "sg-28-p" / <ms% 500> / <wav
2> "gc-28-p" / <ms% 500> / <wav 2> "sg-28-c" * /;

-22111228 <ms% 250> "+" / <wav 2> "lv-28-p" / <ms% 500> / <wav
2> "sg-28-p" / <ms% 500> / <wav 2> "sg-28-c" * /;

+12123228 <ms% 250> "+" / <wav 2> "lv-28-p" / <ms% 500> / <wav
2> "gc-28-p" / <ms% 500> / <wav 2> "lv-28-c" * /;

+11211230 <ms% 250> "+" / <wav 2> "sg-30-p" / <ms% 500> / <wav
2> "lv-30-p" / <ms% 500> / <wav 2> "sg-30-c" * /;

+11213230 <ms% 250> "+" / <wav 2> "gc-30-p" / <ms% 500> / <wav
2> "lv-30-p" / <ms% 500> / <wav 2> "gc-30-c" * /;

-21222230 <ms% 250> "+" / <wav 2> "sg-30-p" / <ms% 500> / <wav
2> "gc-30-p" / <ms% 500> / <wav 2> "gc-30-c" * /;

+11212232 <ms% 250> "+" / <wav 2> "sg-32-p" / <ms% 500> / <wav
2> "gc-32-p" / <ms% 500> / <wav 2> "sg-32-c" * /;

+12121232 <ms% 250> "+" / <wav 2> "lv-32-p" / <ms% 500> / <wav
2> "sg-32-p" / <ms% 500> / <wav 2> "lv-32-c" * /;

+12123232 <ms% 250> "+" / <wav 2> "lv-32-p" / <ms% 500> / <wav
```

```
2> "gc-32-p" / <ms% 500> / <wav 2> "lv-32-c" * /;

+11213233 <ms% 250> "+" / <wav 2> "gc-33-p" / <ms% 500> / <wav
2> "lv-33-p" / <ms% 500> / <wav 2> "gc-33-c" * /;

-21222233 <ms% 250> "+" / <wav 2> "sg-33-p" / <ms% 500> / <wav
2> "gc-33-p" / <ms% 500> / <wav 2> "gc-33-c" * /;

-22111233 <ms% 250> "+" / <wav 2> "lv-33-p" / <ms% 500> / <wav
2> "sg-33-p" / <ms% 500> / <wav 2> "sg-33-c" * /;

-21221235 <ms% 250> "+" / <wav 2> "sg-35-p" / <ms% 500> / <wav
2> "lv-35-p" / <ms% 500> / <wav 2> "lv-35-c" * /;

-22113235 <ms% 250> "+" / <wav 2> "lv-35-p" / <ms% 500> / <wav
2> "gc-35-p" / <ms% 500> / <wav 2> "gc-35-c" * /;

+12122235 <ms% 250> "+" / <wav 2> "gc-35-p" / <ms% 500> / <wav
2> "sg-35-p" / <ms% 500> / <wav 2> "gc-35-c" * /;

+11211236 <ms% 250> "+" / <wav 2> "sg-36-p" / <ms% 500> / <wav
2> "lv-36-p" / <ms% 500> / <wav 2> "sg-36-c" * /;

-22113236 <ms% 250> "+" / <wav 2> "lv-36-p" / <ms% 500> / <wav
2> "gc-36-p" / <ms% 500> / <wav 2> "gc-36-c" * /;

+12122236 <ms% 250> "+" / <wav 2> "gc-36-p" / <ms% 500> / <wav
2> "sg-36-p" / <ms% 500> / <wav 2> "gc-36-c" * /;

-21223237 <ms% 250> "+" / <wav 2> "gc-37-p" / <ms% 500> / <wav
2> "lv-37-p" / <ms% 500> / <wav 2> "lv-37-c" * /;

-22112237 <ms% 250> "+" / <wav 2> "gc-37-p" / <ms% 500> / <wav
2> "sg-37-p" / <ms% 500> / <wav 2> "sg-37-c" * /;

+12121237 <ms% 250> "+" / <wav 2> "lv-37-p" / <ms% 500> / <wav
2> "sg-37-p" / <ms% 500> / <wav 2> "lv-37-c" * /;

+11213239 <ms% 250> "+" / <wav 2> "gc-39-p" / <ms% 500> / <wav
2> "lv-39-p" / <ms% 500> / <wav 2> "gc-39-c" * /;

-21221239 <ms% 250> "+" / <wav 2> "sg-39-p" / <ms% 500> / <wav
2> "lv-39-p" / <ms% 500> / <wav 2> "lv-39-c" * /;

-21222239 <ms% 250> "+" / <wav 2> "sg-39-p" / <ms% 500> / <wav
2> "gc-39-p" / <ms% 500> / <wav 2> "gc-39-c" * /;

+11212242 <ms% 250> "+" / <wav 2> "sg-42-p" / <ms% 500> / <wav
2> "gc-42-p" / <ms% 500> / <wav 2> "sg-42-c" * /;

-22111242 <ms% 250> "+" / <wav 2> "lv-42-p" / <ms% 500> / <wav
```

```
2> "sg-42-p" / <ms% 500> / <wav 2> "sg-42-c" * /;

+12123242 <ms% 250> "+" / <wav 2> "lv-42-p" / <ms% 500> / <wav
2> "gc-42-p" / <ms% 500> / <wav 2> "lv-42-c" * /;



$

0 <line -2> "Take a break…press SPACEBAR when ready.", <line 0> "ここで休憩してください。次のセクションへ進む
準備ができたらスペースバーを押してください。";

$


+11212320 <ms% 250> "+" / <wav 2> "sg-20-p" / <ms% 500> / <wav
2> "gc-20-p" / <ms% 500> / <wav 2> "sg-20-c" * /;

-22111320 <ms% 250> "+" / <wav 2> "lv-20-p" / <ms% 500> / <wav
2> "sg-20-p" / <ms% 500> / <wav 2> "sg-20-c" * /;

+12123320 <ms% 250> "+" / <wav 2> "lv-20-p" / <ms% 500> / <wav
2> "gc-20-p" / <ms% 500> / <wav 2> "lv-20-c" * /;

-21221323 <ms% 250> "+" / <wav 2> "sg-23-p" / <ms% 500> / <wav
2> "lv-23-p" / <ms% 500> / <wav 2> "lv-23-c" * /;

-22113323 <ms% 250> "+" / <wav 2> "lv-23-p" / <ms% 500> / <wav
2> "gc-23-p" / <ms% 500> / <wav 2> "gc-23-c" * /;

+12122323 <ms% 250> "+" / <wav 2> "gc-23-p" / <ms% 500> / <wav
2> "sg-23-p" / <ms% 500> / <wav 2> "gc-23-c" * /;

+11211327 <ms% 250> "+" / <wav 2> "sg-27-p" / <ms% 500> / <wav
2> "lv-27-p" / <ms% 500> / <wav 2> "sg-27-c" * /;

-22113327 <ms% 250> "+" / <wav 2> "lv-27-p" / <ms% 500> / <wav
2> "gc-27-p" / <ms% 500> / <wav 2> "gc-27-c" * /;

+12122327 <ms% 250> "+" / <wav 2> "gc-27-p" / <ms% 500> / <wav
2> "sg-27-p" / <ms% 500> / <wav 2> "gc-27-c" * /;

+11213328 <ms% 250> "+" / <wav 2> "gc-28-p" / <ms% 500> / <wav
2> "lv-28-p" / <ms% 500> / <wav 2> "gc-28-c" * /;

-21222328 <ms% 250> "+" / <wav 2> "sg-28-p" / <ms% 500> / <wav
2> "gc-28-p" / <ms% 500> / <wav 2> "gc-28-c" * /;

+12121328 <ms% 250> "+" / <wav 2> "lv-28-p" / <ms% 500> / <wav
2> "sg-28-p" / <ms% 500> / <wav 2> "lv-28-c" * /;

-21221330 <ms% 250> "+" / <wav 2> "sg-30-p" / <ms% 500> / <wav
```

```
2> "lv-30-p" / <ms% 500> / <wav 2> "lv-30-c" * /;

-21223330 <ms% 250> "+" / <wav 2> "gc-30-p" / <ms% 500> / <wav
2> "lv-30-p" / <ms% 500> / <wav 2> "lv-30-c" * /;

-22112330 <ms% 250> "+" / <wav 2> "gc-30-p" / <ms% 500> / <wav
2> "sg-30-p" / <ms% 500> / <wav 2> "sg-30-c" * /;

+11211332 <ms% 250> "+" / <wav 2> "sg-32-p" / <ms% 500> / <wav
2> "lv-32-p" / <ms% 500> / <wav 2> "sg-32-c" * /;

+11213332 <ms% 250> "+" / <wav 2> "gc-32-p" / <ms% 500> / <wav
2> "lv-32-p" / <ms% 500> / <wav 2> "gc-32-c" * /;

-21222332 <ms% 250> "+" / <wav 2> "sg-32-p" / <ms% 500> / <wav
2> "gc-32-p" / <ms% 500> / <wav 2> "gc-32-c" * /;

-21223333 <ms% 250> "+" / <wav 2> "gc-33-p" / <ms% 500> / <wav
2> "lv-33-p" / <ms% 500> / <wav 2> "lv-33-c" * /;

-22112333 <ms% 250> "+" / <wav 2> "gc-33-p" / <ms% 500> / <wav
2> "sg-33-p" / <ms% 500> / <wav 2> "sg-33-c" * /;

+12121333 <ms% 250> "+" / <wav 2> "lv-33-p" / <ms% 500> / <wav
2> "sg-33-p" / <ms% 500> / <wav 2> "lv-33-c" * /;

+11212335 <ms% 250> "+" / <wav 2> "sg-35-p" / <ms% 500> / <wav
2> "gc-35-p" / <ms% 500> / <wav 2> "sg-35-c" * /;

-22111335 <ms% 250> "+" / <wav 2> "lv-35-p" / <ms% 500> / <wav
2> "sg-35-p" / <ms% 500> / <wav 2> "sg-35-c" * /;

+12123335 <ms% 250> "+" / <wav 2> "lv-35-p" / <ms% 500> / <wav
2> "gc-35-p" / <ms% 500> / <wav 2> "lv-35-c" * /;

+11212336 <ms% 250> "+" / <wav 2> "sg-36-p" / <ms% 500> / <wav
2> "gc-36-p" / <ms% 500> / <wav 2> "sg-36-c" * /;

-21221336 <ms% 250> "+" / <wav 2> "sg-36-p" / <ms% 500> / <wav
2> "lv-36-p" / <ms% 500> / <wav 2> "lv-36-c" * /;

+12123336 <ms% 250> "+" / <wav 2> "lv-36-p" / <ms% 500> / <wav
2> "gc-36-p" / <ms% 500> / <wav 2> "lv-36-c" * /;

+11211337 <ms% 250> "+" / <wav 2> "sg-37-p" / <ms% 500> / <wav
2> "lv-37-p" / <ms% 500> / <wav 2> "sg-37-c" * /;

-22113337 <ms% 250> "+" / <wav 2> "lv-37-p" / <ms% 500> / <wav
2> "gc-37-p" / <ms% 500> / <wav 2> "gc-37-c" * /;

+12122337 <ms% 250> "+" / <wav 2> "gc-37-p" / <ms% 500> / <wav
```

```
2> "sg-37-p" / <ms% 500> / <wav 2> "gc-37-c" * /;

-21223339 <ms% 250> "+" / <wav 2> "gc-39-p" / <ms% 500> / <wav
2> "lv-39-p" / <ms% 500> / <wav 2> "lv-39-c" * /;

-22111339 <ms% 250> "+" / <wav 2> "lv-39-p" / <ms% 500> / <wav
2> "sg-39-p" / <ms% 500> / <wav 2> "sg-39-c" * /;

-22112339 <ms% 250> "+" / <wav 2> "gc-39-p" / <ms% 500> / <wav
2> "sg-39-p" / <ms% 500> / <wav 2> "sg-39-c" * /;

+11213342 <ms% 250> "+" / <wav 2> "gc-42-p" / <ms% 500> / <wav
2> "lv-42-p" / <ms% 500> / <wav 2> "gc-42-c" * /;

-21222342 <ms% 250> "+" / <wav 2> "sg-42-p" / <ms% 500> / <wav
2> "gc-42-p" / <ms% 500> / <wav 2> "gc-42-c" * /;

+12121342 <ms% 250> "+" / <wav 2> "lv-42-p" / <ms% 500> / <wav
2> "sg-42-p" / <ms% 500> / <wav 2> "lv-42-c" * /;

$

0 <line -2> "Take a break…press SPACEBAR when ready.", <line 0> "ここで休憩してください。次のセクションへ進む準備ができたらスペースバーを押してください。";

$

+11213420 <ms% 250> "+" / <wav 2> "gc-20-p" / <ms% 500> / <wav
2> "lv-20-p" / <ms% 500> / <wav 2> "gc-20-c" * /;

-21222420 <ms% 250> "+" / <wav 2> "sg-20-p" / <ms% 500> / <wav
2> "gc-20-p" / <ms% 500> / <wav 2> "gc-20-c" * /;

+12121420 <ms% 250> "+" / <wav 2> "lv-20-p" / <ms% 500> / <wav
2> "sg-20-p" / <ms% 500> / <wav 2> "lv-20-c" * /;

+11212423 <ms% 250> "+" / <wav 2> "sg-23-p" / <ms% 500> / <wav
2> "gc-23-p" / <ms% 500> / <wav 2> "sg-23-c" * /;

-22111423 <ms% 250> "+" / <wav 2> "lv-23-p" / <ms% 500> / <wav
2> "sg-23-p" / <ms% 500> / <wav 2> "sg-23-c" * /;

+12123423 <ms% 250> "+" / <wav 2> "lv-23-p" / <ms% 500> / <wav
2> "gc-23-p" / <ms% 500> / <wav 2> "lv-23-c" * /;

+11212427 <ms% 250> "+" / <wav 2> "sg-27-p" / <ms% 500> / <wav
2> "gc-27-p" / <ms% 500> / <wav 2> "sg-27-c" * /;

-21221427 <ms% 250> "+" / <wav 2> "sg-27-p" / <ms% 500> / <wav
2> "lv-27-p" / <ms% 500> / <wav 2> "lv-27-c" * /;

+12123427 <ms% 250> "+" / <wav 2> "lv-27-p" / <ms% 500> / <wav
2> "gc-27-p" / <ms% 500> / <wav 2> "lv-27-c" * /;
```

```
+11211428 <ms% 250> "+" / <wav 2> "sg-28-p" / <ms% 500> / <wav
2> "lv-28-p" / <ms% 500> / <wav 2> "sg-28-c" * /;

-21223428 <ms% 250> "+" / <wav 2> "gc-28-p" / <ms% 500> / <wav
2> "lv-28-p" / <ms% 500> / <wav 2> "lv-28-c" * /;

-22112428 <ms% 250> "+" / <wav 2> "gc-28-p" / <ms% 500> / <wav
2> "sg-28-p" / <ms% 500> / <wav 2> "sg-28-c" * /;

-22111430 <ms% 250> "+" / <wav 2> "lv-30-p" / <ms% 500> / <wav
2> "sg-30-p" / <ms% 500> / <wav 2> "sg-30-c" * /;

-22113430 <ms% 250> "+" / <wav 2> "lv-30-p" / <ms% 500> / <wav
2> "gc-30-p" / <ms% 500> / <wav 2> "gc-30-c" * /;

+12122430 <ms% 250> "+" / <wav 2> "gc-30-p" / <ms% 500> / <wav
2> "sg-30-p" / <ms% 500> / <wav 2> "gc-30-c" * /;

-21221432 <ms% 250> "+" / <wav 2> "sg-32-p" / <ms% 500> / <wav
2> "lv-32-p" / <ms% 500> / <wav 2> "lv-32-c" * /;

-21223432 <ms% 250> "+" / <wav 2> "gc-32-p" / <ms% 500> / <wav
2> "lv-32-p" / <ms% 500> / <wav 2> "lv-32-c" * /;

-22112432 <ms% 250> "+" / <wav 2> "gc-32-p" / <ms% 500> / <wav
2> "sg-32-p" / <ms% 500> / <wav 2> "sg-32-c" * /;

+11211433 <ms% 250> "+" / <wav 2> "sg-33-p" / <ms% 500> / <wav
2> "lv-33-p" / <ms% 500> / <wav 2> "sg-33-c" * /;

-22113433 <ms% 250> "+" / <wav 2> "lv-33-p" / <ms% 500> / <wav
2> "gc-33-p" / <ms% 500> / <wav 2> "gc-33-c" * /;

+12122433 <ms% 250> "+" / <wav 2> "gc-33-p" / <ms% 500> / <wav
2> "sg-33-p" / <ms% 500> / <wav 2> "gc-33-c" * /;

+11213435 <ms% 250> "+" / <wav 2> "gc-35-p" / <ms% 500> / <wav
2> "lv-35-p" / <ms% 500> / <wav 2> "gc-35-c" * /;

-21222435 <ms% 250> "+" / <wav 2> "sg-35-p" / <ms% 500> / <wav
2> "gc-35-p" / <ms% 500> / <wav 2> "gc-35-c" * /;

+12121435 <ms% 250> "+" / <wav 2> "lv-35-p" / <ms% 500> / <wav
2> "sg-35-p" / <ms% 500> / <wav 2> "lv-35-c" * /;

+11213436 <ms% 250> "+" / <wav 2> "gc-36-p" / <ms% 500> / <wav
2> "lv-36-p" / <ms% 500> / <wav 2> "gc-36-c" * /;

-21222436 <ms% 250> "+" / <wav 2> "sg-36-p" / <ms% 500> / <wav
2> "gc-36-p" / <ms% 500> / <wav 2> "gc-36-c" * /;
```

```
-22111436 <ms% 250> "+" / <wav 2> "lv-36-p" / <ms% 500> / <wav 2> "sg-36-p" / <ms% 500> / <wav 2> "sg-36-c" * /;

+11212437 <ms% 250> "+" / <wav 2> "sg-37-p" / <ms% 500> / <wav 2> "gc-37-p" / <ms% 500> / <wav 2> "sg-37-c" * /;

-21221437 <ms% 250> "+" / <wav 2> "sg-37-p" / <ms% 500> / <wav 2> "lv-37-p" / <ms% 500> / <wav 2> "lv-37-c" * /;

+12123437 <ms% 250> "+" / <wav 2> "lv-37-p" / <ms% 500> / <wav 2> "gc-37-p" / <ms% 500> / <wav 2> "lv-37-c" * /;

-22113439 <ms% 250> "+" / <wav 2> "lv-39-p" / <ms% 500> / <wav 2> "gc-39-p" / <ms% 500> / <wav 2> "gc-39-c" * /;

+12121439 <ms% 250> "+" / <wav 2> "lv-39-p" / <ms% 500> / <wav 2> "sg-39-p" / <ms% 500> / <wav 2> "lv-39-c" * /;

+12122439 <ms% 250> "+" / <wav 2> "gc-39-p" / <ms% 500> / <wav 2> "sg-39-p" / <ms% 500> / <wav 2> "gc-39-c" * /;

+11211442 <ms% 250> "+" / <wav 2> "sg-42-p" / <ms% 500> / <wav 2> "lv-42-p" / <ms% 500> / <wav 2> "sg-42-c" * /;

-21223442 <ms% 250> "+" / <wav 2> "gc-42-p" / <ms% 500> / <wav 2> "lv-42-p" / <ms% 500> / <wav 2> "lv-42-c" * /;

-22112442 <ms% 250> "+" / <wav 2> "gc-42-p" / <ms% 500> / <wav 2> "sg-42-p" / <ms% 500> / <wav 2> "sg-42-c" * /;

\

0 <line -1> "The End...thank you very much for participating", <line 1> "Please call the experimenter. お疲れ様でした。これでこのタスクは終わりです。小島を呼んでください。", <line 2> "[Experimenter: Press Esc to Save the data]";
```

(2) Lexical Decision Task

```
<ep> <azk> <NumberOfItems 198> <scramble 66> <ContinuousRun> <Delay 158> <FrameDuration 250> <Timeout 2200> <id "Keyboard"> <mr +Space> <MapNegativeResponse "+Left Alt"> <MapPositiveResponse "+Right Alt"> <vm 1024,768,768,32,0> <eop>

$
```

0 <line -9> "Instructions (はじめに)", <line -8> "You will hear short *words* that may or may not be real words in Japanese"**, <line -6>** "if it is a real existing word in Japanese, press the **RIGHT (yes) key", <line -5>** "Press the **LEFT (no) key** if what you hear is **NOT** a real word in Japanese."**, <line -3>** " **Please answer *as accurately and as QUICKLY*** as possible."**, <line -1>** "Press **SPACEBAR** to start a short practice with feedback"**, <line 1>** "これから、音声ファイルを聞いていただきます。"**, <line 3>** "日本語の単語の時は**右 YES ボタン**を"**, <line 4> "日本語でない時は左 NO ボタンを押してください。", <line 6> "音声を聞いて、できるかぎり正確に、早く、ボタンを押してください。", <line 7> "スペースバー**を押すと短い練習セッションが始まります。"**;**

999 <ms% 2000> "+" /;

$

+11201001 <cfb "○"> <wfb " × "> <tlfb "Too slow もう少し早く"> <wav 2> "migi" * /;

+11301002 <cfb "○"> <wfb " × "> <tlfb "Too slow もう少し早く"> <wav 2> "sakana" * /;

+11401003 <cfb "○"> <wfb " × "> <tlfb "Too slow もう少し早く"> <wav 2> "wasureru" * /;

+11501004 <cfb "○"> <wfb " × "> <tlfb "Too slow もう少し早く"> <wav 2> "atatakai" * /;

+11201005 <cfb "○"> <wfb " × "> <tlfb "Too slow もう少し早く"> <wav 2> "tsuku" * /;

-11201006 <cfb "○"> <wfb " × "> <tlfb "Too slow もう少し早く"> <wav 2> "odo" * /;

-11301007 <cfb "○"> <wfb " × "> <tlfb "Too slow もう少し早く"> <wav 2> "shugoto" * /;

-11401008 <cfb "○"> <wfb " × "> <tlfb "Too slow もう少し早く"> <wav 2> "gankoku" * /;

-11501009 <cfb "○"> <wfb " × "> <tlfb "Too slow もう少し早く"> <wav 2>

```
"zanposuru" * /;

-11301010 <cfb "○"> <wfb " ✕ "> <tlfb "Too slow もう少し早く"> <wav 2> "gowai"
* /;


$
0 <line -3> "Ready for the real experiment? The feedback is now turned off",
<line -1> "Respond as fast as you can without making mistakes", <line 1> "If you
make a mistake, don't worry and keep going!", <line 2> "ここから実際の実験がはじまります。正
解、不正解などのフィードバックはありません。", <line 3> "間違わずになるべく早く答えてください。間
違えても気にせず、どんどん次に進んでください。", <line 4>"...press SPACEBAR when
ready",<line 6> "準備ができたら、スペースバーを押して実験を開始してください。";


999 <nfb> <ms% 2000>  /;
$


\
+11112101   <wav 2> "sg1-p" * /;
+11111104   <wav 2> "sg4-c" * /;
+11112107   <wav 2> "sg7-p" * /;
+11111110   <wav 2> "sg10-c" * /;
+11221201   <wav 2> "lv1-c" * /;
+11222204   <wav 2> "lv4-p" * /;
+11221207   <wav 2> "lv7-c" * /;
+11222210   <wav 2> "lv10-p" * /;
+11332301   <wav 2> "gc1-p" * /;
+11331304   <wav 2> "gc4-c" * /;
+11332307   <wav 2> "gc7-p" * /;
+11331310   <wav 2> "gc10-c" * /;
-81312103   <wav 2> "sg3-G-p" * /;
-81311106   <wav 2> "sg6-G-c" * /;
-81312109   <wav 2> "sg9-G-p" * /;
-81311112   <wav 2> "sg12-G-c" * /;
```

```
-81121203   <wav 2> "lv3-S-c" * /;
-81122206   <wav 2> "lv6-S-p" * /;
-81121209   <wav 2> "lv9-S-c" * /;
-81122212   <wav 2> "lv12-S-p" * /;
-81132303   <wav 2> "gc3-S-p" * /;
-81131306   <wav 2> "gc6-S-c" * /;
-81132309   <wav 2> "gc9-S-p" * /;
-81131312   <wav 2> "gc12-S-c" * /;
-81211102   <wav 2> "sg2-L-c" * /;
-81212105   <wav 2> "sg5-L-p" * /;
-81211108   <wav 2> "sg8-L-c" * /;
-81212111   <wav 2> "sg11-L-p" * /;
-81322202   <wav 2> "lv2-G-p" * /;
-81321205   <wav 2> "lv5-G-c" * /;
-81322208   <wav 2> "lv8-G-p" * /;
-81321211   <wav 2> "lv11-G-c" * /;
-81231302   <wav 2> "gc2-L-c" * /;
-81232305   <wav 2> "gc5-L-p" * /;
-81231308   <wav 2> "gc8-L-c" * /;
-81232311   <wav 2> "gc11-L-p" * /;
+11205006   <wav 2> "dasu" * /;
+11205009   <wav 2> "batsu" * /;
+11205016   <wav 2> "imi" * /;
+11205019   <wav 2> "migi" * /;
+11305002   <wav 2> "akai" * /;
+11305005   <wav 2> "nanika" * /;
+11305008   <wav 2> "shashin" * /;
+11305038   <wav 2> "soshite" * /;
+11405001   <wav 2> "omiyage" * /;
-81205010   <wav 2> "nune" * /;
-81205013   <wav 2> "rushi" * /;
-81205016   <wav 2> "ami" * /;
```

```
-81205019   <wav 2> "nigi" * /;
-81305002   <wav 2> "agai" * /;
-81305005   <wav 2> "manika" * /;
-81305024   <wav 2> "hitari" * /;
-81305038   <wav 2> "soshute" * /;
-81405001   <wav 2> "oniyage" * /;
+11205005   <wav 2> "tada" * /;
+11205010   <wav 2> "mune" * /;
+11205011   <wav 2> "mochi" * /;
+11205012   <wav 2> "yaku" * /;
+11205013   <wav 2> "rishi" * /;
+11305011   <wav 2> "hanasu" * /;
+11305012   <wav 2> "taberu" * /;
+11305013   <wav 2> "kisetsu" * /;
+11305014   <wav 2> "rekishi" * /;
+11305015   <wav 2> "odoru" * /;
+11305016   <wav 2> "eiga" * /;
+11305017   <wav 2> "totemo" * /;
$
0 <line -2> "Take a break…press SPACEBAR when ready.", <line 0> "ここで休憩してください。次のセクションへ進む準備ができたらスペースバーを押してください。";

999 <ms% 2000> "+" /;
$
+12111102   <wav 2> "sg2-c" * /;
+12112105   <wav 2> "sg5-p" * /;
+12111108   <wav 2> "sg8-c" * /;
+12112111   <wav 2> "sg11-p" * /;
+12222202   <wav 2> "lv2-p" * /;
+12221205   <wav 2> "lv5-c" * /;
+12222208   <wav 2> "lv8-p" * /;
+12221211   <wav 2> "lv11-c" * /;
```

```
+12331302   <wav 2> "gc2-c" * /;
+12332305   <wav 2> "gc5-p" * /;
+12331308   <wav 2> "gc8-c" * /;
+12332311   <wav 2> "gc11-p" * /;
-82312101   <wav 2> "sg1-G-p" * /;
-82311104   <wav 2> "sg4-G-c" * /;
-82312107   <wav 2> "sg7-G-p" * /;
-82311110   <wav 2> "sg10-G-c" * /;
-82121201   <wav 2> "lv1-S-c" * /;
-82122204   <wav 2> "lv4-S-p" * /;
-82121207   <wav 2> "lv7-S-c" * /;
-82122210   <wav 2> "lv10-S-p" * /;
-82132301   <wav 2> "gc1-S-p" * /;
-82131304   <wav 2> "gc4-S-c" * /;
-82132307   <wav 2> "gc7-S-p" * /;
-82131310   <wav 2> "gc10-S-c" * /;
-82212103   <wav 2> "sg3-L-p" * /;
-82211106   <wav 2> "sg6-L-c" * /;
-82212109   <wav 2> "sg9-L-p" * /;
-82211112   <wav 2> "sg12-L-c" * /;
-82321203   <wav 2> "lv3-G-c" * /;
-82322206   <wav 2> "lv6-G-p" * /;
-82321209   <wav 2> "lv9-G-c" * /;
-82322212   <wav 2> "lv12-G-p" * /;
-82232303   <wav 2> "gc3-L-p" * /;
-82231306   <wav 2> "gc6-L-c" * /;
-82232309   <wav 2> "gc9-L-p" * /;
-82231312   <wav 2> "gc12-L-c" * /;
+12205007   <wav 2> "tobu" * /;
+12205014   <wav 2> "ashi" * /;
+12205017   <wav 2> "esa" * /;
+12205020   <wav 2> "kuru" * /;
```

```
+12305003   <wav 2> "honya" * /;
+12305006   <wav 2> "otera" * /;
+12305009   <wav 2> "densha" * /;
+12305039   <wav 2> "omise" * /;
+12405002   <wav 2> "ongaku" * /;
-82205011   <wav 2> "nochi" * /;
-82205014   <wav 2> "achi" * /;
-82205017   <wav 2> "eza" * /;
-82205020   <wav 2> "muru" * /;
-82305003   <wav 2> "bonya" * /;
-82305006   <wav 2> "odera" * /;
-82305025   <wav 2> "tengi" * /;
-82305039   <wav 2> "omize" * /;
-82405002   <wav 2> "ongaku" * /;
+12305018   <wav 2> "kowai" * /;
+12305019   <wav 2> "tsukue" * /;
+12305020   <wav 2> "gohan" * /;
+12305021   <wav 2> "tegami" * /;
+12305022   <wav 2> "wakaru" * /;
+12305023   <wav 2> "dakara" * /;
+12305024   <wav 2> "hidari" * /;
+12305025   <wav 2> "tenki" * /;
+12305026   <wav 2> "megane" * /;
+12305027   <wav 2> "kuruma" * /;
+12305028   <wav 2> "kazoku" * /;
+12305029   <wav 2> "shigoto" * /;
```

$

```
0 <line -2> "Take a break…press SPACEBAR when ready.", <line 0> "ここで休憩してください。次のセクションへ進む準備ができたらスペースバーを押してください。";
```

```
999 <ms% 2000> "+" /;
```

```
$
+13112103   <wav 2> "sg3-p" * /;
+13111106   <wav 2> "sg6-c" * /;
+13112109   <wav 2> "sg9-p" * /;
+13111112   <wav 2> "sg12-c" * /;
+13221203   <wav 2> "lv3-c" * /;
+13222206   <wav 2> "lv6-p" * /;
+13221209   <wav 2> "lv9-c" * /;
+13222212   <wav 2> "lv12-p" * /;
+13332303   <wav 2> "gc3-p" * /;
+13331306   <wav 2> "gc6-c" * /;
+13332309   <wav 2> "gc9-p" * /;
+13331312   <wav 2> "gc12-c" * /;
-83311102   <wav 2> "sg2-G-c" * /;
-83312105   <wav 2> "sg5-G-p" * /;
-83311108   <wav 2> "sg8-G-c" * /;
-83312111   <wav 2> "sg11-G-p" * /;
-83122202   <wav 2> "lv2-S-p" * /;
-83121205   <wav 2> "lv5-S-c" * /;
-83122208   <wav 2> "lv8-S-p" * /;
-83121211   <wav 2> "lv11-S-c" * /;
-83131302   <wav 2> "gc2-S-c" * /;
-83132305   <wav 2> "gc5-S-p" * /;
-83131308   <wav 2> "gc8-S-c" * /;
-83132311   <wav 2> "gc11-S-p" * /;
-83212101   <wav 2> "sg1-L-p" * /;
-83211104   <wav 2> "sg4-L-c" * /;
-83212107   <wav 2> "sg7-L-p" * /;
-83211110   <wav 2> "sg10-L-c" * /;
-83321201   <wav 2> "lv1-G-c" * /;
-83322204   <wav 2> "lv4-G-p" * /;
-83321207   <wav 2> "lv7-G-c" * /;
```

```
-83322210   <wav 2> "lv10-G-p" * /;
-83232301   <wav 2> "gc1-L-p" * /;
-83231304   <wav 2> "gc4-L-c" * /;
-83232307   <wav 2> "gc7-L-p" * /;
-83231310   <wav 2> "gc10-L-c" * /;
+13205008   <wav 2> "nodo" * /;
+13205015   <wav 2> "isu" * /;
+13205018   <wav 2> "oto" * /;
+13305001   <wav 2> "sakana" * /;
+13305004   <wav 2> "atama" * /;
+13305007   <wav 2> "yoyaku" * /;
+13305010   <wav 2> "ryokou" * /;
+13305040   <wav 2> "otoko" * /;
+13405003   <wav 2> "takusan" * /;
-83205012   <wav 2> "yagu" * /;
-83205015   <wav 2> "ishu" * /;
-83205018   <wav 2> "odo" * /;
-83305001   <wav 2> "sagana" * /;
-83305004   <wav 2> "nadama" * /;
-83305023   <wav 2> "dagara" * /;
-83305026   <wav 2> "megame" * /;
-83305040   <wav 2> "odoko" * /;
-83405003   <wav 2> "takuzan" * /;
+13305030   <wav 2> "tango" * /;
+13305031   <wav 2> "shiken" * /;
+13305032   <wav 2> "byouki" * /;
+13305033   <wav 2> "wakai" * /;
+13305034   <wav 2> "tokoya" * /;
+13305035   <wav 2> "ringo" * /;
+13305036   <wav 2> "hayaku" * /;
+13305037   <wav 2> "okashi" * /;
+13405004   <wav 2> "tabemono" * /;
```

```
+13405005    <wav 2> "yasumi" * /;

+13405006    <wav 2> "donna" * /;

+13405007    <wav 2> "suwaru" * /;

\
```

```
0 <line -4> "The End...thank you for participating",  <line -2> "お疲れ様でした。これでこの実験は終了です。", <line 0> "Please call the experimenter!", <line 2> "小島を呼んでください。実験にご参加いただき、まことにありがとうございました。", <line 4> "[Experimenter: Press Esc to Save the data]";
```

(3) Forced Lexical Choice (FLeC)

```
<ep> <azk> <NumberOfItems 72> <scramble 36> <ContinuousRun> <Delay 158> <FrameDuration 250> <Timeout 5000> <id "Keyboard"> <mr +Space> <MapNegativeResponse "+Right Alt"> <MapPositiveResponse "+Left Alt">  <vm 640,480,480,8,0> <eop>
```

```
$

0 <line -8> "Instructions",<line -6> "You will hear 2 items in a row. ", <line -4> "You have to  decide which one is a real JAPANESE word ",<line -2> "Please press the LEFT (1) or the RIGHT (2) button as quickly as possible,",<line 0> "Press LEFT if you think that the first one is the Japanese word ",<line 2> "and Press RIGHT if you think that the the second one is the Japanese word",<line 4> "Press SPACEBAR to start with a short practice.";
```

```
0 <line -10> "はじめに",<line -6> "このタスクは連続して2つの刺激音を聞いていただいた後、",<line -4> "どちらが日本語の単語か判断していただくものです。", <line 2> "最初のものが日本語の単語だと思ったら左 (1) キーを、",<line 4> "2番目の音声が日本語の単語だと思ったら右(2) キーをできるだけ早く押してください。", <line 8> "スペースバーを押すと短い練習セクションが始まります。";
```

```
999 <ms% 2000> "+"  /;

$
```

```
-11201006 <cfb "○"> <wfb " ✕ "> <tlfb "Too slow もう少し早く"> <ms% 500> "+"
```

/ * <wav 2> "achi_NW" / <ms% 1000> / <wav 2> "akai_W" /;

+11301007 <cfb "○"> <wfb "×"> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / * <wav 2> "dasu_W" / <ms% 1000> / <wav 2> "dazu_NW" /;

-11401008 <cfb "○"> <wfb "×"> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / * <wav 2> "keka_NW" / <ms% 1000> / <wav 2> "kesa_W" /;

+11501009 <cfb "○"> <wfb "×"> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / * <wav 2> "kesa_W" / <ms% 1000> / <wav 2> "dazu_NW" /;

-11301010 <cfb "○"> <wfb "×"> <tlfb "Too slow もう少し早く"> <ms% 500> "+" / * <wav 2> "keka_NW" / <ms% 1000> / <wav 2> "akai_W" /;

$

0 <line -3> "**Ready for the real experiment?** The feedback is now turned off",

<line -1> "Respond **as fast as you can without making mistakes**", <line 1> "If you make a mistake, don't worry and keep going!", <line 2> "**ここから実際の実験がはじまります。**正解、不正解などのフィードバックはありません。", <line 3> "**間違わずになるべく早く答えてください。**間違えても気にせず、どんどん次に進んでください。", <line 4>"**...press SPACEBAR when ready**",<line 6> "準備ができたら、**スペースバー**を押して実験を開始してください。";

999 <nfb> <ms% 2000> /;

$

****

+113101 <ms% 300> "+" / * <wav 2> "gc1-c" / <ms% 1000> / <wav 2> "gc1-S-p" /;

+113111 <ms% 300> "+" / * <wav 2> "gc11-p" / <ms% 1000> / <wav 2> "gc11-S-c" /;

+113202 <ms% 300> "+" / * <wav 2> "gc2-p" / <ms% 1000> / <wav 2> "gc2-L-c" /;

+113204 <ms% 300> "+" / * <wav 2> "gc4-c" / <ms% 1000> / <wav 2> "gc4-L-p" /;

+113206 <ms% 300> "+" / * <wav 2> "gc6-p" / <ms% 1000> / <wav

```
2> "gc6-L-c"  /;

+113208   <ms% 300> "+" / * <wav 2> "gc8-c" / <ms% 1000> / <wav
2> "gc8-L-p"  /;

+112101   <ms% 300> "+" / * <wav 2> "lv1-c" / <ms% 1000> / <wav
2> "lv1-S-p"  /;

+112111   <ms% 300> "+" / * <wav 2> "lv11-p" / <ms% 1000> / <wav
2> "lv11-S-c"  /;

+112302   <ms% 300> "+" / * <wav 2> "lv2-p" / <ms% 1000> / <wav
2> "lv2-G-c"  /;

+112304   <ms% 300> "+" / * <wav 2> "lv4-c" / <ms% 1000> / <wav
2> "lv4-G-p"  /;

+112306   <ms% 300> "+" / * <wav 2> "lv6-p" / <ms% 1000> / <wav
2> "lv6-G-c"  /;

+112308   <ms% 300> "+" / * <wav 2> "lv8-c" / <ms% 1000> / <wav
2> "lv8-G-p"  /;

+111301   <ms% 300> "+" / * <wav 2> "sg1-c" / <ms% 1000> / <wav
2> "sg1-G-p"  /;

+111311   <ms% 300> "+" / * <wav 2> "sg11-p" / <ms% 1000> / <wav
2> "sg11-G-c"  /;

+111202   <ms% 300> "+" / * <wav 2> "sg2-p" / <ms% 1000> / <wav
2> "sg2-L-c"  /;

+111204   <ms% 300> "+" / * <wav 2> "sg4-c" / <ms% 1000> / <wav
2> "sg4-L-p"  /;

+111206   <ms% 300> "+" / * <wav 2> "sg6-p" / <ms% 1000> / <wav
2> "sg6-L-c"  /;

+111208   <ms% 300> "+" / * <wav 2> "sg8-c" / <ms% 1000> / <wav
2> "sg8-L-p"  /;

-213110   <ms% 300> "+" / * <wav 2> "gc10-S-p" / <ms% 1000> /
<wav 2> "gc10-c"  /;

-213112   <ms% 300> "+" / * <wav 2> "gc12-S-c" / <ms% 1000> /
<wav 2> "gc12-p"  /;

-213203   <ms% 300> "+" / * <wav 2> "gc3-L-p" / <ms% 1000> /
<wav 2> "gc3-c"  /;

-213205   <ms% 300> "+" / * <wav 2> "gc5-L-c" / <ms% 1000> /
```

```
<wav 2> "gc5-p"  /;

-213207   <ms% 300> "+" / * <wav 2> "gc7-L-p" / <ms% 1000> /
<wav 2> "gc7-c"  /;

-213209   <ms% 300> "+" / * <wav 2> "gc9-L-c" / <ms% 1000> /
<wav 2> "gc9-p"  /;

-212110   <ms% 300> "+" / * <wav 2> "lv10-S-p" / <ms% 1000> /
<wav 2> "lv10-c"  /;

-212112   <ms% 300> "+" / * <wav 2> "lv12-S-c" / <ms% 1000> /
<wav 2> "lv12-p"  /;

-212303   <ms% 300> "+" / * <wav 2> "lv3-G-p" / <ms% 1000> /
<wav 2> "lv3-c"  /;

-212305   <ms% 300> "+" / * <wav 2> "lv5-G-c" / <ms% 1000> /
<wav 2> "lv5-p"  /;

-212307   <ms% 300> "+" / * <wav 2> "lv7-G-p" / <ms% 1000> /
<wav 2> "lv7-c"  /;

-212309   <ms% 300> "+" / * <wav 2> "lv9-G-c" / <ms% 1000> /
<wav 2> "lv9-p"  /;

-211310   <ms% 300> "+" / * <wav 2> "sg10-G-p" / <ms% 1000> /
<wav 2> "sg10-c"  /;

-211312   <ms% 300> "+" / * <wav 2> "sg12-G-c" / <ms% 1000> /
<wav 2> "sg12-p"  /;

-211203   <ms% 300> "+" / * <wav 2> "sg3-L-p" / <ms% 1000> /
<wav 2> "sg3-c"  /;

-211205   <ms% 300> "+" / * <wav 2> "sg5-L-c" / <ms% 1000> /
<wav 2> "sg5-p"  /;

-211207   <ms% 300> "+" / * <wav 2> "sg7-L-p" / <ms% 1000> /
<wav 2> "sg7-c"  /;

-211209   <ms% 300> "+" / * <wav 2> "sg9-L-c" / <ms% 1000> /
<wav 2> "sg9-p"  /;


$

0 <line -2> "Take a break…press SPACEBAR when ready.", <line 0> "ここで休憩してください。次のセクションへ進む準備ができたらスペースバーを押してください。";

999 <ms% 2000> "+" /;
```

```
$

+123210          <ms% 300> "+" / * <wav 2> "gc10-p" / <ms% 1000>
/ <wav 2> "gc10-L-c"  /;

+123212          <ms% 300> "+" / * <wav 2> "gc12-c" / <ms% 1000>
/ <wav 2> "gc12-L-p"  /;

+123103          <ms% 300> "+" / * <wav 2> "gc3-p" / <ms% 1000> /
<wav 2> "gc3-S-c"  /;

+123105          <ms% 300> "+" / * <wav 2> "gc5-c" / <ms% 1000> /
<wav 2> "gc5-S-p"  /;

+123107          <ms% 300> "+" / * <wav 2> "gc7-p" / <ms% 1000> /
<wav 2> "gc7-S-c"  /;

+123109          <ms% 300> "+" / * <wav 2> "gc9-c" / <ms% 1000> /
<wav 2> "gc9-S-p"  /;

+122310          <ms% 300> "+" / * <wav 2> "lv10-p" / <ms% 1000>
/ <wav 2> "lv10-G-c"  /;

+122312          <ms% 300> "+" / * <wav 2> "lv12-c" / <ms% 1000>
/ <wav 2> "lv12-G-p"  /;

+122103          <ms% 300> "+" / * <wav 2> "lv3-p" / <ms% 1000> /
<wav 2> "lv3-S-c"  /;

+122105          <ms% 300> "+" / * <wav 2> "lv5-c" / <ms% 1000> /
<wav 2> "lv5-S-p"  /;

+122107          <ms% 300> "+" / * <wav 2> "lv7-p" / <ms% 1000> /
<wav 2> "lv7-S-c"  /;

+122109          <ms% 300> "+" / * <wav 2> "lv9-c" / <ms% 1000> /
<wav 2> "lv9-S-p"  /;

+121210          <ms% 300> "+" / * <wav 2> "sg10-p" / <ms% 1000>
/ <wav 2> "sg10-L-c"  /;

+121212          <ms% 300> "+" / * <wav 2> "sg12-c" / <ms% 1000>
/ <wav 2> "sg12-L-p"  /;

+121303          <ms% 300> "+" / * <wav 2> "sg3-p" / <ms% 1000> /
<wav 2> "sg3-G-c"  /;

+121305          <ms% 300> "+" / * <wav 2> "sg5-c" / <ms% 1000> /
<wav 2> "sg5-G-p"  /;
```

```
+121307         <ms% 300> "+" / * <wav 2> "sg7-p" / <ms% 1000> /
<wav 2> "sg7-G-c"  /;

+121309         <ms% 300> "+" / * <wav 2> "sg9-c" / <ms% 1000> /
<wav 2> "sg9-G-p"  /;

-223201         <ms% 300> "+" / * <wav 2> "gc1-L-c" / <ms% 1000>
/ <wav 2> "gc1-p"  /;

-223211         <ms% 300> "+" / * <wav 2> "gc11-L-p" / <ms%
1000> / <wav 2> "gc11-c"  /;

-223102         <ms% 300> "+" / * <wav 2> "gc2-S-p" / <ms% 1000>
/ <wav 2> "gc2-c"  /;

-223104         <ms% 300> "+" / * <wav 2> "gc4-S-c" / <ms% 1000>
/ <wav 2> "gc4-p"  /;

-223106         <ms% 300> "+" / * <wav 2> "gc6-S-p" / <ms% 1000>
/ <wav 2> "gc6-c"  /;

-223108         <ms% 300> "+" / * <wav 2> "gc8-S-c" / <ms% 1000>
/ <wav 2> "gc8-p"  /;

-222301         <ms% 300> "+" / * <wav 2> "lv1-G-c" / <ms% 1000>
/ <wav 2> "lv1-p"  /;

-222311         <ms% 300> "+" / * <wav 2> "lv11-G-p" / <ms%
1000> / <wav 2> "lv11-c"  /;

-222102         <ms% 300> "+" / * <wav 2> "lv2-S-p" / <ms% 1000>
/ <wav 2> "lv2-c"  /;

-222104         <ms% 300> "+" / * <wav 2> "lv4-S-c" / <ms% 1000>
/ <wav 2> "lv4-p"  /;

-222106         <ms% 300> "+" / * <wav 2> "lv6-S-p" / <ms% 1000>
/ <wav 2> "lv6-c"  /;

-222108         <ms% 300> "+" / * <wav 2> "lv8-S-c" / <ms% 1000>
/ <wav 2> "lv8-p"  /;

-221201         <ms% 300> "+" / * <wav 2> "sg1-L-c" / <ms% 1000>
/ <wav 2> "sg1-p"  /;

-221211         <ms% 300> "+" / * <wav 2> "sg11-L-p" / <ms%
1000> / <wav 2> "sg11-c"  /;

-221302         <ms% 300> "+" / * <wav 2> "sg2-G-p" / <ms% 1000>
/ <wav 2> "sg2-c"  /;
```

```
-221304          <ms% 300> "+" / * <wav 2> "sg4-G-c" / <ms% 1000>
/ <wav 2> "sg4-p"  /;

-221306          <ms% 300> "+" / * <wav 2> "sg6-G-p" / <ms% 1000>
/ <wav 2> "sg6-c"  /;

-221308          <ms% 300> "+" / * <wav 2> "sg8-G-c" / <ms% 1000>
/ <wav 2> "sg8-p"  /;


\


0 <line -4> "The End...thank you for participating",  <line -2> "お疲れ様でした。これでこの実験は終了です。", <line 0> "Please call the experimenter!", <line 2> "小島を呼んでください。実験にご参加いただき、まことにありがとうございました。", <line 4> "[Experimenter: Press Esc to Save the data]";
```

Chisato Kojima

Department of Chinese and Japanese
Grinnell College
1303 Park Street, Faculty House
Grinnell, Iowa, 50112, U.S. A.
E-mail: kojimac@grinnell.edu

EDUCATION

2019	Ph. D	Linguistics, Indiana University, Bloomington, Indiana, U.S.A.
2008	M.A.	Linguistics, Indiana University Bloomington, Indiana, U.S.A.
2002	M.A.	Linguistics, Sophia University, Tokyo, Japan
2000	B.A.	Linguistics, Tokyo Woman's Christian University, Tokyo, Japan
1998	A.A.	English, St, Margaret's Junior College, Tokyo, Japan

PROFESSIONAL APPOINTMENTS

2016 - Present	Visiting Instructor at Department of Chinese and Japanese, Grinnell College
2013 - 2016	Visiting Instructor at Department of the Asian Studies, Knox College
2007 - 2013	Associate Instructor at the Department of East Asian Languages and Cultures, Indiana University, Bloomington
2003 - 2006	Part-time Lecturer at the Department of Humanities and Social Sciences, Tokyo Metropolitan University
2005 - 2006	Part-time Lecturer at the Department of Social-Human Environmentology, Daito Bunka University

PUBLICATIONS

Darcy, I., Daidone, D., and Kojima, C. (2015). Asymmetric lexical access and fuzzy lexical representations in second language learners. Republished in Phonological and Phonetic Considerations of Lexical Processing: 119-168, edited by Jarema, G., and Libben G, John Benjamin Publishing Company, Amsterdam, Netherlands.

Darcy, I., Daidone, D., and Kojima, C. (2013). Asymmetric lexical access and fuzzy lexical representations in second language learners. *The Mental Lexicon* 8 (3): 372-420, John] Benjamin Publishing Company, Amsterdam, Netherlands.

Kojima, C. (2005). Word Formation by Means of Mutation and Homophony. *The Journal of Social Sciences and Humanities (JINBUN GAKUHO)* 364, *Studies in English Language and Literature*: 89 - 104, The Faculty of Social Sciences and Humanities of Tokyo Metropolitan University, Tokyo, Japan.

Kojima, C. (2004). OCP in the Derived Environment. *Phonological Studies* 7: 1 - 10, Kaitaku-sha, Tokyo, Japan.

Kojima, C. (2003). An Analysis of *ru-kotoba* and its Theoretical Implication. *Phonological Studies* 6: 21-30, Kaitaku-sha, Tokyo, Japan.

PROCEEDINGS

Kojima, C., and Darcy, I. (2014). Learners' Proficiency and Lexical Encoding of the Geminate / Non-geminate Contrast in Japanese. Online proceedings of the 31st Second Language Research Forum (SLRF) pp. 30-38. Selected Proceedings of the 2012 Second Language Research Forum: Building Bridges between Disciplines. Edited by Ryan T. Miller, Katherine I. Martin, Chelsea M. Eddington, Ashlie Henery, Nausica Marcos Miguel, Alison M. Tseng, Alba Tuninetti, and Daniel Walter

Kojima, C. (2012). Learners' lexical encoding of the geminate / non-geminate contrast in Japanese and its implications. Online Proceedings of Princeton Japanese Pedagogy Forum (PJPF: 254 - 269). http://www.princeton.edu/pjpf/past/19th-pjpf/

AWARDS

2012 Nominee for Midwestern Association of Graduate Schools (MAGS) Excellence in Teaching Award

GRANTS

2014 Knox College Conference Travel Allocation, Knox College

2013 Knox College Faculty Travel Funds, Knox College

2012 College of Arts and Sciences graduate Student Travel Award, Indiana University, Bloomington

2012 Graduate Student Travel Grant, Department of Linguistics, Indiana University Bloomington

2012 Student Travel Grant, East Asian Language Center, Indiana University, Bloomington

2012 Princeton Japanese Pedagogy Forum Graduate Student Travel Grant, Princeton University

2011 Householder Research Fund, Department of Linguistics, Indiana University, Bloomington

PRESENTATIONS

Kojima, C. (2018). Bridging Research and Practice: Japanese Language Teaching and Second Language Acquisition, Grinnell College East Asian Studies Colloquium, Grinnell, IA, November 27, 2018,

Kojima, C. (2018). On Asymmetric Lexical Encoding in L2 Japanese Acquisition. Invited poster session for a workshop on Second Language Psycholinguistics, Bloomington, IN, November 9 - 10, 2018.

Kojima, C. (2016). Analyzing Asymmetries in the Lexical Encoding of L2 Phonemic Length. Paper Presentation accepted for the Second Language Research Forum, New York, NY, September 22-25.

Kojima, C. and Darcy, I. (2014). Asymmetric Perception of Consonantal and Vocalic Durational Contrast as L2 Category. Paper presentation accepted for the Second Language Research Forum, Columbia, South Carolina, October 23-25, 2014.

Kojima, C. (2013). Lexical encoding of geminate consonants by advanced learners of Japanese. Poster Presentation accepted for the Second Language Research Forum, Pittsburgh, PA, October 18 -21.

Kojima, C. (2013). Japanese Linguistics 101. World Language Festival 2013, Indiana University, Bloomington, IN.

Kojima, C. (2013). Girls in the forest and new father figures: fashion and lifestyles in Japan. World Language Festival 2013, Indiana University, Bloomington, IN.

Kojima, C. (2013) Lexical encoding of geminate consonants by advanced learners of Japanese. Poster Presentation accepted for the 87th Annual Meeting of the Linguistic Society of America (LSA), Boston, MA, January 3 -6, 2013.

Kojima, C. and Darcy, I. (2012). Learners' Proficiency and Lexical Encoding of the Geminate / Non-geminate Contrast in Japanese. Paper presentation accepted for the Second Language Research Forum, Pittsburgh, PA, October 18-21.

Darcy, I. and Daidone, D. and Kojima, C. (2012). Asymmetric Lexical Access in Second Language Learners. Poster presentation accepted for the 8th International Conference on the Mental Lexicon, Montreal, Canada, October 24-26.

Kojima, C. (2012). Learners' lexical encoding of the geminate / non-geminate contrast in Japanese and its implications.19th Princeton Japanese Pedagogy Forum, May 20th, 2012, Princeton, NJ.

Kojima, C. (2012). Learners' lexical encoding of the geminate / non-geminate contrast in Japanese and its Implications. 6th Annual Linguistic Department Graduate Student Conference, April 13th, 2012, Indiana University, Bloomington, IN.

Kojima, C., and Isabelle, D. (2011). Lexical Encoding of the Geminate / Non-geminate Contrast in L2 Japanese by Advanced and Beginning Learners. Second Language Studies Colloquium, November 4th, 2011, Indiana University, Bloomington, IN

Kojima, C. (2011). Lexicalization of the geminate / non-geminate contrast in Japanese by advanced and beginning learners. Oral presentation at 17th Annual Meeting of Mid-Continental Phonetics & Phonology Conference (Formally known as MCWOP), University of Illinois, Urbana-Champaign, IL.

Kojima, C., Mori, Y., Dixon, M., and Shinagawa, Y. (2011). Learn to Introduce Yourself in Japanese. World Language Festival 2011, Indiana University, Bloomington, IN.

Kojima, C., and Mori, Y. (2011). Japanese Linguistics 101. World Language Festival 2011, Indiana University, Bloomington, IN.

Kojima, C. and Honma, T. (2005). Typology of Blending in Japanese. Tokyo Circle of Phonologists (TCP), University of Tokyo, Japan.

Kojima, C., and Sugiyama, T. (2004) On Considerations of Theoretical Framework for Phonological Aphasia. Phonology Forum 2004, Hiroshima Jogakuin University, Hiroshima, Japan.

Kojima, C. (2003). Haplology in Japanese. Phonology Forum 2003, Kobe College, Hyogo, Japan.

Kojima, C. (2002). On Truncation and the Conjugational Suffix /ru/ in Japanese. The 9th Fall Meeting of Phonological Society of Japan, Nihon University, Tokyo, Japan.

TEACHING EXPERIENCE

Grinnell College

Advanced Japanese I (Fall 2016 & Fall 2018)
Advanced Japanese II (Spring 2017 & Spring 2019)
Intermediate Japanese I (Fall 2017)
Intermediate Japanese II (Spring 2018)
Beginning Japanese I (Fall 2016)
Beginning Japanese II (Spring 2019)
Fashion and Lifestyle in Japan (Fall 2018)
Phonology: The Case of Japanese (JPN/EAS/LIN 295)
Japanese Linguistics (Spring 2017)

Knox College

Advanced Reading and Writing (Fall 2014 & Winter 2014)
Second Year Japanese I (Fall 2014)
Second Year Japanese II (Winter 2014)
Second Year Japanese III (Spring 2015)
First Year Japanese I (Fall 2013 &Fall 2015)
First Year Japanese II (Winter 2013 & Winter 2015)
First Year Japanese III (Spring 2014 & Spring 2016)
Introduction to Applied Linguistics (Spring 2015)
Knox College for Kids - Beginning Japanese (Summer 2014)

Indiana University, Bloomington

Elementary Japanese I (Fall 2007, Fall 2008 and Fall 2009)
Elementary Japanese II (Spring 2008, Spring 2009)
Japanese for Advanced Beginners (*instructor of record, Fall 2011)
Second Year Japanese I (Fall 2010 & Fall 2012)
Second Year Japanese II (Spring 2011 & Spring 2013)

Private Japanese language Tutor

JLPT N2 Level (* in person: Fall 2012 - Spring 2013)
Genki I & II (*online: Summer 2011 - Spring 2012)

Tokyo Metropolitan University

English I (Academic year of 2003 and 2004)
English II (Academic year of 2005 and 2006)

Daito Bunka University

Kankyoo Mondai Eigo I “Studying Environmental Issues in English I” (Fall 2015)
Jitsuyou Eigo IV “Practical English IV” (Fall 2015)

SERVICE / COMMUNITY INVOLVEMENT

2013 - 2016 Weekly Japanese Language Table coordinator, Knox College, Galesburg, IL

2013 Volunteer instructor for Kids' Month: The Arts of Japan, Galesburg Civic Arts Center, Galesburg, IL

2012 Session chair for the Second Language Research Forum, Pittsburgh, PA, October 18 - 21.

2012 Japanese Placement Test Grader at the department of East Asian Languages and Cultures, Indiana University, Bloomington

2012 Volunteer translator/transcriber for a movie called "*Kyoo-o Mamoru* - Resilience: Protecting Today".

2011 - 2012 Volunteer translator for webpage of Disaster Relief Network in Hokkaido (DRNH)http://mouth-mountain.greenwebs.net/english/

LANGUAGES

Japanese

Listening: native
Reading: native
Writing: native
Speaking: native

English

Listening: excellent command
Reading: near native
Writing: very good command
Speaking: near native