

Master's Thesis in Graduate School of Library,
Information and Media Studies

A study towards multilingual singable song

March 2021

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多言語で歌唱可能な楽曲に関する研究

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This study proposes a method of singing a song in multiple languages simultaneously by applying the phenomenon of soramimi. So far, there have been songs that incorporate soramimi in their lyrics and research that automatically generates soramimi, but there has been no idea or actual example of singing a song in multiple languages by applying soramimi phenomenon.

The Japanese lyrics of Kyu Sakamoto's "上を向いて歩こう" were converted into English soramimi lyrics using Web Speech API Speech Recognition. International students, whose Japanese is not good, evaluated these soramimi lyrics and confirmed that they sounded original lyrics to some extent, and the results were used to determine the soramimi lyrics to be sung in the next experiment. In the next experiment, participants compare to sing the Japanese lyrics written in romaji and the soramimi lyrics, and the ease of singing the soramimi lyrics was investigated. In the final experiment, soramimi lyrics were created for Chinese and Russian using the same method. Participants who can speak Japanese, English, Russian, and Chinese sang the song "上を向いて歩こう" simultaneously with the soramimi lyrics in each language, and their singing experience was evaluated, thus the possibility of singing a song simultaneously in multiple languages were presented.

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March 2021

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Chapter 1

Introduction

1.1 Background

In Japan, there is a phenomenon called "Soramimi". The original meaning of "Soramimi" is to hear a sound or voice that is not actually there, or to pretend not to hear something even though you hear it, but it is now widely known as a mishearing phenomenon where people hear a word and interpret it as another word. This phenomenon does not only exist in Japan, but can be found in many other languages. In the United States, this phenomenon is known as mondegreen. It is well known that in the lyrics of Jimmy Hendrix's song "Purple Haze", "Excuse me while I kiss the sky" sounds like "Excuse me while I kiss this guy"[1]. In Dutch, this mishearing phenomenon is known as Mama appelsap (meaning Mommy apple juice) and originates from the lyrics of Michael Jackson's song "Wanna Be Startin' Somethin'" where "Mama-se mama-sa ma-ma-coo-sa" was misheard as "Mama say mama sa mama appelsap". In French, this phenomenon is called "hallucination auditive," and it is known that the title of the movie about the life of Edith Piaf, "La Vie en rose," is often misheard as "L'Avion rose" (The pink airplane) [2]. In Portuguese, it is well known as mondegreen that the lyrics "Na madrugada a vitrola rolando um blues, tocando B. B. King sem parar" (At dawn the phonograph playing blues, playing B. B. King nonstop) in the lyrics of the song "Noite do Prazer" (Night of Pleasure) by Brazilian musician Claudio Zoli sound like "Na madrugada a vitrola rolando um blues, trocando de biquini sem parar" (at dawn the phonograph playing blues, playing B. B. King nonstop). In Japan, it has long been known that "what time is it now" sounds like "掘った芋いじるな"(don't mess with the potatoes we dug). These phenomena of mishearing, such as mondegreen or soramimi, can be observed in many languages other than those listed above.

Mondegreen has a connotation of mishearing within the same language, while soramimi has a connotation of mishearing between different languages. A Japanese TV program called Tamori Club has a popular corner called Soramimi Hour, where they have introduced many examples of how lyrics of foreign songs sound Japanese with humorous videos [3]. While the "Soramimi Hour" introduced soramimi of a part of the song, there are many interesting videos posted on Nico Nico Douga and Youtube that show whole subtitles of Japanese soramimi lyrics on foreign song's promotion videos. There are some Japanese musicians who deliberately incorporate soramimi into their lyrics, known as "留学生" by 岡崎体育[4] "絶望ビリー" by マキシマムザホルモン[5], and

"不思議な第3惑星" by 聖飢魔II [6]. These songs use soramimi between Japanese and English in the lyrics, so that when you listen to them, you can interpret the lyrics in either Japanese or English.

The creation of these soramimi lyrics was largely at the discretion of the individual, but there are several studies that automatically generate soramimi. Sakakima et al. proposed a method to generate Japanese sentences that are similar in pronunciation to English sentences from English audio files [7]. Haga et al. analyzed manually created master data about soramimi and conducted a basic investigation to generate Japanese soramimi sentences from English song lyrics [8]. Shimatani et al. proposed a method for generating soramimi using a limited vocabulary among Japanese [9].

It was mentioned above that a song that incorporates soramimi can be interpreted in both Japanese and English, which may mean that these songs can be sung in two languages, Japanese and English. This is the inspiration for this research. If lyrics of a song can be created in various languages by using soramimi, then there are possibilities people who do not share a language can sing the same song together in their native language. This study proposes a method of generating soramimi in multiple languages, and investigates the possibility of this idea by conducting an experiment in which multinational subjects sang a song with soramimi lyrics generated by the method.

1.2 Research Motivation

This research began with the question of whether it is possible to sing a song in various languages. If we could create an ideal song where the sound and meaning of the lyrics written in each language would be the same, it would essentially be a more global song than a famous song written in English. At this stage, it seems difficult to make both the meaning and the sound the same in each language, so this study focuses on only making the sound of the lyrics similar. With the aim of creating songs that can be sung in various languages by applying the phenomenon of soramimi, this study proposes a method of generating soramimi lyrics using Web Speech API Speech Recognition, and investigates the possibility of this idea by having multinational participants sing the lyrics generated by the method.

1.3 Contribution

The main contributions of this research are as follows.

- A method for generating soramimi lyrics using Web Speech API Speech Recognition has been proposed

- English, Chinese, and Russian soramimi lyrics for the Japanese song "上を向いて歩こう" were generated.
- A subjects' experiment was conducted to test the singability of soramimi lyrics.
- A subjects' experiment was conducted to verify if it was possible to sing a song in multiple languages simultaneously.

Chapter 2

Related Work

2.1 Music

Making music and dancing are central activities in cross-cultural rituals, courtship, identity, and human expression. Based on this universality, it has been argued that music has played an important role in the history of human evolution [10][11][12]. It has been suggested that an important function of music during its development and spread among humans was its ability to create and strengthen social bonds between members of interacting groups.

Freeman argues that the transmission of knowledge across generations requires the establishment of social bonds, and it makes sense to assume that music, which provides these bonds, plays an important role in the early stages of human intellectual evolution [13]. Based on this, Dunbar argues that music became a more efficient means of grooming in early humans, as group sizes became too large for direct grooming [14]. Hagen and Bryant proposed that music evolved as a signal that a group is cohesive and trustworthy in order to establish cooperative relationships with other groups [15]. This effect of musical activities on "social bonding" is the cause of the spread of musical activities, and may have played an important role in the evolution of human sociality.

2.2 Soramimi in entertainment

Soramimi is a type of humor that has long been popular in Japan. A Japanese TV program called Tamori Club has a popular corner called Soramimi Hour, where they have introduced many examples of how lyrics of foreign songs sound Japanese with humorous videos [3]. While the "Soramimi Hour" introduced soramimi of a part of a song, there are many interesting videos posted on Nico Nico Douga and Youtube that show whole subtitles of Japanese soramimi lyrics on foreign song promotion videos. There are some Japanese musicians who deliberately incorporate soramimi into their lyrics. In the song "留学生" by 岡崎体育, "留学生" and "You gotta stay" sound the same, and "部屋 20 平米" and "Hey, I need you here babe" sound the same [4]. 聖飢魔 II's "不思議な第 3 惑星" has all the lyrics sounding like English and Japanese, "俺のお寿司にワサビをたっぷり！鼻にズコーンときた、おーキタ！もうダメ！" and "All I know. Oh, soon she needs, wants some beat. Oh, tap your leads! Hanna needs going to keep the Oh, guitar! More damn it!" sound the

same [6]. マキシマムザホルモンの "絶望ビリー" has a slightly different lyric writing style: the lyrics are first written in English, and then Japanese words are forcibly substituted for the English sounds [5]. These songs sound like English as well as Japanese.

2.3 Demystifying Soramimi

2.3.1 Listening to Sound

There are two stages of hearing. In the first stage, vibrations passing through the ear are detected and the information is delivered to the auditory cortex of the brain. In the second stage, the process of assigning meaning to that information begins [16][17]. According to the cohort model, one of the leading theories of auditory word processing, when we hear a sound, several related words are activated simultaneously in our mind, and then our brain selects the most meaningful one [18]. This process is thought to be influenced by the knowledge of vocabulary, visual information, and context [19].

2.3.2 Analysis of soramimi

Tanaka's study tested subjects' ability to detect Japanese using a dataset of words that are heard as Japanese in Queen songs, and showed that phonetically similar segments cause perceptual reinterpretation [20]. Sanma discusses the similarity between two words that sound similar in terms of discriminative features [21]. Ohtake argues that recent research on lexical recognition has indicated that the L1 and L2 mental lexicons of bilinguals may be activated simultaneously in response to speech input, and that this idea can be developed to explain the linguistic phenomenon of the "Soramimi hour" by analyzing the database [22]. Beck, Kardatzki, and Ethofer identified two top-down factors that affect mondegreens and found that the degree of misrecognition is a function of the wittiness of the misheard sentence and the size of the listener's vocabulary [23].

2.3.3 Neuroscientific Approach

Beck et al. conducted two functional magnetic resonance imaging (fMRI) experiments to investigate the neural basis of lyric knowledge and misrecognition. They found that lyric recognition is associated with activation of reward-related areas and left hemisphere speech regions, and that lyric misrecognition forms a symmetric bilateral network in the thalamus and frontotemporal cortex [24]. Helen et al. conducted an fMRI experiment and found that the left superior temporal sulcus, a region of the brain involved in speech processing, was less active when mishearing occurred. This indicates

that the function of human pre-prediction may be the neural mechanism that causes misrecognition when ambiguous speech signals are heard [25].

2.4 Generating soramimi

Soramimi have been discovered by chance or intentionally created by artists, but there have been several studies on automatically generating soramimi. Sakakima et al. proposed a method to generate Japanese sentences that are close in pronunciation to English sentences by inputting English audio files into a Japanese recognition engine [7]. Haga et al. analyzed manually created master data by comparing the Levenshtein distance of International Phonetic Alphabet (IPA) between Japanese and English sentences, and conducted a basic verification for generating Japanese soramimi sentences from English song lyrics [8]. Shimatani et al. proposed a method to automatically generate soramimi lyrics between Japanese using a limited vocabulary, such as only the names of countries or baseball players [9].

Chapter3

Generating soramimi

3.1 Target song

In creating songs that can be listen with soramimi, this study do not create new songs from scratch, but apply soramimi lyrics in other languages to existing Japanese songs. "上を向いて歩こう"[25] by 坂本九 is selected as the song to be used in this study. This song was released in the early 1960s and was popular not only in Japan, but also in the United Kingdom, France, the United States, Argentina, etc. The tune of the song is considered to be internationally friendly and easy to sing. [Fig.3.1] shows the Japanese lyrics of“上を向いて歩こう”.

上を向いて歩こう
涙がこぼれないように
思い出す 春の日
一人ぼっちの夜

上を向いて歩こう
にじんだ星をかぞえて
思い出す 夏の日
一人ぼっちの夜

幸せは雲の上に
幸せは空の上に

上を向いて歩こう
涙がこぼれないように
泣きながら歩く
一人ぼっちの夜

思い出す 秋の日
一人ぼっちの夜

悲しみは星のかげに
悲しみは月のかげに

上を向いて歩こう
涙がこぼれないように
泣きながら歩く
一人ぼっちの夜

Figure 3.1: Japanese lyrics of “上を向いて歩こう”

上を向いて
歩こう
涙が
こぼれ
ないように
思い出す
春の日
一人ぼっちの夜
にじんだ
星を
かぞえて
夏の日
幸せは
雲の上に
空の上に
泣きながら
歩く
秋の日
悲しみは
星のかげに
月のかげに

Figure 3.2 the lyrics to be inputted

3.2 Web Speech API Speech Recognition

Web Speech API Speech Recognition is used as a tool to generate soramimi lyrics. Speech to text web cam overlay [27] is a web application that overlays subtitles of text recognized by speech using Web Speech API Speech Recognition on the web camera image. In this research, this web application is used to generate soramimi lyrics. Specifically, set the voice input setting to the language in which you want to generate a soramimi sentence, and input a sentence in the language of the source of soramimi by voice recognition. In the case a soramimi sentence of English is generated from Japanese, set the voice input setting to English and input a source sentence in Japanese. By doing so, English sentences that sound like Japanese can be generated.

3.3 Separating lyrics

The output of soramimi will change depending on how the lyrics are separated and input. Web Speech API Speech Recognition tries to generate sentences that make sense to some extent, so if the sentences you input are long, there will be parts that cannot be converted to soramimi. One line of the lyrics to "上を向いて歩こう" could not be converted into an soramimi in some places when it was inputted. In this research, the sound of the lyrics is more important than the meaning of the lyrics, so by inputting the lyrics in smaller segments, English soramimi lyrics that are similar sound to the original Japanese will be generated. In "Ue wo muite arukou," there are pauses between the lyrics where the singer holds his breath. This time, the lyrics were split at those pauses and inputted. Also, lyrics that appear multiple times were entered only once. [Fig.3.2] shows the lyrics to be inputted.

3.4 Recognition

The author speaks out the lyrics and input the voice into Speech Recognition. There are two ways to input the lyrics: one is to read the lyrics out loud, and the other is to sing the lyrics. Even if the same lyrics are inputted, the result of the soramimi will be different depending on how they are inputted. For example, "歩こう" becomes "I do Coke" when sung and recognized, and "alcohol" when read out loud and recognized. The reason why audio files are not used as input is that they only give one result of soramimi, and it is not possible to find other possible soramimi. A total of six soramimi were created for each phrase, three by singing and three by reading. [Fig.4.3] shows generated soramimi phrases. A is from the voice input by singing, and B is from the voice input by reading out loud.

Chapter4

Evaluation of soramimi lyrics

4.1 Experiment purpose

For the soramimi lyrics created in the previous chapter, a subject experiment which investigates how well the soramimi lyrics sound like the original lyrics is conducted. Also the soramimi lyrics which are generated in two ways, singing and reading out loud are compared.

4.2 Participants

Six international students from Tsukuba University, whose Japanese is not good, participated in the experiment. They were asked about their native language and their level of Japanese and English. CEFR (Common European Framework of Reference for Languages: Learning, teaching, assessment) was used to assess the language level. [Fig.4.1] shows the evaluation criteria of CEFR. [Table 4.1] shows the language background of the participants.

Table 4.1: language background of the participants

Participants	Mother tongue	Japanese	English
1	Cantonese	B1	C1
2	Russian	A2	C2
3	Tigrigna	A2	C1
4	Tigrigna	A1	C1
5	Urdu	A1	C1
6	Tigrigna	A1	B1

PROFICIENT USER	C2	Can understand with ease virtually everything heard or read. Can summarise information from different spoken and written sources, reconstructing arguments and accounts in a coherent presentation. Can express him/herself spontaneously, very fluently and precisely, differentiating finer shades of meaning even in more complex situations.
	C1	Can understand a wide range of demanding, longer texts, and recognise implicit meaning. Can express him/herself fluently and spontaneously without much obvious searching for expressions. Can use language flexibly and effectively for social, academic and professional purposes. Can produce clear, well-structured, detailed text on complex subjects, showing controlled use of organisational patterns, connectors and cohesive devices.
INDEPENDENT USER	B2	Can understand the main ideas of complex text on both concrete and abstract topics, including technical discussions in his/her field of specialisation. Can interact with a degree of fluency and spontaneity that makes regular interaction with native speakers quite possible without strain for either party. Can produce clear, detailed text on a wide range of subjects and explain a viewpoint on a topical issue giving the advantages and disadvantages of various options.
	B1	Can understand the main points of clear standard input on familiar matters regularly encountered in work, school, leisure, etc. Can deal with most situations likely to arise whilst travelling in an area where the language is spoken. Can produce simple connected text on topics which are familiar or of personal interest. Can describe experiences and events, dreams, hopes & ambitions and briefly give reasons and explanations for opinions and plans.
BASIC USER	A2	Can understand sentences and frequently used expressions related to areas of most immediate relevance (e.g. very basic personal and family information, shopping, local geography, employment). Can communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar and routine matters. Can describe in simple terms aspects of his/her background, immediate environment and matters in areas of immediate need.
	A1	Can understand and use familiar everyday expressions and very basic phrases aimed at the satisfaction of needs of a concrete type. Can introduce him/herself and others and can ask and answer questions about personal details such as where he/she lives, people he/she knows and things he/she has. Can interact in a simple way provided the other person talks slowly and clearly and is prepared to help.

Figure 4.1: CEFR

4.3 Task

Subjects listen to the segmented audio of "上を向いて歩こう" corresponding to the soramimi lyrics and rate how close the soramimi lyrics sound to the original audio using a 7-point SD method. The evaluation scale is shown in [Fig.4.2].

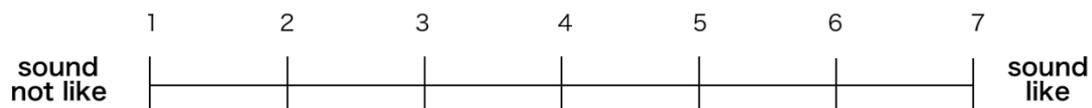


Figure 4.2: Evaluation scale of 7-point SD method

4.4 Evaluation target

The soramimi lyrics of "上を向いて歩こう" created in the previous chapter will be used for evaluation. There are 21 lyrics to evaluate, and each lyric has 3 soramimi lyrics generated by singing and 3 soramimi lyrics generated by reading out loud. The survey sheets used in the experiment are shown in [Fig.4.3]; A is from the voice input by singing, and B is from the voice input by reading out loud.

4.5 Procedure

Participants listen to the audio of the target section. The audio will be played repeatedly until participants finish answering. Participants choose the soramimi lyric that sounds the most like the original lyric from among the three in A (soramimi lyrics generated by singing). Participants rate how well the selected lyrics sound like the original lyrics on a 7-point scale. Participants choose the soramimi lyric that sounds the most like the original lyric from among the three in B (soramimi lyrics generated by reading out loud). Participants rate how well the selected lyrics sound like the original lyrics on a 7-point scale. When the evaluation is finished, move on to the next lyric and repeat the above evaluation in the same way. The experiment took about 20 minutes.

4.6 Result

The box plot is shown in [Fig.4.4]. For the selected soramimi lyrics, the evaluation of the soramimi lyrics generated by singing was MEAN 5.17 ± 1.27 , and the evaluation of the soramimi lyrics generated by reading out loud was MEAN 5.04 ± 1.26 , confirming that the soramimi lyrics sounded like the original lyrics to some extent. A t-test of these two methods (singing and reading out loud) showed no significant difference with a p-value of 0.3416. This means that one method does not produce better soramimi lyrics than the other.

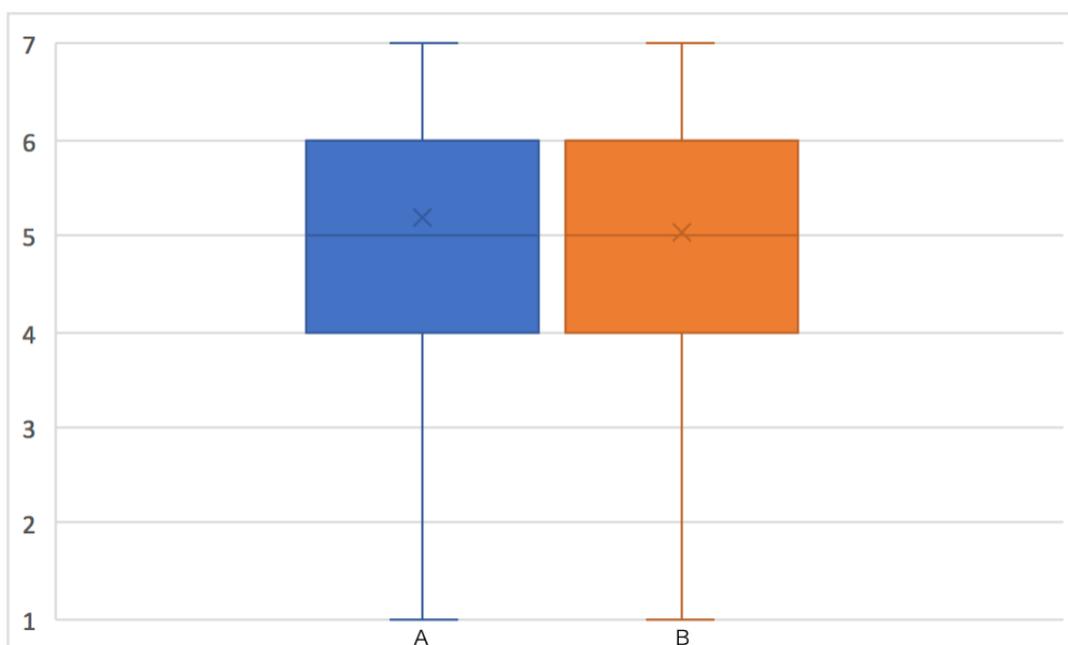


Figure 4.4: Box plot of singing generated lyrics and reading generated lyrics.

4.7 Deciding the lyrics

The soramimi lyrics to sing for the next experiment need to be decided. The selection method is based on the sum of the SD method. The evaluation values of the SD method are summed up, and the one with the highest sum of the SD method evaluation values among the six candidates of soramimi lyrics is judged to sound the most like the original lyrics. [Table 4.2] shows the total value of the SD method ratings for each lyric. The yellow-colored soramimi lyrics are used in the following experiments.

Table 4.2: Total value of the SD method ratings for each lyric.

上を向いて	A	Red Room movie	15	blue arrow movie	0	whoever will move on	13
	B	whale noises	5	Real Madrid	3	Vail movie theater	13
歩こう	A	I do Coke	12	auricle	10	I'm cold	8
	B	alcohol	33	are you cool	4	how do you call	0
涙が	A	nah meaning	0	Nami Dahlia	31	Namenda	6
	B	nanny.com	0	Now yoga	0	Nami Dhaka	33
こぼれ	A	call Bodie	21	cobra	11	cool boy	0
	B	Kubota	0	call Borat	30	cool ball that	0
ないように	A	Naomi	18	now you're funny	0	9 year old	8
	B	9 year old	12	name your knee	0	Naomi	13
思い出す	A	Only You Yazoo	26	Family Medicine	0	on the way	0
	B	on my way.(dot)	0	only does	21	only that's it	12
春の日	A	how do you know he	36	do you know he	0	how do you know here	0
	B	how do you know he	15	how to know he	19	how to negotiate	0
一人ぼっちの夜	A	he told me no llores	8	heat only Balochi Ne-Yo	18	he totally portena you're rude	6
	B	story books in order	2	StoryBots New York	21	StoryBots Toyota	0
にじんだ	A	nizina	16	neogene	4	Newsela	4
	B	amazing	0	agenda	29	Need You Now	0
星を	A	Oh Sheila	6	all she wrote	25	Oshie world	0
	B	what she will	0	what she want	21	Joshua	5
かぞえて	A	cousin	15	Godzilla	12	conduit	0
	B	cuz the weather	6	cut the weather	20	cuz weather	3
夏の日	A	nothing on here	12	none to know he	15	nice to know he	5
	B	Natsu no heat	17	natural Heat	6	not too naughty	11
幸せは	A	shiwase	11	CEO of SeaWorld	25	Ciara	0
	B	Cialis a well	11	Cialis Ava	0	shiwase WAP	26
雲の上に	A	Kumon one	0	Kumon on Rainey	31	Mauna Lani	0
	B	come on already	12	good morning rainy	17	Kumon already	3
空の上に	A	solar panel	0	Solon oh rainy	32	Florida rainy	0
	B	Serrano wedding	20	Sorrento ready	11	Solon already	0
泣きながら	A	Knockin Noggin love	6	NOC Eind I love	3	Nike Nogales	14
	B	Nike negara	35	naughty negara	0	\$99	0
歩く	A	I love you too	0	how do you cook	40	do you cook	0
	B	are you could	23	Eric	0	I do cook	9
秋の日	A	I cannot hear	32	Kino here	5	kinoshita	0
	B	IKEA hours	0	Akino sushi	0	I cannot see	23
悲しみは	A	kind of Simi Valley	22	konaseema	6	kaneshie mean	0
	B	can I send you up	0	can I sing you up	24	can I see Mia	12
星のかげに	A	Jose no car game	0	Hoshi no kaabii	25	hoshino car game	9
	B	Casino Card Game	14	ocean Oak again	4	Hoshi no kaabii ending	11
月のかげに	A	Tookie knows	26	zucchini	4	2 Chainz	0
	B	penal colony	0	Chino Canyon	8	skinny mocha Guinea	18

Chapter5

Singing experiment of soramimi lyrics

5.1 Experiment purpose

The singing experience of the created soramimi lyrics are investigated in terms of enjoyment, ease of singing, and understanding of the lyrics in comparison with the singing experience of Japanese lyrics written in romaji.

5.2 Participants

Five international students from Tsukuba University, whose Japanese is not good, participated in the experiment. They were asked about their native language and their level of Japanese and English. CEFR was used to assess the language level. [Table 5.1] shows the language background of the participants.

Table 5.1: Language background of the participants.

Participants	Mother tongue	Japanese	English
1	Cantonese	B1	C1
2	Russian	A2	C2
3	Urdu	A1	C1
4	Tigrigna	A2	C1
5	Tigrigna	A1	C1

5.3 Task

Participants sing "上を向いて歩こう" with Japanese lyrics written in romaji and English soramimi lyrics. They rate each singing experience in terms of enjoyment, ease of singing, and understanding of the lyrics using a 5-point Likert scale.

5.4 Evaluation target

The target of the evaluation is the soramimi lyrics created in the previous chapter and the Japanese lyrics written in romaji of "上を向いて歩こう". [Fig.5.1] and [Fig.5.2] shows the two lyrics.

Ue o muite arukou
Namida ga kobore nai you ni
Omoidasu haru no hi
Hitoribotchi no yoru

Ue o muite arukou
Nijinda hoshi o kazoete
Omoidasu natsu no hi
Hitoribotchi no yoru

Shiawase wa kumo no ue ni
Shiawase wa sora no ue ni

Ue o muite arukou
Namida ga kobore nai you ni
Nakinagara aruku
Hitoribotchi no yoru

Omoidasu aki no hi
Hitoribotchi no yoru
Kanashimi wa hoshi no kage ni
Kanashimi wa tsuki no kage ni

Ue o muite arukou
Namida ga kobore nai you ni
Nakinagara aruku
Hitoribotchi no yoru
Hitoribotchi no yoru

Figure 5.1: Japanese lyrics written in Roman alphabet.

Red Room movie alcohol
Nami Dhaka call Borat Naomi
Only You Yazoo how do you know he
StoryBots New York

Red Room movie alcohol
Agenda all she wrote cut the weather
Only You Yazoo Natsu no heat
StoryBots New York

Shiawase WAP Kumon on Rainey
Shiawase WAP Solon oh rainy

Red Room movie alcohol
Nami Dhaka call Borat Naomi
Nike negara how do you cook
StoryBots New York

Only You Yazoo I cannot hear
StoryBots New York
Can I sing you up Hoshi no kaabii
Can I sing you up Tookie knows

Red Room movie alcohol
Nami Dhaka call Borat Naomi
Nike negara how do you cook
StoryBots New York
StoryBots New York

Figure 5.2:
English Soramimi lyrics

5.5 Procedure

Participants sing the song "上を向いて歩こう" first with the Japanese lyrics in romaji and later with the soramimi lyrics. Participants don't sing the song in a cappella. This is because it is considered difficult to sing a song for the first time without a lead vocal. When participants sing, "上を向いて歩こう" is played.

Participants listen to "上を向いて歩こう" and check the Japanese lyrics in romaji. After confirming the lyrics, "上を向いて歩こう" is played and they sing the Japanese lyrics in romaji aloud. When they finish singing, they answer the questionnaire. The evaluation items are: enjoyment of the singing experience, ease of singing, and comprehension of the lyrics. Survey sheets are in the appendix.

Participants listen to "上を向いて歩こう" and check the English soramimi lyrics. After confirming the lyrics, "上を向いて歩こう" is played and they sing the English soramimi lyrics aloud. When they finish singing, they answer the questionnaire. The evaluation items are the same as those for the romaji Japanese lyrics.

The experiment took about 20 minutes per person.

5.6 Results

The results of the Likert method questionnaire are shown in [Fig.5.3], and the free writing content is shown in the [Table 5.2]. The expected result was that the familiar English lyrics would be easier to sing than the Japanese lyrics written in romaji, but this was not necessarily the case. Since the results of the experiment varied and the number of participants was small, it was not considered valid to analyze them statistically, so they are analyzed qualitatively.

- Enjoyment

Perhaps because of the familiarity of the song's tune, the overall singing experience was rated as enjoyable, regardless of which lyrics were used.

- Ease of singing

The expected result was that the familiar English lyrics would be easier to sing than the Japanese lyrics written in romaji, but this was not necessarily the case. Participants 4 and 5 rated the soramimi lyrics as more difficult to sing. As Participant 4 said, it may have been difficult to sing the soramimi English lyrics, because they could understand the Japanese of the lead vocal to some extent at the same time and it confuses them. However, this problem would be considered unlikely to occur for people who do not understand Japanese at all. On the other hand, as Participant 2 said, if they know Japanese hiragana, it may be difficult to read Japanese phrases when it is written in romaji.

- Understanding of the lyrics

The expected result was that the soramimi lyric would result in a higher comprehension of the lyrics than a Romanized Japanese lyric, but this was not necessarily the case. It is possible that the

comprehension of the Japanese lyrics in romaji was rated higher when the lyrics could be understood as Japanese even in romaji by participants whose Japanese is not good. It is also possible that the comprehension of the English lyrics was rated lower because the meaning of each word in the English soramimi lyrics was understood, but the meaning was not understood when they became sentences.

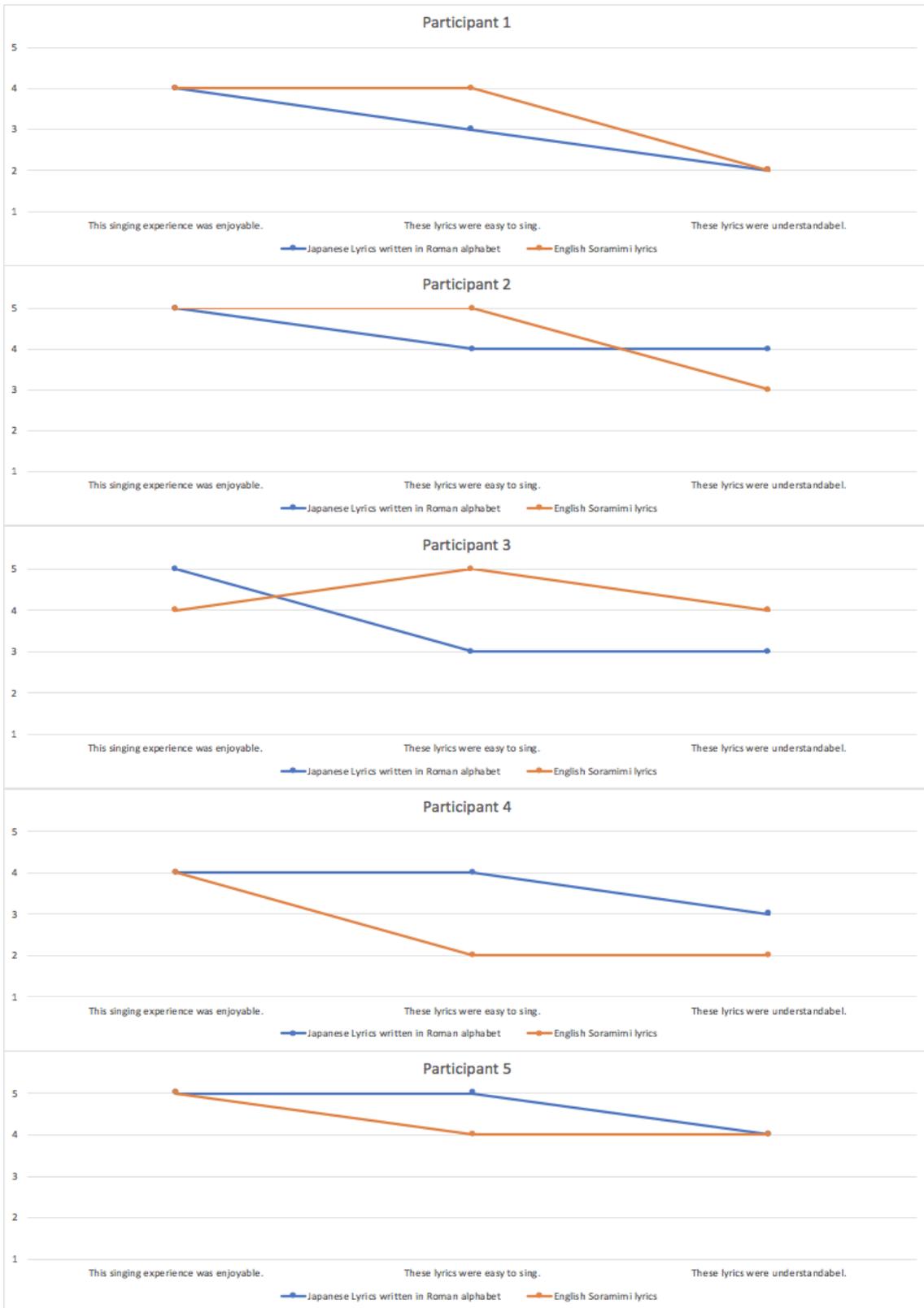


Figure 5.3: Results of the Likert method questionnaire

Table 5.2: Free writing content

Participant 1	Japanese Roman Lyrics	Not easy to sing in Romaji
	English Soramimi lyrics	Easy to sing with English lyrics but the lyrics were not make sense. But it was enjoyable.
Participant 2	Japanese Roman Lyrics	If you know hiragana, etc -> english romaji is confusing. Too many letters. Very similar problem if you can read Cynillie, when you read for example Polish(Latin) ...
	English Soramimi lyrics	There's a difference in rhythm. Agenda...-> Longer than Japanese version. English version has longer lines
Participant 3	Japanese Roman Lyrics	The tone of this song is very enjoyable. Even if you couldn't understand the lyrics but definitely with this tone your mood will be happy. But lyrics are not so difficult to understand. I enjoyed a lot.
	English Soramimi lyrics	The lyrics are easy to understand, not so difficult especially the English lyrics are very relatable to the song and combine it, giving a good vibe. I enjoyed it.
Participant 4	Japanese Roman Lyrics	When the singing voice is soft(especially at the end of the verse), it wouldn't have been easy to catch it, if there weren't the lyrics given.
	English Soramimi lyrics	I know some Japanese language and I can catch some words from the song but when I read the lyrics, it confused me. There is a similarity between the song and the lyrics written down.
Participant 5	Japanese Roman Lyrics	It's a good experience to have karaoke japanese song lyrics written in english.
	English Soramimi lyrics	I found out that such experience will help foreigners to improve their accents and will help then know well to speak japanese.

Chapter 6

Singing experiments in multiple languages

6.1 Experiment purpose

This experiment investigates whether people can sing a song together in multiple languages using soramimi lyrics. Participants sing the song "上を向いて歩こう" with Japanese lyrics and English, Chinese, and Russian soramimi lyrics.

6.2 Participants

One Japanese student and three international students whose Japanese is not good participated in this experiment. Each of the international students can speak Chinese, Russian, and English. [Table 6.1] shows the language backgrounds of the participants and the parts they were assigned in this experiment. CEFR was used to assess the language level.

Table 6.1: language backgrounds of the participants

Participants	Language of the song	Mother tongue	Japanese	English
1	Japanese	Japanese	Mother tongue	B1
2	Russian	Russian	A2	C2
3	Chinese	Cantonese	B1	C1
4	English	Arabic	A2	C2

6.3 Task

Participants sing the song "上を向いて歩こう" together with Japanese lyrics and the soramimi lyrics in English, Russian and Chinese. After finishing the song, they rate their singing experience on a 5-point Likert scale. There are six questions as shown below. The question sheet is shown in the appendix.

Q1: This singing experience was enjoyable.

Q2: These lyrics were easy to sing.

Q3: These lyrics were understandable.

Q4: I felt a sense of unity in this singing experience.

Q5: I felt like we were singing the same song.

Q6: I think it's possible to sing a song in various languages at the same time using this soramimi method.

6.4 Evaluation target

The target of the evaluation is the experience of singing "上を向いて歩こう" with Japanese lyrics and soramimi lyrics in English, Russian, and Chinese. The same method that was used to create the English soramimi lyrics was also used to create the Russian and Chinese soramimi lyrics. The lyric cards used in this experiment are shown in [Fig.3.1] [Fig.5.2] [Fig.6.1] [Fig.6.2].

6.5 Procedure

Participants will first listen to the song and check the lyrics on the lyric card. At this time, each participant has a different lyric card, one in Japanese, one in English, one in Chinese, and one in Russian. Next, practice singing the lyrics written on the lyric card while listening to the song. Finally, all the participants sing the lyrics on the lyric card while playing the song "上を向いて歩こう". After the song, the participants were asked to answer a questionnaire. The experiment took about 20 minutes.

喂我们一点 韩国
哪里疼啊 恐怖类 哪有你
乌鲁木齐的诗 好的老戏
托里伯奇的忧虑

喂我们一点 韩国
你今的 呼吸膜 卡座位
乌鲁木齐的诗 那次诺希
托里伯奇的忧虑

西亚湾 科目农瑞你
西亚湾 苏拉努力

喂我们一点 韩国
哪里疼啊 恐怖类 哪有你
哪几哪个啦 爱旅居
托里伯奇的忧虑

乌鲁木齐的诗 阿基诺西
托里伯奇的忧虑
看悉尼湾 hoshino卡给你
看悉尼湾 刺激了看给你

喂我们一点 韩国
哪里疼啊 恐怖类 哪有你
哪几哪个啦 爱旅居
托里伯奇的忧虑
托里伯奇的忧虑

Figure 6.1 Chinese soramimi lyrics

вы умеете Харьков
нами Дарина кабаре на ё
о моей расы ха лохи
хитори боччи

вы умеете Харьков
Нежин да овощи показывайте
о моей расы pazi нахи
хитори боччи

сияла кимоно
сияла Сура новини

вы умеете Харьков
нами Дарина кабаре на ё
на кино гора арык
хитори боччи

о моей расы а Кинохит
хитори боччи
Каро Синема машина как едет
Каро Синема скин алкогений

вы умеете Харьков
нами Дарина кабаре на ё
на кино гора арык
хитори боччи
хитори боччи

Figure 6.2 Russian soramimi lyrics

6.6 Result

The results of the Likert method are shown in [Fig.6.3], and the contents of the free writing are shown in [Table 6.2].

- About Q1

Perhaps it was because the tune of "上を向いて歩こう" was so good, then the overall rating was high.

- About Q2

Different languages were evaluated differently. The ease of singing soramimi lyrics and whether they can be sung like a Japanese song may vary by language.

- About Q3

The level of comprehension of the lyrics was rated low except for Japanese. It seems that when the lyrics were generated, the focus was on the similarity of sound and not on the meaning, and this was evaluated as such.

- About Q4

Maybe it was because participants were singing together, or doing the same experiment together, the evaluation was high overall .

- About Q5

The evaluations varied by language. It may be because the pronunciation characteristics of each language are different, so when they sing together, they may feel the difference in sound from those around them.

- About Q6

The participants were unanimous in their evaluation and it was Agree. They were able to feel the possibility of singing songs in various languages using these soramimi lyrics.

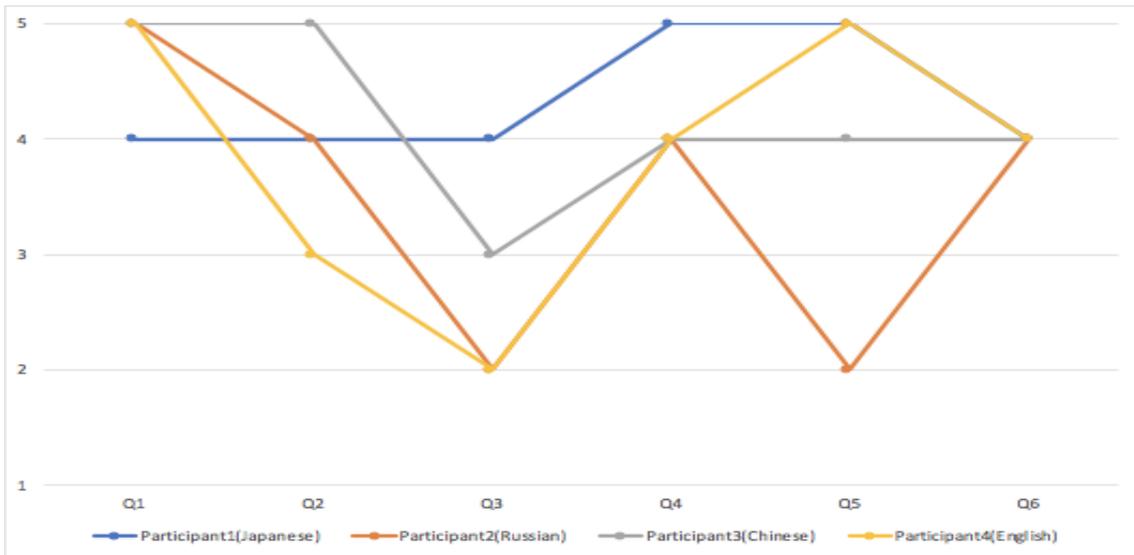


Figure 6.3: Results of the Likert method

Table 6.2: Contents of the free writing

Participant 1	<ul style="list-style-type: none"> ・ 他の人たちの実験はとても面白そうだった ・ 日本語なのでもちろん歌詞を見ればわかるが、歌っていると意味を忘れていたときがあった ・ 実験の主旨がいまいちわかっていなかった
Participant 2	Great idea! However, I think Google Translate is not suitable for this goal. For Example in “hitori bocchi no yoru” line the words “ no yoru” were skipped in Russian. I think using a different voice recognition software could improve the results.
Participant 3	A great experience! It is possible to sing a foreign song without knowing the original lyrics.
Participant 4	I think if actual english words and phrases, like “ Agenda all she wrote cut weather” is much better than wrong words and phrases that don’t exist in english at all, like “Shiawase WAP Kumon on Rainey” or other alike. It was still enjoyable!

Chapter7

Discussion

This study applied the phenomenon of soramimi to create soramimi lyrics for the purpose of simultaneously singing a song in multiple languages. These soramimi lyrics were sung and evaluated by the participants in the experiments. Through the experiments, the possibility of singing a single song in multiple languages simultaneously were shown by using the soramimi lyrics. This chapter discusses the characteristics of this singing experience and how to improve this singing experience. In this study, "上を向いて歩こう" by Kyu Sakamoto was used as the subject song, and this is a Japanese pop song, it is possible that the ease of soramimi perception may vary depending on the genre of the songs. For example, HipHop is a music genre that originated in the U.S., and Japanese HipHop songs have a lot in common with American HipHop songs in terms of rhythm, melody, and flow. It can be thought that those music genres that have musical commonalities among other languages may be more likely to produce soramimi lyrics than others that do not.

Although most of the well-known soramimi lyrics in Japan are between Japanese and English, this study generated soramimi lyrics not only between Japanese and English, but also between Chinese and Japanese, and between Russian and Japanese. In the experiment in Chapter 6, the answers to the questions Q2 (These lyrics were easy to sing.) and Q5 (I felt like we were singing the same song.) were varied. This implies that the ease of soramimi perception between Japanese and each language, as well as the ease of singing the soramimi lyrics of each language, may differ. Based on the linguistic and pronunciation characteristics of each language, it may be helpful to investigate the language combinations that are most likely to generate soramimi, in order to create soramimi lyrics that are easy to sing.

In this study, soramimi lyrics of foreign languages were generated based on a Japanese song. In the experiment of chapter 6, Japanese participant who was in charge of Japanese lyrics commented that the other people's experiments seemed very interesting. Admittedly, some of the non-Japanese soramimi lyrics had funny meanings that were created by accident, whereas the Japanese lyrics were normal lyrics without such funny meanings. Perhaps it would be better to eliminate this gap while the goal is to sing the song together. To eliminate this gap, a method of creating soramimi lyrics that are not based on any language could be explored, or singing in languages other than the original language used as a base.

In this study, the lyrics of the song "上を向いて歩こう" were divided based on the pause at the moment when the singer stopped his breath. However, it is not always possible to divide the lyrics in this way when dealing with other songs. Depending on how the lyrics are separated and imported into speech recognition, the generated soramimi lyrics will be different. In the future, it may be worthwhile to investigate the relationship between the way lyrics are separated and the generated soramimi lyrics to find the most appropriate way to separate the lyrics.

This study did not consider the meaning of the soramimi lyrics at all when generating them, but only concentrated on making them sound like Japanese. So there were lyrics that made no sense in the soramimi lyrics, or words that were not originally in English in the English soramimi lyrics. In the future, it may be possible to create soramimi lyrics that are easier to sing if the meaning is taken into account to some extent.

Chapter8

Conclusion

This study proposes a method of singing a song in multiple languages simultaneously by applying the phenomenon of soramimi. So far, there have been songs that incorporate soramimi in their lyrics and research that automatically generates soramimi, but there has been no idea or actual example of singing a song in multiple languages by applying soramimi phenomenon.

The Japanese lyrics of Kyu Sakamoto's "上を向いて歩こう" were converted into English soramimi lyrics using Web Speech API Speech Recognition. International students, whose Japanese is not good, evaluated these soramimi lyrics and confirmed that they sounded original lyrics to some extent, and the results were used to determine the soramimi lyrics to be sung in the next experiment. In the next experiment, participants compare to sing the Japanese lyrics written in romaji and the soramimi lyrics, and the ease of singing the soramimi lyrics was investigated. In the final experiment, soramimi lyrics were created for Chinese and Russian using the same method that was used in Chapters 3 and 4. Participants who can speak Japanese, English, Russian, and Chinese sang the song "Ue wo muite arukou" simultaneously with the soramimi lyrics in each language, and their singing experience was evaluated, thus the possibility of singing a song simultaneously in multiple languages were demonstrated.

In the future, in order to improve the quality of the multilingual singing experience, it will be necessary to investigate the language combinations and music genres in which soramimi phenomenon are most likely to be observed, to examine the optimal relationship between the way the lyrics are separated and soramimi lyrics that are generated, and to find a way to generate lyrics that not only focus sound but also make sense to some extent.

Appendix

上を向いて	A	Red Room movie	blue arrow movie	whoever will move on	sound	not like	sound	like
	B	whale noises	Real Madrid	Vail movie theater	sound	not like	sound	like
歩こう	A	I do Coke	auricle	I'm cold	sound	not like	sound	like
	B	alcohol	are you cool	how do you call	sound	not like	sound	like
涙が	A	nah meaning	Nami Dahlia	Namenda	sound	not like	sound	like
	B	nanny.com	Now yoga	Nami Dhaka	sound	not like	sound	like
こぼれ	A	call Bodie	cobra	cool boy	sound	not like	sound	like
	B	Kubota	call Borat	cool ball that	sound	not like	sound	like
ないように	A	Naomi	now you're funny	9 year old	sound	not like	sound	like
	B	9 year old	name your knee	Naomi	sound	not like	sound	like
思い出す	A	Only You Yazoo	Family Medicine	on the way	sound	not like	sound	like
	B	on my way.(dot)	only does	only that's it	sound	not like	sound	like
春の日	A	how do you know he	do you know he	how do you know here	sound	not like	sound	like
	B	how do you know he	how to know he	how to negotiate	sound	not like	sound	like
一人ぼっちの夜	A	he told me no llores	heat only Balochi Ne-Yo	he totally portena you're rude	sound	not like	sound	like
	B	story books in order	StoryBots New York	StoryBots Toyota	sound	not like	sound	like
にじんだ	A	nizina	neogene	Newsela	sound	not like	sound	like
	B	amazing	agenda	Need You Now	sound	not like	sound	like
星を	A	Oh Sheila	all she wrote	Oshie world	sound	not like	sound	like
	B	what she will	what she want	Joshua	sound	not like	sound	like

かぞえて	A	cousin	Godzilla	conduit	sound	not like	sound	like
	B	cuz the weather	cut the weather	cuz weather	sound	not like	sound	like
夏の日	A	nothing on here	none to know he	nice to know he	sound	not like	sound	like
	B	Natsu no heat	natural Heat	not too naughty	sound	not like	sound	like
幸せは	A	shiwase	CEO of SeaWorld	Ciara	sound	not like	sound	like
	B	Cialis a well	Cialis Ava	shiwase WAP	sound	not like	sound	like
雲の上に	A	Kumon one	Kumon on Rainey	Mauna Lani	sound	not like	sound	like
	B	come on already	good morning rainy	Kumon already	sound	not like	sound	like
空の上に	A	solar panel	Solon oh rainy	Florida rainy	sound	not like	sound	like
	B	Serrano wedding	Sorrento ready	Solon already	sound	not like	sound	like
泣きながら	A	Knockin Noggin love	NOC Eind I love	Nike Nogales	sound	not like	sound	like
	B	Nike negara	naughty negara	\$99	sound	not like	sound	like
歩く	A	I love you too	how do you cook	do you cook	sound	not like	sound	like
	B	are you could	Eric	I do cook	sound	not like	sound	like
秋の日	A	I cannot hear	Kino here	kinoshita	sound	not like	sound	like
	B	IKEA hours	Akino sushi	I cannot see	sound	not like	sound	like
悲しみは	A	a kind of Simi Valley	konaseema	kaneshie mean	sound	not like	sound	like
	B	can I send you up	can I sing you up	can I see Mia	sound	not like	sound	like
星のかけに	A	Jose no car game	Hoshi no kaabii	hoshino car game	sound	not like	sound	like
	B	Casino Card Game	ocean Oak again	Hoshi no kaabii ending	sound	not like	sound	like
月のかけに	A	Tookie knows	zucchini	2 Chainz	sound	not like	sound	like
	B	penal colony	Chino Canyon	skinny mocha Guinea	sound	not like	sound	like

Survey sheet used in the experiment of Chapter 4

About singing experience with Japanese lyrics written in Roman alphabet,

- This singing experience was enjoyable.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- These lyrics were easy to sing.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- These lyrics were understandable.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- Please write whatever your thoughts, impressions or findings.

Survey sheet used in the experiment of Chapter 5

About singing experience with with English Soramimi lyrics,

- This singing experience was enjoyable.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- These lyrics were easy to sing.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- These lyrics were understandable.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- Please write whatever your thoughts, impressions or findings.

Survey sheet used in the experiment of Chapter 5

About this singing experience,

- This singing experience was enjoyable.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- These lyrics were easy to sing.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- These lyrics were understandable.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- I felt a sense of unity in this singing experience.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- I felt like we were singing the same song.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- I think it's possible to sing a song in various languages at the same time using this soramimi method.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
<input type="radio"/>				

- Please write whatever your thoughts, impressions or findings.

Survey sheet used in the experiment of Chapter 6

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