

L2 letter-sound correspondence: Mapping between English vowel graphemes and phonemes by Japanese EAL learners

by

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B.A., Aoyama-Gakuin University, 1999
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Abstract

The main focus of this dissertation is to investigate to what extent Japanese English-as-an-additional-language (EAL) learners have mastered default grapheme-phoneme correspondence (GPC) patterns of North American English vowels. The underlying motivation of this research comes from my observation that many mispronunciations of English vowels by Japanese EAL learners in formal learning settings are caused by their misinterpretation of English spellings rather than by phonological factors. Traditionally, Japanese speakers' mispronunciations of English vowels have been attributed to a phonological factor that there is a mismatch of vowel inventories between English and Japanese. However, Nogita and Lin (2016) found that when vowel length and diphthongization are taken into consideration, native Japanese speakers are able to produce all the 13 North American English vowels although not necessarily in a native-like manner. This seems to suggest that other factors than the vowel inventory difference are responsible for the Japanese speakers EAL pronunciation errors. One such factor can be that Japanese EAL learners have not grasped the English GPC patterns and their misinterpretation of the spellings causes their pronunciation errors. To see if a GPC problem really plays a role, this dissertation examines how Japanese EAL learners map all the 13 North American English vowels with English vowel graphemes.

In order to examine Japanese EAL learners' knowledge of English vowel GPC, I conducted both reading and spelling tasks with English-like one-syllable nonsense words. In the reading task (e.g., reading aloud <snad>, <staw>, <stoe>, <nube>, etc.), the results showed that the Japanese EAL participants read vowel letters differently from native English speaking participants 40.1% of the time. In the spelling task (e.g., listening and spelling out native utterances of such syllables as [sne^l], [za:d], [gao], [fʌd], etc.), the results showed that the Japanese EAL participants spelled out vowel sounds differently from native English speaking participants 60.0% of the time. These results suggest that the Japanese EAL participants' English vowel grapheme-phoneme mapping patterns were quite different from those of the native English-speaking participants.

In more details, the results showed that some correspondences were performed very well in both grapheme-to-phoneme and phoneme-to-grapheme directions presumably because of the similarities between the English GPC and the standardized Japanese romanization GPC: specifically, <e>-[ɛ] (in a closed syllable) and <oi, oy>-[ɔɪ]. In contrast, some correspondences were performed very poorly in both directions presumably in part because of the differences between the English GPC and the standardized Japanese romanization: specifically, <aw, au>-[ɑ:], <ow, ou>-[aʊ], <uh#>-[ʌ#] (# = word-final), <i>-[ɪ], and to a lesser extent <o>-[ɑ:] (in a closed syllable), and <o#, oe#, oh#>-[o^ʊ]. There were also correspondences that were performed very well only in the grapheme-to-phoneme direction but not in the other direction: specifically, word-medial <ee>-to-[i:] and <a_e>-to-[e^l]. To a lesser extent, the <u>-to-[ʌ] conversion was also much less problematic than the [ʌ]-to-<u> conversion, although the <u>-[ʌ] correspondence was performed relatively poorly overall. Finally, none of the correspondences were performed very well only in the phoneme-to-grapheme direction but not in the other direction, but there were correspondences that

showed this tendency. For example, the [æ: (æə)]-to-<a> conversion was much less problematic than the <a>-to-[æ: (æə)] conversion.

Pedagogically, these results seem to suggest that Japanese EAL learners can benefit from being taught English default GPC patterns in order for them to improve on their graphophonic skills.

Table of Contents

Supervisory Committee	ii
Abstract	iii
Table of Contents	vi
List of Tables	x
List of Figures	xiv
List of Abbreviations	xvi
Acknowledgements	xviii
Chapter 1 Introduction	1
1.1 Introduction	1
1.2 Research questions	5
1.3 Dissertation outline	5
1.4 Notes on symbols and terminology	6
1.4.1 IPA transcription	6
1.4.1.1 Japanese vowels	6
1.4.1.2 English vowels	7
1.4.1.3 Phonemic and phonetic transcription	7
1.4.1.4 IPA transcription of other languages	9
1.4.2 Romanization	9
1.4.3 Terminology	9
Chapter 2 Literature review and background	12
2.1 Background of a relationship between letters and sounds	13
2.1.1 The lexical route and phonological route	15
2.1.2 Negative influence of L2 orthography on L2 phonology	17
2.1.3 Positive influence of L2 orthography on L2 phonology	23
2.1.4 Influence of sounds on orthography	26
2.1.5 L1 orthographic influence on L2: phonographic vs. logographic	30
2.1.6 Orthographic familiarity	34
2.1.7 Conclusion and discussion regarding orthography-phonology relationship	36
2.2 English and Japanese vowel systems	37
2.2.1 North American English vowels and the sound qualities	37
2.2.1.1 Vowel contrasts in North American English	37
2.2.1.2 Diphthongization and duration in English vowels	38
2.2.1.3 Foreign (a): the low central vowel	41
2.2.1.4 Characteristics of Canadian English	41
2.2.1.5 Unstressed vowels	42
2.2.2 Standard Japanese vowels and the sound qualities	43
2.2.2.1 Japanese monophthongs	44
2.2.2.2 Japanese vowel sequences	46
2.2.2.3 Mora division and ultimate components	48
2.2.3 Comparison of the English and Japanese vowel systems	51
2.2.3.1 The popular myth	51
2.2.3.2 Perception-based Japanese-English vowel comparison	52
2.2.4 Conclusion about Japanese and English vowels	55
2.3 English vowel spelling	55
2.3.1 Introduction about vowel spelling	55
2.3.1.1 Regularity and default spelling	56

2.3.1.2	Vowel inventory, alphabet sounds, relative sounds, and rules.....	62
2.3.1.3	Pronunciation respelling.....	66
2.3.1.4	English graphophonic skills and reading comprehension.....	71
2.3.2	English vowel spelling for Japanese EAL learners.....	72
2.3.2.1	Pronunciation respelling for Japanese EAL learners.....	72
2.3.2.2	Phonics for Japanese EAL learners.....	73
2.3.2.3	Error patterns of Japanese EAL learners in previous studies.....	75
2.3.3	Summary.....	80
2.4	Japanese regular (kunrei-shiki, Hebon-shiki, etc.) rōmaji vowel spelling.....	80
2.4.1	Roman alphabet in Japanese.....	80
2.4.2	Romanization and transliteration.....	81
2.4.3	Standardised Japanese romanization.....	84
2.4.4	Other rōmaji variations.....	89
2.4.5	Potential rōmaji transfer to English spelling.....	93
2.5	Japanese loanword rōmaji.....	93
2.5.1	Kanji logographs in Japanese: inconsistent letter-sound-correspondence...94	94
2.5.2	Between-language grapheme-phoneme correspondence.....	96
2.5.3	Is loanword rōmaji Japanese or English?.....	100
2.5.4	Actual usage of loanword rōmaji in the Japanese culture.....	101
2.5.5	Productivity of loanword rōmaji in the Japanese culture.....	110
2.5.6	Loanword rōmaji versus multilingual writings.....	111
2.5.7	My previous study of loanword rōmaji vowel LSC.....	115
2.5.8	Conclusion about loanword rōmaji.....	120
Chapter 3	Experiments of grapheme-to-phoneme correspondence.....	122
3.1	Participants.....	122
3.1.1	General information about participants.....	122
3.1.2	Questionnaire regarding the Canadian participants' low back vowels.....	125
3.2	Stimuli and procedure for the reading task.....	127
3.3	The Canadian participants.....	129
3.3.1	Coding for the Canadian participants.....	129
3.3.2	Results of the Canadian participants.....	130
3.3.3	Discussion.....	131
3.3.3.1	General discussion.....	131
3.3.3.2	Corresponding graphemes of [ɔ] and [aɔ].....	134
3.3.3.3	Realization of foreign (a).....	135
3.3.3.4	Asymmetry between <i, u> and <y, w>.....	136
3.3.3.5	Consistency and word-likeness.....	137
3.4	The Japanese participants: how they compare with the native speakers.....	138
3.4.1	Coding for the Japanese participants.....	138
3.4.2	Results of the Japanese participants.....	144
3.4.3	Discussion.....	148
3.4.3.1	General discussion.....	148
3.4.3.2	Difficult and easy stimuli for the Japanese participants.....	149
3.4.3.2.1	Cluster 1 stimuli by the Japanese participants.....	150
3.4.3.2.2	Cluster 2 stimuli by the Japanese participants.....	157
3.4.3.2.3	Cluster 3 stimuli by the Japanese participants.....	158
3.4.3.2.4	Possible explanation for the difficulties.....	161
3.4.3.3	Silent-E by the Japanese participants.....	163
3.4.3.4	[ɹ] insertion by the Japanese participants.....	164
3.4.3.5	Consistency and word-likeness.....	165
3.4.3.6	Relationship between scores and LOR/AOA/self-evaluation.....	166
3.4.3.7	Brief teaching implication regarding pronunciation.....	168

3.5	The Chinese participants: how they compare with the native speakers.....	169
3.5.1	Background.....	169
3.5.2	Coding for the Chinese participants.....	171
3.5.3	Results of the Chinese participants.....	172
3.5.4	Discussion.....	174
3.5.4.1	General discussion.....	174
3.5.4.2	Difficult and easy stimuli for the Chinese participants.....	175
3.5.4.3	Silent-E by the Chinese participants.....	178
3.5.4.4	[ɹ] insertion by the Chinese participants.....	179
3.5.4.5	Consistency and word-likeness.....	179
3.5.4.6	Relationship between scores and LOR/AOA.....	180
3.6	Comparison between Japanese and the Chinese participants.....	181
3.6.1	Overall results.....	181
3.6.2	Discussion.....	183
3.6.2.1	Score difference between the Japanese and Chinese participants.....	183
3.6.2.2	Silent-E by the Japanese and the Chinese participants.....	184
3.6.2.3	[ɹ] insertion by the Japanese and Chinese participants.....	184
3.6.2.4	Other differences and similarities.....	184
Chapter 4	Experiments of phoneme-to-grapheme correspondence.....	187
4.1	Stimuli and procedure for the spelling task.....	188
4.1.1	Audio stimuli.....	188
4.1.2	Dialectal differences.....	189
4.1.3	Speech rate differences.....	191
4.1.4	Other conditions.....	192
4.1.5	Procedure of the experiment.....	194
4.2	The Canadian participants.....	195
4.2.1	Results of the Canadian participants.....	195
4.2.2	Discussion.....	201
4.2.2.1	Perception-related errors by the Canadian participants.....	201
4.2.2.2	Transcription of phonetic vowel length by the Canadian participants.....	205
4.2.2.3	Revisiting corresponding graphemes of [ʊ] and [aʊ].....	206
4.2.2.4	Spelling of BC [ɑ:], Mississippi [ɑ:], and [ɔ:] ([ɔʊ]).....	208
4.3	The Japanese participants: how they compare with the native speakers.....	211
4.3.1	Evaluation criteria for non-native participants.....	211
4.3.1.1	Points for the Japanese/Chinese EAL participants' spellings.....	211
4.3.1.2	Coding: acceptable spellings and bidirectional consistency.....	213
4.3.2	Results of the Japanese participants.....	216
4.3.3	Discussion.....	231
4.3.3.1	General discussion.....	231
4.3.3.2	Difficult and easy BC Normal stimuli for the Japanese participants.....	232
4.3.3.2.1	Spelling on BC normal stimuli in cluster 1.....	234
4.3.3.2.2	Spelling on BC normal stimuli in cluster 2.....	243
4.3.3.2.3	Spelling on BC normal stimuli in cluster 3.....	245
4.3.3.2.4	Spelling on BC normal stimuli in cluster 4.....	248
4.3.3.2.5	Summary of results on BC normal stimuli.....	249
4.3.3.3	Difficult and easy stimuli (the whole set) for the Japanese participants.....	250
4.3.3.3.1	Spelling on cluster 1 stimuli.....	252
4.3.3.3.2	Spelling on cluster 2 stimuli.....	258
4.3.3.3.3	Spelling on cluster 3 stimuli.....	260
4.3.3.3.4	Spelling on cluster 4 stimuli.....	262
4.3.3.4	<r>-insertion by the Japanese participants.....	265
4.3.3.5	<h>-insertion by the Japanese participants.....	266
4.3.3.6	Silent-E by the Japanese participants.....	267

4.3.3.7	<l, m, n, ng>-insertion by the Japanese participants	268
4.3.3.8	Relationship between scores and LOR/AOA/self-evaluation	270
4.3.3.9	L1-L2 Dual correspondence in <a> and <ai/ay>	276
4.4	The Chinese participants: how they compare with the native speakers.....	278
4.4.1	Results of the Chinese participants	278
4.4.2	Discussion	290
4.4.2.1	General discussion.....	290
4.4.2.2	Difficult and easy BC Normal stimuli for the Chinese participants.....	290
4.4.2.3	Difficult and easy stimuli (the whole set) for the Chinese participants	294
4.4.2.4	<r>-insertion by the Chinese participants	297
4.4.2.5	<h>-insertion by the Chinese participants.....	297
4.4.2.6	Silent-E by the Chinese participants	298
4.4.2.7	<l, m, n, ng>-insertion by the Chinese participants	299
4.4.2.8	Relationship between scores and LOR/AOA.....	300
4.4.2.9	The Chinese participants' learning patterns	303
4.5	Comparison between the Japanese and Chinese participants.....	304
4.5.1	Overall results	304
4.5.2	Discussion	309
4.5.2.1	Score difference between the Japanese and Chinese participants.....	309
4.5.2.2	<r>-insertion by the Japanese and Chinese participants	309
4.5.2.3	<h>-insertion by the Japanese and Chinese participants.....	310
4.5.2.4	Silent-E by the Japanese and Chinese participants	311
4.5.2.5	<l, m, n, ng>-insertion by the Japanese and Chinese participants	311
4.5.2.6	Other differences and similarities.....	314
4.6	Relationship between the reading and spelling tasks	315
4.6.1	Correlation between the reading task and the spelling task.....	315
4.6.2	Relationship between grapheme-to-phoneme and phoneme-to-grapheme conversions by the Japanese participants.....	315
4.6.2.1	Easy/difficult correspondences in both directions.....	316
4.6.2.2	Easy correspondences only in one direction	316
4.6.3	Relationship between grapheme-to-phoneme and phoneme-to-grapheme conversions by the Chinese participants	318
4.7	Overall patterns about GPC by EAL learners.....	318
Chapter 5	Implications and conclusion	320
5.1	Practical application in teaching and the direction of future research.....	320
5.1.1	Teaching method that I suggest	320
5.1.2	Loanword rōmaji and English education	325
5.1.3	Future research and challenges for practical application.....	326
5.2	Limitation	327
5.3	Conclusion	328
References:	333
Appendix 1	The reading task.....	353
Appendix 2	The spelling task.....	356

List of Tables

Table 1.	Phonemic symbols and corresponding approximate phonetic symbols used in this dissertation	8
Table 2.	CE speakers' perception-based Japanese-English counterparts	53
Table 3.	Default and conditioned grapheme-to-phoneme correspondence in American English vowels in monosyllabic words (Kessler & Treiman, 2001, 602)	58
Table 4.	Default and conditioned phoneme-to-grapheme correspondence in American English vowels in monosyllabic words (Kessler & Treiman, 2001, 608)	59
Table 5.	British English PR phoneme-to-grapheme correspondence according to Carney (1994) (Van Berkel, 2005, p.104-105)	61
Table 6.	Alphabet vowel sounds and relative vowel sounds	63
Table 7.	Vowel digraphs	63
Table 8.	13 stressed vowel sounds represented in The American Heritage Dictionary of the English Language	69
Table 9.	Comparison of three major types of phonemic notations: IPA in this paper (top), The American Heritage Dictionary of the English Language (middle), and Scholastic Pocket Dictionary (bottom)	70
Table 10.	Some stimuli of the pseudoword-matching task in Nassaji (2003, 265) and Nassaji and Geva (1999, 247)	71
Table 11.	Japanese EFL learners' English spelling errors in loanwords from English (Goble, 2001, 66-67)	76
Table 12.	Spelling patterns in the spelling task by Japanese second grade middle school students (Shinagawa, 2004)	77
Table 13.	Letter (top) sound (bottom) correspondence of the cabinet-ordered rōmaji for normal/independent morae implemented in 1937	85
Table 14.	The cabinet-ordered rōmaji rules for special/dependent morae updated in 1954	86
Table 15.	Alternative letter (top) sound (bottom) correspondence of rōmaji implemented in 1954 prescribed by the Ministry of Education, Culture, Sports, Science and Technology-Japan	86
Table 16.	Letter (top) sound (bottom) correspondence of British standard rōmaji that do not have the counterparts of the international standard	88
Table 17.	Variations of rōmaji as of 2015	91
Table 18.	Spelling, corresponding North American English vowels, and typical corresponding Japanese vowels based on loanword rōmaji according to Kaneko (2006)	99
Table 19.	Transliteration and phonetic transcription for the station names Japa/ke:o:haʃi:ɔ:dʒi/ and /ʃo:ɸu/	114
Table 20.	Results of letter-to-sound correspondence of loanword rōmaji in English-looking proper names (Nogita, 2016c)	115
Table 21.	Summary of the participants	122
Table 22.	5 Canadian participants' answers regarding low back vowels	126
Table 23.	Written stimuli and distracters for the nonsense word-reading task	127
Table 24.	Results of the Canadian participants' productions in the reading task	130
Table 25.	Word-likeness and the number of production variations by the Canadian participants in the reading task	137
Table 26.	Criteria for evaluating Japanese/Chinese EAL participants' performance in the reading task	143
Table 27.	Results of the Japanese participants' productions in the reading task	144

Table 28.	Cluster 1 (most challenging particularly for lower score participants) stimuli and average scores	150
Table 29.	Cluster 2 (moderately challenging) stimuli and average scores	150
Table 30.	Cluster 3 (easiest) stimuli and average scores	150
Table 31.	The number of silent-E errors and correct productions by 44 Japanese participants	163
Table 32.	The number of [ɹ] insertion/hyper rhotacization by 44 Japanese participants...	164
Table 33.	Word-likeness and the number of production variations by the Japanese participants	166
Table 34.	Average scores by longer and shorter LOR Japanese EAL participants	166
Table 35.	Standardized coefficients of the score and the three factors of the Japanese participants	167
Table 36.	Results of the Chinese participants' responses in the reading task.....	172
Table 37.	Cluster 1 stimuli and average scores.....	176
Table 38.	Cluster 2 stimuli and average scores.....	176
Table 39.	Cluster 3 stimuli and average scores.....	177
Table 40.	The number of silent-E errors and correct productions by 24 Chinese participants	178
Table 41.	Word-likeness and spelling variations by the Chinese participants.....	179
Table 42.	Average scores by Chinese ESL and EFL participants	180
Table 43.	First (most frequent) and second (the second most frequent) choices by the Canadian, Japanese, and Chinese participants in the reading task	181
Table 44.	Average scores by longer and shorter LOR Japanese EAL participants plus Chinese ESL and EFL participants	183
Table 45.	BC accent stimuli	188
Table 46.	Mississippi accent stimuli	188
Table 47.	Distractors	189
Table 48.	The Canadian participants' spellings for British Columbia normal speed stimuli	195
Table 49.	The Canadian participants' spellings for Mississippi normal speed stimuli.....	197
Table 50.	The Canadian participants' spellings for British Columbia normal and slow speed stimuli (4 participants listened to the original stimuli and 10 listened to synthetically lengthened stimuli.).....	198
Table 51.	The Canadian participants' spellings for Mississippi normal and slow speed stimuli (4 participants listened to the normal stimuli and 10 listened to synthetically lengthened stimuli.).....	200
Table 52.	The number of errors in normal speed stimuli by the Canadian participants	202
Table 53.	Errors in synthetically lengthened (or slow) stimuli by the Canadian participants	202
Table 54.	Spelling types for the low back vowels	208
Table 55.	The Canadian participants' spelling patterns in BC /ɑ/ ([ɑ:]), Mississippi /ɑ/ ([ɑ:]), and /ɔ/ ([ɔɔ])	209
Table 56.	Criteria for evaluating the Japanese/Chinese participants' performance in the spelling task	211
Table 57.	The Japanese participants' spellings for British Columbia normal speed stimuli	216
Table 58.	The Japanese participants' spellings for all the stimuli	219
Table 59.	Average scores and the numbers of 0-point spellings by the Japanese participants	230
Table 60.	Cluster 1 (most challenging) BC stimuli for 45 Japanese participants.....	233

Table 61.	Cluster 2 (2 nd most challenging) BC stimuli for 45 Japanese participants	233
Table 62.	Cluster 3 (3 rd most challenging) BC stimuli for 45 Japanese participants.....	233
Table 63.	Cluster 4 (least challenging) BC stimuli for 45 Japanese participants	233
Table 64.	Cluster 1 (most challenging) stimuli for 45 Japanese participants	251
Table 65.	Cluster 2 (the second most challenging) stimuli for 45 Japanese participants ..	251
Table 66.	Cluster 3 (the third most challenging) stimuli for 45 Japanese participants.....	251
Table 67.	Cluster 4 (the least challenging) stimuli for 45 Japanese participants.....	252
Table 68.	The number of <r>-insertion by 45 Japanese participants.....	265
Table 69.	The number of <h>-insertion by 45 Japanese participants	266
Table 70.	Silent-E-related errors by 45 Japanese participants	267
Table 71.	The number of missing-E errors by 45 Japanese participants for each stimulus	267
Table 72.	The number of adding-E errors by 45 Japanese participants for each stimulus	268
Table 73.	Average <l, m, n, ng>-insertion per participant.....	269
Table 74.	The number of <l>-insertion by 45 Japanese participants	269
Table 75.	The number of nasal letter insertion by 45 Japanese participants	269
Table 76.	Scores and the numbers of 0-point spellings by longer and shorter LOR Japanese EAL participants	270
Table 77.	Standardized coefficients of the score and the three factors of the Japanese participants	272
Table 78.	Standardized coefficients of <r> insertion and the three factors of the Japanese participants	274
Table 79.	Standardized coefficients of silent-E-related errors and the three factors of the Japanese participants.....	275
Table 80.	Standardized coefficients of <l, m, n, ng>-insertion errors and the three factors of the Japanese participants.....	275
Table 81.	The Chinese participants' spellings for British Columbia normal speed stimuli	278
Table 82.	The Chinese participants' spellings for all the stimuli.....	281
Table 83.	Average scores and the numbers of 0-point spellings by the Chinese participants	289
Table 84.	Cluster 1 (most challenging) BC stimuli for 24 Chinese participants	291
Table 85.	Cluster 2 BC stimuli for 24 Chinese participants	292
Table 86.	Cluster 3 BC stimuli for 24 Chinese participants	292
Table 87.	Cluster 4 (retrogression) BC stimuli for 24 Chinese participants.....	292
Table 88.	Cluster 4 BC normal stimuli and all the participants' spellings	293
Table 89.	Cluster 1 (most challenging) stimuli for 24 Chinese participants.....	294
Table 90.	Cluster 2 stimuli for 24 Chinese participants.....	295
Table 91.	Cluster 3 (U-shaped) stimuli for 24 Chinese participants.....	295
Table 92.	Cluster 4 (retrogression) stimuli for 24 Chinese participants	295
Table 93.	Cluster 4 stimuli and all the participants' spellings	296
Table 94.	The number of <r>-insertion for each stimulus by 24 Chinese	297
Table 95.	The number of <h>-insertion by 24 Chinese participants	297
Table 96.	The number of missing-E errors by 24 Chinese participants.....	298
Table 97.	The number of adding-E errors by 24 Chinese participants	298
Table 98.	Average <l, m, n, ng>-insertion by 24 Chinese participants	299
Table 99.	The number of <l>-insertion by 24 Chinese participants	299
Table 100.	The number of nasal letter insertion by 24 Chinese participants.....	300
Table 101.	Average scores and the numbers of 0-point spellings by the Chinese EFL, ESL participants	300

Table 102.	Standardized coefficients of <l>-insertion and the two factors of the Chinese participants	302
Table 103.	First (most frequent) and second (second most frequent) choices by the Canadian, Japanese, and Chinese participants in the spelling task	304
Table 104.	Comparison between the Japanese and Chinese participants in performance	309
Table 105.	The average number of <r>-insertion errors in all the 71 stimuli from each participant in both Chinese and Japanese groups	309
Table 106.	Revised <r>-insertion errors with possible British spellings excluded	310
Table 107.	<h>-insertion in all the 71 stimuli by the Japanese and Chinese participants	311
Table 108.	Silent-E-related errors by the Japanese and Chinese participants	311
Table 109.	Average <l, m, n, ng> insertion by the Japanese and Chinese participants	311
Table 110.	Average numbers of unacceptable nasal-letter-insertion errors by the Japanese and Chinese participants (out of 71 stimuli)	313
Table 111.	Both original and revised numbers of 0-point spellings that exclude British English-like <r>-insertion and acceptable nasal-letter-insertion	313
Table 112.	Revised number of 0-point spellings excluding <l>-insertion errors	313
Table 113.	Correlation between the reading task and the spelling task	315
Table 114.	13 stressed vowel sounds represented in The American Heritage Dictionary of the English Language along with perceptually similar Japanese vowel counterparts	322
Table 115.	English consonant inventory	323

List of Figures

Figure 1. The dual-route model of reading aloud (Cook, & Bassetti, 2005, 14).....	15
Figure 2. Normalized F1 and F2 mean vowels \pm one standard error of unstressed vowels by orthographic representation for native English speakers (left) and late Japanese-English bilinguals (right) (Lee et al., 2006, 504).....	18
Figure 3. Schematic diagram of transfer for EAL student who possesses L1 literacy knowledge (Figueredo, 2006, 883, reprinted with permission).....	27
Figure 4. Formant shift of the 12 North American English vowels (Majors, 2005, 173, reprinted with permission).....	39
Figure 5. Average English vowel duration (Hillenbrand et al., 2000, 3014, reprinted with permission).....	40
Figure 6. A problematic common Japanese-English vowel comparison	41
Figure 7. Lip protrusion in standard Japanese [u] (from Nogita et al., 2013, 40).....	44
Figure 8. The 2-mora structure of both Eng[o ⁰] (/V/) and Japa[gjōgjō] (/CCVCCV/).....	50
Figure 9. The problematic popular 3-to-1 correspondence (left) and the more legitimate 1-to-1 correspondence according to our study	55
Figure 10. The Japanese name Kei Nishikori along with the anglicized pronunciation guide from sport news.....	68
Figure 11. Pronunciation respelling in The Westcoast Reader 35(4) December 2015	69
Figure 12. A SENCOFEN sign found in University of Victoria	84
Figure 13. Names with existing English words written with loanword rōmaji along with katakana pronunciation guides.....	102
Figure 14. Names with existing English words written with loanword rōmaji without pronunciation guide	102
Figure 15. English phrases for a practical use along with katakana pronunciation guides	103
Figure 16. English words for a practical use without pronunciation guides	103
Figure 17. English words along with katakana pronunciation guides on a book for preliterate children	104
Figure 18. Kana pronunciation guides put on the right side of kanji and loanword rōmaji in the Japanese magazine Shōnen Jump.....	104
Figure 19. A bank name written with loanword rōmaji along with hiragana	105
Figure 20. A local mall name written with loanword rōmaji with (left) and without (right) hiragana	105
Figure 21. Store names with regular rōmaji with hiragana and rōmaji alone	106
Figure 22. Italian-based loanword rōmaji with katakana (left) and French-based loanword rōmaji without katakana (right)	107
Figure 23. Mixtures of regular rōmaji and loanword rōmaji.....	107
Figure 24. A mixture of French-based BC-LSC rōmaji and regular rōmaji (left) and a mixture of loanword rōmaji, kanji, katakana, and numbers	107
Figure 25. A bus company name written with kanji + katakana and roman alphabet	108
Figure 26. Both Japanese and English words are on a menu	109
Figure 27. A Japanese origin name written with loanword rōmaji	110
Figure 28. A bilingual notice in Richmond, in British Columbia, Canada	111
Figure 29. A bilingual sign in Inner Mongolia: “Please do not throw away your garbage.”	111
Figure 30. Train station names in Japan indicated in Japanese kanji, Japanese hiragana, Chinese and Korean translations, and English translation from the top	112

Figure 31.	Both Japanese and English of a company name (left) and a street name (right)	114
Figure 32.	The F2 difference between the stimulus <staw> (left) with regular [ɑ:] and <sta> (right) with foreign (a) by a 24-year-old male from Vancouver.....	135
Figure 33.	pitch curves (blue lines) of <sta> and <stoh> by a female Japanese participant with three weeks of LOR	142
Figure 34.	<sta> by a male Japanese participant with six years of LOR	143
Figure 35.	Clustered nonsense word stimuli based on the Japanese participants' performance	149
Figure 36.	Orthographic representations and phonetic notations with IPA for an English word and pinyin for a Chinese word.....	170
Figure 37.	Clustered nonsense word stimuli based on the Chinese participants' performance	176
Figure 38.	F2 comparison of MS[smə:], BC[dɑ:], and MS[stɑ:]	190
Figure 39.	Diphthongized Mississippi [snæəm], [spɛəm], and [bɪəm]	191
Figure 40.	Relatively monophthongal BC [dæ:z], [smɛz], and [dɪz]	191
Figure 41.	Vowel durations of the normal speed stimulus [pʊd] (left) and the slow speed counterpart of [sɒd] (right)	192
Figure 42.	The screen for the spelling task	194
Figure 43.	Clustered BC normal stimuli based on the Japanese participants' performance	232
Figure 44.	All the clustered stimuli based on the Japanese participants' performance	250
Figure 45.	Distribution of LOR of the Japanese participants.....	272
Figure 46.	Dual sound-to-spelling correspondence: examples of <a> and <ai/ay>	277
Figure 47.	Clustered BC normal stimuli based on the Chinese participants' performance	291
Figure 48.	Clustered stimuli based on the Chinese participants' performance	294
Figure 49.	Clustered Chinese participants based on difficulty of all the stimuli	303
Figure 50.	Asymmetrical [æ:, æə, ɛə]-to-<a> and <a>-to-[a] conversions	318
1.	Master the sound inventory and corresponding phonographic letters.	320
2.	Put the phonographic letters alongside corresponding logographic letters as pronunciation guides.....	320
3.	Gradually memorize a sound of each logographic letters as well as rules if any.	320
Figure 51.	Hiragana/katakana put on the right side of kanji and loanword rōmaji in the Japanese magazine Shōnen Jump	321
Figure 52.	Pinyin put above hanzi in the children's book dīz ī guī	322

List of Abbreviations

- **AOA:** Age of acquisition (age at which learners began studying English)
- **CE:** Canadian English
- **EAL:** English-as-an-additional language (includes both ESL and EFL)
- **EFL:** English-as-a-foreign-language (learners of English in a place where English is not spoken)
- **ESL:** English-as-a-second-language (learners of English in a place where English is a primary language)
- **F1, F2:** The first formant, the second formant (in acoustic phonetics)
- **GPC:** Grapheme-phoneme/phoneme-grapheme correspondence
- **LOR:** Length of residence (in Canada)
- **IPA:** International Phonetic Alphabet
- **L1:** First language
- **L2:** Second language or any additional language
- **LSC:** Letter-sound/sound-letter correspondence
- **RP:** Received Pronunciation

Brackets

- **< >:** graphemes, or written forms
- **/ /:** phonemes, or mental representations of segment sounds that change word meanings
- **[]:** phonetic representations, or lower-level sound representations that may not necessarily change word meanings

Archiphonemes/archigraphemes (unspecified phonemes/graphemes)

- /V/, [V] = a vowel phoneme/phone
- /C/, [C] = a consonant phoneme/phone
- /#/ = word-final
- <V> = a vowel grapheme
- <C> = a consonant grapheme
- <#> = word-final

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Chapter 1 Introduction

1.1 Introduction

Graphophonic skills, that is, to correctly spell out the sounds heard and to correctly read out orthography are some of the most important aspects in successfully learning second language pronunciation in a formal setting. The main focus of this dissertation is to investigate to what extent Japanese English-as-an-additional-language (EAL) learners have mastered default grapheme-phoneme correspondence (GPC) patterns of North American English vowels. The underlying motivation of this research is this: I consider that second language (L2) pronunciation errors are caused by several factors other than phonetics and phonology, and I hypothesize that many mispronunciations of English vowels by Japanese EAL learners are caused by their misinterpretation of English spellings rather than by articulation problems. As the first step to verify my hypothesis, I will examine how Japanese EAL learners map all the 13 North American English vowels onto vowel graphemes in this dissertation.

Unfortunately, it is not until recently that a relationship between letters and sounds in L2 has come to draw researchers' attention (Bassetti, Escudero, & Hayes-Harb, 2015; Simon & Van Herreweghe, 2010). However, I have always been attaching importance to it. This is because the connection between letters and sounds are virtually unbreakable once letters are learned (Treiman & Cassar, 1997). Even in L1, this is in fact the case as various studies show: for example, Bürki, Spinelli, and Gaskell (2012) in their article "A written word is worth a thousand spoken words" find that looking at spelling once can change the speaker's phonological representations in their mental lexicon, affecting both recognition and production. Particularly in the case of L2 learners in a formal setting, they typically start to be exposed to orthography when their L2 knowledge is limited (Bürki, 2012), so I suspect that a

letter influence on sounds in L2 could be even greater than in L1. Therefore, I consider that a proper understanding of the L2 GPC patterns should not be neglected.

When it comes to EAL learning, a challenge for learners would be the notoriously inconsistent English GPC, particularly in vowel graphemes and phonemes. However, it should be noted that there are default vowel GPC patterns (see §2.3.1.1 for more details), such as <a>, <e>, <i>, <o>, and <u> in closed syllables typically corresponding to [æ:], [ɛ], [ɪ], [ɑ:], and [ʌ] as in *bad*, *bed*, *bid*, *bod*, and *bud*, respectively, in North American English. I believe that learning only such default or “regular” patterns should not be too challenging. I also believe that such patterns need to be learned by EAL learners because otherwise various problems are expected to occur. For instance, if the letter <i> is associated to the vowel sound [i] (but not [ɪ]) in the EAL learner’s interlanguage GPC, when the learner encounters a new regularly spelled written word *hit*, for example, before being exposed to the spoken form [hit], s/he would store the word *hit* as [hit], which sounds closer to *heat*, in his/her mental lexicon. Then, when the learner encounters the spoken form of *hit* (i.e., [hit]) pronounced by a native English speaker, the learner would not associate [hit] with the spelling <hit>, but with a different spelling instead, such as <het>, and would not be able to recognize [hit] as the lexical item *hit*. In other words, the visual form <hit> and the sound form [hit] would not match due to improper GPC knowledge. Empirically, such incidents do happen at least to Japanese EAL learners. So I argue that while it may be overwhelming for EAL learners to be required to memorize all the minor GPC rules, at least the skills of dealing with default GPC patterns are necessary for them.

To acquire such skills, learners need to understand the English phoneme inventory and the default corresponding grapheme of each phoneme. Nevertheless, when it comes to the formal English education in Japan, such skills have been mostly neglected. In most cases, only the English names of the 26 roman alphabet letters (e.g., <A> = [eɪ], = [bi:], <C> =

[si:], etc.) are taught, but virtually no systematic instructions of the English phoneme inventory and default GPC patterns are given in the English education system in Japan. In fact, there are six different English textbooks for middle school (the usual start of formal English teaching in Japan), and which one of them is used depends on the school, but according to Ueda and Otsuka (2010), among these six, five of them do not introduce all the English phonemes and one of them covers as little as 50% of the vowels and 25% of the consonants. Additionally, there are reports like Imanaka (2003), who interviewed 74 native Japanese speaking university students in Japan majoring in British and American language and culture, and found that none of the interviewees had formally learned English GPC rules. This current situation needs to be taken very seriously. Imagine this hypothetical situation: in Mandarin classes, only the traditional Chinese way of calling the roman alphabet letters (e.g., <A> = *a*, = *bai*, <C> = *cai*, <D> = *dai*, etc.) is taught but no systematic instructions of the Mandarin sound inventory and the *pinyin* (the standardized pronunciation guide for the Chinese logographs) GPC rules (e.g., <u> in <su> to /u/ but <u> in <xu> to /y/) are given, or in Korean classes, only the names of the Korean alphabet letters (e.g., <ㄴ> = /niin/, <ㅁ> = /miim/, etc.) are taught but no systematic instructions of the Korean sound inventory and the GPC rules (e.g., <ㄴ>-to-/n/, <ㅁ>-to-/m/, etc.) are given. Teachers of Mandarin or Korean would definitely not accept such a situation. However, it is mostly accepted in English classes in Japan.

To make the problem worse, there is an unfortunate misconception/myth in the Japanese EAL education system that Japanese has few vowels (only 5) while English has more than twice as many, so Japanese EAL learners have to learn many new vowels. In §2.2, I will explain that this popular belief is a fallacy, since it overlooks crucial phonetic qualities, specifically diphthongization and duration. In other words, English vowel sounds are much

less difficult for native Japanese speakers than generally believed in terms of articulation. This indicates that mispronunciations of English vowels by Japanese EAL learners are not necessarily caused by articulation problems, but likely caused by other factors, such as misinterpretation of English spelling. However, because of this popular myth, Japanese EAL learners' mispronunciations of English vowels are typically attributed to articulation problems, and a possibility of learners' misinterpretation of English spelling is often overlooked.

To make the matter even worse, there is the existent roman alphabet spelling of Japanese foreign words which I will call *loanword rōmaji*. Read in the Japanese way, loanword rōmaji is believed by most Japanese speakers to be authentic English. For example, <TM Network> (the name of a Japanese musical band) is pronounced as the Japanese phonology-based /ti:emu nettowa:ku/ as opposed to English /tiem nɛtwɜ:k/ (as will be discussed in §2.5). This roman alphabet reading, called between-language GPC (Kaneko, 2006; Vendelin & Peperkamp, 2006), needs to be clearly separated from English GPC. However, just as Japanese EAL learners often cannot separate loanwords of English origin from cognate English words (Igarashi, 2008; Goble, 2001), loanword rōmaji and English spelling are also mixed up by Japanese speakers (as will be discussed in §2.5). Under this circumstance, it is expected that the conventional between-language GPC in loanword rōmaji greatly influences Japanese EAL learners' English. However, the extensive use of loanword rōmaji in the Japanese culture and its expected influence on Japanese EAL learners' interpretation of actual English spelling usually do not draw much attention in the English education.

As a first step in helping these Japanese EAL learners faced with such daunting obstacles in their EAL learning, it is important to assess how the Japanese EAL learners perform in the two capabilities mentioned above (correctly spelling out English sounds and

reading out English spelling as target-like as possible). Specifically, I will focus on Japanese EAL learners GPC knowledge of all the 13 North American English vowel phonemes (in many dialects) [i:, ɪ, e^l, ε, æ:, α:, o^u, ʊ, u:, ʌ, aɪ, aʊ, ɔɪ]. This is because 1) English vowel GPC is particularly complex, and 2) to my knowledge, no researchers have studied Japanese EAL learners' GPC knowledge of a whole set of the North American English vowel inventory. Along with the above inquiry, I will examine how Japanese EAL learners differ from native English speakers in such knowledge, as well as how Japanese EAL learners differ from other L1 EAL learners, specifically Chinese EAL learners who also have a logographic writing system in their L1.

1.2 Research questions

Following are research questions that this work attempts to answer:

- 1) How do Japanese EAL learners read aloud English vowel letters in unfamiliar words?
- 2) How do Japanese EAL learners spell English vowel sounds in unfamiliar words?

This is my prediction: since virtually no formal instruction of the English phoneme inventory and GPC is given in most English classes in Japan, a scenario that I can imagine is that when Japanese EAL learners encounter unfamiliar written/spoken English words, they would consult either standard rōmaji (*Hebon-shiki* or *kunrei-shiki* rōmaji) or the aforementioned loanword rōmaji.

1.3 Dissertation outline

This dissertation consists of five chapters, including this introduction chapter. Chapter 2 provides background information regarding second language letter-sound correspondence

by reviewing previous studies: specifically, how written forms and sound forms influence each other in §2.1, the English and Japanese vowel sound system in §2.2, the English vowel spelling system in §2.3, and the Japanese vowel spelling system in roman alphabet in §2.4 (regarding regular rōmaji) and §2.5 (regarding loanword rōmaji). Chapter 3 and Chapter 4 answer the research questions by conducting two experiments: a one-syllable English-like nonsense word-reading task and a one-syllable English-like nonsense word-spelling task by Japanese EAL participants, native Canadian English-speaking participants, as well as Chinese EAL learners as a reference. Chapter 5 is a short chapter that provides teaching implications and directions for future research.

1.4 Notes on symbols and terminology

In this section, I define symbols and terms that I use in this paper

1.4.1 IPA transcription

1.4.1.1 Japanese vowels

I use IPA symbols to indicate linguistic sounds. Japanese transcription is based on standard Japanese spoken around the Tokyo region (where I am from). For one-mora monophthongs, I use [ẽ, ĩ, ũ, ě, ǝ] for approximate phonetic transcription in accordance with Makino (2009) and Nogita, Yamane, and Bird (2013), and /a, i, u, e, o/ for phonemic transcription for one-mora monophthongs. For two-mora monophthongs, I use [ɛ:, i:, u:, ɛ:, ɔ:] and /a:, i:, u:, e:, o:/ respectively. One-mora monophthongs and two-mora counterparts are acoustically not necessarily identical, but in this dissertation I use the same symbols for the sake of simplicity, except for [ẽ] and [ɛ:]. See §2.2.2 for more details. Japanese has phonemic pitch accent, but I generally omit pitch accent diacritics unless necessary.

1.4.1.2 English vowels

English transcription is based on the North American English 13 vowel inventory. For phonemic transcription, I adopt the broad phonetic symbols [i:, ɪ, e^ɪ, ε, æ:, α:, o^ʊ, ʊ, u:, ʌ] for the 10 so-called monophthongs and [aɪ, aʊ, ɔɪ] for the three “true” diphthongs in accordance with Nishi, Strange, Akahane-Yamada, Kubo, and Trent-Brown (2008). When I contrast the THOUGHT vowel as the 14th vowel as opposed to the LOT vowel, I adopt [ɔ:] as opposed to [ɑ:] in accordance with Nishi et al. (2008). For phonemic transcription, I adopt /i, ɪ, e, ε, æ, α, o, ʊ, u, ʌ, aj, aw, ɔj/ for phonemic transcription in accordance with Hammond (1999), except that I use the /j/ for the [j]-off-glide rather than /y/ in order to contrast with the rounded high front vowel that occurs in languages like Mandarin. See §2.2.1 for more details. As for [ə], Hammond (1999) mentioned that [ʌ] and [ə] differ only in stress so there is no need for different symbols if stress is marked. Therefore, I treat [ʌ] and [ə] as allophones of /ʌ/, but not as the 14th phoneme. However, I occasionally use the symbol /ə/ or [ə] for unstressed vowels in accordance with custom or when I cite other papers. An English stress diacritic is omitted unless necessary.

1.4.1.3 Phonemic and phonetic transcription

Potential misleadingness is that the same phonemic symbol in English and Japanese can be phonetically very different. For example, the symbols /e, o/ in English, as in *ate* and *oat* respectively, and the same symbols /e, o/ in Japanese, as in *Edo* ‘Edo, the former name of Tokyo’ represent phonetically very different sound qualities: Eng[ei, oo] and Japa[ě, ۆ]. Likewise, the symbol /a/ in English, as in *hot*, and the symbol /a/ in Japanese, as in *ame* ‘rain’, look similar but these represent phonetically noticeably different sounds in both duration and vowel quality: Eng[ɑ:] and Japa[ě]. In cross-linguistic comparisons, this issue does not seem unusual, and can mislead readers: for example, North German /y/ and Parisian French /y/ are phonetically very different although the same symbol is used (Strange, Bohn, Trent, and

Nishi, 2004). Moreover, in Japanese EAL learners' interlanguage phonemes, English [i:] as in *eat* and Japanese [i:] as in *kurīmu* 'cream' are likely to be categorized in the same interlanguage phoneme, but these are assigned to different phonemic symbols based on the conventional transcription (Eng/i/ and Japa/i:/ respectively), so the conventional phonemic transcription and possible Japanese EAL learners' interlanguage phonemes (or mental representations) do not necessarily match. In order to avoid readers' potential confusion, I provide a chart that show phonemic symbols and corresponding approximate phonetic symbols used in this dissertation in Table 1.

Table 1. Phonemic symbols and corresponding approximate phonetic symbols used in this dissertation

Phonemic	English		Phonetic	Japanese
	Phonetic	Example		Example
/i/	[i:]	<i>fleece</i>	[ĩ]	<i>ika</i> 'squid'
/ɪ/	[ɪ]	<i>kit</i>		
/e/	[eʰ]	<i>face</i>	[ĕ]	<i>e</i> 'drawing'
/ɛ/	[ɛ]	<i>dress</i>		
/æ/	[æ:]	<i>trap</i>		
/ɑ/	[ɑ:]	<i>lot</i>		
/o/	[o ^o]	<i>goat</i>	[ō]	<i>ono</i> 'axe'
/ʊ/	[ʊ]	<i>foot</i>		
/u/	[u:]	<i>goose</i>	[ũ]	<i>uma</i> 'horse'
/ʌ/	[ʌ]	<i>strut</i>		
/aj/	[aɪ]	<i>price</i>		
/aw/	[aʊ]	<i>mouth</i>		
/ɔj/	[ɔɪ]	<i>choice</i>		
/ɔ/	[ɔ:]	<i>thought</i>		
/a/			[ĕ]	<i>ashita</i> 'tomorrow'
/a:/			[ɸ:]	<i>obāchan</i> 'grandmother'
/i:/			[i:]	<i>kurīmu</i> 'cream'
/u:/			[u:]	<i>shūji</i> 'calligraphy'
/e:/			[ĕ:]	<i>karē</i> 'curry'
/o:/			[ō:]	<i>sōri</i> 'prime minister'

In this dissertation, for English vowel transcription, I mainly use broad phonetic transcription in order to avoid confusions such as visually very similar phonemic symbols Eng/ɑ/ and Japa/a/ misconceived as phonetically very similar sounds; note that a potential confusion by IPA symbols will be discussed in §2.2.3. In contrast, for Japanese transcription,

I mainly use phonemic transcription for the sake of simplicity. This results in an inconsistency between phonetic transcription for English and phonemic transcription for Japanese, but I prioritize avoidance of readers' confusion.

1.4.1.4 IPA transcription of other languages

In order to clarify what language I am transcribing, occasionally I add 'Eng', 'Japa', 'Chi', 'Kor', 'Spa', 'Fren' and so on to indicate English, Japanese, Mandarin Chinese, Korean, Spanish, French, respectively: for example, Eng/e/ and Japa/e/.

1.4.2 Romanization

There are several different variations in Japanese romanization, as will be discussed in §2.4, but in this paper, I generally adopt *Hebon-shiki* or *Hepburn rōmaji*. The reason for this is that it is more convenient than *kunrei-shiki* for morae used only in loanwords, or loanword morae. For example, with *kunrei-shiki* rōmaji, <ti> indicates Japa[ʧĩ], so the way to spell Japa[tĩ], as opposed to Japa[ʧĩ], is not clear, whereas with Hepburn rōmaji, simply <chi> is Japa[ʧĩ] and <ti> is Japa[tĩ].

1.4.3 Terminology

Phonology-related terms

- **free vowels and checked vowels (in English)**

Free vowels are vowels that can occur word-finally and prevocally, such as [i:, e¹, o⁰, u:, ɑ:] in *free*, *stay*, *hoe*, *zoo*, and *spa*, while *checked vowels* are vowels that require a following consonant, specifically [ɪ, ɛ, æ:, ʌ, ʊ] as in *hit*, *set*, *hat*, *hut*, and *look*. I avoid the term *tense* and *lax* in order to avoid confusion, such that from an articulatory and acoustic point of view [æ:] may be a tense vowel, while from a phonotactic point of view [æ:] may be a lax vowel.

- **mora**

In Japanese, a mora is a timing unit, as opposed to a syllable that forms a curve of sonority (Kubozono, 1998). For example, the word *Honda* (Japa[hōndɔ̃]) (a car manufacturer) is divided into *Hon-da* by syllables, and into *Ho-n-da* by morae.

- **one-mora and two-mora monophthongs (in Japanese)**

These terms indicate Japanese phonemic vowel length. I avoid the terms *long vowels* and *short vowels* in order to avoid confusion with the English *long/alphabet vowels* and *short/relative vowels* that I will mention below. *One-mora-monophthongs* are the short ones, as in /sɔ̃ri/ ‘sleigh’, as opposed to *two-mora monophthongs*, as in /sɔ̃:ri/ ‘prime minister’.

- **vowel sequences/vocalic intervals**

While many phonologists attempt to distinguish diphthongs and vowel hiatuses (vowel sequences in separate syllables) in Japanese, such as /aj/ vs. /a.i/, in this paper, I usually do not distinguish them. I generally call both ‘vowel sequences’ or ‘vocalic intervals’.

Orthography-related terms

- **grapheme-phoneme correspondence**

This indicates a relationship between a grapheme and a phoneme. In this paper, this can be either direction: i.e., grapheme-to-phoneme or phoneme-to-grapheme. Its abbreviation is GPC.

- **letter/spelling-sound correspondence**

Letter-sound correspondence (LSC) is a broader term than grapheme-phoneme correspondence (GPC), including grapheme-mora, grapheme-syllable, grapheme-morpheme, a-sequence-of-graphemes-word, and so on. I also use *spelling-sound correspondence* interchangeably. Note that spelling can also indicate the convention of the writing system in a particular language, rather than letters per se, so I use the term *spelling* in both senses.

- **orthographic depth, a deep/shallow orthography**

In accordance with Frost, Katz, and Bentin (1987) and Liberman, Liberman, Mattingly, and Shankweiler (1980), orthographic depth refers to consistency in letter-sound correspondence. A shallow orthography is more phonemic and its letter-sound-correspondence (LSC) is close to a one-to-one relationship, while a deep orthography is more morphemic and its LSC is deviant from a one-to-one relationship.

- **alphabet vowel sounds and relative vowel sounds (in English)**

In this paper, *alphabet vowel sounds* are the sounds that are the same as the letter names, [e¹, i:, aɪ, o^ʊ, (j)u:] for <a, e, i, o u> as in *hate*, *Pete*, *bite*, *hope*, and *cute* respectively, while *relative vowel sounds* are the sounds that are different from letter names, [æ:, ε, ɪ, ɑ:, ʌ] for <a, e, i, o, u> as in *hat*, *pet*, *bit*, *hop*, and *cut* respectively, in accordance with Gilbert (2012, 10). The terms *long* and *short vowels* are more commonly used in educational literature or phonics as used in Jones (1996) or Carney (1994) or other children's phonics books as well as in sociolinguistic studies, such as Labov, Ash, and Boberg (2006). However, since the terms *long* and *short* can be confused with phonetic length, I avoid these in this paper.

- **romanization, roman alphabet**

In this paper, romanization indicates that languages that are originally not written with the roman alphabet are transliterated with the roman alphabet. Since I use these terms not to indicate a specific language, I start with the lower-case 'r' for both *romanization* and *roman* alphabet. As for other script names, whether starting with a capital letter or a lower-case letter depends on common conventions: for example, *Hangul* and *katakana* (rather than *hangul* and *Katakana*).

Chapter 2 Literature review and background

In this Chapter, I will first discuss how letters relate to sounds in second language (L2) in §2.1 in order to grasp the general idea of it. Then in §2.2, I will discuss the vowel systems in English and Japanese with a special focus on the popular myth that the English vowel system is much more complex than the Japanese vowel system. This discussion is important because the underlying motivation of this dissertation is to take the first step to verify my hypothesis that many vowel pronunciation errors by Japanese EAL learners are due to their misinterpretation of English spellings, and there should be a premise that pronouncing English vowels is in fact not as difficult as generally believed for native Japanese speakers. Not to mention, a comparison between L1 and L2 sound systems is a prerequisite for an investigation of L2 learners' grapheme-phoneme correspondence (GPC) patterns. In §2.3, I will discuss English spelling with a special focus on its regularity, rather than its irregularity. This discussion is also a prerequisite for an investigation of EAL learners' English default GPC patterns. Then in §2.4 and §2.5, I will discuss the usage of the roman alphabet in Japanese in order to predict possible L1 transfer in Japanese EAL learners' English spellings. In §2.4, I will discuss standardized Japanese romanization, or *rōmaji*, including Hepburn *rōmaji*, cabinet-ordered *rōmaji*, and a few other variations: for example, the *rōmaji* in which /to:kjo:/ 'Tokyo' is spelled as <Tōkyō/Tōkyō>. In §2.5, I will discuss another type of *rōmaji*, which I term *loanword rōmaji* for convenience. Loanword *rōmaji* is the one not being taught formally at school but seen commonly in everyday life: for example, /jonekkusu/ (a Japanese manufacturer of sporting equipment) spelled as <Yonex>, instead of the standardized *rōmaji* way *<Yonekkusu>.

2.1 Background of a relationship between letters and sounds

In §2.1, I will discuss how orthography and pronunciation are closely related in second language (L2) in general. One may ask why this is important. One of the reasons is that I consider that mispronunciations in L2 can be caused by several factors other than articulation difficulties, and one of these factors is misinterpretation of the spellings, as mentioned above.

In formal L2 teaching settings, what L2 teachers hope to avoid would be misdiagnosing learners' mispronunciations as their inability to produce certain sounds and provide unnecessary articulatory trainings only to further confuse learners when those mispronunciations are in fact misinterpretations of spelling, just as when one's illness is misdiagnosed and the wrong medicine is administered only to make the patient suffer more from side effects. A good example of this is that there is a popular assumption that Japanese English-as-an-additional-language (EAL) learners are unable to distinguish English /s/ and /ʃ/ before /i/ and /ɪ/ as in *seat* versus *sheet* and *sip* versus *ship* because in Japanese the /s/-/ʃ/ contrast is neutralized before /i/. However, Nogita (2016a) and Nogita (2010a) found that Japanese EAL learners' /s/ and /ʃ/ confusion is due to their lack of knowledge of the English <s>-/s/ and <sh>-/ʃ/ grapheme-phoneme correspondence (GPC) rules and not due to their inability to produce these sounds. In fact, in a more careful analysis of the Japanese phonology, /si/ and /ʃi/ are marginally contrastive at least in peripheral vocabulary as in <水橋パルス イ>-/midzuhaʃi parusi(:)/ (name of a game character) (Nogita, 2010a). In addition, Nogita (2010a) collected data from 93 monolingual standard Japanese speakers (ages 17 to 89), all of who distinguished [si] and [ʃi] in Japanese contexts in both production and perception. This means that native Japanese speakers have no problem with the [si]-[ʃi] contrast in Japanese contexts (although phonetic qualities of Japanese /s/ and /ʃ/ and their English counterparts are not the exactly same). Meanwhile, in Nogita's (2016a) nonsense English word reading and spelling tasks, many Japanese ESL learners confused the sounds

[s] and [ʃ] when reading the letters <s> and <sh> before <i>, and they also confused the letters <s> and <sh> when spelling out the sounds [s] and [ʃ] before [i:], suggesting that they had not acquired the English <s>-/s/ and <sh>-/ʃ/ correspondences. Moreover, Nogita (2010a) demonstrated that teaching these English grapheme-phoneme correspondence (GPC) rules without any articulatory training dramatically reduced Japanese ESL learners' mispronunciations regarding /si-/ʃi/ in the passage reading task. These studies imply the importance of L2 learners' GPC knowledge, not to mention the necessity to carefully analyse L1 and L2 phonological systems.

I suspect that the same logic applies to Japanese EAL learners' mispronunciations of vowels. For example, Nogita (2010b) investigated the source of pronunciation errors of /ɔɪ, αɪ, ɪ, æ, ε, e/ by four beginner/intermediate Japanese ESL learners in a passage reading task, and after interviewing the participants, it turned out that reportedly only 6% of these English vowel/rhyme production errors were caused by articulation and 94% were caused by the participants' intention to pronounce a different sound: for example, participants misconceived that <a> as in *wrapped* or *last* was the same as the Japanese /a/, which often sounded like Eng/ʌ/, or they misconceived that both <ar> in *hard* and <ir> in *first* were supposed to be [a:]. Moreover, some correct pronunciations were accidental, which should be regarded as covert errors due to the same problem: for example, the participants were not certain whether [e¹]s in *made* and *they* were exactly the same phoneme or slightly different sounds because of their spelling differences, so the participants pronounced these sounds "by instinct". These results suggest that these Japanese ESL learners had not correctly memorized vowels/rhymes in the phonological forms of lexical items. A question to ask is why this problem is so rampant that the Japanese EAL learners incorrectly memorize the phonological forms of lexical items. An obvious reason is a well-discussed inordinate amount of loanword interference (e.g., Goble, 2001), but another reason that I suspect is misinterpretation of English vowel spellings, just

as seen in <s> and <sh>. In fact, empirically, many of their vowel production errors seem to be corrected by only teaching English GPC patterns without any articulatory training (except that Japanese EAL learners need to acquire the production of [ɹ] for rhotic vowels). So it is important to understand how orthography and pronunciation influence each other.

2.1.1 The lexical route and phonological route

While all the linguists would agree that written languages are secondary in human languages, a writing system plays an important role in them. According to Coltheart (2006), in our mental lexicon, three kinds of knowledge about each word are stored: the orthographic knowledge, the phonological knowledge, and the semantic knowledge. The process of reading English words aloud is commonly conceptualized with a “dual-route-model” (Coltheart, 2006, 9; Cook & Bassetti, 2005). Figure 1 shows the dual-route model from Cook & Bassetti (2005, 14).

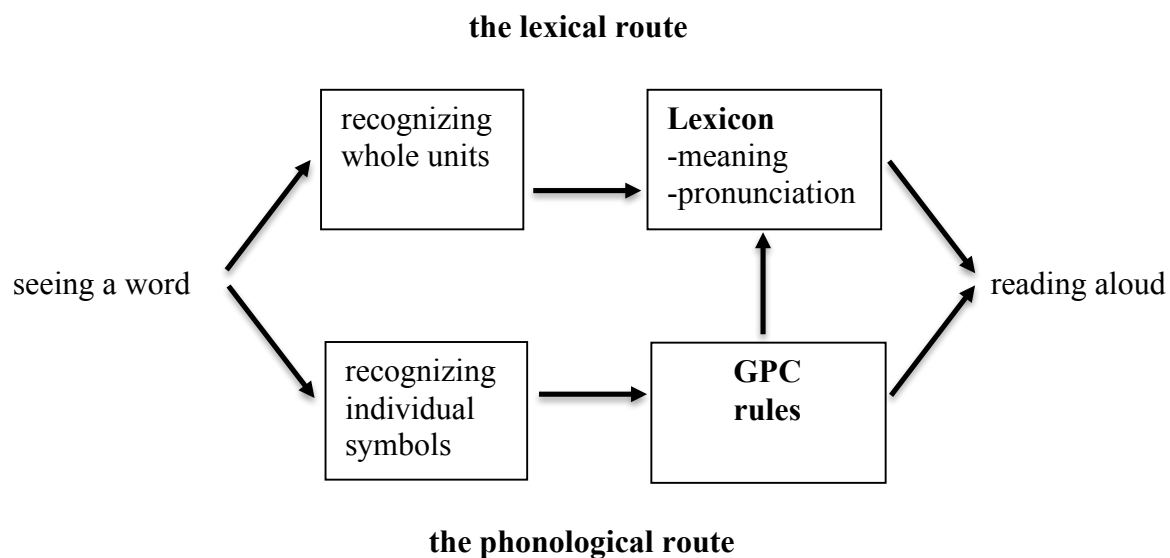


Figure 1. The dual-route model of reading aloud (Cook, & Bassetti, 2005, 14)

When an English speaker reads aloud a regularly spelled word, the phonological route is used: for example, <tree> becomes [tri:] by the graphophonic knowledge <t>→[t], <r>→[ɹ], and <ee>→[i:]; the meaning is not necessarily recognized, or the meaning can be consulted in the mental lexicon (Cook & Bassetti, 2005, 14). When a speaker reads aloud an irregularly

spelled word, the lexical route is used: for example, <yacht> is recognized as a whole, and then its meaning ‘boat’ and pronunciation [jɑ:t] are retrieved from the mental lexicon (Cook & Bassetti, 2005, 14). In this case, the phonological route will result in wrong pronunciation: <a> → [æ:], <ch> → [tʃ], and <t> → [t] resulting in *[jæ:tʃt] (Coltheart, 2006, 9). When one hears a word and writes what s/he hears, the process is mostly the same. A regularly spelled word exploits the phonological route, while an irregularly spelled word exploits the lexical route: for example, [jɑ:t] yacht will be likely spelled <yot> if it goes through only the phonological route (Cook & Bassetti, 2005, 17-18).

Usage of these two routes varies depending on the writing system. In some languages, meaning-based orthographies exploit the lexical route: for example, the Japanese <札幌> is recognized as a whole and the meaning ‘Sapporo (a place name)’ and pronunciation /sapporo/ are retrieved from the mental lexicon, since there is no way to know the pronunciation of this word from the characters unless readers happen to know it, the phonological route cannot be used (see §2.5.1 for more details about the nature of Japanese kanji) (Cook & Bassetti, 2005, 17). In contrast, a sound-based orthography relies on the phonological route to a greater extent, as in the Italian word <pace> with four graphemes corresponding to four phonemes /patʃe/ (Cook & Bassetti, 2005, 17). Nevertheless, in reality, how these two routes interact is still controversial; the phonological route may be primary even in meaning-based writing systems, or one route may produce the word quicker than the other (Cook & Bassetti, 2005).

Based on the dual route model, if Japanese EAL learners have stored incorrect sound forms in their English lexical items due to loanword interference, and if they also incorrectly understand the English GPC rules, no matter which route is exploited, their English pronunciation will be deviant from that of native English speakers. However, if they incorrectly memorized pronunciation of English lexical items at the beginning but have proper knowledge of English GPC rules, they could self-correct their mental lexicon by

exploiting the phonological route. This is one of the reasons why I suggest that understanding default English GPC is important for Japanese EAL learners.

2.1.2 Negative influence of L2 orthography on L2 phonology

Treiman and Cassar (1997) state that the connection between symbols and phonemes are so strong that once orthography is learned, it is virtually impossible to separate them completely. Since the relationship between orthographic representation and phonological representation in L1 has been widely accepted, it is plausible that literacy in L2 also affects the formation of L2 phonological categories, although the issue regarding L2 is still a relatively new area (Bassetti, Escudero, & Hayes-Harb, 2015; Simon & Van Herreweghe, 2010).

There are differences between L1 and L2 regarding orthographic influence on phonology. L1 learners begin to learn reading after their oral language proficiency has reached an adequate level, so what they need is to convert a graphic input into a language that they already know (Nassaji, 2014). In contrast, L2 learners start to be exposed to orthography when their L2 knowledge is limited, and for many L2 learners, the beginning stage of reading is more for developing basic L2 skills, rather than for converting orthography into meaning (Bürki, 2012). Moreover, humans can distinguish a far greater number of visual signals produced with written materials than auditory signals produced by human voice (Rollings, 2004). Especially with beginner/intermediate L2 learners who are often not comfortable with identifying L2 sounds, so in formal learning settings, it is expected that learners rely on orthography to understand L2 sounds more often than when learning L1. In fact, Showalter and Hayes-Harb (2015) summarize that in L2, orthographic information may override auditory information when orthographic and auditory information conflict (e.g., nonsense words made from English phonemes <degund> for /degəd / or <kezef> for /kefəf/ (examples

are from Hayes-Harb, Nicol, & Barker, 2010, 373)) or when learners cannot perceive auditory contrasts.

Japanese EAL learner's vowel productions are good examples of orthographic influence. In Lee, Guion, and Harada's (2006) study, late Japanese-English bilinguals (mean age of arrival 21.0 years old and mean length of residence 10.4 years) with highly proficient English skills were instructed to read aloud written English words, and their productions of unstressed vowels were examined. The results showed that their unstressed vowels were dispersed in five locations in the acoustic vowel space depending on the spelling: for example, <i> was pronounced as [i], <e> was pronounced as [e], just like the Japanese romanization rules although their patterns were not completely the same as Japanese romanization (Lee et al., 2006). However, native English speakers' productions of unstressed vowels were not all influenced by spellings, as shown in Figure 2; only the one corresponding to the letter <o> is deviant but this is phonetic coarticulatory effects from adjacent consonants, not orthographical influence (Lee et al., 2006).

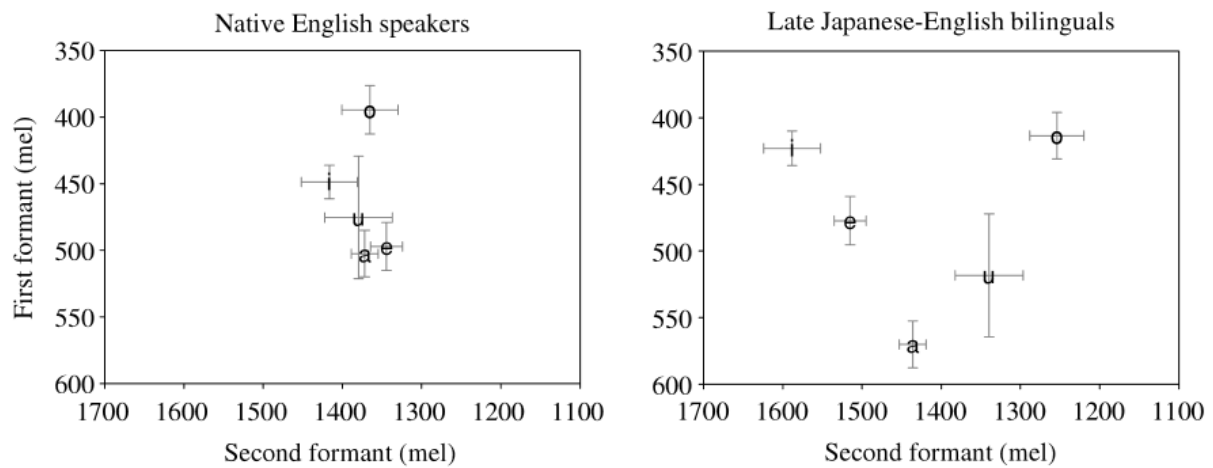


Figure 2. Normalized F1 and F2 mean vowels \pm one standard error of unstressed vowels by orthographic representation for native English speakers (left) and late Japanese-English bilinguals (right) (Lee et al., 2006, 504).

Spelling influence on Japanese EAL learners' unstressed vowels is also found by Kondo, Tsubaki, and Sagisaka's (2015) investigation of 94 Japanese EAL learners at various

fluency levels in a passage reading task. They reported that among the 3,557 vowel productions that were identified as “different” from American pronunciation, 704 were found for unstressed schwa. Again, their unstressed vowel qualities were based on the alphabet letters in orthography: for example, [ɔ] for *considered*, *obliged*, and *confess* (Kondo et al., 2015, 11). Makino’s (2009, 27) research of 202 Japanese university students’ English vowel productions also revealed that unstressed vowels showed the most phonetic variations: more specifically, while 40.9% of the time unstressed vowels were correctly pronounced as [ə], incorrect realizations showed variations of [ɐ, ɔ, ε, α, i, e, a, æ, ə, ɜ, eɪ, εɪ, i, o, ʊ, u, w], many of which seem to reflect various spellings corresponding to the sound. All this suggests that although ESL learners must have some exposure to native English speakers’ productions of the most frequent vowel [ə], Japanese EAL learners’ orthographic impression overrides their perceptual impression, or they trust/rely on their eyes more than their ears. Conversely, if these Japanese EAL learners had learned English unstressed vowels exclusively in a perception-based way, these results would not be expected.

Takakuwa (2012) also provided other examples based on his experience as an English teacher at a university in Japan. He mentioned that the word *bought* tends to be pronounced as [boot] by Japanese university students presumably because in the Japanese romanization <ou> usually corresponds to Japa/ou/, and as a result, *bought* is pronounced like *boat*. Another example from Takakuwa (2012) is that <w> in the spelling can often trigger the [ʊ]-off-glide, as observed in *saw* pronounced as [soʊ] by Japanese university students.

There are also studies regarding vowel productions by other L1 speaking EAL learners. In Bassetti and Atkinson’s study (2015, 78), native Italian speaking high school students (average age 16.9 years old, average period of studying English 9.4 years), whose L1 orthography is phonologically transparent, read aloud an English word list that includes vowels spelled with digraphs (e.g., *bee*, *see*, *seen*, *moon*, *door*, *trainees*) and vowels spelled

with single or zero vowel letters (e.g., *B, C, scene, June, more, Chinese*). The results showed that vowels spelled with digraphs were pronounced significantly longer than singleton/zero vowel letters in duration (237 ms vs. 208 ms), suggesting that spelling affected their vowel production. Bassetti and Atkinson (2015, 85) also tested other native Italian speaking high school students (average age 17.1 years old, average period of studying English 11.2 years) in both a word-reading task (no audio input) and a repetition task (both orthographic and audio input) to examine whether they pronounce homophones with different spellings differently (e.g., *sun* vs. *son*, *one* vs. *won*, *principal* vs. *principle*, *aloud* vs. *allowed*). The results showed that in the reading task, 57% of the homophone pairs were pronounced differently (e.g., /ʌ/ in *son* realized as [ɔ], or /l/ in *allowed* realized as [l:]), and in the repetition task, only 23% percent of the pairs were pronounced differently (Bassetti and Atkinson, 2015).

Mispronunciation of English unstressed vowels due to misinterpretation of spelling is not limited to Japanese EAL learners. According to Coutsougera (2007, 3), L1 Greek speaking EAL learners, whose L1 has a more transparent orthography than English, typically pronounce English unstressed suffixes, *-us, -um, -ure, -ous, -ful, -ate, -age*, for instance, as [us, um, ur, us, ul, eit, ɐtʒ] respectively, as well as other unstressed syllables, such as *about, exact, catalogue, theory, seven* are pronounced as [ɐ' bɛ.ut, ɛ' gzɛkt, 'kɛtɛlog, 'θiɔri, 'seven] respectively.

Native Japanese speakers learning other languages also make pronunciation errors influenced by spelling. According to Uchida (1979, 14), Japanese learners of French make pronunciation errors, but many of the pronunciation errors are not due to their inability to produce target sounds, but are due to misinterpretation of spellings: for example, *Seine* Fren/sɛn/, *moi* Fren/mwa/ tend to be pronounced as [seinu] and [moi] respectively with diphthongs based on Japanese romanization, and *pipe* /pip/ and *face* /fas/ pronounced as [paip] and [feis] with diphthongs influenced by English, *grande* /grãd/ pronounced as

[grande] with the final silent <e> pronounced based on Japanese romanization, silent <u> in *quell* /kɛl/ and *quand* /kɑ̃/ pronounced as [u], *petit* /pəti/ pronounced as [peti] in which <e> is pronounced as [e] based on Japanese romanization, *mer* /mɛ:r/ pronounced as [mea] in which <r> is pronounced as [a] (presumably based on the loanword *rōmaji* discussed in §2.5) and so on. Uchida (1979) mentions that it would be difficult to acquire native-like French pronunciation for L2 learners, but it should be possible to acquire French GPC rules. Uchida (1979) also mentions that if students say, “French pronunciation is difficult” without memorizing French GPC rules, their actual challenge is typically not articulation, but French GPC rules. I suspect that the English education in Japan is in the same situation.

There are also studies regarding consonant productions. According to Rafat (2011), in the variety of Spanish used in her study, the GPC rules are <d>-[ð], <v>-[b], <z>-[s], and <ll>-[j] unlike the English rules <d>-[d], <v>-[v], <z>-[z], and <ll>-[l], so that <zatico>, for example, is expected to be pronounced as [zatico] instead of target-like [satiko] by English speakers if there is L1 orthography transfer. Rafat (2011) had two groups of novice adult English-speaking learners of Spanish learn 108 Spanish words with one group using images and auditory input only, while the other used images, auditory input and orthography. The results showed that the participants in the no orthography group showed L1 transfer only 0.08% of the time in their productions, whereas those in the orthography group showed it 54 % of the time (Rafat, 2011). Moreover, their error patterns showed interesting tendencies; <d> ([ð]) and <v> ([b]) were mispronounced due to L1 grapheme-sound correspondence 98% and 92% of the time respectively (no significant difference between <d> and <v>), and <z> ([s]) and <ll> ([j]) were so 67% and 21% respectively with significant differences from <d> and <v> (Rafat, 2011). These results suggest that the less salient the phonetic differences between the L1 and L2 sounds are, the more likely L1 transfer occurs (Rafat, 2011).

Likewise, according to Erdener and Burnham (2005), when monolingual Turkish

speakers listened to Spanish nonsense words including a velar fricative [x] as audio stimuli, they always correctly reproduced [x], but when the audio stimuli were presented with orthography, the participants mispronounced the target [x] as [ʒ] 45.83% of the time. This is because Spanish [x] and Turkish [ʒ] are both represented with the letter <j>, so these Turkish speakers were interfered by their L1 GPC rules (Erdener & Burnham, 2005).

Another example is that when monolingual Australian English speakers repeated Irish nonsense words as audio stimuli, they confused [d] and [dʒ] only 2.44% of the time, whereas when the audio stimuli were presented with orthography, their confusion increased to 14.29% (Erdener & Burnham, 2005). This is because Irish <d> is pronounced as [dʒ] in certain contexts in which it would be pronounced as [d] in Australian English, such as <Deaip> as [dʒæ:p] (Erdener & Burnham, 2005, 228).

These above studies are regarding learners' productions. There are also similar studies regarding awareness. Pytlyk (2012) demonstrated that English speakers learning Mandarin as L2 with L2 letter knowledge count phonemes in L2 more accurately and more quickly when the number of phonemes and the number of letters match (e.g., Mandarin <suān> - [swan] 'sour' (4 letters and 4 phonemes)) than when they mismatch (e.g., Mandarin <duì> - [dweɪ] 'correct' (3 letters and 4 phonemes)). That means that in L2, as seen in L1, letter knowledge can either facilitate or hinder phoneme detection depending on whether the number of phoneme and the number of letters match or mismatch.

Up to this point, I have introduced quite a few previous studies, and my interpretation of these studies is that the reason why orthography hinders L2 learners' pronunciation and awareness is that learners did not have proper knowledge of the L2 GPC rules. Conversely, if the learners do have proper knowledge, could such errors be avoided? The answer will be in the next section.

2.1.3 Positive influence of L2 orthography on L2 phonology

If L2 learners have sufficient knowledge of L2 orthography, does orthography help L2 learners' production, perception, or understanding of the phonological system of the target language? According to studies mentioned below, the answer seems to be yes.

In Escudero and Wanrooij's (2010) study, Latin American Spanish speaking people learning Dutch had difficulty with the Dutch /a/-/ɑ/ contrast in the perception test with only audio stimuli, but in the vowel identification task in which the participants needed to match the sound stimuli /a, ɑ, i, ɪ, y, ʏ/ with corresponding spellings <aa, a, ie, i, uu, u>, even beginner level learners performed much better for the /a/-/ɑ/ contrast. Escudero and Wanrooij (2010) proposed that when Spanish speaking people hear audio input of Dut/a, ɑ/ without visual information, they activate Span/a/, which makes it difficult to distinguish these Dutch sounds for them, whereas when visual information <aa, a> is given, <aa> activates Span/a/ + /a/ and <a> activates a single Span/a/, which helps them pay attention to length difference between Dut/a/ (longer) and Dut/ɑ/ (shorter). Alternatively, Escudero and Wanrooij (2010) also proposed that the longer duration of Dut/a/ activates the orthographic label <aa>, and when they see <aa>, their activation is reinforced. In either analysis, orthographic information helps learners with perceptually difficult L2 contrasts (Escudero & Wanrooij, 2010).

Showalter and Hayes-Harb (2013) tested whether native English speakers with no knowledge of Mandarin learn Mandarin tone contrasts better when there are orthographic tone markers than when there is only audio information. Mandarin has 4 contrastive tones marked with diacritics on the top of vowel letters in the romanized writing system *pinyin*: for example, high-level (tone 1) <mā> 'mother', high-rising (tone 2) <má> 'hemp', low-falling-rising (tone 3) <mǎ> 'horse', and high-falling (tone 4) <mà> 'scold' (Showalter & Hayes-Harb, 2013). Since English does not have tone contrasts, acquisition of Mandarin tones for

English speakers is notoriously difficult (Showalter & Hayes-Harb, 2013). However, they found that in the sound-picture matching task, English-speaking participants who were instructed Mandarin tones with tone markers (i.e. <↑>, <í> etc.), performed significantly better than participants who were instructed without tone markers (i.e. <í>), suggesting that even unfamiliar diacritics can facilitate L2 word-form learning.

According to Rafat (2015), L1 Canadian English speakers with no knowledge of Spanish were divided into two groups and were asked to learn the Spanish assibilated/fricative rhotics (e.g., [r̃] in <ahumar>–[aumar̃]). In one group, the participants were taught this target sound with both sound and written forms, while in the other group, they were taught with only sound forms. The results showed that the participants who did not see written forms were more likely to pronounce [r̃] as fricatives (e.g., [ʃ, h, x]) more frequently than [ɹ] but none of them pronounced it as [r̃]. On the other hand, the participants who saw the written forms pronounced the target sound as [ɹ] the most frequently, followed by [r̃], followed by [h]. Rafat (2015) concluded that the written input <r> aided participants in noticing the rhoticity of the Spanish assibilated/fricative rhotics.

According to Pytlyk (2011), native English speakers with no knowledge of Mandarin took 4.5 hours of lessons about Mandarin syllables, and one group of participants took instruction via romanized phonetic notation pinyin, while another group of participants took instruction with no orthography at all. The results of their Mandarin syllable discrimination task showed that those who learned L2 sounds via pinyin performed better than those who learned only sounds, although the difference was not significant. Pytlyk (2011) suggested that in the very beginning stage, their cognitive load of learning sounds without visual aids was considerably high, while the requirement for learning sounds with pinyin is only mapping new sounds onto their familiar scripts, suggesting that at least in the very beginning stage, using familiar orthography has an advantage.

As well, it is known that Japanese EAL learners tend to insert a vowel after a word-final consonant in English words, such as *fast* as [fɛstō] or *ship* as [ʃippū] (Hatae & Nagakura, 2015). According to Hatae and Nagakura (2015), when they had grade 6 Japanese speaking children read aloud one syllable nonsense English words (e.g., <zoc>, <sug>, <kom> and so on), 20% of the time they added a vowel after a coda consonant. However, in the post-test after a phonics lesson, their vowel insertion rate was reduced to 14%. Explicit spelling knowledge helps Japanese EAL learners to recognize when to pronounce or not to pronounce a vowel.

Moreover, orthography can help L2 learners efficiently utilize their existing L1 phonemic categories rather than establishing a new category. According to Best and Tyler (2007), L1 English-speaking learners of French may recognize the French uvular fricative [ʁ] and the English retroflex/bunched approximant [ɹ] as the same interlanguage phoneme /r/ despite the big phonetic difference, in part because of orthographic bias <r>. In this case, the single interlanguage phoneme /r/ has two phonetic categories [ʁ] and [ɹ]. It requires much effort to establish a new interlanguage phoneme, but the letter <r> enables English-speaking learners of French to use the existing phonemic category for the French [ʁ].

Orthography also helps learners' awareness of L2 suprasegmentals. Ueyama (2003) tested both beginner and advanced native English speakers learning Japanese as L2 in the mora division task with visually presented Japanese words. The results showed that beginner L2 Japanese learners mostly incorrectly divided Japanese words into syllables rather than moras, whereas advanced L2 Japanese learners almost performed like native Japanese speakers (Ueyama, 2003). Ueyama (2003) also tested Japanese ESL learners in the syllable division task with visually presented English words. The results showed that even advanced Japanese ESL learners divided one-syllable English words into one unit only 5% to 44% of the times (e.g., *Pete* divided into two or three units, *eyes* into two or three units, *kept* into

three units, *strive* into three to five units, *striped* into three to six units, etc.) (Ueyama, 2003, 89). Ueyama (2003) suggested that a possible reason for this asymmetry is that the English orthography does not indicate syllable boundaries, while the Japanese orthography shows mora boundaries in most cases, so presence or absence of mora/syllable divisions in orthographies can help or not help L2 learners' awareness of suprasegmentals.

These studies suggest that if L2 learners are explicitly taught how to read L2 orthographies, they can take advantage of the orthographies for acquiring L2 sounds or sound systems.

2.1.4 Influence of sounds on orthography

The studies I discussed above are regarding how orthographies affect pronunciation, perception, or understanding of phonology. In contrast, there are also studies that show spoken language influence on written language.

In L1, according to Landerl (2003), previous studies showed that deficits in phonological processing are often seen as the central cause of dyslexia. It is often explained that this is because problems in speech perception lead to underspecified phonological representations, which, in turn, makes it difficult to automatically associate phonological representations with orthographic representations (Landerl, 2003). Landerl (2003) tested both 10-year-old German speaking poor spellers and normal spellers in a vowel length categorization task with both real words and nonsense words. The results revealed that poor spellers performed less accurately and consistently slower than normal spellers. This implies that categorical perception skills are related to spelling skills.

There are also studies about how sounds affect orthographies in L2. In this case, L1 literacy plays an important role. Figueredo (2006) organized the mechanism of EAL learners' correct or incorrect spellings as shown in Figure 3.

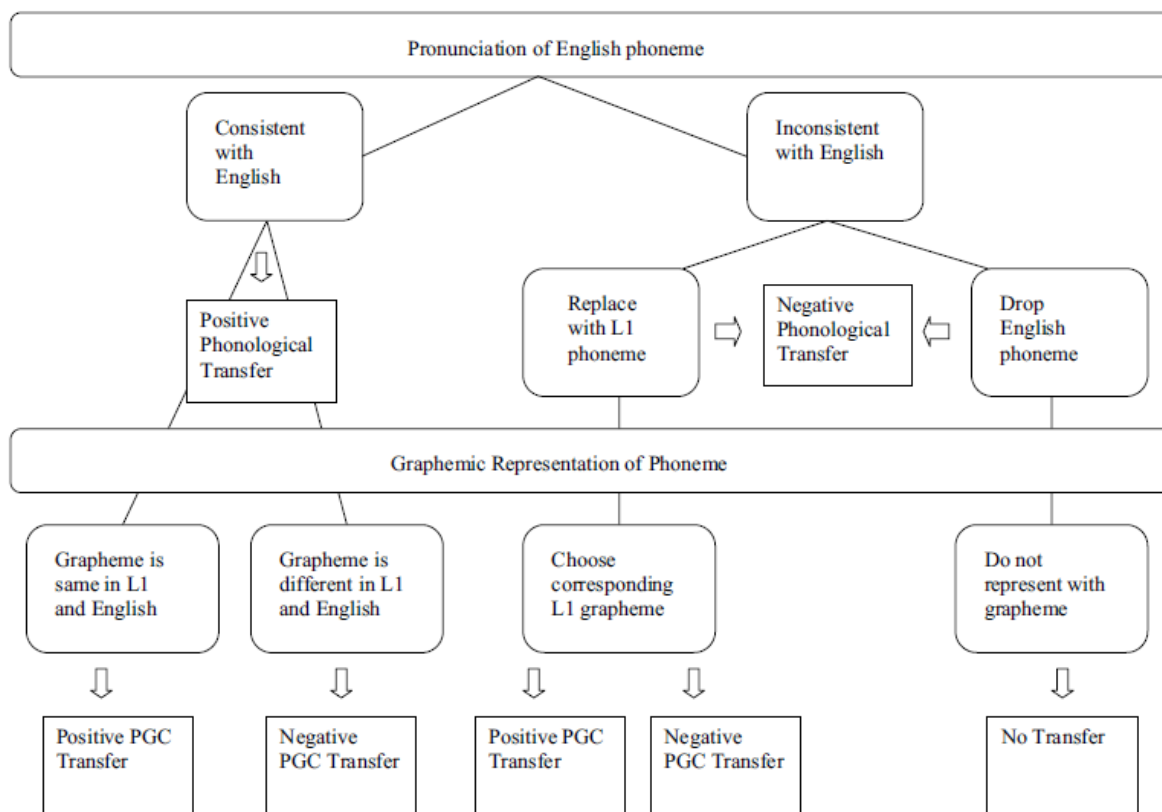


Figure 3. Schematic diagram of transfer for EAL student who possesses L1 literacy knowledge (Figueredo, 2006, 883, reprinted with permission)

Nb. PGC = phoneme-grapheme correspondence

Referring to Figure 3, there are some interesting examples from Shinagawa (2004). He reported English spelling errors by Japanese middle-school students learning English; specifically, *fade* spelled as <feid>, *dike* spelled as <daik>, and *dote* spelled as <dout> (I will discuss more detailed spelling error patterns in §2.3.2.3). Based on Figure 3, in these cases, Japanese has phonetically similar counterparts of Eng[e¹], [a¹], and [o⁰] (i.e., Japa/ei/, /ai/, and /ou/ respectively), but GPC rules between English spelling and Japanese romanization are different, and these Japanese learners associated Eng[e¹], [a¹], and [o⁰] to <ei>, <ai> and <ou> respectively based on Japanese romanization <ei>-Japa/ei/, <ai>-Japa/ai/ and <ou>-Japa/ou/ correspondences. This is “Negative GPC Transfer” on the basis of Figure 3. There is also a phoneme inventory-related error type. According to Okada (2005), the most common misspelling pattern by Japanese EFL learners in word-initial positions is a mix-up between and <v> (e.g., <bisitor> for *visitor*), followed by a mix-up between <l> and <r> (e.g.,

<runch> for *lunch*). Based on Figure 3, in these cases, there is inconsistency between English and Japanese phonemes, or specifically, Japanese lacks /v/ and /l/, so these were substituted for the Japanese existing phonemes /b/ and /r/, and then corresponding Japanese rōmaji letters and <r> were chosen respectively. This is another “Negative PGC Transfer” based on Figure 3. On the other hand, if *rabbit* is spelled as <rabbit> by Japanese EAL learners, for example, Eng/ɹ/ was replaced with Japa/r/, and the corresponding letter <r> was chosen. This is “Positive PGC Transfer” on Figure 3.

In addition to interlanguage phonology affecting L2 writing, interlanguage phonology also affects L2 reading. For example, regarding the notoriously problematic English [l]-[ɹ] distinction for Japanese learners of English, Ota, Hartsuiker, and Haywood (2009) found that Japanese ESL learners (university students, mean length of residence 3.6 years) who could perceive the sounds [l] and [ɹ] with high levels of accuracy still tended to confuse written <l> and <r> in reading: for example, when seeing the written stimulus <rock>, the word <lock> was also activated in their mental lexicon. In contrast, a pair like <rock> and <sock> did not show the same effect. Ota et al. (2009) also reported the same effect with L1 Arabic speakers learning English who confused written <p> and with hearing the corresponding sounds, such as <pad> and <bad> because the Arabic sound system lacks the [p]-[b] distinction. Ota, Hartsuiker, and Haywood (2010) also found the same effect with the Eng[æ:]-[ʌ] distinction by Japanese EAL learners who could perceptually accurately distinguish Eng[æ:] and [ʌ]; when seeing the written stimulus <fan>, the word <fun> was also activated in their mental lexicon. In loanword adaptation patterns, both Eng[æ:] and [ʌ] are typically adapted to Japa/a/ despite their phonetic differences, which may confuse Japanese EAL learners. Ota et al.’s (2010; 2009) remarkable finding is the evidence of L2 learners’ phonological representations in the mental lexicon in the written forms.

The same phenomenon is reported with Japanese learners of other languages. Matsumoto (2011) reported that when Japanese learners of Spanish both aurally and visually are presented words <julio> /xúljo/ ‘July’ and <frío> /frío/ ‘cold’ in the classroom, they incorrectly identified these visually very different words <julio> and <frío> as homophones. Matsumoto (2011) mentioned that the reason for this confusion is a difficulty in the Span/f-/ /x/ and /r/-/l/ contrasts in perception. Matsumoto also (2011) reported that in her previous experiments of Spanish /CCV/ and /CVCV/ word identification task, the Japanese participants’ correct answers were only around 50%, and her other experiment revealed that accuracy in identification of Spanish /CCV/ and /CVCV/ words is not related to learners’ length of learning experience. Such perceptual difficulties in the /xúljo/-/frío/ contrast cause a confusion in visually very different words in reading.

An example of other L1 EAL learners is found in Escudero, Hayes-Harb, and Mitterer’s (2008) eye tracking paradigm study with highly proficient Dutch speakers learning English as L2 who find it difficult to distinguish Eng/ε/ and /æ/. Escudero et al. (2008) reported that when the Dutch participants heard a word with /æ/, they also looked at a picture along with a spelling that has <e> (/ε/) in its name, while when they heard a word with /ε/, they did not look at a picture along with a spelling that has <a> (/æ/) in its name. In other words, the Dutch participants were biased toward <e> (/ε/). However, when they did the same vowel perception task with only pictures without written cues, such asymmetry was not observed. These results demonstrate which grapheme is activated in the participants’ minds. Escudero et al. (2008) explained that this asymmetry is likely because Dutch <e> corresponds to the vowel /ε/, which is similar to English, while Dutch <a> corresponds to /ɑ/ or /a/, which is very different from English <a> typically corresponding to /æ/.

To sum up, learners’ phonological representations have an impact on L2 writing and reading.

2.1.5 L1 orthographic influence on L2: phonographic vs. logographic

If L1 and L2 orthographies are processed differently, the development of word recognition by phonological decoding might be adversely affected (Nassaji, 2014). Specifically, L1 orthographic depth affects how readers process orthography; according to the definition presented by Rollings (2004) and Venezky (1999), a shallow orthography is more phonemic and its letter-sound-correspondence (LSC) is close to a one-to-one relationship, while a deep orthography is more morphemic and its LSC is deviant from a one-to-one relationship. There is also the concept of “grain size”, which is the amount of necessary orthographic information to decode phonological information; readers of a phonologically transparent orthography may rely on GPC, while readers of a meaning-based orthography may need to rely on a longer unit (or a bigger grain size), such as a rhyme or a whole word (Cook, & Bassetti, 2005, 16). When it comes to L2, according to Frost, Katz, and Bentin’s (1987) Orthographic Depth Hypothesis (ODH), speakers with a shallow orthography in L1 tend to read letters on a one-by-one basis through the phonological route (see Figure 1), while speakers with a deep orthography in L1 tend to first identify a word through the lexical route before decoding its phonemes. It should be noted that there are also cases that L2 learners who do not have L1 orthographic knowledge need to learn L2 orthography. For example, Fall (2011) reported that the Wolof language in Senegal is primarily oral although its writing system has been recently developed, so Wolof speaking children still do not read and write in their L1. The lack of their L1 literacy skills slows in the process of learning L2 since they have no pre-existing skills to positively transfer from L1 to L2 (Fall, 2011).

In terms of Japanese EAL learners, there are some studies that suggest Japanese EAL learners read English logographically rather than phonographically. Hamada and Koda (2010), who argue that phonological decoding is crucial in both reading and learning new words, examined L2 learners’ ability to decode phonological information from the spelling

and a systematic relationship between their phonological decoding ability and word-meaning inference in their L2 from a psycholinguistic point of view. In their experiment, the participants were two groups of ESL learners. The first group consisted of L1 speakers of Korean and Turkish who have alphabetic but non-roman L1 orthographies¹, while the second group consisted of L1 of Chinese and Japanese who mainly use logographic L1 orthographies. There were two tasks, the naming task and the meaning inference tasks. In the naming task, the participants read aloud 20 English real words and 20 English nonsense words, and the reaction times of accurate productions were measured. The results showed that the participants in the L1 logographic group needed significantly more time to read the stimuli than those in the L1 alphabetic group. This suggests that the L1 logographic group was not efficient in the bottom-up process. In the meaning-inference task, participants were asked to read passages and figure out the inferred meaning of the target nonsense words in sentences. The accuracy of identifying the inferred meanings was not significantly different between the two groups (Hamada & Koda, 2010). This suggests that the top-down process for guessing the nonsense words from the contexts did not seem different between both groups. Interestingly, in the L1 alphabetic group, an individual phonological decoding ability showed a significant correlation with word-meaning inference and even a TOEFL reading score, whereas in the L1 logographic group, a phonological decoding ability was not significantly correlated with either factor (Hamada & Koda, 2010). Hamada and Koda (2010) concluded that ESL learners whose L1 has alphabetic orthography can more efficiently read English than those with L1 logographic orthography.

Koda (1990) also compared L1 Spanish and Arabic ESL learners, whose L1 orthographies are alphabetic, as well as L1 Japanese ESL learners, whose L1 orthography is mainly logographic, by having the participants read passages that include several fictional

¹ In fact, modern Turkish uses a roman orthography.

words. In one condition, fictional words were written with regular English orthography, such as <son̄ta> or <mōffi> so these phonological forms were accessible if readers know the English GPC rules, whereas in the other condition, these fictional words were written with unfamiliar Sanskrit scripts, such as <𑖦𑖯> and <𑖦𑖱> (410). The results showed that L1 Spanish and Arabic ESL learners as well as native English speakers read the passage with fictional words in English orthography much faster than those in with Sanskrit orthography, whereas Japanese ESL learners remained somewhat constant under the two conditions, and about half of the Japanese participants read the Sanskrit orthography version faster. This suggests that compared to Spanish and Arabic ESL learners, Japanese ESL learners read English more logographically.

Akamatsu (2003) also tested ESL learners' reading speed with three different L1 orthographic backgrounds: Japanese (syllabary and logograph), Chinese (logograph), and Persian (alphabet). In one condition, the participants read passages written with regular spellings, while in the other condition, letter cases were alternated (e.g., "ThErE iS nO aBsOIUtE lImIt To ThE eXiStEnCe Of AnY tReE.") (Akamatsu, 2003, 203). The results showed that while all the three L1 groups read the alternated case version slowly, Chinese and Japanese ESL learners were more adversely affected by case alternation than Persian EAL learners. Akamatsu (2003) concluded that Chinese and Japanese ESL learners process English words less efficiently.

As well, in my informal observation, there is other evidence of logographic reading in Japanese professional singers' productions of English words. A good example is that in the Japanese song *Get Wild* sung by TM Network and Golden Bomber in April 2014, as well as by Naoto Kine in April 2015, the lyrics "chance and luck" were pronounced as [tʃʌns ɛnd lʌk]; notice that the same vowel letter <a> in <chance> and <and> was pronounced differently ([a, ɛ] respectively), while the different letters <a> in <chance> and <u> in <luck>

were pronounced the same ([a]), implying that they did not consult vowel GPC rules, but rather logographically recognized *chance*, *and*, and *luck* as a whole, and possibly at least the vowels in *chance* and *luck* may have been associated with the cognate Japanese loanwords /ʃānsu, rakku/ respectively (retrieved from <https://www.youtube.com/watch?v=SzwQNX-Ipak> and <https://www.youtube.com/watch?v=9IFLxT4W7kQ&list=PLh0t5-da8C1yoAA-DaUjjRnM0uUJHnJ44>)².

Other than Japanese EAL learners, there are also studies of other language learners on this matter. Chikamatsu (1996) tested that L1 English and Chinese learners of Japanese in the word recognition test written with Japanese kana syllabary. Chikamatsu (1996) found that English-speaking learners of Japanese relied more on phonological information so their reaction time was affected by word length more than Chinese learners of Japanese. Chikamatsu (1996) concluded that this difference came from L1 orthographic differences; although English has a relatively deep orthography, it is still phonographic relative to the Chinese orthography.

Mori (1996) tested two groups of L2 Japanese learners: participants whose L1 orthographies were phonographic (i.e., L1 American English and L1 Korean learners) and those whose L1 orthographies were morphemic (i.e., L1 Chinese learners). The participants were asked to memorize non-existing pseudo-kanji-characters, and in one condition, part of a pseudo-character is a phonographic katakana letter (e.g., the right part is the katakana <ホ> corresponding to /ho/) so that participants could associate the character with a sound, while in the other condition, a pseudo-character does not contain sound information. The results showed that the phonographic language background group memorized pseudo-characters containing a katakana letter more accurately, while the morphographic language background

² At least one of the singers, Takashi Utsunomiya, reported on his radio program that he could not speak English but just mimic English sounds by ears, so it is highly likely that they did not know the English vowel GPC rules. His band member, Naoto Kine is likely in the same situation.

group memorized pseudo-characters equally accurately in both conditions. These studies suggest that although the English orthography is not phonologically transparent, native English-speaking people still use the lower-level process in reading more than native Chinese speaking people.

Finally, coming back to our discussion of Japanese EAL learners, I need to mention that while there is a fair amount of evidence that Japanese learners of English mainly read English logographically, there is also evidence that Japanese learners read foreign languages phonographically. As mentioned above, Japanese EAL learners confuse visually different English words <rock> and <lock>, suggesting that their lower-level process is active. Likewise, Japanese learners of Spanish also confuse visually very different new words <Julio> and <frío> as mentioned above. These suggest that Japanese speakers do not read foreign language exclusively logographically. This can be because the Japanese writing system also has phonographic mora-based hiragana/katakana and phoneme-based rōmaji. In consideration of this, I assume that since Japanese has both phonographic (hiragana, katakana, rōmaji) and logographic (kanji) writing systems, Japanese L2 learners can choose either logographic or phonographic mode depending on whether the L2 writing system Japanese learners “think” is phonographic or logographic. In other words, if Japanese EAL learners assume that English GPC is very inconsistent, they might mainly use the logographic mode, and otherwise, they might mainly use the phonographic mode.

2.1.6 Orthographic familiarity

In Japan, there is a debate that rōmaji (Japanese romanization) hinders Japanese EAL learners from learning English spelling and pronunciation. However, some studies have shown that familiar scripts reduce learners’ cognitive load, so at least in the beginning stages, a familiar script shows a facilitative effect despite cross-linguistic LSC rules. Based on this

theory, learning rōmaji for native Japanese speakers should help them learn English more than hinder them.

Pytlyk (2011) examined English speakers learning Mandarin with both romanized pinyin (e.g., <ang>-/aŋ/) and a non-roman syllabary *zhuyin*, also known as *bopomofo* (e.g., <ㄤ>-/aŋ/). She hypothesized that the shared script between L1 and L2 (i.e., roman alphabet) hinders learners pronunciation when there is L1-L2 PGC discrepancy (e.g., <h>-/h/ in English and <h>-/x/ in Mandarin), while unfamiliar orthography, zhuyin, does not hinder learners' pronunciation because there is no L1 interference (e.g., <ㄏ>-/x/). The results of her study showed that instruction via zhuyin (non-roman) does not appear to have an advantage over instruction via pinyin (roman) (Pytlyk, 2011). Moreover, the participants who took instruction via pinyin (roman) did the Mandarin syllable discrimination task slightly better than the participants who took instruction via zhuyin (non-roman) as well as than those in the control group who took instruction without orthographic aids, although the differences were not statistically significant. The lesson was only 4.5 hours in total (1.5 hours × 3 days), so Pytlyk (2011) concluded that at least in the very beginning stage, learning the unfamiliar script zhuyin (non-roman) and learning L2 sounds without visual aids require considerably higher cognitive demands than being aided with a familiar script (roman). Therefore, at least at the very beginning stage, a familiar script shows a facilitative effect.

Tamaoka and Menzel (1994) tested L1 English, French, and German learners of Japanese who had already passed the Japanese-Language Proficiency Test 3 *kyū* (1500 words and 300 kanji characters) in word and sentence reading tasks by using both words/sentences written with hiragana and rōmaji. The results showed that despite GPC differences between rōmaji and their L1 orthographies, all of them pronounced and understood words/sentences written with rōmaji more accurately and much faster than with hiragana. More interestingly, the L1 English participant correctly read aloud rōmaji <you> as [jo:] in the rōmaji rule, not

*[ju:] like the L1 English word *you*; the L1 German participant correctly read aloud *rōmaji* <onaji> as [onadʒi], not *[onaji] in the L1 German way; the L1 French participant correctly read *rōmaji* <ha> in <hajime> as [ha], not in the L1 French way [a] (Tamaoka & Menzel, 1994, 112). This suggests that L2 learners who already have learned 1500 words still perform better with their familiar shared orthography (i.e. *rōmaji*) despite GPC differences than with an unfamiliar script (Tamaoka & Menzel, 1994).

These studies indicate that visually familiar scripts are easier to learn compared to visually unfamiliar scripts. In the case of *rōmaji* influence on English spelling by Japanese EAL learners, it seems that *rōmaji* facilitates learning English since native Japanese speakers are already familiar with the roman script. Moreover, even if *rōmaji* is not taught in order to prevent *rōmaji* GPC influence on English, if English GPC rules are not taught, it would not make any difference. On the basis of previous studies discussed in this chapter, what is important would be to teach the English GPC rules to Japanese EAL learners, but not to expel *rōmaji*.

2.1.7 Conclusion and discussion regarding orthography-phonology relationship

In L2, orthographic information clearly affects L2 learners' pronunciation, and L2 phonological knowledge also affects L2 spelling and reading. In consideration of the tight connection between letters and sounds, it is possible that at least some pronunciation errors by L2 learners are not due to difficulty with articulation, but due to orthographic influence. Particularly in formal L2 teaching settings, the understanding of orthographic influence would be crucial in order not to provide unnecessary articulation practice, just as seen in the English /si/-/ʃi/ confusion discussed by Nogita (2016a) and Nogita (2010a). It should be noted that L2 orthographic influence is not necessarily something that hinders learners from learning proper pronunciation. While insufficient knowledge of L2 LSC can cause pronunciation errors, if learners have proper knowledge of L2 LSC, L2 orthography helps

learners acquire proper pronunciation and understand the L2 phonological system. This is the main reason that I argue that Japanese EAL learners need to understand English GPC patterns properly. However, according to the previous studies, Japanese EAL learners use the logographic mode in English more than L1 English-speaking people. This indicates that Japanese EAL learners tend to pay little attention to English GPC patterns. So I suggest that when Japanese EAL learners learn English GPC patterns, they would first need to shift towards the phonographic mode.

2.2 English and Japanese vowel systems

In order to examine Japanese EAL learners' knowledge of English vowel grapheme-phoneme correspondence (GPC), a discussion of the vowel systems of both American English and standard Japanese is in order.

2.2.1 North American English vowels and the sound qualities

2.2.1.1 Vowel contrasts in North American English

North American English has 13 (or 14 depending on the dialect) contrastive vocalic entities; 10 (or 11 depending on the dialect) so-called monophthongs [i:, ɪ, e^l, ɛ, æ:, ʌ, ɑ:, (ɔ:), o^u, ʊ, u:] and three “true” diphthongs [aɪ, aʊ, ɔɪ]³ (Labov, Ash, & Boberg, 2006; MacKay, 1978; Wardhaugh, 1977); for broad phonetic transcription, I follow Nishi et al.'s (2008) and Strange et al.'s (2001), in which intrinsic vowel length is indicated (see the next section for more details). While in standard Southern British English, so-called “broad” <a> as in *father* is contrastive from so-called “relative/short” <o> as in *lot*, in most North American English dialects outside Eastern New England, these two vowels are merged, so *father* rhymes with *bother*, and *bomb* and *balm* are homophones according to Boberg (2009, 358). The [ɑ:]-[ɔ:] merger is almost complete in Canada and the Western region in the United States, so *cot* and *caught* are homophones according to Boberg (2009) and Labov, Ash, and Boberg (2006),

³ In non-rhotic accents, there are triphthongs, like [aɪə] and [aʊə] due to post-vocalic vocalization, but this paper focuses on rhotic dialects which lack triphthongs.

although the inland North and Mid-Atlantic States show a solid resistance to this merger according to Labov et al. (2006).

Note that it is unwise to jump to a hasty conclusion that English has 2.6 (or 2.8) times more vowels than Japanese by looking at only the number 13 (or 14) since the number of phonemes change depending on the definition of a phoneme in a particular language.

2.2.1.2 Diphthongization and duration in English vowels

According to previous studies, North American English monophthongs vary in vowel duration, and some of the so-called monophthongs may exhibit diphthongization. According to Hillenbrand, Getty, Clark, and Wheeler (1995), when the first formant (F1) and the second formant (F2) at the midpoint in each vowel are compared, there are considerable overlaps, especially between [ɛ] and [æ:], as well as [ɔ] and [u:]. Strange, Akahane-Yamada, Kubo, Trent, Nishi, and Jenkins's (1998) acoustic analysis also shows that the midpoints of [e¹, æ:, ɔ:, ɪ] most often overlap with adjacent vowels depending on speakers: specifically, [e¹] with [i:, ɪ], [æ:] with [ɛ, a:], [ɔ:] with [ɑ:], [ɪ] with [e¹], as well as [ɑ:] with [ʌ].

Despite such overlap, each vowel is perceptually highly identifiable because listeners depend not only on F1 and F2 at the midpoint, but also on duration, and even more on diphthongization patterns to identify vowels. This means that this is not the case that English has 10 Japanese one-mora-monophthong-like vowels, which have short duration, no diphthongization, or no pitch contour, i.e., *[ĩʔ, ỹʔ, ẽʔ, ẽʔ, æʔ, ǣʔ, ǫʔ, ǫʔ, ǫʔ, ǫʔ, ǫʔ] ([~] = extra short, [ʔ] = glottal stop). For instance, while [u:] is fairly monophthongal, [ɔ] has a much greater deal of formant shift (Majors, 2005). In many North American dialects, typically in the South and South Midland, “bid,” “bed,” “bad,” “bud,” and “good,” for example, are realized as [bɪəd], [bɛəd], [bæəd], [bʌəd], and [gʊəd] respectively, in which the latter parts of these checked vowels are moving toward schwa (Anderson, 1972). Diphthongization in checked vowels sometimes results in two distinctive vowels rather than vowel-glide

sequences: for example, /æ/ in some areas in New England is [eʰ], rather than [eʰ] (Wood, 2010). As for free vowels, the mid-free vowels [eʰ] and [oʰ] are moving toward peripheral positions, as opposed to checked vowels (Nishi et al., 2008). Figure 4 shows formant shift patterns of 12 of the North American English vowels, including [ɜ˞] (or the syllabic [ɹ]) as in *bird*, provided by (Majors, 2005).

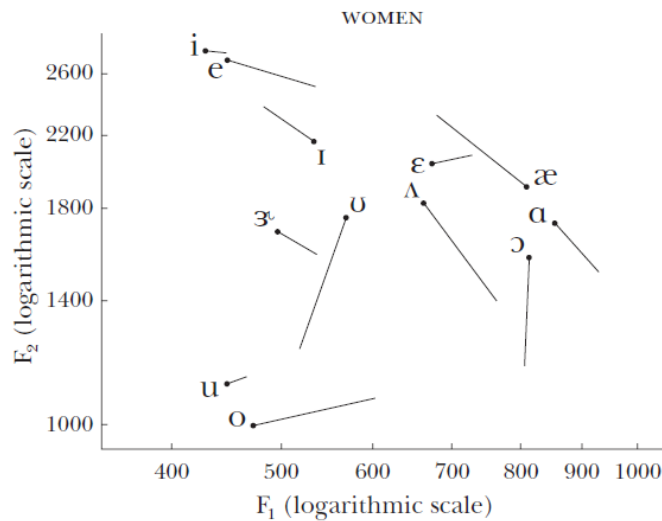


Figure 4. Formant shift of the 12 North American English vowels (Majors, 2005, 173, reprinted with permission)

In addition to diphthongization, duration also has a role for vowel distinction. Although vowel length is not phonemic in North American English in the same way as Japanese, English vowels vary in phonetic “intrinsic duration” (Nishi et al., 2008, 277). Strange, Akahane-Yamada, Kubo, Trent, and Nishi (2001) and Strange et al. (1998) divided North American English monophthongs into two groups according to the phonetic length: shorter vowels [ɪ, ɛ, ʌ, ʊ], and longer vowels [iː, eː, æː, ɑː, ɔː, oʊ, uː]. According to Strange et al.’s (2001) measurement, the mean ratio in duration of longer versus shorter North American English vowel is around 1.3. This grouping is based on Hillenbrand, Clark, and Houde’s (2000) comparison among previous four studies of American English vowel duration as shown in Figure 5. Incidentally, Strange et al. (2001) and Strange et al. (1998) reported that

native Japanese speakers are sensitive to such length differences between English shorter vowels and longer vowels.

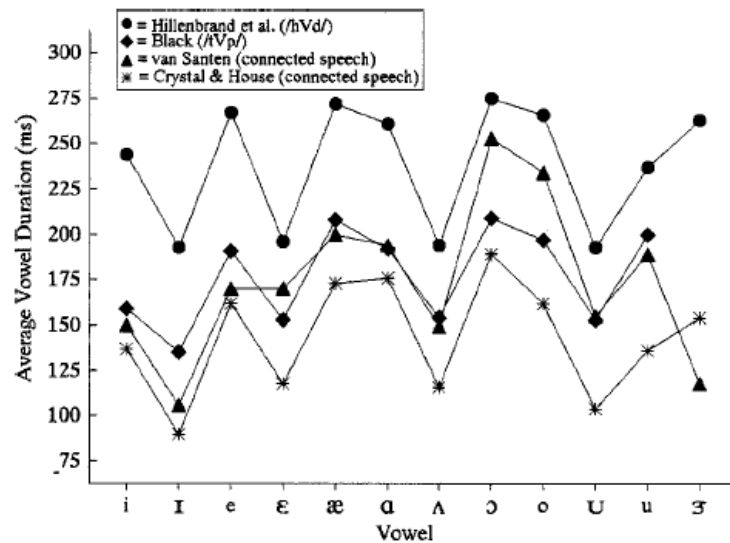


Figure 5. Average English vowel duration (Hillenbrand et al., 2000, 3014, reprinted with permission)

Hillenbrand et al. (2000) reported that when durations of 11 non-rhotic vowels, including [ɔ:] as in *caught*, were manipulated, there was a significant effect on identifying [ɑ:]-[ɔ:]-[ʌ] and [æ:]-[ε] by native English speakers. Shortened [ɔ:] is likely to be misidentified as [ɑ:] or [ʌ], while lengthened [ʌ] is likely to be misidentified as either [ɑ:] or [ɔ:]. To a lesser extent but more straightforwardly, shortened [æ:] is likely to be misidentified as [ε] and vice versa, though diphthongization patterns play a more important role for the [æ:]-[ε] distinction. To an even lesser extent, shortened [ɑ:] can be misidentified as [ʌ]. In contrast, [e^h] and [ε] were minimally affected by duration, and there was no effect on [i:] versus [ɪ] or [u:] versus [ʊ] (Hillenbrand et al., 2000).

Since diphthongization and duration patterns have a large role in English vowel identification, they cannot be neglected in EAL teaching. Especially, unlike English, Japanese allows any vowel sequences (with some infrequent combinations) and has phonemic vowel length contrasts, the information about these characteristics would be beneficial. This suggests that the commonly seen Japanese-English vowel comparison like

Figure 6 with impressionistic vowel qualities at midpoints without duration and diphthongization is very misleading.

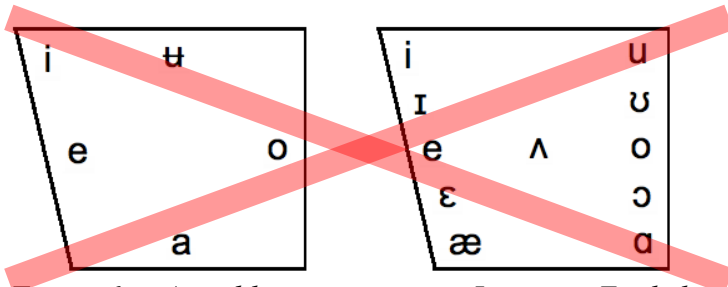


Figure 6. A problematic common Japanese-English vowel comparison

2.2.1.3 Foreign (a): the low central vowel

The 13-vowel system lacks the low central vowel [a:]. However, according to Boberg (2009, 355), young Canadian and some American English speakers tend to pronounce the low central vowel [a:] for the letter <a> in loanwords, such as *plaza*, *façade*, *lava*, *lasagna*, *taco*, and so on, which is phonetically between [æ:] and [ɑ:] and phonologically of an extraphonemic status. For example, *taco* is neither [ta:ko⁰] nor [tæ:ko⁰], but is like [ta:ko⁰] if [a:] emerges. Boberg (2009) calls it “foreign (a)”. In the 13-vowel system, in which the *cot-caught* merger (the [ɑ:]-[ɔ:] merger) has taken place, there is a wide space between [æ:] and [ɑ:], so this foreign (a) occupies this open space (Boberg, 2009). This vowel is also usually distinct from the mid central [ʌ] in vowel height, but depending on the phonetic environment, it is close enough to [ʌ]: for example, *pasta* with foreign (a) is close enough to /pʌstə/, perhaps showing phonetic vowel shortening and raising followed by a voiceless obstruent cluster (Boberg, 2009, 372).

2.2.1.4 Characteristics of Canadian English

Since my experiment to be discussed in Chapter 3 and Chapter 4 is done with native Canadian English (CE) speakers, I briefly discuss Canadian English vowels.

There are three major North American English dialects, the Northern area where the Northern Cities Vowel Shift is undergone, the Southern area where the Southern Shift is

undergone, and the elsewhere including Canada (Clark, Elms, & Youssef, 1996). While the “elsewhere” region is said to have a fairly stable vowel system, CE is undergoing a substantial vowel shift (Clark et al., 1996). The back vowels [u:] as in *food*, [ʊ] as in *book*, and the first part of [aʊ] as in *cow* in CE are becoming more front (Clark et al, 1996). Therefore, Japanese [ɯ:] and [ɯ̥], which are central or front rather than back (see §2.2.2.1), may be similar to CE[u:, ʊ] in backness. The best-known characteristic in CE is Canadian Raising, which is the raising of the nuclei of the true diphthongs /aj/ and /aw/ followed by a tautosyllabic voiceless obstruent: for example, *pout* realized as [pʌwt], instead of [pawt] (D’Arcy, 2005). The aforementioned /aw/ fronting are favoured in environments where Canadian Raising do not occur, so that the vowels in *pout* and *mouse* are expected to be [ʌw] with no fronting rather than [ɛw] or [ɐw], while the vowels in *proud*, *town*, and *cow* are expected to be [æw] or [aw] with fronting (D’Arcy, 2005). Another characteristic of CE is front lax vowel lowering or retracting; [æ:] is likely to be retracted and lowered especially before a lateral or a fricative, which triggered the retracting or lowering of [ɪ] and [ɛ] as well as the lowering or/and centralizing of [ʌ] (Roeder & Jarmasz, 2008; D’Arcy, 2005). High vowels are generally not diphthongs (D’Arcy in personal communication, 2011) and [e^h] is minimally diphthongized (Labov et al., 2006). In CE, except for the Atlantic Provinces, [æ:] is more raised before [g], and in some areas [æ:] and [e^h] before [g] merged (Labov et al., 2006).

2.2.1.5 Unstressed vowels

The most misunderstood English vowel by Japanese EAL learners is probably the schwa [ə] occurring only in unstressed syllables, as discussed in §2.1.2. In languages that have both stressed and unstressed syllables, unstressed syllables tend to have fewer phonemic contrasts. For example, in Central Italian dialects, stressed syllables contrast seven vowels, while unstressed syllables contrast five, and in Russian, stressed syllables contrast five

vowels, while unstressed vowels contrast three (Flemming, 2004). This is because unstressed vowels are pronounced shorter and with less effort, which makes it difficult to make distinctive vowel qualities (Crosswhite, 2004; Flemming, 2004).

In North American English unstressed syllables, all the 13 vowel contrasts are reduced to one vowel [ə] in word medial positions, and are to three vowels [i:, o^u, ə] in word-final position, as in *pretty* [pɪrɪ:], *motto* [mɑ:ro^u] and *beta* [be'tə] (Flemming & Johnson, 2007, 92). The English unstressed vowel [ə] is not a target-less vowel. According to Yamane-Tanaka, Gick, and Bird's (2004) study of English schwas in function words, such as *a*, and *the*, there was a target of articulation (although their study was about British English). As mentioned in §2.1.2, in Japanese EAL learners' pronunciation, English unstressed vowels tend to be pronounced differently depending on spellings, but in native English speakers' pronunciation, <a> in *probable*, <e> in *begin*, <o> in *compare*, and <u> in *suggest*, for example (examples are from Flemming & Johnson, 2007), are all realized as the same vowel. As can be seen, unstressed vowels are one of the factors of inconsistent English vowel GPC patterns.

Although whether [ʌ] and [ə] are the same phoneme or different phonemes is still debatable, I regard them as the same phoneme in this paper rather than regarding /ə/ as the 14th phoneme. In fact, some dictionaries, such as Scholastic Pocket Dictionary (2005), use the same phonetic notation for unstressed vowel such as <a> in *ago* and <u> in *but*, so they do not distinguish [ʌ] and [ə] in American pronunciation. Likewise, Hammond (1999) mentions that [ʌ] and [ə] differ only in stress, so there is no need for different symbols if stress is marked.

2.2.2 Standard Japanese vowels and the sound qualities

In order to predict possible positive and negative L1 interference, I will discuss the Japanese vowel system in this section.

2.2.2.1 Japanese monophthongs

Japanese has five short/one-mora monophthongs /i, e, a, o, u/ and phonologically distinctive long/two-mora counterparts /i:, e:, a:, o:, u:/: for example, /sori/ ‘sleigh’ versus /so:ri/ ‘prime minister’. Unlike English, all of these Japanese monophthongs are fairly monophthongal (Nishi et al. 2008). Four of the one-mora vowels are phonetically realized as approximately [i], [e̞], [ɤ], and [ɔ̞] ([,] indicates lowered in tongue position) respectively (Makino, 2009). Japa/i/ is near the cardinal vowel [i] (Tsuzuki, 1996). Japa/e/ is between the cardinal vowels [e] and [ɛ] (Tsuzuki, 1996), and the actual realizations vary from [e] to [ɛ] (Inozuka & Inozuka, 2009). Likewise, /o/ is between the cardinal vowels [o] and [ɔ] (Tsuzuki, 1996). Japa/a/ is central and between the cardinal vowels [a] and [ɑ], and it has the widest range of allophones among the five one-mora vowels (Tsuzuki, 1996). Japa/a/ is not fully open (Makino, 2009) and it is realized as [ə] in an unaccented syllable, such as in the last mora /ra/ [rə] in /sajo:nara/ ‘farewell’ (Tsuzuki, 1996). After /j/, /a/ is realized as [æ] (Yamaoka, 2008). In the case of /u/, although this is typically treated as an unrounded back vowel [u], Nogita, Yamane, and Bird’s (2013) ultrasound and video recording study revealed that this vowel pronounced by linguistically naïve native Japanese speakers from the Tokyo region is central or rather front with lip rounding. Figure 8 shows unambiguous lip protrusion as shown in Figure 7, so its actual realizations are [ɯ ~ ʏ].



Figure 7. Lip protrusion in standard Japanese [ɯ] (from Nogita et al., 2013, 40)

At least this vowel is not actively unrounded, unlike the Korean actively unrounded /u/. Moreover, having an unrounded back /u/ without its rounded counterpart is typologically less preferable. Therefore, I follow Nogita et al.'s (2013) recommended symbol [ɯ] for this vowel⁴. Another characteristic of the Japanese vowel system is that utterance-final one-mora vowels are typically followed by a glottal stop: for example, /a#/ → [aʔ#] (Vance, 2008).

With regard to two-mora monophthongs, /i:, e:, a:, o:, u:/ are spectrally similar – not necessarily identical – to their one-mora counterparts and are slightly more peripheral than the short counterparts (Ingram & Park, 1997). Nishi et al.'s (2008) acoustic study demonstrates that two-mora monophthongs are almost consistently outside of the one-mora counterparts in the vowel space. Another characteristic is that according to Hisagi, Nishi, and Strange (2008), one-mora monophthongs are much more affected by consonantal coarticulatory effects, while two-mora monophthongs are much more resistant; specifically, /a, o, u/ in the /dVt/ context are much more front than those in /bVp/, while /a:, o:, u:/ in /dVt/ are only slightly front than those in /bVp/. All of these results from previous studies suggest that one-mora monophthongs and two-mora counterparts are not necessarily the same in vowel qualities. This indicates that it is not wise to assume that Japanese has only five vowel qualities.

As to duration, Hirata (2004) reported that Japanese two-mora monophthongs are usually almost twice as long as their one-mora counterparts, and Tsukada (1999) reported

⁴ In “prestigious” standard Japanese spoken by trained speakers such as newscasters or voice actors (Akiyama, 2009), and in Japanese-as-an-additional-language textbooks, the vowel [ɯ] is regarded as an unrounded vowel [u]. At least in “prestigious” Japanese, vowel devoicing/deletion between voiceless consonants and word-finally preceded by a voiceless consonant is obligatory. For example, the polite copula is obligatorily pronounced as [des] but not as *[desʷ/desʷ]. If this final vowel is underlyingly rounded, the surface representation could be [des^w] with the remnant of the underlying roundness feature, while if it is underlyingly unrounded, roundness would not occur at the surface level. In other words, if the underlying representation of both [s] and [su] is /su/, it is consistent in roundness (The Japanese pronunciation seminar conducted by NHK Communications Training Institute in July, 2009).

that the two-mora monophthongs are 2.4-3.2 as long as their monophthong counterparts. The duration ratio varies with speaking style, rate, and contexts but long vowels are still over 50% longer than the short counterparts (Hisagi, Nishi, & Strange, 2008; Nishi et al., 2008). In any event, Japanese one-to-two-mora duration ratio in vowels is considerably larger than that in North American English, which is around 1.3 (Strange, Akahane-Yamada, Kubo, Trent, and Nishi, 2001). According to Hisagi et al.'s (2008) data of average vowel duration at natural speech rate in Japanese (Kansai dialect) and English (New York dialect), Japanese one-mora monophthongs were 86 milliseconds (ms), two-mora monophthongs were 159ms, while New York English shorted vowels [ɪ, ɛ, ʌ, ʊ] were 124ms, and longer vowels [i:, e^l, æ:, ɑ:, ɔ:, o^o, u:] were 158ms. This suggests that Japanese one-mora vowels are noticeably shorter than English [ɪ, ɛ, ʌ, ʊ], so Japanese one-mora vowels are not likely to have sufficient time to make diphthongization as cues for vowel contrasts, unlike English checked vowels.

As another characteristic, Strange, Akahane-Yamada, Kubo, Trent, Nishi, and Jenkins (1998) mention that Japanese two-mora monophthongs often have rising or falling pitch contour. Pitch contour is a supplementary cue of the one-mora-two-mora distinction for native Japanese listeners (Kinoshita, Behne, & Arai, 2002).

2.2.2.2 Japanese vowel sequences

Phonotactically, any Japanese vowel can be adjacent to any other, as Vance (2008) lists all the non-identical vowel-vowel sequences within the same morpheme. However, some vowel-vowel sequences in the same morpheme are rare and occur only in recent loanwords or foreign proper names (Vance, 2008). For example, /ou/ in the same morpheme is very rare even in recent loanwords: a possible example is a Korean loanword <ソウル> /souru/ ‘Seoul’ (Vance, 2008, 62). However, /ou/ across the morpheme boundary occurs in native and Sino-Japanese words (Chinese loanwords): for example, <大和歌> /jamatouta/ (/jamato + uta/ “Japanese poem” and the verb <添う> /sou/ “accompany” in which /-u/ is the nonpast

affirmative ending (Vance, 2008, 68). Another infrequent vowel sequence within the same morpheme is /ei/, but much more frequent than /ou/. According to Okada (2004), /ei/ is likely to occur in loanwords with (relatively) low familiarity, such as <ネイティブ> /neitibu/ ‘native (speaker)’ and <クレイジー> /kureidzi:/ ‘crazy’, and /ei/ followed by /N/, such as <トレイン> /toreiN/ ‘train’ and <レインコート> /reiNko:to/ ‘raincoat’. As an example of native Japanese words that have /ei/, Vance (2008) and Okada (2004) name <えい> /ei/ ‘ray (fish)’. The point is that perceptually similar Japanese counterparts of Eng[o^u] and [e^h] do exist as Japa/ou/ and /ei/ respectively, as will be discussed in §2.2.3.2.

There are also multiple vowel sequences, as in <青い> /aoi/ ‘blue (adjective)’ <田植え> /taue/ ‘rice-planting’, and <相生> /aioi/ (a surname). Identical vowel sequences /aa, ii, uu, ee, oo/ contrast with two-mora monophthongs /a:, i:, u:, e:, o:/: a well-known minimal pair is /sato:ja/ 砂糖屋 ‘sugar dealer’ and /satooja/ 里親 ‘foster parents’ (Vance, 2008, 58). There are combinations of a one-mora monophthong and the two-mora counterpart or the other way round: for example, <呼应> /koo:/ (/o + o:/) ‘hailing each other’ and <好悪> /ko:o/ (/o: + o/) ‘likes and dislikes’ (Vance, 2008, 59). Notice that Japanese has many different types of vowel contrasts that are not present in English. These contrasts will be overlooked if one assumes that Japanese has a much simpler vowel system.

There is one more issue to note. There are /CjV/ (and marginally /CwV/) sequences in Japanese and there is no consensus on whether these glides are consonants or part of diphthongs. Some linguists, such as Clements (1990) and Kondo (2000), analyze that /G/ in /CGV/ belongs to an onset, while other (possibly fewer) linguists, such as Hashimoto (1984), argue that /G/ is better treated as part of a nucleus⁵. Likewise, a similar issue arises in English

⁵ There is another argument that Japanese [CG] sequences are palatalized and labialized consonants /C^j/ and /C^w/, but according to Nogita’s (2016b) comparison between Japanese [Cj] and Russian [C^j] in duration, the Japanese palatalized /C^j/ analysis is the least likely

/CGV/ sequences, although it seems less ambiguous than in the case of Japanese; in North American English, /w/ in /CwV/ belongs to an onset, while /j/ in /CjV/, which occurs only in /Cju:/ and /Cjɹ/, is doubly linked to an onset and nucleus (Kehoe, Hilaire-Debove, Demuth, & Lleó, 2008; Goad, 2006). Despite these complexities, in this dissertation, I regard /j/ and /w/ in the /CGV/ contexts as consonants in both Japanese and English for the sake of convenience.

2.2.2.3 Mora division and ultimate components

There is one more issue to note to deeply understand the Japanese vowel system. There has been a long-standing debate over whether a syllable (defined as a sequence of sounds with a sonority peak as the nucleus) is a linguistically relevant unit in standard Japanese (e.g., Labrune, 2012; Kubozono, 1998). While English-speaking children learn to count syllables as part of growing up, Japanese speaking children learn to count morae (defined as a unit for measuring duration (Kubozono, 1998)) as part of growing up, so morae are much more clearly natural to Japanese speakers (Vance, 2008). Since a syllable-based division and a mora-based division make a difference in recognition of both vowel sounds and vowel letters, it is therefore necessary to discuss this issue here.

According to Kubozono (1998), a mora was originally a unit used for measuring length of syllables in Western classic poems. In Japanese, a mora functions as a unit for measuring duration of speech sounds, as opposed to a syllable that forms a curve of sonority (Kubozono, 1998). In general, an onset does not count as a mora, except that some languages, such as Pattani Malay, have moraic geminate onsets (Topintzi, 2008). Whether the second half of a long vowel or a diphthong and a coda are moraic or not is language specific, but Japanese counts these as moraic. Kubozono (1989) demonstrated speech errors that suggested that Japanese lacks a rhyme constituent. In his examples, the second half of a long vowel is

since Russian [C^j] and [C] are not different in duration while Japanese [Cj] is significantly longer than the [C] counterpart.

replaced with a second half of a diphthong, or with a consonant, or, in infrequent cases, even with a CV mora, as shown below:

3) pa: séN. to → paN. séN. to ‘percent’ (p.255)

/CV:/ - /CVN/ alternation

4) ko. ku. ro:.. do:. ro: → ko. ku. ro:.. do. ku. ro:

‘*Kokurō* and *Dōrō* (names of railway workers’ labour unions)’ (p.265)

/CV:/ - /CVCV/ alternation

In these cases, only the second half of a syllable, or non-tone-bearing/dependent mora, is replaced with another non-tone-bearing/dependent or even with an tone-bearing/independent mora instead of the whole rhyme constituent being replaced. This indicates a lack of a rhyme constituent and tendency of mora division in Japanese.

In contrast, English speech errors do not show the same pattern as Japanese. Vance (2008) suggested that the English diphthong /aj/ as in *wine* is better analyzed as a single unit rather than two units, i.e., [a] + [i]. If *wine glass*, for example, is analyzed as [wain glæs]⁶ in which [ai] can be divided into two units like Japanese, a speech error involving transposing [a] and [æ] would result in *[wæin glas], but this is in fact inadmissible due the phonotactic constraint of the *[æi] sequence (Vance, 2008, p.41). Thus, /aj/ cannot be divided into two units. Due to such severe phonotactic constraints in English, it is possible to interpret that vowel contrasts are more limited in English than in Japanese.

⁶ In this paper, I transcribe the TRAP vowel as [æ:] in the (broad) phonetic transcription, but in this case, I transcribe it as [æ] without [:] in order to be consistent with Vance’s (2008) explanation.

Because of the mora division in Japanese, native Japanese speakers can be clearly aware of each vowel ultimate component, and a connection with an adjacent vowel component is not tight. Moreover, probably in part due to the mora division system, one vowel component is assigned to one vowel letter (e.g., /a/-<a> or /a/-<あ>), which visually helps speakers be aware of vowel components. When it comes to English, vowels also can be divided into vowel components; according to Wardhaugh (1977), seven different symbols /i, e, æ, ə, a, o, u/ plus two glides /j, w/ can represent all the vowel contrasts in various dialects (see Wardhaugh, 1977 for more details). If the inventory is limited to a particular North American dialect, English vowel components can be analyzed with five /I, E, A, O, U/ as discussed by Yamamoto (2011). In Yamamoto's (2011) analysis, the 13 vowels [i:, ɪ, e¹, ε, æ:, ɑ:, ɒ⁰, ʊ, u:, ʌ, aɪ, aʊ, ɔɪ] are transcribed as /II, I, EI, E, EA, AA, OU, U, UU, A, AI, AU, OI/ respectively by deploying /I, U, A/ for off-glides. However, English speakers may not be aware of each vowel component. For example, native English speakers would not divide [e¹] (/EE/) or [ɒ⁰] (/OO/) into two components. Moreover, a combination of two vowel components often correspond to one letter in spelling, such as [e¹] to <a> in *tasty* or [ɒ⁰] to <o> in *coopious*, which would make it difficult to be visually aware of vowel components. What is important is that if Japanese EAL learners are not aware of such tight connections of vowel components in English, in many cases they might recognize one English vowel phoneme as a combination of multiple vowels, which, in turn, could affect their recognition of English vowel spelling. For instance, for Japanese speakers, Eng[o⁰] (2 morae) can be an equivalent unit to Japa/gjogjo/ (2 morae) in /gjogjo:/ 'fishery', in an extreme case; in other words, Eng/V/ and Japa/CCVCCV/ are an equivalent unit, as described in Figure 8.



Figure 8. The 2-mora structure of both Eng[o⁰] (/V/) and Japa[gjogjo] (/CCVCCV/)

This can be a barrier for Japanese EAL learners to assigning Eng/o^u/, for example, to only one letter <o>.

2.2.3 Comparison of the English and Japanese vowel systems

2.2.3.1 The popular myth

The majority of papers and pronunciation textbooks presuppose that Japanese has only five vowels whereas English has many more vowels, so Japanese EAL learners apparently need to learn many new vowels. If this were really the case, one might expect that Japanese learners at the beginning stage of EAL learning would be able to pronounce the over 13 different vowel graphemes in only five ways, and they would be able to perceive only five contrasts among 13 English vowels (or at least 10 so-called monophthongs) and would assign 13 vowels to graphemes that correspond to five sounds. This means that for Japanese EAL learners, before learning English GPC rules, mastering English vowels would be a big challenge. Contrary to this popular “myth”, a minority of scholars, such as Kurimoto (1990), argue that American English vowels should be easily learned by using their L1 Japanese vowels. If this is the case, Japanese EAL learners’ mispronunciations of English vowels are not necessarily due to their inability to produce vowel sounds, but due to other factors, such as misinterpretation of spelling. Before discussing Japanese EAL learners’ knowledge about English GPC patterns, it is essential to examine whether Japanese speakers only can produce and perceive five vowel contrasts or can produce and perceive a sufficient number of vowel contrasts.

A good analogy of this popular myth would be Schütz’s (1981) reanalysis of the phonology of Hawaiian, which is typically regarded as a language with an oddly small number of phonemes and a simple sound system. Below is Schütz’s (1981, 33) claim:

“The popular view of Hawaiian phonology as a sparse, simple system seems to have developed from a tendency to count the letters in the alphabet rather than to analyze the phonology. Once such a myth was established, linguists and lay writers tended to repeat it (and thereby strengthen it) without testing it.”

Schütz's (1981) claim can be applied to the Japanese phonology. Since in common IPA transcription, many more vowel IPA symbols are adopted for English vowels than for Japanese IPA symbols, there is a possibility that the visual information of common IPA transcription gives a false impression that actual Japanese vowel system is also simple.

2.2.3.2 Perception-based Japanese-English vowel comparison

In this section, I will review researches of a perception-based comparison between English and Japanese vowels in order to explain that native Japanese speakers (not necessarily Japanese EAL learners) can distinguish all the 13 North American English vowels, at least in production, although not necessarily in a native-like manner. In Nogita and Lin (2016) and Nogita (2014), we investigated whether standard Japanese has perceptually similar counterpart vowels, as judged by native Canadian English (CE) listeners, for all the 13 North American English vowel phonemes. We selected 23 Japanese vocalic intervals out of the complete 35 vowel interval inventory (that consists of five one-mora monophthongs, five two-mora monophthongs, and 25 two-different-monophthong sequences) as candidates in order to establish the perceptually most similar counterparts of the 13 English vowels, taking into consideration both duration and diphthongization patterns.

The 23 Japanese vocalic intervals were extracted from Japanese [CVC_ě] sequences (e.g., [Ci:C_ě], [C_ěC_ě], [C_ěěC_ě], etc.) and then synthetically embedded in the English [b_C] contexts in which [C] is one of [b, d, g, p, t, k]. Both the Japanese vowels and the English frames were uttered in syllables read at a normal speech rate. Then, 14 native Canadian English (CE) speakers listened to the 138 stimuli (23 vowel categories × 6 contexts = 138), and chose one of the 13 English vowels that best matched the Japanese vowel interval in each

stimulus. For a pair to be deemed corresponding, we adopted Bundgaard-Nielsen et al.'s (2011) stringent criterion in which consistency is 70% or above, and lenient criterion in which consistency is 50% or above. Table 2 shows the 13 best matches.

Table 2. CE speakers' perception-based Japanese-English counterparts

Japa	[i:]	[ẽ]	[ẽĩ]	[ɛ:]	[ẽẽ]	[ɸ:]	[õũ]
Eng	[i:]	[ɪ]	[e']	[ɛ]	[æ:]	[ɑ:]	[o ^o]
e.g.	<i>fleece</i>	<i>kit</i>	<i>face</i>	<i>dress</i>	<i>trap</i>	<i>lot</i>	<i>goat</i>
Japa	[ũ]	[u:]	[ɸ]	[ɸõ]	[õĩ]	[ẽĩ]	
Eng	[ʊ]	[u:]	[ʌ]	[aʊ]	[ɔɪ]	[aɪ]	
e.g.	<i>foot</i>	<i>goose</i>	<i>strut</i>	<i>mouth</i>	<i>choice</i>	<i>price</i>	

Note. Yellow: $\geq 70\%$, Blue: $\geq 50\%$ and $< 70\%$, White: $< 50\%$ in consistency

As is shown in Table 2, all English vowels have a Japanese vocalic counterpart except [ɑ:], judged by the $\geq 50\%$ criterion. As the Eng[ɑ:]'s best selection, the Japa[ɸ:] was perceived as Eng[ɑ:] only 41% of the time. Interestingly, according to previous perceptual studies in both Japanese vowels perceived by English speakers and the reverse (Nishi et al, 2008; Strange et al., 2001; Strange et al., 1998), Japa[ɸ:] and Eng[ɑ:] was found to be a reasonably good one-to-one match at least in some conditions. The difference between our and their results could be due to dialectal differences. In Strange et al. (2001) and Strange et al. (1998) the English speakers distinguished [ɑ:] and [ɔ:], so their [ɑ:] must be more front than CE[ɑ:]. Probably, Japa[ɸ:] is closest to the aforementioned extraphoneme foreign (a) as in *taco* by some Canadian English speakers.

Among the English vowels that have a Japanese corresponding counterpart, some are more strongly corresponding than others. The weakest corresponding vowels are those for Eng[ɛ], [æ:], and [ʊ] barely meeting the 50% criterion. It is interesting to note that contrary to our finding that Japa[ɛ:] was perceived as Eng[ɛ] only slightly over 50% of the time, which implies that producing target-like CE[ɛ] could be challenging for Japanese EAL learners to some extent, Kondo et al.'s (2015) and Makino's (2009) studies regarding Japanese EAL learners' productions, learners make relatively few errors with Eng[ɛ]. This may be due to

aforementioned CE front lax vowel lowering/retracting, although more research will be needed.

As well, we made some very fascinating discoveries among our correspondences (Nogita & Lin, 2016). One, that while Eng[æ:, ɪ] are generally regarded as difficult vowels for Japanese EAL learners or non-existing vowels in L1, Japa[ẽ] is perceived as Eng[ɪ] around 60% of the time and Japa[ẽẽ] as Eng[æ:] around 50% of the time, and in some consonantal contexts, these percentages become higher (e.g., Japa[ẽẽ] → Eng[æ:] before [t, d] 72%, Japa[ẽ] → Eng[ɪ] before [k, g] 74%). Two, that Japa[ɛ:]-[ɪ] contrast can correspond to Eng[ɛ]-[ɪ] contrast. That is, the (mostly) duration difference between the two Japanese vowels is mapped by *two different* English vowels. To our knowledge, this interesting correspondence has not been reported previously. This difference could be due to that there is a length difference between Eng[ɛ] and [ɪ]. As shown in Figure 5 in §2.2.1.2, previous studies have found that Eng[ɛ] is consistently longer than Eng[ɪ], although the difference is small. Three, it is commonly assumed that Eng[æ:, ɑ:, ʌ] all correspond to Japa[ẽ]. Our findings reveal a much more complex picture—they all have their own specific counterparts: Eng[æ:] corresponds to Japa[ẽẽ], Eng[ɑ:] to Japa[ɸ:], and Eng[ʌ] to Japa[ẽ]⁷. Incidentally, Makino's (2009)'s finding that Japanese EAL learners most often pronounce Eng[ɑ:] as [ɔ] also rejects the popular assumption. It seems that the popular assumption does not take duration and diphthongization into account, or perhaps it comes from a comparison of similar looking conventional IPA symbols (i.e., <a> vs. <ɑ, æ, ʌ>), rather than actual phonetic qualities.

⁷ When I was first taught phonics by an American teacher from Iowa, I perceived Eng[æ: (æə), ɑ:, ʌ] as Japa/ea, a:, a/. At that time, I was still in high school and was a complete beginner learner of English, and had absolutely zero knowledge of linguistics, but still perceived Eng[æ:, ɑ:, ʌ] differently. The purpose of our study was to prove my impression. Considering my experience, I suspect that those who assume the Eng/æ, ɑ, ʌ/-Japa/a/ relationship are biased by the IPA's visual impression. Alternatively, since I did not know IPA symbols at that time, perhaps I could purely concentrate on sounds without IPA interference.

Figure 9 summarizes the common 3-to-1 fallacy and a more reasonable 1-to-1 model, although the 1-to-1 model is still somewhat simplistic.

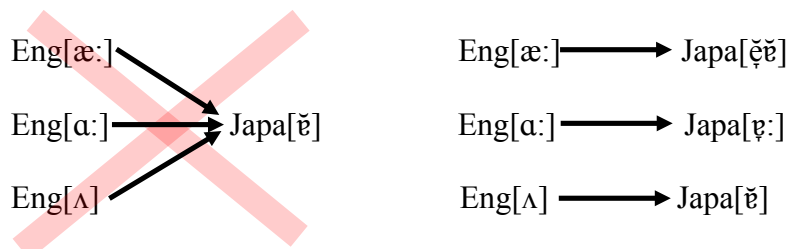


Figure 9. The problematic popular 3-to-1 correspondence (left) and the more legitimate 1-to-1 correspondence according to our study

In terms of GPC, based on the popular myth that Japanese has only five vowels and English has many, one might assume that Japanese EAL learners would pronounce over 13 English vowel spellings in only five ways because Japanese EAL learners can produce only five vowels. However, according to Nogita and Lin (2016), at least in production, Japanese EAL learners would be able to produce 13 different English vowel contrasts.

2.2.4 Conclusion about Japanese and English vowels

To conclude, English vowels themselves should not be as difficult for the Japanese EAL learners as previously thought, although acquiring native-like pronunciation is a different story. From a different angle, I could argue that Japanese has many more vocalic variations than English. A real challenge would be that since standard Japanese is a mora-based language, Japanese EAL learners are expected to have difficulty recognizing one English vowel phoneme as one unit, which could potentially affect their recognition of English vowel spelling.

2.3 English vowel spelling

2.3.1 Introduction about vowel spelling

English spelling is known as a relatively deep/opaque orthography in which grapheme-phoneme-correspondence (GPC) is not of a straightforward one-to-one

relationship. In the English education in Japan, its complexity and difficulty of acquisition are generally emphasized. In contrast to this popular view, I will emphasize learnability or approachability of English spelling in this section. Specifically, I will focus on regularity and default rules of English GPC, rather than its irregularity, since English default GPC rules are worth learning in order to learn English efficiently, as discussed below.

2.3.1.1 Regularity and default spelling

English spelling is not phonographically completely random, that is, a spelling like <Dale> read as /tɑ:məs/ is very unlikely; note that even this type of arbitrary correspondence is possible in the Japanese orthography as will be discussed in §2.5.1. In this section, I discuss phonographic regularity in English spelling and its importance.

To illustrate irregularity in English spelling, there is the much-cited <ghoti> as a creative respelling of [fɪʃ], in which <gh>-[f] is from *tough* [tʌf], <o>-[ɪ] is from *women* [wɪmɪn], and <ti>-[ʃ] is from *nation* [neɪʃən]. However, in reality, such grapheme sequences do not exist since <gh>-[f] does not occur morpheme-initially and <ti>-[ʃ] does not occur morpheme-finally (Rollings, 2004; Venezky, 1999). In other words, English spelling is not this irregular. In fact, as mentioned in §2.1.5, native English speakers rely on graphophonic skills more than Japanese EAL learners when seeing English words.

The question is what default GPC rules are. It is true that vowel phonemes and vowel sounds are especially deviant from one-to-one relationship, in part because of the discrepancy between the number of phonological vowel contrasts (13 in the dialect at issue) and the number of letters (5). Indeed, there are so many cases of one-phoneme-to-many-grapheme or one-grapheme-to-many-phoneme correspondences. For example, [ʌ] can be spelled as <u> as in *fun*, <o> as in *won*, <ou> as in *touch*, <oo> as in *blood*, and so on. However, such correspondences are not evenly distributed, but some correspondence rates are fairly high while others are not as high. For example, the [ʌ]-to-<u> correspondence is 86% (Hanna,

Hanna, Hodges, & Rudorf, (1966) cited in Ota, Hartsuiker, & Haywood (2010)), so the [ʌ]-to-<u> correspondence and the [ʌ]-to-<o, ou, oo> correspondences are not in the same status. Due to this default [ʌ]-to-<u> correspondence, if native English speakers hear a nonsense word like [blʌsp], they would likely adopt the basic spelling like <blusp>, rather than less used variants <blosp>, <blousp>, or <bloosp>. Strauss and Altwerger (2007, 303) mentioned that vowels of the words shown in 5)-a are “regularly” spelled, whereas those in 5)-b are entirely unpredictable from the spellings.

- 5) a. *seen* ([i:]), *lone* ([o^ʊ]), *con* ([ɑ:]), *new* ([u:]), *road* ([o^ʊ]), *cut* ([ʌ])
 b. *been* ([ɪ]), *gone* ([ɑ:]), *son* ([ʌ]), *sew* ([o^ʊ]), *broad* ([ɑ:]), *put* ([ʊ])

In reality, overall English GPC consistency is controversial. According to Hanna, Hanna, Hodge and Rudorf (1996) cited in Kessler and Treiman (2001), 73% of the phonemes would be spelled correctly if the default rules were applied. Another study estimates 75% regularity (Crystal, 1987, cited in Jones, 1996). Another study mentions that a compute corpus analysis of 17,000 words indicates that 84% of words are spelled based on regular spelling patterns (Hanna et al., 1971, cited in Jones, 1996). The extreme report is that according to Hanna et al, (1971, cited in Jones, 1996), the spelling of only about 3% of English words are unpredictable, but some 100 of those irregular spellings are found in the most frequently used words, which makes English spelling look more irregular than it actually is. In any case, these studies argue that English GPC is relatively consistent.

For details of default vowel spellings, Kessler and Treiman (2001) examined vowel GPC patterns of 3117 monosyllabic American English words, of which 1329 had the CVC structure and the rest had other structures. Due to the onset-rhyme structure in English, English vowels are more influenced by a coda than by an onset except for the onsets [w, j]

(Rollings, 2004), which is a major difference from Japanese as mentioned in §2.2.2.3. So Kessler and Treiman (2001) took rhyme constituents into consideration and examined both default correspondences and conditioned correspondence according to coda consonants. Table 3 shows default and conditioned grapheme-to-phoneme correspondence patterns and Table 4 shows default and conditioned phoneme-to-grapheme correspondence patterns in American English vowels in monosyllabic words summarized by Kessler and Treiman (2001). Note that Kessler and Treiman (2001) distinguish [ɑ:] and [ɔ:], but in this present study, I adopt the 13 vowel system that does not distinguish [ɑ:] and [ɔ:], and I combined these two vowels. Also of note is that Kessler and Treiman (2001) regarded <o> in *corn* as [ɔ:] when, in fact, the rhyme in *four*, *pour*, and *your* is generally phonologically transcribed as /ɔɪ/ or a similar variation in common IPA transcription, but according to Wells (1982), the vowel in /ɔɪ/ is regarded as the same phoneme as [o^u] in *no* or *hope* by many General American English speakers (including my Canadian English-speaking participants in the experiments in Chapter 3 and 4), so I follow Wells (1982).

Table 3. Default and conditioned grapheme-to-phoneme correspondence in American English vowels in monosyllabic words (Kessler & Treiman, 2001, 602)

Spell	Default		conditioned		
	Sound	Example	Sound	Coda	Example
<a>	[æ:]	<i>act</i>	[ɑ:]	Empty	<i>spa</i>
				<r>	<i>card</i>
			[e ^l]	<nge>	<i>change</i>
			[ɑ:]	<l>	<i>bald</i>
<a_e>	[e ^l]	<i>bake</i>	[ɛ]	<r>	<i>rare</i>
<ai>	[e ^l]	<i>chain</i>	[ɛ]	<r>	<i>chair</i>
<al>	[ɑ:]	<i>chalk</i>	[æ:]	<f, v>	<i>calf</i>
<au>	[ɑ:]	<i>cause</i>	[o ^u]	<ve, che>	<i>mauve</i>
<ay>	[e ^l]	<i>say</i>	[ɛ]	<s>	<i>says</i>
<e>	[ɛ]	<i>neck</i>	[i:]	Empty	<i>she</i>
<e_e>	[i:]	<i>gene</i>	[ɪ]	<r>	<i>sphere</i>
<ea>	[i:]	<i>beach</i>	[ɪ]	<r>	<i>beard</i>
			[ɛ]	<d>	<i>thread</i>
<ee>	[i:]	<i>cheek</i>	[ɪ]	<r>	<i>steer</i>
<i>	[ɪ]	<i>bit</i>	[aɪ]	<nd, ld>	<i>mind</i>
<ie>	[i:]	<i>priest</i>	[aɪ]	Empty	<i>tie</i>
			[ɪ]	<r>	<i>fierce</i>

<o>	[ɑ:]	<i>clock</i>	[o ^ʊ]	<l>	<i>old</i>
				Empty	<i>go</i>
			[o ^ʊ] ^a	<r>	<i>corn</i>
<o_e>	[o ^ʊ]	<i>cope</i>	[u:]	Empty	<i>who</i>
<oa>	[o ^ʊ]	<i>coat</i>	[o ^ʊ] ^a	<r>	<i>core</i>
<oo>	[u:]	<i>boot</i>	[ʊ]	<k, r>	<i>book</i>
<ou>	[aʊ]	<i>cloud</i>	[ʌ]	<gh>	<i>tough</i>
			[u:]	<p>	<i>group</i>
<ough>	[o ^ʊ]	<i>dough</i>	[ɑ:]	<t>	<i>bought</i>
<ow>	[aʊ]	<i>crowd</i>	[o ^ʊ]	Empty	<i>grow</i>
<u>	[ʌ]	<i>bug</i>	[ʊ]	<ll, sh>	<i>bull</i>
<u_e>	[u:]	<i>dune</i>	[ʊ]	<r>	<i>pure</i>
<y>	[ɪ]	<i>gym</i>	[aɪ]	Empty	<i>shy</i>

Note. ^a In this paper, <o> in <or> as in *corn*, *core* is transcribed as [o^ʊ], which is the same phoneme as <o_e> in *hope*, since the 13 vowel system does not have [ɔ:], but in Kessler and Treiman (2001), <o> in *corn* is regarded as [ɔ:].

Table 4. Default and conditioned phoneme-to-grapheme correspondence in American English vowels in monosyllabic words (Kessler & Treiman, 2001, 608)

Sound	Default		conditioned		
	Spell	Example	Spell	Coda	Example
[æ:]	<a>	<i>bat</i>	<al>	[f, v]	<i>calf</i>
[aɪ]	<i_e>	<i>bride</i>	<i>	[ld, nd]	<i>wild</i>
			<igh>	[t]	<i>night</i>
			<y>	Empty	<i>try</i>
[ɑ:]	<o>	<i>dot</i>	<a>	[ɪ]	<i>bark</i>
	<au>	<i>flaunt</i>	<al>	[m]	<i>calm</i>
				[k]	<i>talk</i>
			<augh>	[t]	<i>caught</i>
			<aw>	[n, k]	<i>lawn</i>
				Empty	<i>law</i>
			<ough>	[t]	
[aʊ]	<ou>	<i>count</i>	<ow>	Empty	<i>cow</i>
				[n, l, z]	<i>crown</i>
[e ^ɪ]	<a_e>	<i>ape</i>	<ai>	[l, n, θ]	<i>fail</i>
			<ay>	Empty	<i>day</i>
[ɛ]	<e>	<i>bell</i>	<a_e>	[ɪ]	<i>care</i>
			<ai>	[ɪ]	<i>chair</i>
			<ea>	[d, θ, lθ]	<i>bread</i>
[i:]	<ea>	<i>beach</i>	<ee>	Empty	<i>tree</i>
			<ie>	[f, dʒ] C+ [d]	<i>brief</i>
[ɪ]	<i>	<i>bit</i>	<ea>	[ɪ]	<i>near</i>
			<ee>	[ɪ]	<i>deer</i>
[o ^ʊ]	<o_e>	<i>bone</i>	<o>	[l]	<i>gold</i>
			<o> ^a	Nonfinal [ɪ]	<i>fork</i>
			<o_e> ^a	Empty [ɪ]	<i>shore</i>
			<oa>	2C	<i>boast</i>

				[f, t, θ, ʃ]	<i>loaf</i>
			<ow>	Empty	<i>glow</i>
[ɔɪ]	<oi>	<i>coin</i>	<oy>	Empty	<i>toy</i>
[u:]	<oo>	<i>cool</i>	<ew>	Empty	<i>new</i>
[ʊ]	<oo>	<i>good</i>	<u>	[i, s, ʃ, ʒ]	<i>full</i>
			<u_e>	[ɪ]	<i>pure</i>
[ʌ]	<u>	<i>bug</i>	<o>	[v, n]	<i>love</i>

Note. ^a In this paper, <o> in <or> as in *corn*, *core* is transcribed as [o^ʊ], which is the same phoneme as <o_e> in *hope*, since the 13 vowel system does not have [ɔ:], but in Kessler and Treiman (2001), <o> in *corn* is regarded as [ɔ:]. As well, Kessler and Treiman showed the [ɑ:] → [ɔ:] alternation before [s, θ, f, g] as in *frost* and *dog*, but I excluded it.

While Kessler and Treiman’s (2001) study is limited to monosyllabic words, Carney’s (1994) (cited in Van Berkel (2005)) study examined phoneme-to-grapheme correspondence patterns from some 26,000 lemmata including multisyllabic words in British English Received Pronunciation (RP). According to Carney’s (1994) (cited in Van Berkel, 2005) criterion, the spellings corresponding to a particular phoneme over 80% of the time are regarded as the basic spellings. For example, <a> in *later*, <a_e> in *name*, and <ay> in *day* together cover 83% of the spellings that correspond to [e¹], and these spelling variations are in complementary distribution on the basis of the position of the word: in a multi-syllabic word (<a>), in a word-final closed syllable (<a_e>), and word-finally (<ay>) (Van Berkel, 2005, 107). Among these three, the most frequent <a> as in *later* is regarded as the basic/default spelling (Van Berkel, 2005). Likewise, <ou> in *house* and <ow> in *owl*, *down*, or *how* correspond to [ao], are equally distinguishable depending on the contexts, and their total coverage comes to 99%, with the most frequent <ou> being regarded as the default (Van Berkel, 2005, 108). Interestingly, [i:] does not have the default spelling since its main corresponding spellings are <e> in *Peter*, <e_e> in *theme*, and final <ee> in *see* with a total coverage of 38%, which is too low to predict [i:]’s spelling, so these spellings are categorized as “word-specific spelling” (Van Berkel, 2005, 109). Note that non-final <ee> as in *seem* adds another 26%, and <ea> as in *sea* and *seam* adds 25% (Van Berkel, 2005, p.109) but notice that these are not in complementary distribution. Table 5 shows British English RP

phoneme-to-grapheme correspondence sub-divided into default, conditioned/contextual, and word-specific spelling according to Carney (1994) (Van Berkel, 2005, 104-105). Since British English and North American English has some different vowel distributions according to word classes (e.g., *bath* as /bɑ:θ/, both *caught* and *court* as /kɔ:t/ in RP), I keep the original table in Van Berkel (2005).

Table 5. British English PR phoneme-to-grapheme correspondence according to Carney (1994) (Van Berkel, 2005, p.104-105)

Sound	Default spelling	Conditioned spelling	Word-specific spelling
/æ/	<a> cat		
/ɛ/	<e> ten		<ea> bread; <ie> friend
/ɪ/	<i> pit		<ui> build; <y> gym;
/ɒ/	<o> pot	<a> wash	<ou> cough
/ʌ/	<u> cut		<ou> young; <oo> blood; <o> monk
/ʊ/			<u> push; <oo> book; <o> wolf
/ə/	<e> the		
/ɑ:/	<ar> card	<a> fast	<ear> heart; <er> clerk; <al> calm; <au> draught
/i:/			<ee> seem; <ea> team; <e> he; <e_e> theme; <ie> field; and others
/ɔ:/			<or> fork; <ore> more; <aw> law; <oa> broad; <ought> ought; and others
/ɜ:/			<er> her; <ir> girl; <ur> turn; <or> word; <ear> learn
/ju:/	<u> tulip	<u_e> tune; <ew> few	
/u:/			<oo> food; <u> ruler; <u_e> rule; <ue> blue; <ou> group; and others
/eɪ/	<a> lady	<a_e> name; <ay> day	<ai> rain; <ea> break; <eigh> eight; <aigh> straight; <ey> they; and others
/aɪ/	<i> tidy	<i_e> time; <y> fly; <ie> tie	<igh> night; <y_e> type; <eigh> height; <eye> eye
/ɔɪ/	<oi> coin	<oy> boy	
/əʊ/	<o> cosy	<o_e> home; <ow> show	<oa> coat; <ought> thought; <ou> soul; folk
/aʊ/	<ou> house	<ow> cow, down	<ough> plough
/ɪə/			<ear> ear; <ere> here; <eer> cheer

/ɛə/	<are> care; <air> pair; <ear> wear; <ere> where; <eir> their
/ʊə/	<ure> pure; <oor> poor; <our> tour

What is intriguing and important for this present study in Table 5 is that [ʊ, i:, u:] do not have default spellings. Another interesting point to note is that the conditioned spelling of [ɹ] in *wash* is an example of an onset, rather than a coda, affecting a vowel. The origin of <a> in <wa> pronounced as American English [ɑ:] and British English [ɒ] is that the lip rounding of <w>-[w] spreads to <a>-[æ:], and [æ:] changed to [ɑ:] that is the descendant of an earlier rounded vowel (Kessler & Treiman, 2001). As a result, in Modern North American English, <a> between letters representing [w] and nonvelar consonants is pronounced as [ɑ:] (e.g., *wad* vs. *sad* and *wag*) (Kessler & Treiman, 2001, 593).

To sum up, there are default and conditioned GPC patterns in English, except for a few vowel phonemes.

2.3.1.2 Vowel inventory, alphabet sounds, relative sounds, and rules

When EAL learners learn English default GPC patterns, as the first step, an organized chart of the 13 vowels and their default corresponding graphemes will be very helpful, just as the Japanese 50 *kana* chart is very helpful for both L1 and L2 Japanese learners, so I will provide a chart in this section. As Gilbert (2012), Invernizzi (2009), as well as phonics textbooks for native English-speaking children (e.g., *PHONICS Grade 1*, School Specialty Publishing (2007), and *Phonics Smart Workout Grade 1*, Popular Book Company (Canada)Ltd. (2004)) explain, English has five vowel letters <a, e, i, o, u> among 26 letters, and each letter has two default sounds, “alphabet sounds” and “relative sounds,” so there are 10 sounds in total. This could be analogous to each Japanese kanji character having two readings, *on’yomi* and *kun’yomi* (as it will be discussed in §2.5.1). “Alphabet sounds” and “relative sounds” are more commonly referred to as “long sounds” and “short sounds”

respectively in educational literature (e.g., Jones, 1996; Carney, 1994) or sociolinguistic studies (e.g., Labov, Ash, & Boberg, 2006). However, since the terms “long” and “short” do not indicate durational length in this case and do not necessarily correspond to Old English long and short vowels, I avoid these terms. Table 6 shows both “alphabet” and “relative” vowel sounds. Compare with the aforementioned default rules shown in Table 3 and Table 4.

Table 6. Alphabet vowel sounds and relative vowel sounds

Vowel letters	<a>	<e>	<i>	<o>	<u>
Alphabet sounds	[e ^l]	[i:]	[aɪ]	[o ^o]	[(j)u:]
Relative sounds	[æ:]	[ɛ]	[ɪ]	[ɑ:]	[ʌ]

Notice that all the “alphabet sounds” finish with the off-glide [ɪ ~ j] or [ʊ ~ w] (Gilbert, 2012). In addition to these 10 sounds, there are three more vowel phonemes, [ɔɪ, aʊ, ʊ] which are represented with the digraphs <oi>, <ou>, and “short” <oo> respectively. Some papers call the FOOT vowel ([ʊ]) “short U” (e.g., Labov & Boberg, 2006), whereas other papers call [ʊ] “short OO” as opposed to “long OO” (the GOOSE vowel [u:]) (e.g., Fry, 1964). In this paper, I follow the latter way in order to clarify the difference between the FOOT vowel (“short OO”) and the STRUT vowel (“relative/short U”). Table 7 shows digraphs and their sounds. Compare with Table 3 and Table 4.

Table 7. Vowel digraphs

Vowel letters	<oi>	<ou>	short <oo>
Corresponding default sounds	[ɔɪ]	[aʊ]	[ʊ]

These are all the English vowels in many North American dialects with the 13-vowel system. I suggest that when the vowel inventory is organized according to the default GPC patterns, the English vowel system can be fairly simply organized. Note that there is also <au> to represent the vowel in *August* as the 14th vowel in some dialects, but since my experiments discussed in Chapter 3 and 4 are conducted in a place where a dialect with the 13 vowel

system is spoken, I do not include <au> in the table above by treating it as a different spelling variation of “relative O”.

Knowledge of this vowel inventory would be a prerequisite of English spelling acquisition. After EAL learners memorize this inventory to build the foundation, their next concern would be when to pronounce “alphabet” and “relative” vowels. There are some markers for the “alphabet-relative” distinction, and one of the major markers is so-called word-final silent E/magic E/fairy E as in words like *make*. Although silent E is a vowel letter, it does not represent a vowel sound, but it functions as a marker. The most familiar use of it is that in the <VCe#> (V = vowel, C = consonant, # = word-final) structure, silent E indicates that the vowel before is an “alphabet sound”. This pattern also applies to the <Vste> structure. Without the knowledge of silent E, EAL learners cannot handle pseudoword-matching tasks like one shown in Table 10, and this knowledge is one of my concerns in my experiments that I will discuss in Chapter 3 and 4. Below are examples of silent E as the “alphabet sound” marker:

6) *mate-mat* *mete-met* *site-sit* *note-not* *cute-cut*
 [me't]-[mæ:t] [mi:t]-[mɛt] [saɪt]-[sɪt] [noʊt]-[nɑ:t] [kju:t]-[kʌt]

(Venezky, 1999, 83)

7) *baste* *chaste* *haste* *paste* *waste*
 [be'st] [ʃe'st] [he'st] [pe'st] [we'st]

(Venezky, 1999, 83)

In addition to silent E, another useful rule to distinguish “alphabet” and “relative” vowels would be “When two vowels go walking, the first one does the talking” (Jones, 1996,

20), which means that if there is a two-vowel-letter sequence, only the first letter says its “alphabet” sound and the second letter is silent: for example, in <ai>, the first letter <a> sounds [e¹] (not [æ:]) and the second letter <i> is silent. Here are more examples:

8) rain cream soap suit

(The underlined letters say their “alphabet” sounds respectively.)

(Jones, 1996, 20)

Another rule is that consonant doubling is a marker of the preceding vowel to be a “relative sound”, such as *super-supper* and *hypo-hippo*, in which <u> in *supper* is its “relative” sound [ʌ], and <i> in *hippo* is its “relative” sound [ɪ] (Venezky, 1999, 87). Likewise, when the suffixes *-ing*, *-ed*, *-er*, and *-est* are added to the VC# (# = word-final) structure in which this V is a stressed “relative” vowel, this word-final consonant letter must be doubled to clarify that the preceding vowel is a “relative sound”, except that <w, x, y> are not doubled: for example, <sit> → <sitting> (Jones, 1996, 20). Note that in Japanese romanization, consonant doubling indicates a geminate (or arguably glottalized) consonant, as in <katta> /katta/ ‘won’ as opposed to <kata> /kata/ ‘shoulder’, which is somewhat similar to Italian geminate consonants, but English consonant letter doubling has completely different functions in part because the English phonology lacks the consonant gemination contrast.

Aside from the five vowel letters, another helpful rule is word-final <y>; when word-final <y> is stressed, it sounds “alphabet I”, as in *my*, *fry*, *reply*, whereas when word-final <y> is not stressed, it sounds “alphabet E”, as in *baby*, *happy*, *ready* (Jones, 1996, 20). This is also going to be partially tested in my experiments.

In addition to the function of “alphabet-relative” distinction, there are other functions of silent E. One of the silent E’s other functions is seen in words like *create*, *intermediate*, and *heroine*, in which silent E indicates that the preceding vowel is a separate vowel spelling as opposed to a digraph (Venezky, 1999, 84). Other than a marker of vowel sounds, silent E also functions as a marker of consonants. Silent E after <l> signals the presence of a syllable, as in <able> (Venezky, 1999, 84). Silent E after <c> and <g> marks “soft C” [s] and “soft G” [dʒ] respectively, not “hard C” [k] and “hard G” [g], as in *face*, *fleece*, *change*, *bulge*, and so on (Venezky, 1999, 84). Silent E after <th> marks voiced <th> [ð], as in *breath-breathe*, *cloth-clothe*, *teeth-teethe*, and so on (Venezky, 1999, 84). Silent E is also added in order to avoid the appearance of the suffix <s>, as in *moose*, *goose*, *collapse*, *dense*, and so on, but exceptions are *summons*, *lens*, and <ous>-ending words (Venezky, 1999, 85). Silent E is added after what would otherwise be a word-final <v> and <u>, as in *love*, *have*, *glove*, *glue*, *plague*, *continue*, and so on (Venezky, 1999, 85). English spelling has an aversion to two-letter words except for high frequency function words, such as *am*, *an*, *at*, *be*, *do*, *he*, *in*, *or*, *so* and so on, so silent E is added to avoid two-letter words, as in *doe*, *foe*, *hoe*, *toe* and so on (Venezky, 1999, 86).

To sum up, the 13-vowel inventory can be simply organized according to default GPC rules. There are some rules to identify whether the vowel letter says an “alphabet” sound or a “relative” sound. These rules would be very helpful for Japanese (or any L1 speaking) EAL learners.

2.3.1.3 Pronunciation respelling

As one of the aspects of the English writing system, the existence of pronunciation respelling should not be forgotten. I consider that to acquire default English vowel GPC rules, it would be beneficial for EAL learners to know what pronunciation respelling is and how it

works. So first I will discuss what it is, and then discuss how it helps learners acquire default English vowel GPC patterns.

Despite the aforementioned default GPC rules, roughly 20 to 30% of English phonemes are spelled unpredictably. This means that English spelling is not fully phonographic, so it needs pronunciation guides, just as Japanese kanji and Mandarin hanzi do. In fact, Japanese and Mandarin have fully developed standardized pronunciation guides; Japanese has furigana and Mandarin has pinyin or zhuyin. Likewise, English also does have pronunciation guides, except that English lacks a standardized system. For example, IPA is a type of English pronunciation guides and it is used in some dictionaries. In some EFL environments, such as China and Japan, IPA is fairly commonly adopted in dictionaries and textbooks. Needless to say, IPA is not the only way to indicate pronunciation of English spellings. In fact, pronunciation respelling (or phonemic spelling) is also commonly found in dictionaries: for example, <**jur**-muh-nee> (a stressed syllable is bold) for *Germany* (Scholastic Pocket Dictionary, 2005). While pronunciation respelling seems quite common in English speaking countries, impressionistically, the majority of Japanese teachers of English do not seem familiar with it, but I would emphasize its importance.

Pronunciation respelling first appeared in Universal Etymological English Dictionary by Nathan Bailey in 1727, and Samuel John developed Bailey's system and adopted it in A Dictionary of the English Language in 1755 (Bronstein, 1986). While the concept of this system is equivalent to IPA, it avoids symbols other than the 26 ordinary letters, such as <æ, θ, ʒ>, to be easy to understand.

Pronunciation spelling is possibly more commonly used for helping native English speakers than for ESL teaching purposes. For example, anglicized pronunciation of foreign names are written in the pronunciation respelling way (e.g., the Serbian tennis player's name *Ivanovic* written as <ee-VAN-oh-vich> on the page 43 in Complete WTA Official Guide

(2015) retrieved from <http://www.wtatennis.com/SEWTATour-Archive/Archive/MediaInfo/mediaguide2015.pdf>, or the Japanese tennis player's name *Kei Nishikori* written as <kay nee-shee-KOHR'-ee> in the sport news on January 17, 2016 retrieved from <http://wbt.com/update-on-the-latest-in-sports-55/>); the original of one of these examples is shown in Figure 10.

Kei Nishikori (kay nee-shee-KOHR'-ee)

Figure 10. The Japanese name Kei Nishikori along with the anglicized pronunciation guide from sport news

Pronunciation respelling is also used in more informal situations; for example, in a forum about the pronunciation of a Russian tennis player's name *Sharapova*, it was indicated as <Share-uh-POV-a> for its anglicized pronunciation (retrieved from <https://ca.answers.yahoo.com/question/index?qid=20070826222454AArot0M>).

In informal writing, pronunciation respelling can also be used as part of the text, rather than as a pronunciation guide. This suggests that there is a fairly big chance that at least ESL learners (but possibly not necessarily EFL learners) encounter pronunciation respelling. A good example is *love* spelled as <luv> based on the one-to-one GPC mapping. Another interesting example is *please* spelled as <puhleeze>, <puh-leez>, <puh-leezz> and so forth, to represent emphatic pronunciation. In commercial settings, pronunciation respelling is also frequently seen, such as <THRU> in *drive thru* for *through*, and <Gon> in *Weed B Gon* (a herbicide) for *gone*.

It should be noted that pronunciation respelling is also used in some ESL materials. For example, The Westcoast Reader, a newspaper for adult ESL learners in British Columbia, adopts pronunciation respelling, rather than IPA. Figure 11 shows a word list in The

Westcoast Reader 35(4) December 2015, that has <kwor-**tet**> for *quarter*, <**kom**-pruh-myz>⁸ for *compromise*, and <duh-**mok**-ruh-see> for *democracy*.

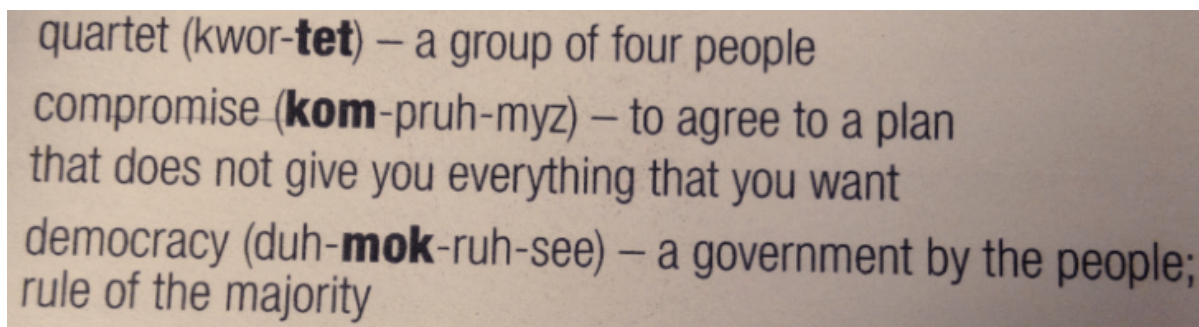


Figure 11. Pronunciation respelling in *The Westcoast Reader* 35(4) December 2015

Likewise, some ESL teachers may use the same method: for example <ank-shus> for *anxious* or <stay-shun> for *station*.

These above examples are not the only type of pronunciation respelling. Notice that in these examples, diacritics are not used. While this style is easy to type with a computer, it may not always have a one-to-one GPC mapping: for example, [ə] may be spelled as <u> in a closed syllable as in <ank-shus> and <uh> in an open syllable as in <duh-mok-ruh-see>, and in a more informal setting, [ə] can be inconsistently spelled within the same word, such as <uh> and <a> as in <Share-uh-POV-a> for *Sharapova*. To pursue one-to-one relationship, some dictionaries adopt diacritics: a macron <¯> commonly represents “alphabet sounds” and a breve <˘> commonly represents “relative sounds”. Table 8 shows 13 stressed vowel sounds represented in *The American Heritage Dictionary of the English Language*, and Table 9 compares three types of phonemic notations, IPA, pronunciation respelling with diacritics, and that without diacritics.

Table 8. 13 stressed vowel sounds represented in *The American Heritage Dictionary of the English Language*

Alphabet vowels	ā	ē	ī	ō	(y)ōō ^a
Relative vowels	ǎ	ě	ĩ	ǒ	ũ

⁸ The spelling <myz> in <**kom**-pruh-myz> is more likely to be read as [mɪz] or [mi:z] rather than [marz], although <y> can be read as [aɪ] as in *my*. The problem is that even pronunciation respelling can be read in a few different ways in some cases.

Digraphs	oi	ou	õo
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Note. ^a In many dictionaries, the vowel [ju:] as in *use* is treated as two phonemes [j] + [u:], so [ju:] is represented as <yõo>, instead of <ü>. There are also some other symbols for vowels followed by [ɹ] (or rhotic vowels), such as <âr> for *air*, as well as <ä> for *father* and <ô> for *law*, in consideration of dialectal variations, but I omitted these symbols to limit the number of vowel symbols to 13. For the same purpose, I avoid <ə> although some dictionaries distinguish stressed <ü> and unstressed <ə>.

Table 9. Comparison of three major types of phonemic notations: IPA in this paper (top), The American Heritage Dictionary of the English Language (middle), and Scholastic Pocket Dictionary (bottom)

Alphabet vowels	[e ^ɪ]	[i:]	[aɪ]	[o ^o]	[(j)u:]
	ā	ē	ī	ō	(y)õo
	ay	ee	eye	oh	(y)oo
word	<i>mate</i>	<i>mete</i>	<i>site</i>	<i>note</i>	<i>cute/coo</i>
Relative vowels	[æ:]	[ɛ]	[ɪ]	[ɑ:]	[ʌ]
	ǎ	ě	ĭ	ǒ	ŭ
	a	e	i	o	uh
word	<i>mat</i>	<i>met</i>	<i>sit</i>	<i>not</i>	<i>cut</i>
Vowel digraphs	[ɔɪ]	[aʊ]	[ʊ]		
	oi	ou	õo		
	oi	ou	u		
word	<i>coin</i>	<i>loud</i>	<i>foot</i>		

Note. I made IPA transcriptions consistent with those used in this paper.

Notice that both pronunciation respelling types (with and without diacritics) adopt default and conditioned spellings as shown in Table 3, Table 4, and Table 5, except for the without-diacritic-versions of <eye>, <oh> and <uh>. This suggests that learning pronunciation respelling can help EAL learners acquire default spellings. Incidentally, there are many other types of pronunciation respelling depending on dictionaries; for more details, see pronunciation respelling for English (n.d.) in Wikipedia (Retrieved December 15, 2015, from https://en.wikipedia.org/wiki/Pronunciation_respelling_for_English).

As mentioned above, the relationship between actual spelling and pronunciation respelling in English is much like the relationship between kanji logographs and furigana (a pronunciation guide with hiragana/katakana) in Japanese, or that between hanzi logographs

and pinyin/zhuyin in Mandarin. Due to this cross-linguistic similarity, the concept of pronunciation respelling is expected to be easy to understand for Japanese EAL learners. For example, in Japanese, the kanji character <愛> represents the meaning of ‘love’ but does not represent its sound, so it needs to be along with the furigana pronunciation guide <あい/アイ> (</ai/) for both L1 and L2 beginner readers. Likewise, in Mandarin, the hanzi character <爱> represents the meaning of ‘love’, and it needs to be along with pinyin/zhuyin <āi>/<ㄞ> (</aj/) for both L1 and L2 beginner readers. In comparison with these languages, the spelling <luv>/<lüv> in English, for example, can be considered equivalent to the Japanese furigana <あい/アイ> or the Mandarin pinyin/zhuyin <āi>/<ㄞ>, and the spelling <love> is equivalent to the Japanese kanji <愛> and the hanzi <爱>.

To sum up, since English spelling has a logographic characteristic, pronunciation respelling is developed for pronunciation guides, just like Japanese furigana and Chinese pinyin/zhuyin. It is mostly based on default English GPC patterns, so learning pronunciation respelling can help learners acquire default English GPC patterns.

2.3.1.4 English graphophonic skills and reading comprehension

Although I have mainly discussed the benefit of graphophonic skills for pronunciation up to now, I should mention that previous studies demonstrate that graphophonic skills also contribute to reading comprehension. This is another reason that I attach importance to graphophonic skills. For example, in Nassaji (2003, 265) and Nassaji and Geva (1999, 247), the authors presented a list of pairs of pseudowords to L1 Farsi speaking ESL learners and asked them to judge whether the pair of words are phonologically the same or not. Table 10 shows some examples.

Table 10. Some stimuli of the pseudoword-matching task in Nassaji (2003, 265) and Nassaji and Geva (1999, 247)

<i>thake-thack</i>
<i>flemb-flem</i>

<i>murt-mert</i>
<i>pague-paig</i>
<i>fype-fip</i>

To accomplish this pseudoword-matching task, knowledge of the default English GPC rules is required. For example, in order to identify that the pairs *thake-thack* and *fype-fip* are not homophones, the knowledge of the aforementioned silent E as the “alphabet sound” marker is required. The benefit of this skill is that according to these authors, their participants’ performance of this task significantly contributes to discrimination between skilled and less-skilled readers (although lexical-semantic (vocabulary) knowledge most contributes). This suggests that investigating Japanese EAL learners’ graphophonic skills could assess their reading comprehension to some extent, in addition to pronunciation.

2.3.2 English vowel spelling for Japanese EAL learners

2.3.2.1 Pronunciation respelling for Japanese EAL learners

If Japanese EAL learners do not have proper knowledge of English GPC, they would not be able to utilize the aforementioned pronunciation respelling. This is one of the reasons why I am interested in Japanese EAL learners’ English GPC knowledge. For example, when ESL teachers in classroom write <duh-mok-ruh-see> and <stay-shun> to teach pronunciation of *democracy* and *station* respectively, or when Japanese ESL learners encounter spellings like <luv> or <cuz> in informal writings or spellings like <sus-KA-chi-win> or <suh-skatch-uh-wahn> for *Saskatchewan* in an internet forum (from <http://skyscraperpage.com/forum/showthread.php?t=209368&page=76>), how can Japanese EAL learners interpret these spellings if they have never been formally taught any type of pronunciation guides? Or, if they hear a new English word, how do they transcribe its pronunciation other than Japanese-phonology-based hiragana/katakana?

The same question applies to L2 Japanese or Mandarin learners. How do L2 Japanese learners interpret pronunciation guides with hiragana/katakana for kanji character (e.g., <あい> for <愛> ‘love’) without being taught hiragana/katakana, or how do L2 Mandarin learners interpret pronunciation guides with pinyin/zhuyin for hanzi character (e.g., <āi>/<ㄞ> for <愛> ‘love’) without being taught pinyin/zhuyin? If L2 Japanese/Mandarin learners hear a new Japanese/Mandarin word, how do they transcribe it without using their L1 phonology based L1 orthography, if they have never been formally taught hiragana/katakana or pinyin/zhuyin?⁹ In order to solve such problems, I would emphasize the importance of English pronunciation respelling and default spelling GPC rules, which are marginalized in the English education in Japan. The experiments that I will discuss in Chapter 3 and 4 have been designed to reveal this problem.

2.3.2.2 Phonics for Japanese EAL learners

Related to pronunciation respelling and default rules, it is also important to discuss phonics. Recently, the term *phonics* has been mentioned in the English education in Japan. Phonics is a method for teaching English GPC in order to enable readers to decode spellings of new words. For L1 English speakers, the US government mandates the implementation of intensive phonics instruction in elementary classrooms (Strauss & Altwerger, 2007). Even for L2 learners, Stuart (1999) reported that when 5-year-old ESL learners took a phonics programme, it not only accelerated children’s phoneme awareness, but also improved their reading and writing skills, and possibly oral vocabulary development, although this is left for future research. Stuart (1999) also mentioned that teachers needed very little training or support to use the phonics materials to good effects. On the other hand, in Japan, according to

⁹ This question is partially realistic. The Japanese regular orthography does not indicate phonemic pitch accent patterns, unlike Chinese pinyin/zhuyin that indicates tones, so how L2 Japanese learners transcribe pitch accent patterns is an interesting topic if they are aware that pitch is phonemic but have never been taught its transcription.

Imanaka's (2003) interviews of 74 native Japanese speaking university students in Japan majoring in British and American language and culture, 85.1% of them reported that they did not know phonics, and the rest answered that they had heard only its name. In addition, among 45 Japanese participants in my experiments that I will discuss in Chapter 3 and 4, only one participant reportedly learned phonics in his middle school. Also, as of 2016, six different English textbooks are used in middle school English classes in Japan, but none of those have systematic instructions of the basic English sound system (such as all the phonemes and major segment combinations) or the basic GPC rules (such as "alphabet sounds" and "relative sounds"), although there are some partial pronunciation and spelling instructions. In contrast, beginner Mandarin and Korean textbooks have formal instruction of the basic sound system and GPC rules at the very beginning. This implies that only very few Japanese EAL learners are fortunate enough to have a chance to be formally and thoroughly taught phonics¹⁰.

Moreover, according to my impression, many Japanese EAL learners who have heard the term phonics seem to misconceive that phonics is a substitute for IPA or any pronunciation guide, and erroneously assume that once they learn phonics rules, they could read all the English words without IPA or any pronunciation guide. Of course this is not the case since English spelling is partially morphemic.

The fundamental problem of phonics for Japanese EAL learners is that phonics is originally for native English-speaking children who already know the English sound system, but phonics is not beneficial for those who do not know the English sound system, such as Japanese EAL learners (Imanaka, 2004). Another problem is its complexity and a large number of rules, as many researchers point out (e.g., Ono, 2012; Strauss & Altwerger, 2007). Especially to Japanese EAL learners who do not know the English phonological system, such

¹⁰ I am one of the very few fortunate Japanese EAL learners.

complex rules must be nothing but a burden (Imanaka, 2004). I have a solution to deal with these problems, although it is still at the stage of a pilot study. I will come back to this issue in Chapter 5 that briefly discusses my current pilot study and future research.

To conclude, the English education in Japan does not yet seem to be ready for teaching phonics at this moment. However, I consider that it should be ready in the future. This dissertation is designed for the first step to make the English education in Japan ready for teaching at least some basic phonics rules.

2.3.2.3 Error patterns of Japanese EAL learners in previous studies

Finally, I discuss common spelling errors by Japanese EAL learners. There are several studies about Japanese EFL learners' spelling error patterns, although there are not many studies of Japanese ESL learners as far as I searched. While native English speakers also make spelling errors, according to Okada (2005), Japanese EFL learners' spelling errors and those of native English speakers have different properties; when native English speakers do not remember the spelling of a particular lexical item, they can rely on the sound form of the target word to guess possible spellings, whereas when Japanese EFL learners encounter the same situation, their spelling is influenced by the cognate loanword in Japanese and *rōmaji* spelling rules. This is because Japanese EFL learners memorise English lexical items visually, not aurally, and in many cases they probably know the meaning without knowing its phonetic form, so they cannot rely on the phonological route (Okada, 2005).

According to Mitton and Okada (2007) and Okada (2005, 169), the most common misspelling pattern by Japanese EFL learners in word-initial positions is a mix-up between and <v> (e.g., <bisitor> for *visitor*, <visiness> for *business*), followed by a mix-up between <l> and <r> (e.g., <runch> for *lunch*, <labbit> for *rabbit*). Cook (1997, 482) also reported that the <l>-<r> confusion by Japanese adult EFL learners, such as <walmer>, <familiality>, <grobal>, and <sarary>. Cook (1997) analyzes that while their <l>-<r>

confusion obviously comes from the well-known [l]-[ɾ] pronunciation difficulty, it may also in part come from conventional rōmaji spelling, such as <sararī> ‘salary’, so it is not exclusively a phonological problem.

Another common pattern is vowel letter insertion (e.g., <Engrishu> for *English*, <animaruu> for *animal*) (Okada, 2005, 176). This pattern is likely rōmaji interference (Okada, 2005); recently most native Japanese speakers type Japanese kana syllabary via Japanese romanization (as I will discuss in §2.4), and the loanwords from English イングリシユ ‘English’ and アニマル ‘animal’ are typed as “i-n-g-u-r-i-s-s-h-u/i-n-g-u-r-i-s-s-y-u” and “a-n-i-m-a-r-u” respectively. Another interesting vowel letter insertion pattern is an extra <e> in word-final positions; the word-final silent E rule is absent in Japanese rōmaji, so this is not L1 interference, but in the process of acquiring L2 rules (Okada, 2005). Incidentally, Japanese EAL learners’ silent E usage can also be seen in the nonsense word spelling task in my experiment as will be discussed in Chapter 4. Cook (1997, 484) reported other vowel letter insertion, such as <English>, <respectively>, <subjects>, and <courese>. The first three may be for breaking consonant sequences into a CV structure (Cook, 1997) except that <e> in <courese> is not clear. Or, those Japanese EAL learners may have been aware that English spelling was not completely phonetic and they may have almost randomly inserted silent letters without phonetic reasons, or a type of hyper-correction.

Goble (2001) had Japanese EFL college students spell English words that have cognate loanwords in Japanese. Table 11 shows the target English words, cognate English loanwords in Japanese spelled with Japanese official Hepburn rōmaji, and errors from Goble (2001, 66-67).

Table 11. Japanese EFL learners’ English spelling errors in loanwords from English (Goble, 2001, 66-67)

Target English	Cognate loanwords in Japanese written with Hepburn rōmaji	Errors
salad	<i>sarada</i>	sarada

gallery	<i>gyararī</i>	garary
veranda	<i>beranda</i>	belanda
stress	<i>sutoresu</i>	stoless
duet	<i>dyuetto</i>	duetto
doughnut	<i>dōnatsu</i>	<u>don</u> atsu
honeymoon	<i>hanemūn</i>	<u>han</u> em <u>oo</u> n
drum	<i>doramu</i>	dor <u>am</u>
newscaster	<i>nyūsukyasutā</i>	news <u>ky</u> aster
volleyball	<i>barēbōru</i>	<u>ball</u> ay <u>ba</u> ll
tennis court	<i>tenisukōto</i>	tennis <u>coa</u> t
concert hall	<i>konsātohōru</i>	concert <u>hole</u>
platform	<i>purattohōmu</i>	platt <u>home</u>
apron	<i>epuron</i>	<u>e</u> plon
bracelet	<i>buresuretto</i>	<u>bl</u> ess <u>le</u> t
boy scout	<i>bōisukauto</i>	boy sk <u>au</u> t
slipper	<i>surippa</i>	suripp <u>a</u>
necklace	<i>nekkuresu</i>	neck <u>le</u> ss
campus	<i>kanpasu</i>	camp <u>a</u> s
stadium	<i>sutajiamu</i>	stagia <u>m</u>
chicken	<i>chikin</i>	chik <u>i</u> n

Note. I underlined vowel letter errors since my focus in this study is on vowel GPC.

I bolded and underlined vowel letter errors in Table 11. Their vowel letter errors are basically based on the Japanese romanization spelling in the cognate loanwords in both stressed and unstressed vowels, except for <ay> in <ballay ball> (volley ball) and <oa> in <tennis coat> (tennis court) and silent E's. Goble (2001) revealed "an astonishing lack of awareness among students that Japanese loanwords and their English counterparts are not equivalent entities" (55) as well as "an inordinate amount of mother-tongue interference in students' L2 usage" (55).

Shinagawa (2004) did a spelling task with 45 Japanese second grade middle school students (13-14 years old); participants listened to orally produced words and spelled what they heard. Table 12 shows the results. In this test, students were allowed to spell multiple different spellings as long as these are read with the same sound, so the sum of percentages exceed 100%.

Table 12. Spelling patterns in the spelling task by Japanese second grade middle school students (Shinagawa, 2004)

Words	Correct spelling	The 2nd most frequent spelling	Other spellings
-------	------------------	--------------------------------	-----------------

1	mate	42%	meit (38%)	mait (24%)
2	fade	64%	feid (42%)	faid (20%) faide (20%)
3	tide	73%	taide (29%)	taid (20%)
4	dike	80%	daike (31%)	daik (29%)
5	dote	76%	dout (38%)	dowt (13%)
6	duke	78%	dyuke (24%)	douk (11%)
7	bride	76%	bryde (29%)	braid (13%)
8	spice	60%	spise (69%)	spyse (20%) spyce (20%)
9	prime	82%	pryme (27%)	praim (13%)
10	spade	89%	speid (18%)	spaid (13%) spayd (13%)

Shinagawa (2004) prioritizes knowledge of spelling rules, and he argues that even if the spelling is incorrect, different spellings with the same pronunciation, such as <faid> for *fade*, are regarded as meaningful or “better” errors, compared to errors like <feid> which could be read as [fe¹d] (c.f., *eight*), but not the default spelling for [e¹]. For [e¹], [ai], [o^u], and [ju:], error patterns like <ei>, <ai>, <ou, ow>, and <yu(_e)> respectively are based on Japanese romanization rules. On the other hand, errors like <pryme> for *prime*, and <spise> for *spice* suggest that students have acquired the silent E rule (Shinagawa, 2004).

There are also a few studies about reading of English spelling by Japanese EFL learners. These studies demonstrate mismatches between learners’ knowledge and actual English spelling rules. In Kokufukata’s (2000) experiment, she did a 20 English phrase memorization task with adult Japanese EFL learners: examples of phrases for the phrase memorization task are *the Department of Agriculture*, *a man of many abilities*, and so on. In one group, participants were given only written forms without any sounds, while in the other group, participants were given only sound forms without any written forms (Kokufukata, 2000). Intriguingly, all the participants in the written form group reported that there were no words that they did not know how to pronounce in the stimuli (Kokufukata, 2000). The results showed that when the participants spoke out what they memorized, participants in the written form group made 14.7% on average (median 14.3%) of segmental pronunciation errors and none of them marked 100%, while those in the sound form group made errors only

6.9% in average (median 0%) of segmental errors, and four out of seven participants pronounced all the segments correctly (Kokufukata, 2000). This suggests that even though the participants thought that they could read all the spellings in the given phrase list, they in fact did not know how to read the spellings. In other words, there are mismatches between their knowledge and actual English word forms.

As well, Honda, Ogawa, and Maeda (2007) had 131 Japanese grade five elementary school students see 24 English words, such as *jump*, *come*, *many*, and so on, and transliterate these English words into the Japanese katakana orthography. In this elementary school, there were English activities conducted by native English-speaking teachers, so students already had English knowledge to some extent (Honda et al., 2007). The results showed that in many cases, Japanese romanization influence were seen: for example, *come* was most frequently transliterated into <コメ> Japa/kome/ based on the rōmaji rule, rather than the more closer to the English sound <カム> Japa/kamu/; other examples are <マニー> Japa/mani:/ for *many* (rather than more similar sound <メニー> Japa/meni:/), <レン> Japa/ruN/ for *run* (rather than more similar <ラン> Japa/raN/), <モウンタイン> Japa/mouNtaiN/ for *mountain* (rather than more similar <マウンテン> Japa/mauNteN/ based on the cognate loanword, or <マオンテン> Japa/maoNteN/ based on Nogita and Lin 's (2016) perceptual similarity analysis), and so on (Honda et al., 2007). In these errors, strong rōmaji interference can be seen. Other errors were not completely based on rōmaji but somewhere in the intermediate stage: for example, <ガム> /gamu/ for *game* (rather than the English-based <ゲイム> /geimu/ or <ゲーム> /ge:mu/, or rōmaji-based <ガメ> /game/) and <フネ> /ɸune/ for *fine* (rather than the English-based <ファイン> /ɸaiN/, or rōmaji-based <フイネ> /ɸine/) (Honda et al., 2007). Honda et al. (2007) suggested that while Japanese EFL learners should take

advantage of rōmaji in order to be accustomed to the roman script, teachers must have learners aware that rōmaji is not English.

To sum up, Japanese EFL learners' spelling and reading error patterns show L1 pronunciation-related errors, such as the <l>-<r> confusion, rōmaji related errors, such as spelling <feid> for *fade*, or reading *come* as Japa/kome/([kõmẽ]), and interlanguage stage errors, such as spelling <courese> for *course* or reading Japa/ϕune/ ([ϕũnẽ]) for *fine*.

2.3.3 Summary

English spelling is partially morphemic, just like Japanese kanji logographs. As well, English spelling has default GPC rules, and it is not completely irregular as phonographs. To deal with irregularly spelled words, there is pronunciation respelling, which functions like Japanese furigana. In terms of vowels, I recommend importing the default vowel spellings for the 13 vowels and pronunciation respelling to the English education in Japan.

2.4 Japanese regular (kunrei-shiki, Hebon-shiki, etc.) rōmaji vowel spelling

2.4.1 Roman alphabet in Japanese

There may be a misconception in English education that Japanese is a language with non-roman alphabet orthography so Japanese EAL learners have a hard time handling the English script. In reality, nowadays, the roman alphabet is ubiquitous in Japan.

Japanese romanization is officially taught in the third grade of elementary school. Moreover, as Okada (2005) mentions, recently most people type the Japanese orthography with computers using the roman alphabet, just as many Chinese speakers type Chinese characters using the roman alphabet-based *pinyin*. For example, pressing “a” makes the letter <あ> /a/, pressing “k-a” makes <か> /ka/, pressing “k-y-a” makes <きゃ> /kja/, and so forth. As mentioned in §2.1.3, hiragana/katakana contributes to mora awareness. Likewise, rōmaji

and rōmaji-based typing may contribute to native Japanese speakers' phoneme/segment awareness (Tamaoka, 1993).

As mentioned at the beginning of this chapter, there are two types of usage of the roman alphabet in the Japanese writing system, 1) what I call *regular rōmaji* and 2) what I call *loanword rōmaji* (or 外来語ローマ字 in Japanese) for the sake of convenience. In this section (§2.4), I discuss regular rōmaji and its background. Note that I focus only on vowels in this study, so I will omit details of consonants, diacritics, punctuations, spaces, capitalization, and other topics.

2.4.2 Romanization and transliteration

First, I discuss what Japanese romanization or latinization is: it is transliteration from hiragana/katakana syllabaries to the roman script. In other words, rōmaji is the alternative phonographic letters to hiragana/katakana to write *Japanese*, but not to write English or any other languages. Moreover, rōmaji was not invented to enable English-speaking people with no Japanese knowledge to pronounce Japanese words properly.

There are the International Standard ISO3602, the internationally standardized rōmaji spelling rules, accepted by ISO (the International Organization for Standardization) in 1989, as well as BS4812, the one accepted by BSI (the British Standards Institution) in 1972. The documentation of romanization of Japanese (ISO 3602, 1989) explains why International Standard of Japanese romanization is necessary. Below is the citation (retrieved from <https://www.iso.org/obp/ui/#iso:std:iso:3602:ed-1:v1:en>):

The words in a language, which are written according to a given script (the converted system), sometimes have to be rendered according to a different system (the conversion system), normally used for a different language. This procedure is often used for historical or geographical texts, cartographical documents and, in particular, bibliographical work where characters must be converted from different writing systems into a single alphabet to allow for alphabetical intercalation in bibliographies, catalogues, indexes, toponymic lists, etc.

It is indispensable in that it permits the univocal transmission of a written message between two countries using different writing systems or exchanging a message the writing of which is different from their own.

It thereby permits transmission by manual, mechanical, as well as electronic means.

To be brief, in international situations, using the same script is convenient. Imagine that if all the athletes' names in the Olympic Games had to be displayed with scripts from their own countries - for example, Korean names with Hangul, Russian names with Cyrillic, Chinese names with Hanzi, and so on - preparing all the fonts would be quite troublesome. In such cases, transliteration (conversion from one script to another) is a convenient way to display names that would normally be written with various alphabets..

It should be noted that the same script is not necessarily pronounceable by speakers of other languages with the shared script. A good example is that the same letter <e> is pronounced as [ĕ] ([˘] = extra short, [˙] = lowered in tongue position) in Japanese, [i:] or [ɛ] in English, diphthongized [ɿ] in Mandarin, and rounded [ə] in French, none of which sounds perceptually similar to another. Using existing words as an example, the Spanish name <Jorge> is pronounced as [xorxe] in Spanish, but based on English GPC, it would be [dʒɔːɹdʒ]. As well, the Chinese romanization pinyin letters <xiǎo Qiān> as [ɛjaw.tɛ^hjɛn] 'little Qian (a Chinese surname)' would not be correctly read by English-speaking people who do not know Mandarin. The same is true among non-roman alphabet languages. A familiar example for Japanese speakers is that the same graphemes <学校> 'school' are pronounced as [gɛkkɔː] in Japanese and as noticeably different [ɛɸɛ.ɛjaw] in Mandarin (Lin 2001), and therefore, <学校> cannot be pronounced properly in the Japanese way by Mandarin speakers unless they have knowledge of Japanese. Even among Chinese dialects, the same graphemes are pronounced differently: for example, <发财> 'to make a fortune' is pronounced as [fa.tɕ^hɛj] in Mandarin and as [fɛʔ.sɛ] in Shanghainese (Ruǎn, 2009).

The same script has various GPC/LSC rules depending on the language, and hence, readers are required to learn conventionalized GPC/LSC rules in each language. It is important to note that there is a fundamental difference between human language writing systems and pictures/drawings. Language writing systems need conventions understood by a particular group of people, and without instruction, no writing system is immediately comprehensible, while pictures/drawings can be comprehensible without learning (Coulmas, 2003). This means that even though Japanese rōmaji is a familiar script for roman alphabet language speaking people, they cannot properly pronounce rōmaji writings unless they have learned Japanese.

Romanization is done in many languages whose standard script is a non-roman-alphabet orthography, and Japanese rōmaji is only one of them; for example, from Hangul <최지우> to <Choi Ji Woo> (a Korean actress's name), and from Cyrillic <Евгений Викторович Плющенко> to <Evgeny Viktorovich Plyushchenko> (a Russian figure skater). Such romanization requires readers to learn GPC rules in each language.

Another good example of romanization is recently devised roman alphabet-based orthographies in languages that did not use to have writing systems. For example, for SENĆOFEN (pronounced as 'sun-CHAH-thun' in the Anglicized way), which is a Coast Salish language spoken by First Nations Saanich people on Southern Vancouver Island and surrounding islands in British Columbia in Canada, a Saanich person named Dave Elliott invented the SENĆOFEN alphabet in 1978 (SAEC, 2015). In order to be able to utilize existing ordinary English typewriters that anyone could use, Dave Elliott decided to use regular roman alphabet adding some diacritics to create the SENĆOFEN alphabet, rather than inventing a completely new script (SAEC, 2015). Again, although based on a romanized alphabet, readers of the SENĆOFEN orthography are still required to learn conventional GPC rules in each language: for example, plain <C> and <T> in SENĆOFEN roughly

correspond to the English <k> (/k/) and <t> (/t/) respectively, and <Ć> with an acute accent and <F> with a bar roughly correspond to the English <ch> (/tʃ/) and <th> (/θ/) respectively (North West Coast Keyboards, 2013). Figure 12 shows a sign written in SENĆOŦEN found at the University of Victoria, <HÍSWKE SI,ÁM,> [háysx^wqə siʔém] ‘thank you’ (IPA transcriptions are from SENĆOŦEN Word List (n.d.)); in Figure 12 <S> and <M> in <SIÁM> lacks the glottal stop diacritic <,>, so it seems there are orthographic variations.

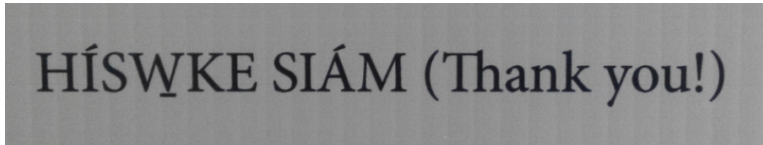


Figure 12. A SENĆOŦEN sign found in University of Victoria

To sum up, the purpose of romanization is not for enabling English-speaking people to read their languages correctly without learning. The Japanese rōmaji is transliteration of Japanese, but not for enabling English-speaking people to pronounce Japanese correctly.

2.4.3 Standardised Japanese romanization

Early Japanese romanization was mostly based on Portuguese used by Portuguese Christians in the 16 and 17 century (Taylor & Taylor, 1995). This is like when Chinese people arrived in Japan around the late 4th and 5th centuries, they wrote Japanese sounds with their Chinese characters using phonetically similar Old Chinese sounds (Ōno, 2002). So before rōmaji became a major script in Japanese, rōmaji (or the roman script) had already had more than 400 years of history of use in the country (Taylor & Taylor, 1995).

In 1886, the third edition of American missionary James C. Hepburn’s Japanese-English dictionary adopted Japanese romanization, in which consonants are based on English and vowels are based on Italian (Taylor & Taylor, 1995), although modern standard Japanese does not have the open-mid and closed-mid vowel contrasts /ɛ/-/e/ and /ɔ/-/o/ like in Italian, and Italian does not have phonemic vowel length contrasts in the same way as Japanese does. In 1908, his romanization was slightly revised, and this was called “(revised) Hepburn style”,

which is nowadays what we call *Hebon-shiki rōmaji* (ヘボン式ローマ字) ‘Hepburn rōmaji’ (Taylor & Taylor, 1995). In the meantime, in 1886, Tanakadate Akitsu proposed *Nippon-shiki rōmaji* (日本式ローマ字) ‘Japan-style rōmaji’ (Taylor & Taylor, 1995). The difference between these two styles is seen in some coronal obstruents, which reflect inconsistencies in some coronal obstruents in hiragana/katakana. In the hiragana/katakana chart (the 50-sound chart), /ta, t̥i, tsu, te, to/ with three different consonants /t, t̥, ts/¹¹, for example, are aligned in the same consonant column. This reflects the historical sound change [t̥i, t̥u] → [t̥i, ts̥u]. In Japan-style rōmaji, /ta, t̥i, tsu, te, to/ are spelled as <ta, ti, tu, te, to> to be consistent with hiragana/katakana, whereas in Hepburn rōmaji, these morae are spelled as <ta, chi, tsu, te, to> to be consistent with sounds. Phonologically speaking, Japan-style rōmaji is more towards deep or higher level structures, whereas Hepburn rōmaji is more towards surface or lower level structures.

In 1937, *kunrei-shiki rōmaji* (訓令式ローマ字) ‘cabinet-ordered rōmaji’ was implemented (Taylor & Taylor, 1995). Table 13 shows the first cabinet-ordered rōmaji.

Table 13. Letter (top) sound (bottom) correspondence of the cabinet-ordered rōmaji for normal/independent morae implemented in 1937

<a> /a/	<i> /i/	<u> /u/	<e> /e/	<o> /o/			
<ka> /ka/	<ki> /ki/	<ku> /ku/	<ke> /ke/	<ko> /ko/	<kya> /kja/	<kyu> /kju/	<kyo> /kjo/
<sa> /sa/	<si> /ʃi/	<su> /su/	<se> /se/	<so> /so/	<sya> /ʃa/	<syu> /ʃu/	<syo> /ʃo/
<ta> /ta/	<ti> /t̥i/	<tu> /tsu/	<te> /te/	<to> /to/	<tya> /t̥ja/	<tyu> /t̥ju/	<tyo> /t̥jo/
<na> /na/	<ni> /ni/	<nu> /nu/	<ne> /ne/	<no> /no/	<nya> /nja/	<nyu> /nju/	<nyo> /njo/
<ha> /ha/	<hi> /hi/	<hu> /hu~ϕu/ ¹²	<he> /he/	<ho> /ho/	<hya> /hja/	<hyu> /hju/	<hyo> /hjo/
<ma> /ma/	<mi> /mi/	<mu> /mu/	<me> /me/	<mo> /mo/	<mya> /mja/	<myu> /mju/	<myo> /mjo/

¹¹ In this paper, I regard /ʃ, t̥, ts, dʒ, ϕ/ as phonemes in accordance with Vance (2008).

¹² Whether the underlying representation of [ϕu] is /hu/ or /ϕu/ is not clear since /h/ and /ϕ/ are contrastive in other vowels as in /hairu/ ‘enter’ and /ϕairu/ ‘file’ but not before /u/, so I transcribed /hu~ϕu/.

<ya> /ja/		<yu> /ju/		<yo> /jo/			
<wa> /wa/							
<ga> /ga/	<gi> /gi/	<gu> /gu/	<ge> /ge/	<go> /go/	<gya> /gja/	<gyu> /gju/	<gyo> /gjo/
<za> /dza/	<zi> /dzi/	<zu> /dzu/	<ze> /dze/	<zo> /dzo/	<zya> /dza/	<zyu> /dzu/	<zyo> /dzo/
<da> /da/	(<zi> (/dzi/))	(<zu> (/dzu/))	<de> /de/	<do> /do/	(<zya> (/dza/))	(<zyu> (/dzu/))	(<zyo> (/dzo/))
<ba> /ba/	<bi> /bi/	<bu> /bu/	<be> /be/	<bo> /bo/	<bya> /bja/	<byu> /bju/	<byo> /bjo/
<pa> /pa/	<pi> /pi/	<pu> /pu/	<pe> /pe/	<po> /po/	<pya> /pja/	<pyu> /pju/	<pyo> /pjo/

Note. Bracketed ones are redundant members.

Cabinet-ordered rōmaji is based on Japan-style rōmaji with slight modifications, such as discarding irrelevant spellings to be consistent with the modern Japanese phonological system (Taylor & Taylor, 1995).

In 1954, the government updated cabinet ordered rōmaji by allowing Hepburn and Japan-style spellings to some extent. Table 14 and Table 15 show the updated rules and newly added spelling patterns (the Ministry of Education, Culture, Sports, Science and Technology-Japan, 2009).

Table 14. The cabinet-ordered rōmaji rules for special/dependent morae updated in 1954

The moraic nasal /N/	Spell <n> in any phonetic environment. Spell <n'> before a vowel or <y>
Geminate consonants	Double the consonant letter. For digraphs, double the first consonant letter.
Two-mora vowels	<â, î, û, ê, ô> For capital letters, you may double vowel letters.

Table 15. Alternative letter (top) sound (bottom) correspondence of rōmaji implemented in 1954 prescribed by the Ministry of Education, Culture, Sports, Science and Technology-Japan

<sha> /ja/	<shi> /fi/	<shu> /fu/	<sho> /fo/
		<tsu> /tsu/	
<cha> /tja/	<chi> /tʃi/	<chu> /tʃu/	<cho> /tʃo/
		<fu>	

		/hu~φu/	
<ja> /dʒa/	<ji> /dʒi/	<ju> /dʒu/	<jo> /dʒo/
<dya> /dʒa/	<di> /dʒi/	<dyu> /dʒu/	<dyo> /dʒo/
		<du> /dzu/	
<kwa> /kwa/ ^a			
<gwa> /gwa/			
			<wo> /wo/

Note. ^a I coloured <kwa> and <gwa> in grey because according to Vance (2008), modern Standard Japanese phonotactics does not allow /Cw/ onsets, or only marginally allows them if any.

According to Taylor and Taylor (1995), in Table 15, the parts filled in grey are extracted from Hepburn rōmaji and the rest are extracted from Japan-style rōmaji. Generally, rōmaji spelling should follow Table 13 and Table 14, but the spelling patterns in Table 15 can be used under some circumstances in which it is difficult to immediately change traditional customs, or in international situations (the Ministry of Education, Culture, Sports, Science and Technology-Japan, 2009).

As to morae used only in recent loanwords, which are phonologically accepted whether widely or marginally, such as [tī], [tʃē], [pě], [wī] and so on, there are no cabinet-ordered spelling rules, so writers can spell them how they want (the Ministry of Education, Culture, Sports, Science and Technology-Japan, 2009).

In addition to cabinet ordered rōmaji, there is also the internationally standardized rōmaji spelling rules, accepted by the ISO in 1989. This standard is basically the same as the cabinet-ordered rōmaji shown in Table 13 and Table 14, but it does not include Table 15, nor does it establish any spelling rules for morae used only in recent loanwords as well as morae in other dialects than standard Japanese. It also clarifies that two-mora monophthongs and two identical vowel sequences divided by a morpheme boundary must be distinguished: for

example, <satooya> (*<satôya>) for /satooja/ ‘foster parents’, as opposed to <satôya> (*<satooya>) for /satoija/ ‘sugar dealer’.

Likewise, there is also the standardized rōmaji accepted by British Standards Institution in 1972 (BS4812, 1972). The British standard is based on Hepburn rōmaji as opposed to the international standard. Moreover, a more noticeable difference from the international standard is that the British standard has loanword morae. Table 16 shows that LSC of loanword morae that appear only in the British standard.

Table 16. Letter (top) sound (bottom) correspondence of British standard rōmaji that do not have the counterparts of the international standard

			<she> /ʃe/				
	<ti> /ti/	<tu> /tu/				<tyu> /tju/	
	<di> /di/	<du> /du/				<dyu> /dju/	
<t <u>s</u> a> /tsa/	<t <u>s</u> i> /tsi/		<t <u>s</u> e> /tse/	<t <u>s</u> o> /tso/			
			<ch <u>e</u> > /tʃe/				
			<ch <u>e</u> > /dʒe/				
							<ny <u>e</u> > /nje/
							<hy <u>e</u> > /hje/
<f <u>a</u> > /ɸa/	<f <u>i</u> > /ɸi/		<f <u>e</u> > /ɸe/	<f <u>o</u> > /ɸo/		<f <u>y</u> u> /ɸju/	
	<w <u>i</u> > /wi/		<w <u>e</u> > /we/	<w <u>o</u> > /wo/			
	<k <u>w</u> i> /kwi/		<k <u>w</u> e> /kwe/	<k <u>w</u> o> /kwo/			
	<g <u>w</u> i> /gwi/		<g <u>w</u> e> /gwe/	<g <u>w</u> o> /gwo/			
<v <u>a</u> > /va/	<v <u>i</u> > /vi/	<v <u>u</u> > /vu/	<v <u>e</u> > /ve/	<v <u>o</u> > /vo/	<v <u>y</u> a> /vja/	<v <u>y</u> u> /vju/	<v <u>y</u> o> /vjo/

Note. Morae spelled in the same way as the internationally standardised rōmaji are omitted. The bottom three grey rows indicate morae that are generally disallowed in the modern standard Japanese phonological system according to Vance (2008) and Matsuzaki (1993) but seen in written forms. The British standard also includes some other phonotactically disallowed morae, such as <tsyu>, <fye>, <kye> for */tsju/, */ɸje/, */kje/ respectively. Such morae are excluded here.

To sum up, there are standardized rōmaji spelling rules but there are variations. With regard to vowel spellings, the five vowel letters <a, i, u, e, o> correspond to the one-mora Japanese vowels /a, i, u, e, o/. Two-vowel sequences are spelled with two vowel letters, such as <ai>-/ai/ and <ae>-/ae/. Three-vowel sequences are spelled with three letters, such as <aoi>-/aoi/ and <aeu>-/aeu/. Two-mora monophthongs in cabinet-ordered rōmaji (and the international standard) are supposed to be spelled as <â, î, û, ê, ô> with a circumflex (^), while those in Hepburn rōmaji (and the British standard) are <ā, ī, ū, ē, ō> with a macron (¯).

2.4.4 Other rōmaji variations

Aside from above-mentioned rōmaji variations, there are also several other variations. In addition to “regular” Hepburn rōmaji discussed above, there is another standard of Hepburn rōmaji, which is the standard for passports. Although it is called Hepburn rōmaji, the spelling rules are quite different from the Hepburn rōmaji discussed above. The major difference is that passport rōmaji does not use diacritics, and therefore, it does not distinguish one-mora and two-mora-monophthongs: for example, <u> for both /u/ and /u:/ (Gunma Prefecture, 2015; Hyogoken Ryoken Jimusho, 2015; Kanagawa Passport Center, 2015; Takakuwa, 2012). However, only for /o:/, but not for the other two-mora monophthongs, passport rōmaji admits the lengthening function of <h> for people who are not satisfied with the loss of the /o/-/o:/ distinction in their written names; people can choose either <o> or <oh> for /o:/ (Gunma Prefecture, 2015; Hyogoken Ryoken Jimusho, 2015; Kanagawa Passport Center, 2015). Besides, loanword mora spelling rules for passports are also quite different from the British standard, although I do not mention this here.

Based on these variations mentioned above, the discrepancy between rōmaji and hiragana/katakana is that in rōmaji, both one-mora and two-mora monophthongs are spelled with one letter (e.g., /a:/ → <â>, <ā>, or <a>), whereas in hiragana/katakana two-mora monophthongs are spelled with two letters: /a:/ → <あ あ>, /i:/ → <い い>, /u:/ → <う う>.

/e:/ → <ええ> or <えい>, /o:/ → <おお> or <おう>. In order to solve this hiragana-rōmaji discrepancy, *Nihon Rōmaji Kai*, a public service organization, suggested 99-shiki rōmaji¹³ (99式ローマ字) in 1999, in which rōmaji vowel spellings are always consistent with their corresponding hiragana spellings: <あ>-<a>, <い>-<i>, <う>-<u>, <え>-<e>, <お>-<o>, <ああ>-<aa>, <いい>-<ii>, <うう>-<uu>, <ええ>-<ee> (/e:/), <えい>-<ei> (/e:/), <おお>-<oo> (/o:/), <おう>-<ou> (/o:/) (*Nihon Rōmaji Kai*, 1999).

There are also many non-standard variations, such as traffic sign Hepburn rōmaji, rōmaji in sport players' names on their uniforms, and so on (Takakuwa, 2012). Especially of note is that diacritics are often omitted in non-standard variations. Professional sport players adopt spellings on their uniforms like <uu> for /u:/. As can be observed, rōmaji spellings for /o:/ are especially complex: it can be spelled <ō/ô>, <oh>, <oo>, <ou>, or <o> (Takakuwa, 2012). As a result, /eNdo:/ (a surname), for example, can be spelled as <Endō/Endô>, <Endoh>, <Endoo>, <Endou>, and <Endo>.

In addition, although passport rōmaji allows <h> as the two-mora monophthong marker only for /o:/, in more freely spelled non-standard variations, <h> is also used for /a:, i:, u:, e:/. A good example is <AH> /a:/ in *BAHN* /ba:N/ (a professional Japanese hip hop group *ICE BAHN*). Other examples seen on the web are <uh> /u:/ in *Yuhko* /ju:ko/ (a girl's name), <ih> /i:/ in *onihsan* /oni:saN/ 'older brother', <eh> /e:/ in *onehsan* /ne:saN/ 'older sister', and so on. Overall, in non-standard spellings, <h> can be used for a two-mora monophthong marker. This function of /h/ is similar to German silent *h* for long vowel phoneme marking, as in *sehr* /se:v/, *Bahn* /ba:n/, and *Sohn* /zo:n/ (examples are from Landerl & Reitsma, 2005,

¹³ There are also some public service organizations that encourage people to use a certain type of rōmaji, such as *Nihon Rōmaji Kai* established in 1885 (*Nihon Rōmaji Kai*, n.d.), *Nihon-no-Rōmaji-Sya*, or *NRS*, established in 1909 (*Nihon-no-Rōmaji-Sya*, n.d.), and *Ôsaka Rōmaji Kai* established in 1996 (*Ôsaka Rōmaji Kai*, n.d.).

325), but not at all similar to the English rule. This information needs to be taught to Japanese EAL learners.

One more crucial type is what Komaba Organization for Educational Development (2009) calls *wāpuro-shiki rōmaji* (ワープロ式ローマ字), or ‘word processor rōmaji’, used for typing hiragana/katakana and kanji through the rōmaji way on a computer or cell phone. As mentioned above, this is like Chinese-speaking people typing Chinese characters via roman alphabet-based *pinyin*. In this way, pressing “m-o” keys makes the letter <も> /mo/, and pressing “m-y-o” keys makes <みよ> /mjo/, and so on. *Wāpuro-shiki rōmaji* was established for its own spelling rules in order to deal with discrepancies between hiragana and rōmaji spelling as well as to deal with rōmaji variations. For example, to type <ち> /tʃi/, pressing either “t-i” based on the cabinet-ordered rōmaji or “c-h-i” based on Hepburn rōmaji is fine. As for vowels, two-mora monophthongs are based on aforementioned *99-shiki rōmaji*, which is consistent with hiragana/katakana, since *wāpuro-shiki rōmaji* is for typing hiragana/katakana. Since nowadays, many Japanese speakers often type Japanese texts via *wāpuro-shiki rōmaji*, it affects their rōmaji writings: for example, since /N/ is often typed with “n-n” in *wāpuro-shiki rōmaji*, /ke:hiN/ tends to be spelled as <Keihinn> with double <nn> by many Japanese speakers, which is a non-standard way (Komaba Organization for Educational Development, 2009). *Wāpuro-shiki rōmaji* can also affect two-mora vowel spellings: for example, Japanese speakers may prefer <ou> or <oo> for /o:/ over <ô> or <ō> since the former is more familiar with them. Table 17 summarizes variations of rōmaji in some vowels.

Table 17. Variations of rōmaji as of 2015

Phoneme(s)	hiragana katakana	<i>kunrei-shiki</i>	<i>Hebon-shiki</i>		<i>99-shiki</i>	<i>wāpuro-shiki</i>
		ISO	BSI	passport		
/o/	お	<o>	<o>	<o>	<o>	<o>
/oo/	おお	<oo>	<oo>	<oo>	<oo>	<oo>
/o:/	おお	<ô>	<ō>	<o/oh>	<oo>	<oo>

	オー	<ô>	<ō>	<o/oh>	<oo>	<o->
	おう	<ô>	<ō>	<o/oh>	<ou>	<ou>
/ou/	おう	<ou>	<ou>	<ou>	<ou>	<ou>
/e:/	ええ	<ê>	<ē>	<e>	<ee>	<ee>
	エー	<ê>	<ē>	<e>	<ee>	<e->
	えい	<ei>	<ei>	<ei>	<ei>	<ei>
/ei/	えい	<ei>	<ei>	<ei>	<ei>	<ei>

Note. <-> indicates a hyphen.

Despite standardized rules, in reality, many Japanese speakers do not always follow or may not recognize the cabinet-ordered rōmaji spelling rules, and everybody spells what they like, although some individuals attempt to solve such inconsistency and suggest new spelling rules from a linguistic perspective on an individual basis on the web.

Such inconsistency in romanization may not be unusual in other languages. For example, in Korean romanization, aforementioned Hanguk <최지우> (a Korean actress's name) is converted to <Choi Ji Woo> in the way commonly used for the public, or to <Choy Ci-wu> in Yale Romanization preferred by linguists, and so on (UNGEGN, 2013). Likewise, in Russian, Cyrillic <Евгений Викторович Плющенко> (a Russian skater's name) is converted to <Evgeny Plyushchenko> or to <Evgeni Plushenko>¹⁴ or a number of other ways (Pedersen, 2009). Such inconsistencies are also common in other scripts. For instance, in ancient times, before Japanese people invented hiragana/katakana, they wrote Japanese by using Chinese characters phonographically, known as *Man'yōgana*, in which one sound was inconsistently written with multiple different characters: for example, Japa/a/ was inconsistently written with three characters seen in the history book *Nihon Shoki* 'The Chronicles of Japan' written in 720 AD (Ōno, 2002), and other books, there were as many as ten kanji variations for /a/ (Coulmas, 2003). Another example is variations of aforementioned English pronunciation respelling (see §2.3.1.3).

¹⁴ This can be seen in sport news like <http://www.olympic.org/evgeny-plyushchenko> (retrieved on Oct, 16, 2015).

Finally, there are a number of debates about rōmaji spelling inconsistency, but the goal of this section is neither to oppose nor to support inconsistency, but to describe the status quo.

2.4.5 Potential rōmaji transfer to English spelling

In consideration of these rōmaji characteristics, there are potential challenges for Japanese EAL learners. First, since the rōmaji vowel GPC rules are mainly based on Italian, the transfer from rōmaji vowels to English vowels is expected to be more challenging than consonants, especially if Japanese EAL learners are not aware that rōmaji vowel GPC rules are *not* based on English. Second, Japanese EAL learners may have a difficulty acquiring spellings of English diphthongs/monophthongs with diphthongization which correspond to one letter in writing, such as Eng [aɪ]-<i>, or a vowel with a schwa off-glide such as [æ:] ([æə])-<a>. Third, Japanese EAL learners may have trouble being aware that vowel lengthening by duplicated letters or by <h> does not exist in English in part because the English vowel system does not have a phonemic length contrast in the same way as Japanese: for example, in English, <o> is [o⁰], while <oh> is also [o⁰] (not *[o:⁰]). Fourth, Japanese EAL learners may have difficulty in realizing that vowel letter duplication in English does not have a phonemic vowel lengthening effect: for example, <o> in *go* is [o⁰], while <oo> in *goo* is [u:] (not *[o:⁰]).

2.5 Japanese loanword rōmaji

Rōmaji variations that I just mentioned in the previous section are not the whole story of the roman alphabet in Japan. There is another type of rōmaji, which I term *loanword rōmaji* (外来語ローマ字 or *gairaigo rōmaji*) as opposed to *regular rōmaji*; regular rōmaji refers to cabinet-ordered rōmaji, Japan-style rōmaji, Hepburn rōmaji, and other variations discussed in the previous section. A good example of loanword rōmaji is /ro:raNdo/ (a

Japanese manufacturer of electronic musical instruments) spelled as <Roland> instead of regular rōmaji *<Rōrando/Rôrando>; in regular rōmaji, the letter <l> is never used, and word-final <d> never occurs. Another example is a made-up Japanese sports brand name /jonekkusu/ spelled as <Yonex>, as opposed to the regular rōmaji spelling <YONEKKUSU>. In this section I will discuss loanword rōmaji in order to understand how native Japanese speakers treat the roman alphabet, because their interpretation of the roman alphabet could affect their acquisition of English spelling.

2.5.1 Kanji logographs in Japanese: inconsistent letter-sound-correspondence

Before discussing Japanese loanword rōmaji in Japanese, it is important to briefly discuss the nature of the Japanese orthography observed in kanji logographs. The reason why I need to discuss kanji logographs is that there may be a misconception that the Japanese orthography hiragana/katakana and regular rōmaji are so phonetic that native Japanese speakers are not familiar with one-to-many or many-to-one GPC systems. However, this is not true. In this section, I will demonstrate very inconsistent letter-sound-correspondence (LSC) in Japanese, which leads native Japanese speakers to logographic reading. The point here is that native Japanese speakers are so used to inconsistent LSC that Japanese EAL learners may not pay much attention to English default GPC rules. More importantly, the nature of kanji seems to be transferred to loanword rōmaji as I will discuss below, so understanding kanji can help us understand loanword rōmaji.

Japanese kanji logographs originally came from Chinese, but Japanese kanji and Chinese hanzi are not the same in LSC consistency (Cook, & Bassetti, 2005). In Chinese, each hanzi (Chinese logograph) often represents one syllable sound, except for *duōyīnzi* ‘multiple reading characters’ which correspond to a few different sounds, such as <乐> corresponding to *yuè* and *lè*. On the other hand, each Japanese kanji logograph generally has more readings. This is because most kanji characters have both *on’yomi*, which represents

Japanized sounds of Chinese morphemes, and *kun'yomi*, which represents sounds of Japanese translation of Chinese morphemes (Yanaïke, 2009). For example, the *on'yomi* of <心> ‘heart, mind’ mainly sounds *shin* /ʃiN/ based on the Chinese sound (c.f., Mandarin *xīn* /ɕín/) and that of *kun'yomi* mainly sounds *kokoro* /kokoro/ based on the Japanese translation. Moreover, *on'yomi* has three main categories depending on when the words were imported from Chinese. For example, the Japanese kanji characters <行> and <明> are read as /gjo:/ and /mjo:/ respectively (with the *Goon* reading), as /ko:/ and /me:/ respectively (with *Kan'on*), and as /aN/ and /miN/ respectively (with *Tōon*) (Takebe, 1979, 83-84). As for *kun'yomi*, or Japanese translation of Chinese morphemes, each kanji character represents a meaning(s), so technically any sound can be assigned as long as it is semantically related. For example, the character <行> is assigned to the Japanese verbs /i(ku)/ ‘go’ and /okona(u)/ ‘conduct’ in addition to the aforementioned multiple *on'yomi* sounds (Takebe, 1979, 87). Takebe (1979) mentioned that in this sense, the character <犬> read as /inu/ ‘dog’ with *kun'yomi* (the native Japanese word) could also be read as /doggu/ based on the loanword from English ‘dog’. In fact, in the manga/drama story *Death Note*, the main protagonist’s name /raitō/ named after the English word *light* is written with <月> ‘moon, month’, one of whose usual Japanese readings is /tsuki/ with *kun'yomi*. Another example of manga characters is in *Ansatsu Kyōshitsu* ‘Assassination Classroom’, /karuma/ named after *karma* is written as <業>, which is commonly read as /go:/ or /gjo:/, one of whose meanings is *karma*.

Another point to note is recently adopted so-called *buttagiri-yomi* (literally ‘chopping-off-reading’). According to Zhū (2014), *buttagiri-yomi* indicates that part of the sound of a particular kanji character is chopped off. A somewhat well-recognized example is that only /koko/ in /kokoro/-<心> ‘heart’ and only /a/ in /ai/-<愛> are used, and <心愛> together is read as /kokoai/ (a girl’s name), instead of */kokoroai/.

There are also many other completely unpredictable readings. For example <服> commonly read as /fuku/ and <部> commonly read as /bu/ combine to form a family name <服部> /hattori/, but not */fukubu/. As well, many different readings of the aforementioned girl's name <心愛> other than /kokoa/ can also be found on the web, such as /urara/, /kijona/, /jioN/, /noa/, /mia/, /mirai/, /runa/, and so on, many of which are not easy to analyze why they are being read these ways¹⁵. An extreme example is that over 20 years ago, a Japanese comedian said that his family name was /ifibafi/ but written with <田中> which is usually read as /tanaka/ (another family name). This <田中>-/ifibafi/ (but not */tanaka/) correspondence is as arbitrary as English <Dale> read as /tɑ:məs/, for example. This joke was used to illustrate irregularities of kanji LSC.

Overall, native Japanese speakers are very familiar with inconsistent LSC. One website says that the character <生> corresponds to as many as 150 different sounds (retrieved from <http://d.hatena.ne.jp/hiiragi-june/20090304/p1>). Whether this number is accurate or not, what is important is that these kanji-reading ways are also transferred to the roman alphabet in Japan as I will discuss below. I consider that it would be very helpful if teachers made Japanese EAL learners aware that both Japanese and English have similarly inconsistent LSC systems, or L2 English LSC is possibly less inconsistent by demonstrating a comparison between Japanese kanji and English spelling.

2.5.2 Between-language grapheme-phoneme correspondence

Keeping the logographic nature of the Japanese orthography in mind, I will discuss loanword rōmaji below. Loanword rōmaji has been created based on between-language grapheme-phoneme correspondence (henceforth BL-GPC). BL-GPC is “the way borrowers

¹⁵ Generally those creative but not traditional naming ways are called *DQN name* /dokūN ne:mə/ ‘surprising name’ with a negative connotation, or called *kirakira name* ‘twinkling name’ with a positive connotation (Zhū, 2014).

have learned to pronounce [foreign] graphemes” (Kaneko, 2006, 51; Vendelin & Peperkamp, 2006). An English example of BL-GPC is the Spanish origin word *jalapeño* where <j> is [h], <a> is [a:], and <e> is [e^l] as opposed to the default English correspondences <j>-[dʒ], <a>-[e^l, æ:], <e>-[i:, ε], and still not the same as the Spanish <j>-[x], <a>-[a], and <e>-[e] (some English-speaking people may pronounce [hæ:ləpi:njo^o] in a more Anglicized way in vowels, but the consonants are still Spanish flavoured). A more familiar example to Japanese speakers is the loanword from Japanese *sake* (alcohol drink) pronounced as [sá:ki:], as opposed to *sake* [se^lk] reading based on the default English GPC rule. Although Eng[sá:ki:] is an attempt to make a foreign flavoured sound, it would hardly be recognized as the original Japanese word Japa[sə̀kə́(?)] ([`] = low tone, [´] = high tone) by monolingual native Japanese speakers. There are a few variations of English *sake*, such as [sá:ke^l], but all of them sound noticeably different from the original Japanese sound in terms of vowel qualities, the number of morae (4 morae in English vs. 2 morae in Japanese), the position of stress, and so on. This example could give Japanese speakers an idea of how different BL-GPC in English and actual Japanese Hepburn rōmaji GPC for the same word are. What I call loanword rōmaji in Japanese is the same type of reading way. Loanword rōmaji is defined as roman alphabet pronounced based on BL-GPC by native Japanese speakers.

In Japan, written English or English-like words (that many Japanese speakers may mistake for actual English) are ubiquitous. For example, among the top 20 Japanese-pop songs in November, 2013, eight songs were written with the roman alphabet, and most of the words originate from English: for example, *True Blue Traveler*, *Anniversary*, and so on. These are pronounced based on the Japanese phonology, meaning that while the GPC patterns are assimilated to that of English, they are still different from English, as seen in the English loanwords *jalapeño* from Spanish and *sake* from Japanese. *True Blue Traveler* and *Anniversary* are pronounced as /turu: buru: torabera:/ and /aniba:sari:/ in which <ue> is /u:/

and <er> is /a:/ as opposed to regular rōmaji, <ue>-/ue/ and <er>-/er/, also as opposed to North American English <er>-/ɪ/ or <a>-/æ/ ([æ:]). Interestingly, loanword rōmaji is expanded to native Japanese words, such as singers' names *Aska* /asuka/ and *GACKT* /gakuto/ as opposed to regular rōmaji spellings <Asuka> and <Gakuto> respectively. Furthermore, loanword rōmaji is used for made-up names, such as brand names or names of products, whose sounds are English loanword-flavoured rather than native Japanese words or Sino-Japanese words (Chinese loanwords), such as /sumappu/-<SMAP> (*<SUMAPPU>) and /panasonikku/-<Panasonic> (*<Panasonikku>).

Notice that loanword rōmaji prefers English-like consonant letter sequences that are not allowed in regular rōmaji. Briefly, in standard regular rōmaji, word-initial consonant letter sequences are only <Cy> and three consonant digraphs <ch>, <sh>, and <ts> (and marginally <kw> and <gw>), and the word-final consonant letter is only <n> (and <h> in passport rōmaji) as shown in §2.4.3. Therefore, spellings like <SMAP> with the word-initial <SM> sequence and word-final <P>, for example, can be instantly recognized as a foreign-flavoured word by Japanese speakers.

Loanword rōmaji is not only used for English or English-like words, but also for other foreign words. For example, there are some bands named after French or Spanish words, such as the French based music group <Le Couple> read as /rukupuru/, and the Spanish based group <GUIRO> read as /giro/. There are also some creative versions, which are not exactly loanword “rōmaji”, but have a similar nature. For example, there is a music group written with IPA symbols “[iksí:d]” pronounced as /ikuɸi:do/. Although this is IPA, it is pronounced in the Japanized way where <sí> becomes /ɸi/ since in Japanese the /si-/ /fi/ phonemic contrast is only marginally allowed (Nogita, 2016a; Nogita, 2010a) and /si/ is commonly replaced with /ɸi/. In addition, after word-final <d>, there is vowel epenthesis. So more accurate phonetic IPA transcription for standard Japanese pronunciation could be [ikɸi:do] (or

[ɪkʰeɪ:dõ]) rather than the original [iksɪ:d]. The point is that non-linguistically trained Japanese speakers prioritize fancy looks over phonetic accuracy. More importantly, loanword rōmaji ways can be applied to non-English materials.

Table 18 shows some examples of typical vowel spellings and corresponding Japanese vowels in English-based BL-GPC (or in other words what I call loanword rōmaji) provided by Kaneko (2006). Note that unlike regular rōmaji, loanword rōmaji does not have formally established rules, so this table represents only tendencies.

Table 18. Spelling, corresponding North American English vowels, and typical corresponding Japanese vowels based on loanword rōmaji according to Kaneko (2006)

Spelling	Corresponding American English vowel	Corresponding Japanese vowel based on BL-GPC
<au>	[ɑ:] ([ɔ:])	[ɔ:] (/o:/)
<o>	[ɑ:]	[ɔ] (/o/)
<u>	[ʌ]	[ɛ] (/a/)
<e>	[ɛ]	[ɛ] (/e/)
<i>	[ɪ]	[ɪ] (/i/)
<ou>/<oo>	[ʊ] (as in <i>should</i>)	[ɯ] (/u/)
<a>C<e>	[e ^l]	[ɛ:] (/e:/)
<ea>	[i:]	[i:] (/i:/)
<o>C<e>	[o ^o]	[ɔ:] (/o:/)
<oo>	[u:] (as in <i>food</i>)	[u:] (/u:/)

Notice that one of the interesting characteristics of Japanese BL-GPC is that unlike many North American dialects, <au> and <o> are distinguished in Japanese BL-GPC, while <au> and <o>C<e> are not. If linguistically naïve native Japanese speakers can generalize these loanword rōmaji patterns to at least some extent, Japanese EAL learners might transfer the loanword rōmaji patterns to English. If this is the case, one of the reasons why Japanese EAL learners find it difficult to acquire the English vowel system can be traced to some big differences between loanword rōmaji GPC and the actual English GPC, which keep confusing learners, especially if Japanese EAL learners misconceive that loanword rōmaji is the actual English.

Finally, I summarize four types of loanword rōmaji:

1) Existing English words but pronounced with the Japanese phonology: for example, <anniversary>-/aniba:sari:/

2) Existing non-English foreign words (such as French words) but pronounced with the Japanese phonology: for example, <Le Couple>-/rukupuru/

3) Existing Japanese words but spelled in a non-regular rōmaji way: for example, <Aska>-/asuka/ (c.f., regular rōmaji <Asuka>)

4) Made-up foreign-looking words spelled in a non-regular rōmaji way but pronounced with the Japanese phonology: for example, <SMAP>-/sumappu/

2.5.3 Is loanword rōmaji Japanese or English?

There is a fundamental question of whether loanword rōmaji is part of the Japanese orthography or the English orthography. I suggest that loanword rōmaji must be regarded as part of the Japanese orthography, and I would draw a clear line between the Japanese orthography and the English orthography. I would also emphasize that this boundary must be explicitly taught to Japanese EAL learners to help their understanding about English.

The reasons are as follows: first, loanword rōmaji is designed mainly for monolingual Japanese speakers who communicate with Japanese speakers in the Japanese contexts. Loanword rōmaji is not designed for non-Japanese speakers who live in or are visiting Japan, and it is also not designed as a lingua franca for different language groups in Japan, which is a major difference from bilingual writing. Therefore, it should be part of the Japanese writing system. Second, words written with loanword rōmaji are not used as code-switching, but as part of Japanese vocabulary. According to Grosjean (1989), code-switching involves complete shifts to a different language including phonology when interlocutors share knowledge of two or more languages. However, words written with loanword rōmaji are used in monolingual Japanese speakers' conversation and those words' phonology is completely based on Japanese. Third, in English Wikipedia, at least many well-known made-up words

written with loanword rōmaji are along with Hepburn rōmaji: <zādo> for *ZARD* and <Eibekkusū Torakkusū> for *Avex Trax*. This can be interpreted as evidence that English-speaking people do not regard loanword rōmaji words as English, but as Japanese. Because of these reasons, I use the term *rōmaji* for loanword rōmaji in order to emphasize that this is part of the Japanese orthography.

Japanese loanword rōmaji is much like loanword spelling in English, such as *café* and *El Niño*, which still keep their original French and Spanish spellings and diacritics, but pronounced in the English between-language grapheme-phoneme correspondence way. As well, these words need to be read by monolingual English-speaking people. As long as these words are already part of the English vocabulary set, this type of spelling is regarded as the English orthography. Japanese loanword rōmaji seems to have the same status.

As another familiar analogy, loanword rōmaji can be interpreted as a mirror image of kanji logographs. Kanji was originally imported from China as the script of a foreign language. However, since kanji has been used in Japan for such a long time, it has almost lost its foreign identity. Loanword rōmaji may be in the same track, but since its usage only recently started, it still has a strong foreign identity. However, it might eventually be settled in the Japanese language just like kanji. This can also be analogous to the English word *strata*; loanwords from Latin like *immortal* and *convict* almost lost their foreign identity, while more recent loanwords like *lasagna* and *kimchi* are recognized as foreign words. A possible counterargument would be that loanword rōmaji is the orthography of one of the varieties of World Englishes, specifically “Japanese English”. For this argument, the first step is to define Japanese English, but this is beyond the scope of this present study.

2.5.4 Actual usage of loanword rōmaji in the Japanese culture

In this section, I will demonstrate how loanword rōmaji is used in Japan. There are two ways: 1) loanword rōmaji along with katakana/hiragana or some type of pronunciation

guide, and 2) loanword rōmaji alone without any pronunciation guides. For example, Figure 13 shows company and product names made from existing English words written with loanword rōmaji along with katakana pronunciation guides. Figure 14 shows store names made from existing English words written with loanword rōmaji without pronunciation guides.

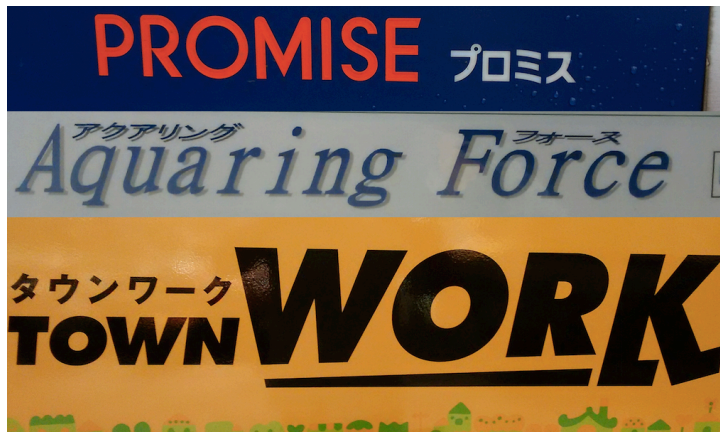


Figure 13. Names with existing English words written with loanword rōmaji along with katakana pronunciation guides



Figure 14. Names with existing English words written with loanword rōmaji without pronunciation guide

In Figure 13, from the top, there are <promise>-<プロミス>-/puromisu/, <Aquaring Force>-<アクアリング フォース>-/akuaringuφo:su/, and <TOWN WORK>-<タウンワーク>-/tauNwa:ku/. Thanks to katakana pronunciation guides, monolingual Japanese speakers can read these words. In Figure 14, <LITTLE MERMAID>-/ritoruma:meido/, <TULLY'S COFFEE>-/tari:dzuko:hi:/ and <ITALIAN TOMATO Café Jr. Bakery>-/itarian tomato

kaɸedʒunia be:kari:/ do not have pronunciation guides, so not all people, including L1 and L2 Japanese speakers, are able to read these. In such cases, people need to ask other people or search for katakana/hiragana pronunciation guides on the web. Since Japanese kanji characters have very inconsistent LSC, Japanese speakers are accustomed to such situations and would not find it particularly inconvenient. Needless to say, these words are not expected to be read based on the English phonology with the /l/-/ɹ/ contrast by monolingual Japanese speakers, but are expected to be pronounced based on the Japanese phonology.

In addition to proper names, real English word-based loanword rōmaji is used with for practical uses. Figure 15 and Figure 16 are examples.



Figure 15. English phrases for a practical use along with katakana pronunciation guides



Figure 16. English words for a practical use without pronunciation guides

In Figure 15, there are signs of <Recycle Center>-<リサイクルセンター>-/risaikuru seNta:/ (although *recycling center* would sound more natural as English) and <FLOOR GUIDE>-<フロアガイド>-/ɸuroagaido/. These pronunciations are shown with katakana, which enables monolingual Japanese speakers to read these. All of these words have already become Japanese dictionary entries so these katakana forms should already be familiar to many

Japanese speakers. In Figure 16, there are <OPEN> and <CLOSE> that indicate business hours of the café. These words are already commonly used loanwords in Japanese and their roman alphabet forms are also fairly familiar to Japanese speakers, so these words are expected to be read as /o:puN/ and /kuro:dzu/ respectively. This also means that these <OPEN> and <CLOSE> are used logographically just like kanji logographs.

Another interesting example of real English words is found in a book for preliterate kindergarteners, *Mikke*, the Japanese translation of *I Spy* (Marzollo & Wick, 1992). There are English words along with katakana pronunciation guides shown in Figure 17. The English words <SWAN> and <Grace> are along with katakana <スワン> /suwaN/ and <グレース> /gre:su/ respectively.

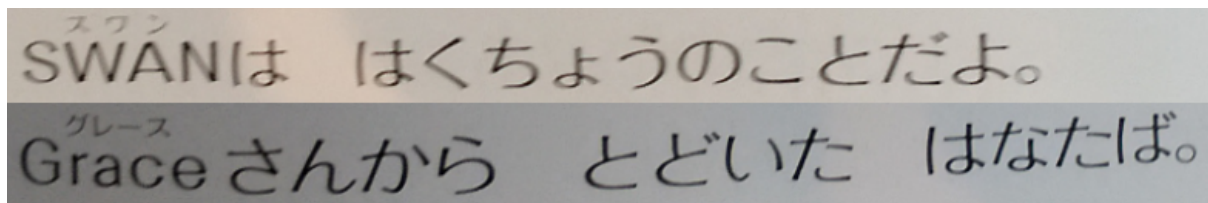


Figure 17. English words along with katakana pronunciation guides on a book for preliterate children

Figure 18 shows an example cited from the Japanese manga *Toriko* (in the Japanese manga magazine Weekly Shōnen Jump no. 41, 2015, p. 306).

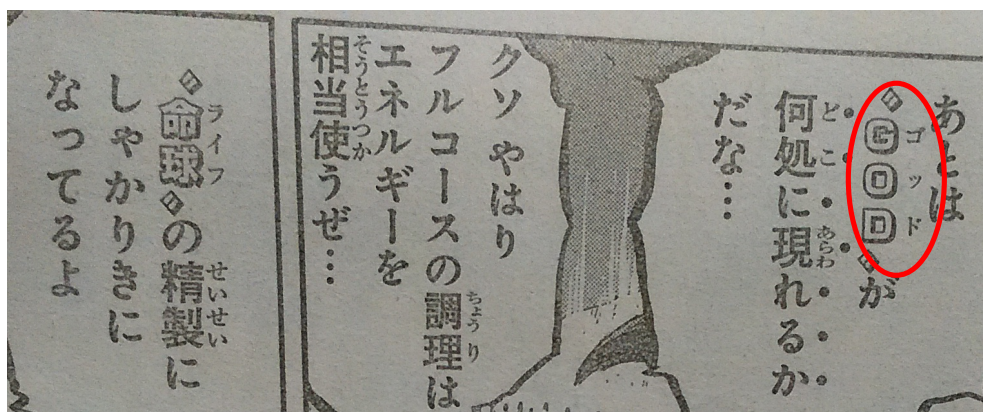


Figure 18. Kana pronunciation guides put on the right side of kanji and loanword rōmaji in the Japanese magazine *Shōnen Jump*

Notice that in Figure 18, both kanji and loanword rōmaji words have pronunciation guides with small hiragana/katakana on the right side: <GOD> is along with the katakana pronunciation guide <ゴッド> /goddo/. The word <GOD> obviously originates from the real English word *god*, but it is used as the proper name of ingredients in this story, so this is a Japanese word written with loanword rōmaji, not an English word embedded in the Japanese context. What is interesting is that kanji and loanword rōmaji are treated in the same way.

There are also made-up words written with loanword rōmaji. Figure 19 shows a bank name written with both loanword rōmaji and hiragana.



Figure 19. A bank name written with loanword rōmaji along with hiragana

Because of the pronunciation guide <りそな> for <RESONA>, this can be read as /risona/.

Without pronunciation guides, <RESONA> is very unlikely to be read as /risona/ since in the regular rōmaji way, it is supposed to be /resona/. Likewise, Figure 20 is a local shopping mall name in Saitama prefecture written with loanword rōmaji with or without pronunciation guides: <CUPOLA>-<きゅぽら>-/kjupora/.

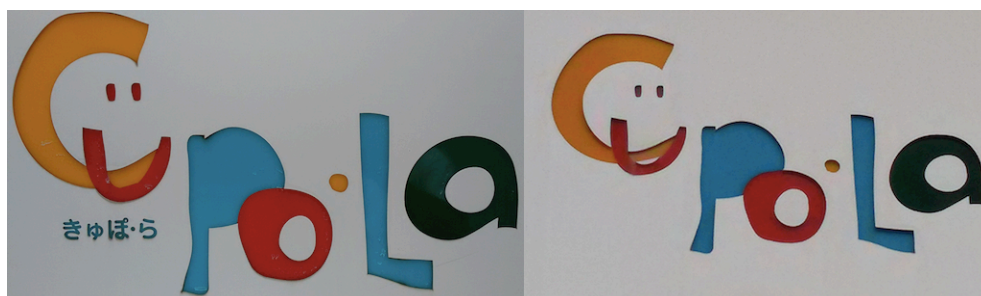


Figure 20. A local mall name written with loanword rōmaji with (left) and without (right) hiragana

In regular rōmaji, /kjupora/ is spelled as *<KYUPORA>, but this word is not spelled this way. Therefore, without pronunciation guides, <CUPOLA> is very unlikely to be read as

/kjuɔɾa/. In this mall, some logos are along with a hiragana pronunciation guide while others are not, meaning that those who unfortunately cannot find its pronunciation guide have to bother asking other people or check it on the web.

What is interesting is that regular rōmaji is also used for signboards in the same way as loanword rōmaji. Figure 21 shows store names: <sakura>-<さくら> and <TSUTSUMI>.

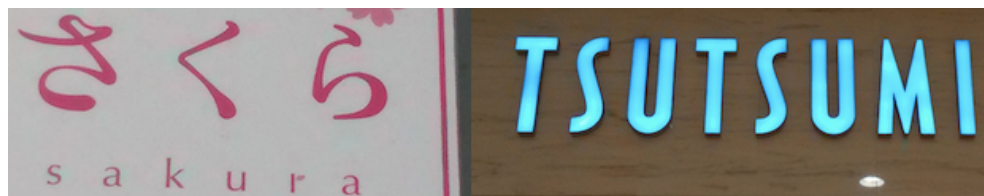


Figure 21. Store names with regular rōmaji with hiragana and rōmaji alone

The left signboard has both hiragana and regular rōmaji. Since regular rōmaji PGC is fairly transparent, this hiragana is not a pronunciation guide but could be just a design of the logo. The point here is that since both regular rōmaji and loanword rōmaji are treated similarly, many Japanese speakers may not be able to clearly distinguish regular rōmaji and loanword rōmaji. This in turn means that if Japanese speakers cannot clearly distinguish loanword rōmaji and actual English, it would also be hard to distinguish regular rōmaji and actual English. To make it clear, if A and B are perceived as the same and B and C are perceived as the same, then A and C would be perceived as the same as well.

There are also non-English-based loanword rōmaji with and without pronunciation guides. Figure 22 shows an Italian-based yoga studio name with a katakana pronunciation guide <CALDO>-<カルド>-/karudo/ and a French-based fashion brand without pronunciation guide <frou-frou>-/furuφuru/.



Figure 22. Italian-based loanword *rōmaji* with katakana (left) and French-based loanword *rōmaji* without katakana (right)

For the left one, people can read the name confidently due to the katakana pronunciation guide. For the right one, people have to check the pronunciation by asking other people or on the web. What is important is that Japanese speakers do not need to know which language these names are from as long as they know the pronunciation in the Japanese way, so there is a possibility that many Japanese speakers assume that any foreign-looking names are English.

More intriguingly, mixtures of regular *rōmaji* and loanword *rōmaji* are not at all unusual, as shown in Figure 23 and Figure 24. Figure 24 also shows a mixture with kanji, katakana, and numbers.



Figure 23. Mixtures of regular *rōmaji* and loanword *rōmaji*



Figure 24. A mixture of French-based BC-LSC *rōmaji* and regular *rōmaji* (left) and a mixture of loanword *rōmaji*, kanji, katakana, and numbers

In Figure 23, <Hiro> in <Hiro Clinic> is a Japanese proper name written with regular *rōmaji*, and the actual English word <Clinic> is read as /kurinikku/ in the loanword *rōmaji* way as indicated with katakana alongside. The right one is the name of a local mall in Saitama prefecture in Japan. <KAWAGUCHI> is the name of a city written with regular *rōmaji* and

<CASTY> is a made-up word from a combination of *cast* and *city* pronounced as /kjasuti:/ by local people. In the left picture in Figure 24, a beauty salon's name <Salon de Miki> is read as /saroNdomiki/ (according to their website's katakana pronunciation guide) in which <Salon de> is French-based loanword rōmaji and <Miki> is a Japanese proper name written with regular rōmaji. In the right one, loanword rōmaji is mixed with kanji and katakana. This <Ash> in the first line is a name of a hair salon read as /aʃʃu/ (according to their website's katakana pronunciation guide). In the third line of the left picture, there is <3F> meaning 'the third floor', but this can be pronounced as the Japanese word /saNkai/ meaning 'the third floor', suggesting that this <3F> is used logographically. Again, <CASTY>, <Salon de Miki>, and <Ash> on these Figures do not have pronunciation guides, so people somehow need to check how to read them just as I did.

Another example of an interesting mixture is Figure 25, in which the bus company name is written in two ways, a combination of kanji and katakana, and that of regular rōmaji and loanword rōmaji.



Figure 25. A bus company name written with kanji + katakana and roman alphabet

The phrase <国際興業バス> in the bottom picture and <KOKUSAI KOGYO BUS> in the top picture are supposed to be read in the same way, /kokusaiko:gjo:basu/. The kanji part <国際興業> /kokusaiko:gjo:/ in the bottom picture is replaced with regular rōmaji <KOKUSAI KOGYO> in the top picture, but the katakana part <バス> /basu/ 'bus' in the bottom picture is not replaced with regular rōmaji *<basu>, but with loanword rōmaji <bus> (or possibly an English translation). In Japan, it is common that loanwords from English are replaced with

equivalent actual English words, rather than written with regular rōmaji. Figure 25 is one of such cases. There would be no wonder that Japanese speakers assume that loanwords written with katakana and the cognate English words are the same entity when they are always exposed in these circumstances. Incidentally, in the right corner of the picture, there are also loanword rōmaji of made-up words, <PASMO> and <Suica> written. These are the names of bus and rail cards. Based on the sounds of /pasumo/ and /suika/ respectively, these words will be spelled as *<PASUMO> and *<Suika> in regular rōmaji, but this is not the case.

Another interesting example of a mixture is shown in Figure 26, which is part of a menu in a café.



Figure 26. Both Japanese and English words are on a menu

Interestingly, Japanese words are written with regular rōmaji and loanwords are written with loanword rōmaji; specifically, the Japanese word <GOHAN> ‘rice’ is written with regular rōmaji instead of the English translation <RICE>, while the loanwords /su:pu/ ‘soup’ and /kare:/ ‘curry’ are written with loanword rōmaji <SOUP, CURRY> instead of regular rōmaji *<SŪPU, KARĒ>. The word /sarada/ ‘salad’ is spelled as <SALADA> instead of <SALAD> perhaps mistakenly. This example may reflect Japanese speakers’ mind in which the boundaries among regular rōmaji, loanword rōmaji, and actual English spellings are not clear.

To sum up, I suggest that loanword rōmaji has the same status as kanji as part of the Japanese writing system. However, on the basis of the usage of loanword rōmaji, there are many factors that can mislead Japanese speakers to assume that loanword rōmaji is actual English, and that katakana pronunciation guides along with loanword rōmaji indicate actual sounds of English. Moreover, non-English-based loanword rōmaji and even regular rōmaji can be confused with English-based loanword rōmaji.

2.5.5 Productivity of loanword rōmaji in the Japanese culture

Loanword rōmaji words are fairly productive. Loanword rōmaji words can be produced by people only in a particular region, so these words are not necessarily known by the whole nation. For example, the aforementioned local shopping mall <CUPOLA>-/kju:pora/ in Kawaguchi city in Saitama prefecture shown in Figure 20 originates from the loanword /kju:pora/ ‘*cupola furnace*’ because this city used to be famous for metal casting factories. Another example is another local mall <QURUNE>-/kurune/ in my hometown Higashi-Kurume city in Tokyo prefecture, shown in Figure 27.



Figure 27. A Japanese origin name written with loanword rōmaji

The origin of <QURUNE> is a combination of part of the city name *Higashi-Kurume* and the Japanese phrase *mata kurune* ‘I’ll come again’. Its spelling is also not the regular rōmaji way *<KURUNE> but in the fancy foreign-looking loanword rōmaji way.

Loanword rōmaji words’ productivity spreads to a personal level. For example, many amateur music bands made their own names with loanword rōmaji. For example, the amateur band name of my acquaintance is <laki laki lucky band>-/rakiraki rakki:baNdo/ originating from a pun of the Hawaiian word *kilakila* and the English word *lucky*. It is not spelled in the regular rōmaji way *<raki raki rakkī bando>. Another example is my other acquaintance’s amateur band name <nkjet>-/enuke:džetto/, originating from a combination of the initials of the members’ names, which accidentally includes the English word *jet*. Again, <jet> is read as /džetto/ in the loanword way, and /džetto/ is not spelled as the regular rōmaji way *<jetto>.

As can be seen, loanword rōmaji is very productive and ubiquitous in Japan, and their GPC patterns are often so unique that people often have no way to read unless they ask other

people or search the web, much like proper names written with very creative kanji characters as mentioned in §2.5.1.

2.5.6 Loanword rōmaji versus multilingual writings

Loanword rōmaji must be separated from multilingual writings in terms of their usage. Multilingual writings are intended for people in different language groups, whereas loanword rōmaji is intended for monolingual Japanese speakers to be used in the Japanese contexts. As an example of a multilingual environment, in Richmond in British Columbia, Canada, English and Chinese are often seen, as shown in Figure 28. Likewise, in Inner Mongolia Autonomous Region in China, where at least two major ethnic groups live (Han Chinese and Mongols in China), both Chinese and Mongolian written with the traditional Mongolian alphabet are seen, as shown in Figure 29.



Figure 28. A bilingual notice in Richmond, in British Columbia, Canada

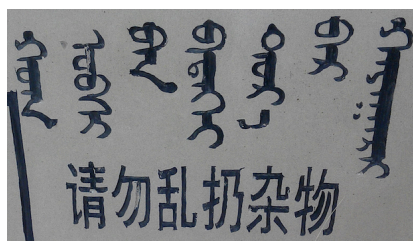


Figure 29. A bilingual sign in Inner Mongolia: “Please do not throw away your garbage.”

In these multilingual situations, if one understands one of these languages, s/he does not necessarily have to recognize other languages. In contrast, in the Japanese mixed writing

system, all the scripts, including loanword rōmaji, need to be recognized by monolingual Japanese speakers.

In some places in Japan, there are multilingual writings, such as with English, Chinese, Korean, and other language translations mainly for tourists, but what is interesting is that English translations include regular rōmaji. For example, Figure 30 shows train announcements in four different languages in Japan.

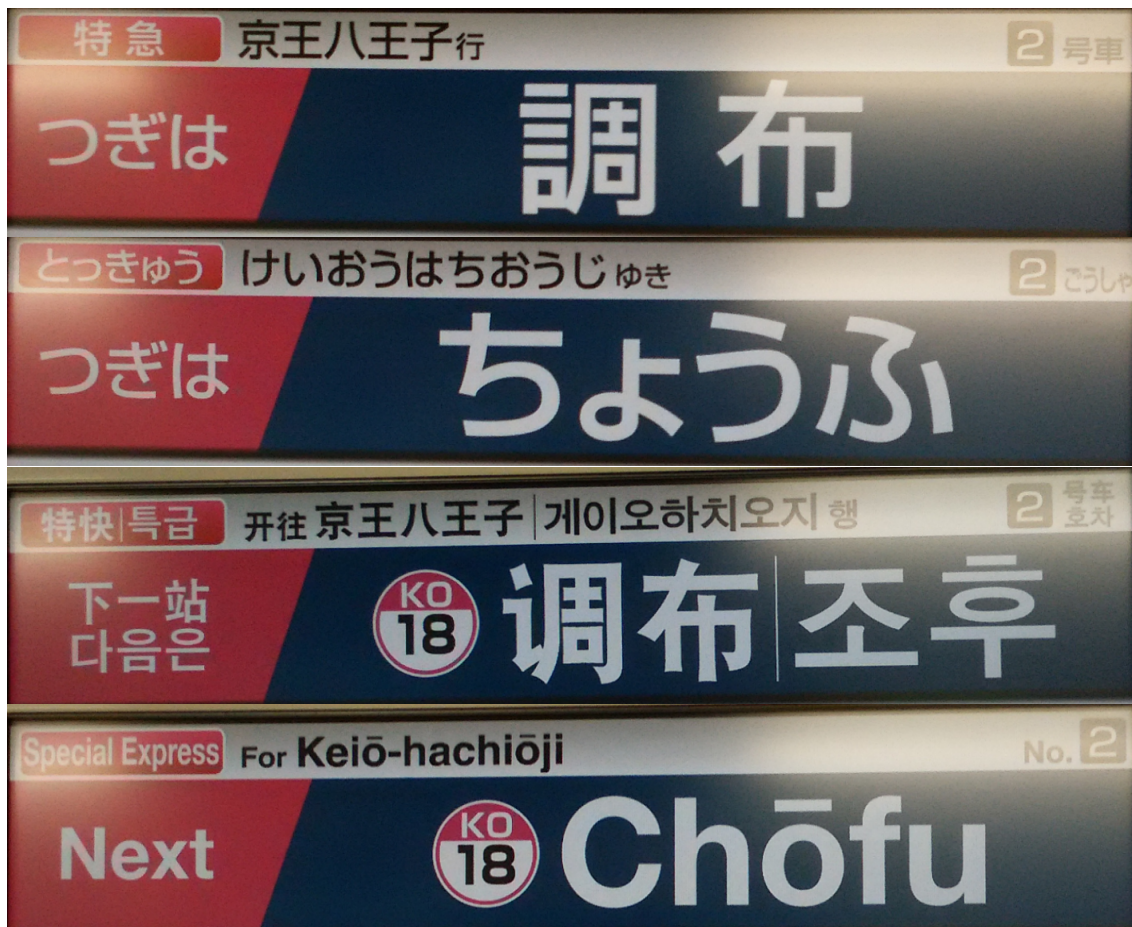


Figure 30. Train station names in Japan indicated in Japanese kanji, Japanese hiragana, Chinese and Korean translations, and English translation from the top

The top picture shows Japanese with a mixture of kanji and hiragana in the most common writing style, <特急 京王八王子行 2号車> ‘Special Express for Keiō-hachiōji, Car No. 2’ and <つぎは 調布> ‘The next station is Chōfu’. The second one is also Japanese but written only with hiragana to indicate the pronunciation of the kanji characters of the top

picture, <とっきゅう けいおうはちおうじゆき 2 ごうしゃ> /tokkju: ke:o:hafjio:dʒi juki nigo:ʃa/ and <つぎは ちょうふ> /tsugiwa ʃo:ɸu/. The third picture is translations of Chinese and Korean, in which proper names are written with hanzi in Chinese, and with the Korean alphabet, Hangul, for the phonetic transcription of Koreanized pronunciation. Finally, the bottom one is the English translation, in which proper names are written with regular rōmaji, <Keiō-hachiōji> and <Chōfu>. In the Chinese translation of the proper name contains the exotic character <调> to Japanese speakers (compare the Japanese <調>), which is obviously a foreign script. As well, <下一站> (*xiàyīzhàn*) ‘The next station’ is completely exotic. Needless to say, the Korean translation <조후> /dʒohu/ and <게이오하치오지> /geiohateiodʒi/¹⁶ are written with a completely foreign script.

In contrast, the English translation adopts regular Hepburn rōmaji for proper names. For “true” English translation, there should be two other possible ways to represent proper names. One is transliteration with the *English* orthography, such as <Keio-hachioji> and <Chofu> without macrons <˘>, and pronounced in the anglicized way like [ke^lo^uha:ʃi:o^udʒi:] and [ʃo^ufu:] respectively; compare the English dictionary entries of *Tokyo* and *ramen* (loanwords from Japanese) without <˘>, as opposed to the Japanese standard rōmaji *Tōkyō* and *rāmen*. This transliteration with a minor change is the same as that in the Chinese translation, Japa<調布> → Chi<调布>, which is read based on the Chinese LSC *diàobù*. The other translation way is phonetic transcription of Anglicized pronunciation with pronunciation respelling, such as <kay-oh-hah-chee-oh-jee> and <cho-foo> respectively, just as seen in the Korean translation <게이오하치오지> /geiohateiodʒi/ and <조후> /dʒohu/. Interestingly, the case of Figure 30 is neither of these; this transliteration includes regular rōmaji, in other words the *Japanese* orthography, <Keiō-hachiōji> and <Chōfu>, with the

¹⁶ Korean IPA transcriptions are according to Brew and Beckman (2002).

evidence of using macrons <̄>. Table 19 shows comparisons among transliteration with the Japanese orthography, with the English orthography, and phonetic transcription of Anglicized pronunciation with pronunciation respelling (see §2.3.1.3 for more details about pronunciation respelling).

Table 19. Transliteration and phonetic transcription for the station names
Japa/ke:ɔ:haʃiɔ:dʒi/ and /ʃo:ɸu/.

Transliteration		Phonetic transcription (Anglicized pronunciation)
Japanese orthography	English orthography	
<Keiō-hachiōji>	<Keio-hachioji>	<kay-oh-hah-chee-oh-jee>
<Chōfu>	<Chofu>	<cho-foo>

Note. <Keio-hachioji> and <Chofu> can also be the Japanese orthography as passport rōmaji as mentioned in §2.4.4.

Under this circumstance that regular rōmaji is used for English translation rather than English transliteration or phonetic transcription, there is no wonder that Japanese speakers confuse regular rōmaji and the English orthography. If <Keio-hachioji> and <Chofu> without macrons, which can be regarded as the English orthography, are adopted for English translation, these would look slightly exotic for Japanese speakers due to a lack of the vowel length contrasts and could be recognized as a different entity from regular rōmaji.

Moreover, in some cases, it is unclear whether the translation is for bilingual or monolingual purposes. Figure 31 shows a company name and a street name written in both Japanese and English.

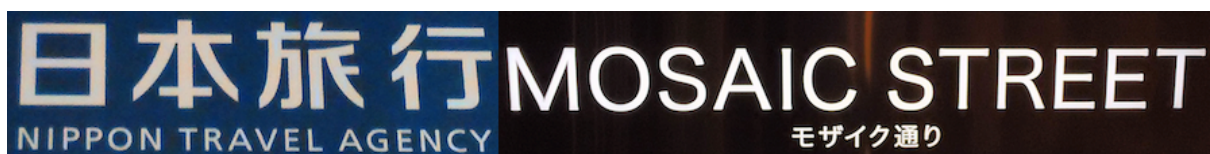


Figure 31. Both Japanese and English of a company name (left) and a street name (right)

The left one is a travel agency, whose Japanese name is <日本旅行>/nihoNɾjoko:/ and its English name is <NIPPON TRAVEL AGENCY>. In the right one, the Japanese name <モザイク通り>/modzaikudo:ri/ is translated into <MOSAIC STREET> where the loanword <モザイク> is written with the cognate English word <MOSAIC> and the native Japanese word

<通り> is translated to <STREET>. It is not clear whether these translations are for the bilingual purpose, or a logo design intended to be read in the loanword rōmaji way by monolingual Japanese speakers, in part because <日本>/nihon/ is converted to <NIPPON> (the other way of calling Japan besides <NIHON>) rather than <JAPAN>.

To sum up, boundaries between regular rōmaji, loanword rōmaji, and actual English are not clear in many cases.

2.5.7 My previous study of loanword rōmaji vowel LSC

Although loanword rōmaji is very commonly used in everyday life in Japan, its LSC in actual usage has not been fully examined. To fill in this gap, I examined actual made-up words written with loanword rōmaji in order to analyze its vowel-letter-vowel-sound correspondence patterns (Nogita, 2016c). It is important to know loanword rōmaji LSC patterns since these patterns could help us better understand acquisition patterns of English GPC by native Japanese speakers, as I will discuss below. In Nogita (2016c), I selected 424 English-looking proper names, including names of professional singers, bands/groups, record labels, and some other related companies, which are typically seen in roman alphabet form, such as Japa/sumappu/ (a name of a Japanese boy band) spelled as <SMAP>, instead of the regular rōmaji way *<SUMAPPU> Table 20 shows the overall vowel-letter-to-vowel-sound correspondence patterns.

Table 20. Results of letter-to-sound correspondence of loanword rōmaji in English-looking proper names (Nogita, 2016c)

Letter	To-tal #	Sound	#	Rōmaji or English-like ^a	Environment	Example
<a>	242	/a/	224	R		<u>A</u> nimetal /animetaru/
		/ei/	6	E[e']		FA <u>K</u> Y /fɛiki:/
		/a:/	4			Litoma <u>t</u> h /ritoma:su/
		/e:/	2			UKAWANIM <u>A</u> TION /ukawanime:ʃoN/
		/ja/ ^b	2			Applicat /apurikjatto/
		/o/	2			Only in <ca> Only in <al> or quasimode /kuoʃimo:do/

				<ua>		
		/e/	1			Spontania /supoNtenia/
		/o:/	1		Only in <aI>	au Legal /orugo:ru/
<ai>	13	/ai/	11	R		A <u>icoo</u> /aiku:/
		/ei/	2	E[e']		R <u>ails-Tereo</u> /reirusutereo/
<ar>	11	/a:/	7			Z <u>ard</u> /dza:do/
		/aru/	3			H <u>ARCO</u> /haruko/
		/o:/	1		only in <war>	W <u>AR-ED</u> /wo:do/
<ay>	6	/ei/	5	E[e']		TH <u>PLAY</u> /supurei/
		/ai/	1	R?		ch <u>ay</u> /tʃai/
<au>	5	/au/	2	R		Vo Vo <u>Tau</u> /bobotau/
		/o:/	2			A <u>UTRIBE</u> /o:toraiibu/
		/o/	1			au Legal /orugo:ru/
<aw>	4	/o:/	2			D <u>AMIJAW</u> /damidʒo:/
		/au/	1	R?		n <u>awii</u> /nau:/
		/a:/	1	E[ɑ:]?		Y <u>AWMIN</u> /ja:min/
<aa>	4	/a:/	4	R		B <u>AAD</u> /ba:do/
<ah>	3	/a/	2			A <u>HN</u> /aN/
		/a:/	1	R, E[ɑ:]?		B <u>AHN</u> /ba:N/
<a_e>	2	/ei/	1	E[e']		S'cap <u>ade</u> /esukapeido/
		/e/	1		in <age#>	jamz <u>village</u> /dʒamudzubiredʒi/
<e>	77	/e/	64	R		E <u>NDLI-x</u> /eNdorikkusu/
		/i:/	5	E[i:]		S <u>OLIDEMO</u> /soridhi:mo/
		/u/	3			R <u>YTHEM</u> /ridzumu/
		/e:/	1			L <u>EMONed</u> /remone:do/
		/i/	1			CH <u>IKENz</u> /ʃikiNdzu/
		/o/	1			R <u>OTTENGRAFFTY</u> /rottoŋguraʔiti:/
		/a/	1			J <u>UDE</u> /juda/
		null	1	E	only in <-ed>	W <u>AR-ED</u> /wo:do/
<ee>	15	/i:/	12	E[i:]		B <u>EREEVE</u> /biri:bu/
		/i/	3	E[i:]?		A <u>CKEE</u> /aki/
<ie>	12	/i:/	8	E[i:]		B <u>ENNIE</u> /beni:/
		/ie/	3	R		As <u>riel</u> /adzurieru/
		/e/	1		from "friend"	L <u>IFriends</u> /riʔureNdzu/
<er>	12	/a:/	10			A • capp <u>ellers</u> /akappera:dzu/
		/a/	2			L <u>astier</u> /rasutia/
<ey>	7	/ei/	2	R?		G <u>ALEYD</u> /gareido/
		/i:/	2	E[i:]		Key <u>co</u> /ki:ko/
		/i/	2			S- <u>KEY-A</u> /sukia/
		/e/	1			H <u>EESEY</u> /hi:se/
<ea>	6	/i:/	3	E[i:]		Happ <u>ea</u> /happi:su/
		/ei/	1	E[e']		B <u>REAKERZ</u> /bureika:dzu/
		/e/	1			ALS <u>DEAD</u> /orusudeddo/

		/ua/	1			jealkb /dʒuaruke:bi:/
<ei>	3	/ei/	3	R		eico /eiko/
<eu>	2	/ju:/	2	E[ju:]		eufonius /ju:ɸoniasu/
<ew>	1	/u:/	1	E[u:]		PaniCrew /panikuru:/
<ye>	1	/ai/	1	E[ai]		Mye /mai/
<eye>	1	/ai/	1	E[ai]		eyelis /airisu/
<yee>	1	/i/	1			Akyee /aki/
<iee>	1	/i/	1			ediee /edi:/
<iie>	1	/i:/	1			NIKIIE /niki:/
<eeee>	2	/i:/	2			GReeeeN /guri:N/
<eeeeeee eee>	1	/i:/	1			BAReeeeeeeeN /bari:N/
<i>	170	/i/	142	R		ALvino /arubino/
		/ai/	14	E[ai]		TWILL /tuwairu/
		/i:/	8			isis+ /i:ʃisu/
		/e/	1	E[iʃ]?		Civilian /ʃiberian/
		cons	5	E[jʃ]	only in <ti> or <si> as /ʃ/	MISIA /mi:ʃa/
<i_e>	7	/ai/	6	E[ai]		PLIME /puraimu/
		/i:/	1			Naomile /naomi:ru/
<iu>	5	/iu/	2	R		asobius /asobiusu/
		/ia/	2	R, E[i:ʌ]		Aldius /arudiasu/
		/ju:/	1			BAMIUDA /bamju:da/
<ii>	3	/i/	3			Suchii /saʃi/
<yi>	2	/i:/	1			YA-KYIM /jaki:mu/
		/i/	1			every♥ing! /eburiNgu/
<iy>	2	/i:/	2			NIY /ni:/
<iyiy>	1	/i:/	1			iyiy /i:mu/
<iw>	1	/ju:/	1			GUNIW /gunju:/
<ioo>	1	/ju:/	1			Ki/oon /kju:N/
<ir>	1	/ea/	1			FIR~REFORLE /ɸeari:ɸo:re/
<o>	159	/o/	142	R		CoCoBAT /kokobatto/
		/o:/	13	R, E[o ^o]		Ovall /o:baru/
		/a/	4	E[ɑ:]?		GOTCHAROCKA /gatʃarokka/
<oo>	16	/u:/	13	E[u:]		SHANADOO /ʃanadu:/
		/u/	2	E[u:]?		Boogaloob /bugaru:pu/
		/a/	1	E[o]?		BLOODDEST /buraddesuto/
<ow>	6	/o:/	4	R?		KISHOW /kiʃo:/
		/au/	2	E[ao]?		WOWOW /wauwau/
<or>	6	/o:/	3			KORN /ko:n/
		/a:/	2			UVERworld /u:ba:wa:rudo/
		/oru/	1			KOR /koru/
<o_e>	4	/o:/	3	E[o ^o]?		KONE /ko:n/

		/a/	1		Welc <u>ome</u> z /weruk <u>a</u> mud <u>z</u> /
<ou>	3	/o:/	1	R	SOUL'd /so:ru <u>d</u> o/
		/u/	1		You <u>ca</u> /ju <u>k</u> a/
		/o/	1		Sou <u>l</u> ja /so:ru <u>d</u> z <u>a</u> /
<oi>	3	/oi/	3	R, E[ɔɪ]	BOLZO <u>I</u> /bo:ru <u>d</u> zo <u>i</u> /
<oy>	3	/oi/	2	R?, E[ɔɪ]	OTOTO <u>Y</u> /ototo <u>i</u> /
		/o:i/	1		BO <u>Y</u> Z /bo:u <u>i</u> d <u>z</u> /
<oe>	2	/oe/	1	R	clo <u>e</u> /ku <u>r</u> oe/
		/u:/	1		m.o.e.v /mu:bu/
<oa>	1	/oa/	1	R	fra-fo <u>a</u> /f <u>u</u> raho <u>a</u> /
<our>	1	/a:/	1		Jaa Bo <u>u</u> r Bo <u>n</u> z /d <u>z</u> a:ba:bo <u>n</u> d <u>z</u> /
<owoo>	1	/o:/	1		Ryowoo /r <u>j</u> o:/
<u>	62	/u/	24	R, E[ɔʔ]	KEL <u>U</u> N /keru <u>N</u> /
		/a/	20	E[ʌ]	<u>U</u> N'z /a <u>N</u> d <u>z</u> /
		/u:/	5	R, E[u:]	<u>U</u> A /u:a/
		/ju:/	4	E[ju:]	mu <u>z</u> ie /mju:d <u>z</u> i:/
		/ju/	4	E[ju:]?	<u>U</u> C <u>A</u> R <u>Y</u> /ju <u>k</u> a <u>r</u> i/
		/o/	1		CO <u>L</u> U <u>M</u> B <u>I</u> A /ko:ro <u>m</u> u <u>b</u> ia/
		/i/	1		Bu <u>z</u> y /b <u>i</u> d <u>z</u> i:/
		/au/	1		KR <u>U</u> D /ku:ra <u>u</u> d <u>o</u> /
		null	1		Aquarifa /akari <u>ɸ</u> a/
				only in <qua>	
<u_e>	5	/ju:/	3	E[ju:]	cun <u>e</u> /kju:n/
		/u:/	1	E[u:]	R <u>U</u> LE <u>Z</u> /ru:ru <u>d</u> z <u>u</u> /
		/ju/	1	E[ju:]?	nano <u>C</u> U <u>N</u> E /nanokju <u>N</u> /
<ue>	3	/u:/	1	E[u:]	Bl <u>u</u> em /bu:ru:mu/
		/u/	1	E[u:]?	PhilHarmoUni <u>Q</u> ue /f <u>u</u> ruha:moju <u>n</u> i:ku/
		/ue/	1	R	S <u>U</u> EM <u>I</u> T <u>H</u> /suem <u>i</u> su/
<uu>	1	/u:/	1	R	yuuk <u>i</u> ss /ju:k <u>i</u> su/
<y>	44	/i:/	22	E[i:]	Hass <u>y</u> /haf <u>i</u> :/
		/i/	15		HAS <u>Y</u> MO /haf <u>i</u> mo/
		/ai/	6	E[ai]	F <u>Y</u> T /f <u>a</u> it <u>o</u> /
		/a/	1		bin <u>y</u> l /bain <u>a</u> ru/
<y_e>	3	/ai/	3	E[ai]	Hilcrh <u>y</u> me /hiruku <u>r</u> aimu/
<yy>	1	/i:/	1		Z <u>Y</u> Y <u>G</u> /d <u>z</u> i:gu/
<w>	4	/u/	4		Tw <u>i</u> G <u>y</u> /tsu <u>i</u> gi:/

Note. ^a ‘Rōmaji or English-like’ means whether the LSC pattern is regular rōmaji-like or English-like in the North American 13 vowel system. For example, if <i> is read as Japa/i/, this is based on regular rōmaji, whereas if <i> is read as Japa/ai/, this is simulating the Eng<i>-[ai] correspondence, according to the Japa-Eng vowel correspondence discussed in §2.2.3.2. In this column, ‘R’ means ‘regular rōmaji’ and ‘Eng[ai]’, for example, means it simulates Eng[ai]. Bolded parts indicate English-like correspondences.

^b The whole <ca> is read as Japa/kja/ so it is not clear whether /j/ belongs to <c> or <a>.

As can be observed, many of the vowel spellings correspond to multiple sounds. However, their corresponding patterns are not completely random but can be divided into four groups, 1) letters mostly read in English-like ways, 2) letters read in both English-like and regular rōmaji ways, 3) letters mostly read in the regular rōmaji ways, and 4) letters spelled and read in creative ways (Nogita, 2016c).

As examples of the first group, the monograph <y> and digraphs <ay>, <ee>, <ie>, <ea>, and <oo> are more frequently read in English-like ways than in regular rōmaji ways. Likewise, <eu>, <ew>, <ye>, and <ue> tend to be read in English-like ways although their occurrences are relatively infrequent. The silent E digraphs, <a_e>, <e_e>, <i_e>, <o_e>, <u_e>, and <y_e> are also read in English-like ways. The R-vowels <ar>, <or>, and <er> are not read in regular rōmaji ways either, although <er> and <ar> are both read as /a:/ in many cases, which results in a partial loss of the <ar>-<er> distinction (in part because Japanese lacks the phonological counterpart of the English syllabic /ɹ/ as in *herd*). As examples of the second group, the monograph <u> and the digraphs <aw>, <au>, <ou>, and <ey> are read in both English-like and regular rōmaji ways, so I cannot decide their default LSC patterns at least in my data set in Nogita (2016c). As examples of the third group, the monographs <a>, <e>, <i>, <o> and digraphs <ow>, <ai>, and <ei> are more frequently read in the regular rōmaji way than in English-like ways (if I assume that <ow> is treated like <ou>). Examples of the fourth group are <iie>, <iyiy>, and <yy>, all of which are read as Japa/i:/. Incidentally, an interesting characteristic of the fourth group is that some letters are partially used logographically, such as <eeee> and <eeeeeeeeee> in which the number of <e> indicates the number of the members in the music groups.

What the tendencies of these four groups suggest is that for some spellings, such as spellings in the first and the fourth groups, native Japanese speakers tolerate non-regular-rōmaji readings, whereas for other spellings, such as spellings in the third group as well as in

the second group to a lesser extent, native Japanese speakers are reluctant to accept non-regular-rōmaji readings. Such asymmetry may be caused by many factors, such as native Japanese speakers psychology and the nature of the Japanese phonology and orthography. At this moment, what exactly these factors are is unknown, but in terms of L2 acquisition, it is possible that these tendencies of loanword rōmaji are related to acquisition patterns of English GPC by native Japanese speakers; some English graphemes may be difficult to be associated with particular phonemes by Japanese EAL learners, and such English GPC patterns may not be easily incorporated into loanword rōmaji either.

It should also be noted that although loanword rōmaji LSC is very inconsistent in general, not all the letters or sounds are equally inconsistent. For example, <o> has the fewest corresponding sounds among all the vowel monographs; it mostly corresponds to Japa/o/ and /o:/, and the only non-regular-rōmaji reading is /a/. This suggests that there may be certain native Japanese speakers' psychological factor that tightly connects the letter <o> with the sounds /o/ and /o:/ but avoids non-regular-rōmaji correspondences. In terms of L2 acquisition, this could potentially impede Japanese EAL learners' acquisition of the English <o>-[o^u] and <o>-[ɑ:] correspondences. Likewise, many of the creative spellings, such as <iie>, <iyiy>, <yy>, and <eeee>, correspond to Japa/i:/. This suggests that there may be a native Japanese speakers' psychological factor that allows Japa/i:/ to be linked to multiple letters. This could affect Japanese EAL learners' acquisition of corresponding graphemes of Eng[i:].

Overall, loanword rōmaji LSC is very inconsistent, but there are tendencies, which can reflect native Japanese speakers' different tolerance levels of non-regular-rōmaji LSC depending on letters and sounds.

2.5.8 Conclusion about loanword rōmaji

The status of loanword rōmaji in Japanese is much like the status of kanji. It is generally used logographically. The difference is that kanji (originally from Chinese) has lost

its foreign identity in Japanese whereas loanword rōmaji is recognized as coming from a foreign language at this stage. If loanword rōmaji keeps being used in Japanese, it might be fully nativized and lose its foreign identity after several hundreds of years, just like kanji. And, loanword rōmaji LSC patterns may be related to acquisition patterns of English GPC by native Japanese speakers.

Chapter 3 Experiments of grapheme-to-phoneme correspondence

In Chapter 3, I will attempt to answer the first research question: how do Japanese EAL learners read out English vowel graphemes in unfamiliar words? In other words, I will examine their grapheme-to-phoneme conversion patterns. In order to answer this question, I conducted a nonsense English word-reading task, in which participants are asked to read aloud English nonsense words.

3.1 Participants

3.1.1 General information about participants

In total, 83 participants were involved in the experiment: 45 Japanese EAL learners, 24 Chinese EAL learners, and 14 native Canadian English speakers. The main focus of this experiment was on Japanese EAL learners' letter-to-sound conversion patterns in comparison with native North American English speakers', so the Canadian participants were recruited as a control. Chinese EAL learners were also recruited as a reference in order to examine whether the English letter-sound correspondence problem is only specific to Japanese EAL learners or it can be generalized to EAL learners of other L1 backgrounds. Table 21 shows the summary of the participants, including the number of participants, their ages, and for EAL participants, their length of residence in Canada (LOR henceforth) and age of acquisition or the age at which the participants began to learn English regardless of whether they did so in their countries or in English-speaking countries (AOA henceforth).

Table 21. Summary of the participants

Group	Number	Age range (median)	LOR range (median)	AOA range (median)
Canadian	14 (M8, F6)	20 – 56 (27)	N/A	N/A
Japanese LOR < 1y	18 (M3, F15)	19 – 32 (24.5)	0 – 11m (4.5m)	4 – 12 (12)
Japanese LOR > 1y	27 (M10, F17)	19 – 71 (30)	1 – 20y (4.5y)	4 – 12 (12)
Japanese total	45 (M13, F32)	19 – 71 (27)	0 – 20y (1.5y)	4 – 12 (12)
Chinese EFL	15 (M2, F13)	19 – 47 (25)	0	5 – 13 (9)
Chinese ESL	9 (M2, F7)	20 – 37 (24)	2m – 6.5y (1.5y)	6 – 13 (12)
Chinese total	24 (M4, F20)	19 – 47 (24.5)	N/A	5 – 13 (10)

Note. M = male, F = female, LOR = length of residence in Canada, AOA = age of acquisition

In more details, 14 native Canadian English speakers (8 males and 6 females) were recruited in Victoria, British Columbia in Canada. Monolingual English speakers would be ideal for this experiment. However, it is difficult to find completely monolingual English speakers in Victoria, so I managed to recruit 10 reportedly relatively monolingual Canadian English speakers, one Canadian English-Mexican Spanish bilingual male, one male who could speak Swiss German, one female who could speak Japanese, and one female whose grandmother was Chinese. Despite the language backgrounds of these four speakers, as I will mention later, their results did not show differences from the relatively monolingual participants, so I included the data from these four. About their hometowns, 11 were from British Columbia, one was from Saskatchewan, one was from Alberta, and one was half-Canadian-half-Mexican who spent almost 17 years in Mexico and five years in British Columbia (as I will discuss below, this half-Mexican bilingual participant's responses in the experiments were not any different from the other participants, so I included him).

Regarding the Japanese participants, I recruited one female EFL learner from Sophia University (上智大学) in Tokyo, and all the other 44 participants were Japanese ESL learners living in Victoria, British Columbia in Canada, some of whom were studying in the ESL program of the University of Victoria, some were undergraduate students at the University of Victoria or Camosun College in Victoria, some were graduate students, and some were working people¹⁷. There were 13 males and 32 females. The Japanese participants' ages ranged from 19 to 71 years old (average = 30.2 years old, median = 27). Eighteen (3 males and 16 females) of their LORs were less than one year (average = 5.2 months, median

¹⁷ I originally planned to collect the same number of both EFL learners (who have never lived in an English-speaking country) from a university famous for its high-level English education and ESL learners (who live in an English-speaking country) from the University of Victoria. However, due to various constraints, I managed to collect only one female EFL learner from Sophia University in Tokyo whose English education is arguably one of the best among all the universities in Japan, and all the other 44 Japanese participants were recruited in Canada.

= 4.5 months) and that of the rest of 27 were more than one year (average = 5.2 years, median = 4.5 years). Only four of their LORs were 10 years or more. As to their age of acquisition (AOA) or their ages at which they began learning English (in Japan), 34 of them began at the first year of middle school (or grade 7), and 11 of them began earlier, ranging from four to 10 years old. The average AOA in total was 10.7 years old.

As for the Japanese participants' English proficiency, since they had not taken the same English tests, there were no standardized measures for their English proficiency. Instead, I referred to their own evaluations of their estimate overall English proficiency in the 5-point scale (5 = the same level as L1). They were allowed to include decimals. Their self-evaluation ranged from 1 to 4.2 (average = 2.58, median = 2.5). According to Dunning, Johnson, Ehrlinger, and Kruger (2003), in any fields, poor performers tend to overestimate their skills while top performers can more accurately estimate or slightly underestimate their skills. This means that self-evaluation does not necessarily represents their actual overall English proficiency. In fact, some participants with relatively long LOR who could communicate in English relatively fluently evaluated their English lower than some of those with less than one year of LOR who were studying English in an ESL program. In consideration of this, their self-evaluation could be better interpreted as their confidence level. As for their language backgrounds, three of them were learning English as the third language, or they spoke another language better than English; one spoke Spanish (self-evaluation at 3) and two spoke Mandarin (self-evaluation at 5 and 3).

In regard to the Chinese participants, I recruited 15 EFL learners who had never lived in an English-speaking country, and nine ESL learners who were living in Canada. EFL learners were recruited at East China Normal University (华东师范大学) in Shanghai, China. They were undergraduate or graduate students. ESL learners were also taking undergraduate or graduate courses at the University of Victoria or Camosun College in Victoria. As for

AOA, seven of the nine ESL and three of the 15 EFL participants began English (in China) in middle school, while the rest began earlier. Overall, their AOA ranged from five to 13 years old (average = 10 years old, median = 10).

As to their English proficiency, nine of the EFL participants had passed the College English Test level 6 (CTE 6), and four of them had passed the Test for English Majors level (TEM 8) in China. The other two EFL participants had taken IELTS and their overall marks were both 6.5. All the ESL participants had been accepted to undergraduate or graduate courses in Canada, and two of them had an overall mark of 7.5 in IELTS a few years ago. Overall, the Chinese participants' backgrounds were more controlled than the Japanese participants'. About their language backgrounds, while they did not speak another language more fluently than English, many of them spoke other Chinese dialects in addition to Mandarin. Specifically, eight of them were from Shanghai, three from Zhejiang (Suzhou, Hangzhou, and Shengsi), two from Sichuan, and two from Changsha. For these participants, English could be regarded as the third language. On the other hand, the rest of the nine were from places where dialects that are intelligible (at least to some extent) with Mandarin are spoken, such as Beijing, Shandong, and Hubei (Wuhan and Jingzhou).

These pieces of information regarding participants were collected at the beginning of the experiment by asking the participants to fill out a questionnaire sheet.

3.1.2 Questionnaire regarding the Canadian participants' low back vowels

Before the experiment, the Canadian participants were asked the following questions regarding their vowel contrasts in the low back region and their awareness of foreign (a).

- Do *hot* and *bought* rhyme in your dialect?
- Do *father* and *bother* rhyme in your dialect?
- Do *law* and *spa* rhyme in your dialect?

While nine of them answered that all of these pairs rhymed, five of them answered as shown in Table 22.

Table 22. 5 Canadian participants' answers regarding low back vowels

Gender	Age	LOR in BC (years)	Hometown	<i>hot</i> <i>bought</i>	<i>father</i> <i>bother</i>	<i>law</i> <i>spa</i>
M	50	50	BC	Yes	No	No
M	25	7	Calgary	Yes	Yes	No?
F	20	20	BC	Yes	Yes	No?
F	30	30	BC	Yes	No?	Yes
M	22	22	BC	No	No	Yes

Note. M = male, F = female, LOR in BC = length of residence in British Columbia; “Yes” indicates the paired words rhyme. “No” indicates the paired words certainly do not rhyme. “No?” indicates that the speakers mentioned that it was “slightly” different.

Two Canadian participants said that ‘aw’ in *law* and ‘a’ in *spa* were “slightly” different, and one gave the same comment about ‘a’ in *father* and ‘o’ on *bother*. This implies that these vowels may not be fully phonologically contrastive for them, so ‘a’ in *spa* or *father* was likely the extra phoneme [a:]. On the other hand, the other two participants more confidently answered that the paired words did not rhyme. Regarding the 50-year-old male, although he was born and grew up in British Columbia in Canada, his mother is British, so for him, the *father-bother* and *law-spa* pairs may possibly be phonologically contrastive as seen in British English, rather than due to the extra phonemic foreign (a). The 22-year-old male who grew up in Vancouver confidently answered that *hot* and *bought* did not rhyme. If *hot* and *bought* were distinguished by him, he may have the [ɑ:]-[ɔ:] contrast, which correspond to the graphemes <o> and <aw/au> respectively as the default rule. However, in the nonsense word-reading task, he did not distinguish <o> and <aw> in the nonsense word stimuli *tob* and in *staw*. The reason is unknown at this moment. In any case, at least a few of the participants were aware of foreign (a).

3.2 Stimuli and procedure for the reading task

For the stimuli, 50 one-syllable nonsense words (33 stimuli and 17 distractors) that are with possible English grapheme combinations as well as phonotactically possible English phoneme combinations were created. Table 23 shows both stimuli and distractors for the reading task.

Table 23. Written stimuli and distractors for the nonsense word-reading task

Target spelling	Default corresponding phoneme	Written stimulus	Expected sound
<ay#>	[e ¹]	<i>skay</i>	[ske ¹]
<ai>		<i>paip</i>	[pe ¹ p]
<a e>		<i>tate</i>	[te ¹ t]
<ee>	[i:]	<i>peest</i>	[pi:st]
<ea>		<i>skeap</i>	[ski:p]
<e e>		<i>pede</i>	[pi:d]
<y#>	[aɪ]	<i>smy</i>	[smaɪ]
<ie#>		<i>kie</i>	[kaɪ]
<i e>		<i>mibe</i>	[maɪb]
<o#>	[o ⁰]	<i>zo</i>	[zo ⁰]
<oe#>		<i>stoe</i>	[sto ⁰]
<oh#>		<i>stoh</i>	[sto ⁰]
<oa>		<i>poad</i>	[po ⁰ d]
<o e>		<i>zobe</i>	[zo ⁰ b]
<oo#>	[u:]	<i>spoo</i>	[spu:]
<coronal C + u e>		<i>nupe</i>	[nu:p]
<non coronal C + ew>	[ju:]	<i>bew</i>	[bju:]
<non-coronal C + u e>		<i>pude</i>	[pju:d]
<a(C#)>	[æ:]	<i>snad</i>	[snæ:d]
<e(C#)>	[ɛ]	<i>teb</i>	[teb]
<i(C#)>	[ɪ]	<i>tib</i>	[tɪb]
<u(C#)>	[ʌ]	<i>spug</i>	[spʌg]
<uh>		<i>tuh</i>	[tʌ]
<o(C#)>	[ɑ:]	<i>tob</i>	[tɑ:b]
<aw#>		<i>staw</i>	[stɑ:]
<au>		<i>faud</i>	[fa:d]
<a#>	[ɑ:] (or [a:])	<i>sta</i>	[stɑ:] or [sta:]
<ah>		<i>kah</i>	[kɑ:] or [ka:]
<oo(k)>	[ʊ]	<i>pook</i>	[pʊk]
<oy#>	[ɔɪ]	<i>noy</i>	[nɔɪ]
<oi>		<i>poid</i>	[pɔɪd]

<ow#>	[aʊ] or [o ^ʊ]	<i>fow</i>	[faʊ] or [fo ^ʊ]
<ou>	[aʊ]	<i>koun</i>	[kaʊn]
distractors	<i>thas, ree, rass, cuth, cib, vock, lipe, zhoo, hooz, woom, cass, yee, meethe, psyme, plin, sith, shiff</i>		

Note. <C> = consonant letter, <#> = word-final

The target vowel graphemes were those corresponding to all the Canadian English 13 vowel contrasts [i:, ɪ, e^ɪ, ε, æ:, ɑ:, o^ʊ, ʊ, u:, ʌ, aɪ, aʊ, ɔɪ], as well as what Boberg (2009) calls extraphonemic “foreign (a)” [a:], which is phonetically somewhere between [æ:] and [ɑ:] as in *lasagna* and *taco* by some speakers (see §2.2.1.3). The stimuli did not include the graphemes <l, r, v, th> that correspond to [l, ɹ, v, θ, ð], which do not have counterpart phonemes in Japanese. Likewise, graphemes corresponding to North American rhotic vowels, as in *fear, hair, car, more, poor, her*, and so forth were not included.

Most of the stimuli were created on the basis of English basic grapheme-phoneme correspondence (GPC) patterns, including adjacent consonant letter effects, in Van Berkel (2005) as well as Kessler and Treiman (2001) mentioned in §2.3.1.1. I also added <oe>, <oh>, <ah>, and <uh>. The graphemes <oe> and <ah> were selected from the 46 basic phonics rules on in New-phonics-tools.com (n.d.). The reason why I added <oe> and <ah> is because regular rōmaji ways of <oe> (Japa/oe/) and the difference between <ah> (Japa/a:/) and <a> (Japa/a/) may be transferred to English. The occurrences of <uh> and <oh> in real words are limited to peripheral vocabulary (e.g., *duh* and *oh*), but these are commonly used in aforementioned pronunciation respelling systems as seen in some dictionaries and ESL materials (see §2.3.1.3 for more details). Good examples of these are (anglicized) pronunciation guides for foreign names, such as <see-bool-KOH-vuh> for the Slovak tennis player’s name *Cibulková* (from Complete WTA Official Guide, 2015, p.43). Being unable to decode such phonetic spellings would be a huge disadvantage for EAL learners, so it is worth examining whether Japanese and Chinese EAL learners can read these spellings.

There were also 17 distractors, most of which include <l, r, v, th> that correspond to [l, ɹ, v, θ, ð] that are missing in the (standard) Japanese phoneme inventory in order to have the Japanese participants pay attention to the consonants in these.

All the 50 stimuli, including 17 distractors, were printed on a sheet of paper in randomized order, as shown in Appendix 1. Participants were first instructed to practice and familiarize themselves with the stimuli as well as the experimental situation before recording. During recording, they were allowed to correct themselves if they were aware of their mistake or if they changed their mind. In such cases, I analyzed their second choice as their final decision.

For participants who were in Victoria, the experiment was conducted mainly in the Phonetics Lab at the University of Victoria, or in participants' quiet rooms in case the Lab was not convenient for them. For those who were in Shanghai, it was mainly conducted in a quiet study room in the student dormitory at East China Normal University, or in participants' quiet rooms. Recording was done either with an external microphone connected to a laptop MacBook Air or with the built-in microphone in a Xiaomi Mobile Phone. The participants' native languages were used through the whole process of the data elicitation, including instructions (see Appendix 1), in order not to give EAL participants a chance to learn or recall GPC rules from any English materials; i.e., English for the Canadian participants, Japanese for the Japanese participants, and Mandarin for the Chinese participants.

3.3 The Canadian participants

3.3.1 Coding for the Canadian participants

Coding was done based on phonemic contrasts. This was somewhat complicated by extraphonemic foreign (a). Judgement of foreign (a) production was done based on perception by a phonetically trained male native Canadian English-speaking graduate student

in the Linguistics Department, as well as based on acoustics. In case his perception-based judgement and acoustic information were not 100% confident, I directly asked the participants whether they intended to pronounce <ah> in *stah* and <aw> in *staw*, for example, in the same way or in different ways.

3.3.2 Results of the Canadian participants

Table 24 shows the overall results of all the stimuli.

Table 24. Results of the Canadian participants' productions in the reading task

	Grapheme and stimuli								
Graph. Stimuli	<ay#> <i>skay</i>	<a_e> <i>tate</i>	<ai> <i>paip</i>	<ee> <i>peest</i>	<ea> <i>skeap</i>	<e_e> <i>pede</i>	<y#> <i>smy</i>	<i_e> <i>mibe</i>	<ie#> <i>kie</i>
Response #	[e ¹] 14	[e ¹] 14	[e ¹] 12	[i:] 14	[i:] 14	[i:] 13	[aɪ] 12	[aɪ] 11	[aɪ] 7
Response #			[aɪ] 2			*[ɛ] 1	[i:] 2	[i:] 3	[i:] 7
Total	14	14	14	14	14	14	14	14	14

Grapheme and stimuli								
<oa> <i>poad</i>	<o_e> <i>zobe</i>	<o#> <i>zo</i>	<oe> <i>stoe</i>	<oh> <i>stoh</i>	<oo> <i>spoo</i>	<cor. C + u_e> <i>nupe</i>	<non-cor. C + u_e> <i>pude</i>	<non-cor. C + ew> <i>bew</i>
[o ^o] 14	[o ^o] 12	[o ^o] 14	[o ^o] 14	[o ^o] 14	[u:] 14	[u:] 14	[u:] 9	[ju:] 13
	[o ^o _i:] ^a 2						[ju:] 5	[u:] 1
14	14	14	14	14	14	14	14	14

Note. ^a [o^o_i:] for *zobe* indicates that <o> was read as [o^o] and the word final <e> was also read as [i:].

Grapheme and stimuli									
<aC#> <i>snad</i>	<eC#> <i>teb</i>	<iC#> <i>tib</i>	<uC#> <i>spug</i>	<uh> <i>tuh</i>	<oC#> <i>tob</i>	<aw#> <i>staw</i>	<au> <i>faud</i>	<a#> <i>sta</i>	<ah> <i>kah</i>
[æ:] 14	[ɛ] 14	[ɪ] 14	[ʌ] 14	[ʌ] 12	[ɑ:] 14	[ɑ:] 14	[ɑ:] 9	[a:] ^b 9	[a:] ^b 9
				[u:] 2			[o ^o] 5	[ɑ:] 4	[ɑ:] 3
								*[æ:] 1	*[æ:] 1
									*[ʌ] 1
14	14	14	14	14	14	14	14	14	14

Note. ^b [a:] indicates the extra phoneme foreign (a), which is phonetically between [æ:] and [ɑ:].

Grapheme and stimuli				
<ooC#>	<oy#>	<oi>	<ow#>	<ou>

<i>pook</i>	<i>noy</i>	<i>poïd</i>	<i>fow</i>	<i>koun</i>
[u:] 13	[ɔɪ] 14	[ɔɪ] 14	[o ^ʊ] 10	[aʊ] 7
[ʊ] 1			[aʊ] 4	[u:] 4
				[o ^ʊ] 3
14	14	14	14	14

Note. The numbers indicate the number of productions out of 14. Shaded boxes indicate that the consistency of the most frequent response is below 80%. Sounds with * were judged as unacceptable by two native English-speaking graduate students in the linguistic department.

3.3.3 Discussion

3.3.3.1 General discussion

Twenty-five out of the 33 target vowel graphemes met over 80% (in this case 12 or more out of 14) consistency. This suggests that while English spelling is generally called a deep orthography, at least these graphemes are read highly consistently by native English speakers. Among these 25 consistent graphemes, 14 of them were read only in one way. The rest of the 11 graphemes were also predominantly read in one way. Moreover, the second choices for these 11 graphemes were mostly acceptable matches in English as well; that is, they are not random. For example, the two variations of *bew* (i.e., [ju:] by 13 participants and [u:] by one) are only a matter of whether [j] is pronounced or not. About the case that *zobe* was predominantly read as [zo^ʊb] based on the default reading but also read as [zo^ʊbi:] by two participants, the realization of word-final <e> as [i:] may be due to the foreign appearance of *zobe*, as will be discussed below, or an influence from words like *Kobe* or *Adobe*. Likewise, about the cases that *paip* and *smy* were read as [paɪp] and [smi:] by two participants aside from the default readings [pe^ɪp] and [smaɪ], the digraph <ai> in *paip* as [aɪ] may be an influence of foreign words like *chai tea*, *Thailand*, *Taiwan*, or less foreign words like *aisle*, and so on, and <y> in *smy* as [i:] may be an influence of unstressed <y>s read as [i:] as in *chewy*. As for *pook*, according to Kessler and Treiman's (2001) statistical analysis, the default sound of <oo> before <k> is [ʊ], as in *book*, but on the contrary to their data, only

one out of 14 participants chose [ʊ] in this present experiment, suggesting that native English speakers' intuition seems inclined to [u:]. As well, based on the aforementioned pronunciation respelling, <uh> in the stimulus *tuh* was intended for [ʌ] (including [ə]), but two participants read *tuh* as [tu:]. This may be an influence of words in which <uh> is read as [u:] such as the surname *Kuhl*. Finally, only the case that *pede* was read as [pɛd] by one participant was judged as a (perhaps careless) mistake by two linguistically trained native English speakers. Aside from *pede*, all the other 10 graphemes seem to have reasons for being read in two ways.

With regard to the rest of the eight stimuli with below 80% consistency, the most consistent one was *mibe*, which was pronounced by [maɪb] by 11 out of 14 in accordance with the aforementioned silent-E as a marker of “alphabet sounds” (also known as “long sounds”). However, despite the silent-E rule, *mibe* was also read as [mi:b] by three participants. This may be an influence of words with <i_e> pronounced as [i:], such as *zine*, *machine*, *expertise*, and so on. The case of *pude* is an issue of whether [j] is pronounced or not, as seen in *bew*.

As for *fow*, according to Kessler and Treiman (2001), word-final <ow> is [o^ʊ], and in fact, 10 out of 14 pronounced *fow* as [fo^ʊ]. Still, four of them pronounced it as [faʊ], which is the default sound of (non-final) <ow>. One of the participants commented about <ow> after the experiment that he had a hard time deciding between [fo^ʊ] and [faʊ], and made the final decision of [faʊ]. He also mentioned that if *fow* is a verb, he would pronounce [fo^ʊ] referring to *grow*, *glow*, or *stow*, whereas if *fow* is not a verb, he would pronounce [faʊ] referring to *how*, *cow*, or *now*. This implies that a part of speech may affect the results. As for <ou> in *koun*, which is visually similar to <ow>, the default sound of <ou> is [aʊ] as in *cloud* and *noun* (Kessler & Treiman, 2001), and in fact, the Canadian participants most frequently chose [aʊ] for *koun*. In addition, according to Kessler and Treiman (2001), <ou> sounds [u:] before

<p>, as in *group*. Interestingly, although <ou> in the stimulus *koun* is not before <p>, four out of 14 read it as [u:]. This may be an influence of words with <ou> pronounced as [u:] not before <p>, such as *route*, or more than one syllable words like *acoustic*, *Vancouver*, and so on. Furthermore, <ou> was read as [o^u] by three participants. One of them commented after the experiment that she could only recall real words with <ou> sounding [o^u] before <r> such as *four*, *pour*, and *your*¹⁸, before <l> such as *soul* and *shoulder*, or before silent <gh> such as *though* and *dough*, but could not recall any words with <ou> before <n> sounding [o^u]. Nevertheless, her spontaneous first choice was [o^u] for *koun*. These patterns imply that native speakers' intuition and statistically analyzed spelling conditions do not necessarily match.

As for *faud*, according to Kessler and Treiman (2001), the default sound of <au> is [a:], and in fact, [a:] was the most frequently chosen sound by the Canadian participants. However, *faud* was also pronounced as [fo^ud] by five of them although the <au>-[a:] correspondence occurs in many basic words, such as *August*, *cause*, *caution*, *pause*, *sauce*, and so forth, as well as *taught*, *caught*, *daughter*, *naughty*, and so forth followed by <gh>. There are also words starting with <fau> sounding [fa:], such as *fault*, *fauces*, and so forth, as well as <au> followed by <d>, such as *laud*, *audio*, and so forth, meaning that the <fau>-[fa:d] correspondence is expected to be reasonable. Some of the participants who chose [fo^ud] commented that they associated *faud* with *faux* [fo^u]. In this case, the visual image of the whole word may have affected the results. Other than the explanation of *faux* triggering [o^u], according to Kessler and Treiman (2001, 602), <au> before <ve> and <che> are read as [o^u] as in *mauve*, so these words could have been a trigger. Another possible explanation is that <au> before <r> is commonly read as [o^u], as in *aura*, *aural*, *thesaurus*, *dinosaur*, *Laura*,

¹⁸ In common IPA transcription, the rhyme in *four*, *pour*, and *your* is generally transcribed as /ɔɪ/, but the vowel in /ɔɪ/ is regarded as the same phoneme as /o/ in *no* by many General American English speakers (Wells, 1982).

*Maureen*¹⁹, and so forth. Just as <our> in word like *pour* triggered [o^u] in *koun*, <aur> in those words may have triggered [o^u] in *faud*. Still, another possible explanation is that since Canada's official languages are English and French, an influence of the French <au>-Fr/e/o/ correspondence may have triggered [o^u] in *faud*, although many of the participants were reportedly relatively monolingual. If this is the case, the same experiment with American English speakers with less exposure to French may demonstrate different results.

As for *kie*, half of them pronounced [kaɪ] and the other half pronounced [ki:]. According to Kessler and Treiman (2001), the default sound of word-final <ie> is [aɪ] as in *tie*, and in other conditions it is [i:], but still half of them chose [i:] for *kie*. Again, there is a gap between statistical analyses and native speakers' intuition. Finally, I will discuss *kah* and *sta*, which involve foreign (a), below.

Overall, Kessler and Treiman's (2001) default grapheme-to-phoneme conversions based on statistical analysis in existing words generally match native Canadian English speakers' intuition, but not in some cases.

3.3.3.2 Corresponding graphemes of [ʊ] and [aʊ]

Among the 13 vowels, [ʊ] occurred only once; only one participant read *pook* as [pʊk]. As mentioned above, according to Kessler and Treiman's (2001) statistical analysis, the default sound of <ook> is [ʊk], but the participants were still strongly inclined to [u:k] in a nonsense word. This suggests that there are no solid corresponding graphemes for [ʊ]. I will come back to this issue in the spelling task section (see §4.2.2.3).

To a much lesser extent, [aʊ] also occurred infrequently: *fow* was read as [faʊ] four times out of 14, and *koun* was read as [kaʊn] seven times. This means that corresponding graphemes to [aʊ] are also not as stable as those for the rest of the 11 vowel phonemes. I will discuss the issue of [aʊ] in the spelling task section again (see §4.2.2.3).

¹⁹ Again, <aur> in *aura* and other words is generally transcribed as /ɔɪ/, but this vowel is regarded as the same phoneme as /o/ in many North American English dialects.

In English, at least two vowel phonemes do not have stable corresponding graphemes. This may be a characteristic of the English writing system, which notably differs from the Japanese writing system.

3.3.3.3 Realization of foreign (a)

As for *sta* and *kah*, the most frequently pronounced sound was the extraphonemic [a:], rather than the regular phoneme [ɑ:], although [ɑ:] was second most frequently chosen. As mentioned in §2.2.1.3, the foreign (a) [a:] is not a regular member in the 13 vowel phoneme system, but according to this present data, for word-final stressed <a> and <ah>, the foreign (a) seems to be recognized as the default sound at least by some speakers. The phonetic difference between *staw* with the regular [ɑ:] and *sta* with foreign (a) is shown in Figure 32.

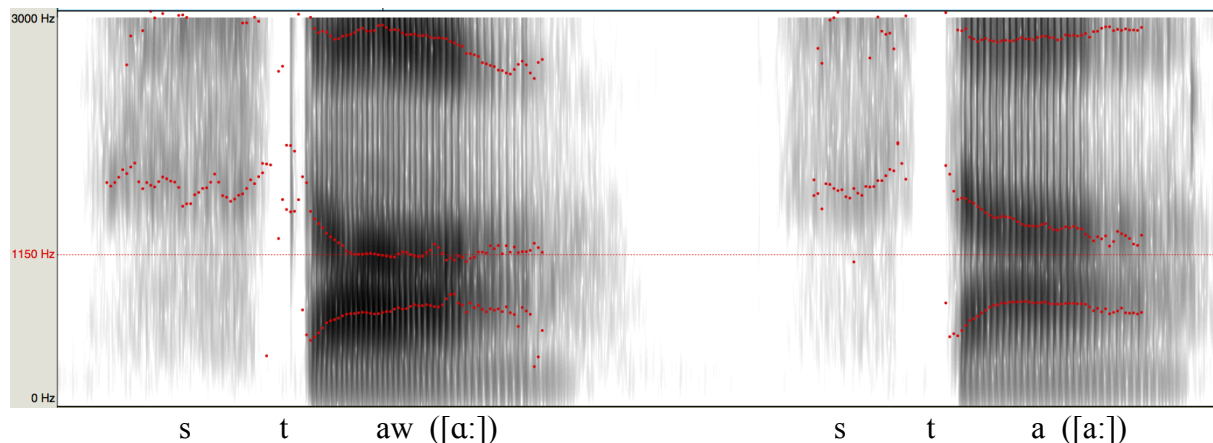


Figure 32. The F2 difference between the stimulus <staw> (left) with regular [ɑ:] and <sta> (right) with foreign (a) by a 24-year-old male from Vancouver

In Figure 32, the second formant (F2), corresponding to the frontness of the tongue, is indicated in the red horizontal broken line; F2 of [ɑ:] in *staw* (left) is around 1150 Hz as indicated, but F2 of [ɑ:] in *sta* is noticeably higher, suggesting that the tongue position of [ɑ:] is noticeably more front.

Regarding participant variations, three of the 14 participants (a 29-year-old female from BC, a 46-year-old female originally from Saskatchewan, and a 56-year-old female from BC) never pronounced foreign (a), while six of them pronounced [ɑ:] for both *sta* and *kah*.

However, the 50-year-old male who pronounced [a:] for both *sta* and *kah* has a British mother, so his [a:] may not be foreign (a) in the same way as the other participants, but his [a:] may be a fully contrastive phoneme.

Sta was pronounced as [stæ:] by one participant and *kah* was also pronounced as [kæ:] by another, but these were judged as unacceptable at least for the “model” pronunciation by two phonetically trained native English-speaking graduate students. Note that phonotactically [æ:] occurs word-finally only in limited peripheral words, like *dada*, suggesting that [stæ:] is phonotactically not preferable as an English word. *Kah* was also read as [kʌ] by one participant. Indeed, unstressed <ah> can be read as [ə] (which is phonemically /ʌ/ under the assumption that [ə] and [ʌ] are allophones of /ʌ/) in real words, as in *Sarah*, but *kah* as [kʌ] was judged as unacceptable at least for the “model” pronunciation.

Overall, the most common sounds for *sta* and *kah* were [sta:] and [ka:] respectively, followed by [sta:] and [ka:].

3.3.3.4 Asymmetry between <i, u> and <y, w>

Although <ay(#)>, <aw(#)>, and <ow(#)> are visually similar to <ai>, <au>, and <ou> respectively, these pairs behave differently in some respects; that is, <y, w> are not simply substitutes for <i, u> for the purpose of avoiding word-final <i, u>.

Firstly, whilst <ay> and <aw> were consistently pronounced as [e^ɪ] and [ɑ:] respectively by all the participants, <ai> and <au> showed other variations, possibly with foreign word influences. Secondly, the relationship of <ow> and <ou> is apparently different from that of <ay/aw> and <ai/au>. The digraph <ow> was pronounced in two ways, [o^ʊ] and [aʊ], unlike consistent <ay/aw>. However, <ow> was more consistent than <ou>; <ou> had more variations (i.e., [aʊ], [u:] and [o^ʊ]). In fact, the digraph <ou> is notorious for its GPC variations, as in *country* sounding [ʌ], *bought* sounding [ɑ:], *tour* sounding [ʊ], and so forth, in addition to [aʊ], [u:] and [o^ʊ], although <ough> and <our> may need to be treated together

with the following consonant letter(s) rather than <ou> alone. All this suggests that overall, <y, w>-ending digraphs seem more consistent than <i, u> ending counterparts.

As for <oy> and <oi>, both were consistently pronounced as [ɔɪ] by all the participants. Although, there might potentially be inconsistency with <oi> as seen in *croissant* or *choir*, at least in this present data in the word-reading task, an asymmetry between <oy> and <oi> was not observed.

3.3.3.5 Consistency and word-likeness

As discussed above, some stimuli showed a few sound variations while others showed only one variation. There is a possibility that one of the factors of the number of variations is to what extent the stimuli are English-like. In order to examine this, five native English-speaking undergraduate and graduate students in the Linguistics Department (1 male and 4 females, 3 Canadians and 2 Americans whose English vowel inventory is also the 13 vowel system, with ages ranging from 21 to 28 (average = 25.2)) were asked to rate word-likeness of each stimulus with the 7-point-scale (7 indicates that the stimulus looks like a real English word, 4 indicates neutral, and 1 indicates very foreign). Table 25 shows both average word-likeness and the number of production variations by the Canadian participants in the reading task.

Table 25. Word-likeness and the number of production variations by the Canadian participants in the reading task

stimulus	varia- tions	like- ness	stimulus	varia- tions	like- ness	stimulus	varia- tions	like- ness
<i>tate</i>	1	6.4	<i>stoh</i>	1	3.6	<i>faud</i>	2	3.6
<i>staw</i>	1	6	<i>skeap</i>	1	3.4	<i>paip</i>	2	3.4
<i>poad</i>	1	5.8	<i>teb</i>	1	3.4	<i>fow</i>	2	3.4
<i>spug</i>	1	5.4	<i>poid</i>	1	3.2	<i>kie</i>	2	2.6
<i>nupe</i>	1	4.8	<i>noy</i>	1	2.4	<i>mibe</i>	2	2.6
<i>tib</i>	1	4.6	<i>zo</i>	1	2.2	<i>zobe</i>	2	2.2
<i>tob</i>	1	4.6	<i>spoo</i>	1	2.2	<i>smy</i>	2	1.8
<i>peest</i>	1	4.4	<i>pook</i>	2	5.6	<i>tuh</i>	2	1.8
<i>skay</i>	1	4.2	<i>pude</i>	2	4.6	<i>koun</i>	3	2.6
<i>stoe</i>	1	4.2	<i>bew</i>	2	4.2	<i>sta</i>	3	2.4
<i>snad</i>	1	3.6	<i>pede</i>	2	3.8	<i>kah</i>	4	2

The Pearson's R Correlation test shows that $r = -0.455$ ($p < 0.01$), meaning that there is a significant moderate negative correlation; the higher the word-likeness is, the fewer production variations the stimulus tends to show. For example, two participants read *zobe* as [zo⁰bi:] rather than the default sound [zo⁰b]. This may be partially because of its low word-likeness (2.2 out of 7). Likewise, *pede* was (mistakenly) pronounced as [pɛd] by one participant possibly because of its relatively low word-likeness (3.8). Stimuli like *paip* (3.4) and *faud* (3.6) read in foreign fashions can also be explained by word-likeness. All this suggests that, if a word looked foreign, the participants may have been tempted to read it in a foreign fashion rather than in the English default way.

In contrast, some stimuli whose word-likeness is lower than 4 (neutral) were still consistently read in one way (i.e., *snad*, *stoh*, *skeap*, *teb*, *poid*, *noy*, *zo*, *spoo*). This suggests that despite their non-English looks, these vowel graphemes are stably connected to one particular vowel phoneme; note that one participant first read *skeap* as [ske¹p] and then changed it to [ski:p].

3.4 The Japanese participants: how they compare with the native speakers

In this section, I will compare the results of the Canadian participants and that of Japanese EAL participants.

3.4.1 Coding for the Japanese participants

A phonetically trained native English speaker from Utah in the Linguistics Department at the University of Victoria and myself transcribed the Japanese participants' productions. As can be expected of a second language performance, some of the productions were more or less "accented" than others within the same phonemic category. However, since

this study focuses on which graphemes correspond to which (interlanguage) phonemes, we did not transcribe phonetic details. For example, [æʊ, aʊ, ɔʊ, aʌ] and so forth were all grouped into the same category, which can be the equivalent of Eng/aw/. Our ultimate goal is to transcribe the participants' underlying or mental representations, rather than their surface or physical representations.

However, it is not straightforward to examine Japanese EAL learners' mental representations. For example, there was an interesting finding during the post experimental casual interview with a 22 year-old female participant (LOR 7 years, AOA 5 years old) who was in 1st place in the reading task in overall scores (and in 2nd place in the spelling task), whose overall English proficiency seemed the highest (self-evaluation 4 out of 5, scoring 7 in IELTS almost five years prior to the experiment) among all the Japanese participants. Reportedly, she recognized <i> in *train* representing the off-glide of the phoneme [e^l] (i.e., [ʰ]), and <a> representing the nucleus of [e^l] (i.e., [e]). This is a good example of native Japanese speakers' strong intuition of mora division, as mentioned in §2.2.2.3. Even the most proficient Japanese participant with early AOA was no exception. Such Japanese EAL learners' intuition is a noticeable difference from that of native English speakers who would not interpret <i> in *train* as a correspondence to [ʰ] in the vowel [e^l], and who may not even recognize [e^l] as a diphthong. Meanwhile, this Japanese participant also said that she recognized <a> in *April* as [e^l], even though there is no apparent corresponding letter to [ʰ]. This implies a possibility that although her surface representations of *train* and *April* were apparently the same [e^l], she may have interpreted it differently in her mental representations (e.g., /ě.ĩ/ vs. /eĩ/). Besides, my previous study, Nogita (2010b), also reports that my Japanese ESL participants were not certain whether [e^l]s in *made* and *they* were exactly the same or slightly different because of spelling differences. The participants of this present experiment

can be in the same boat. All this means that apparently the same surface representation can be underlyingly different.

To make matters worse, although participants were instructed to pronounce as clearly as possible in the reading task, many Japanese participants produced “mumbly” sounds probably due to shyness, hesitation, an insecurity of their pronunciation, or nervousness in the experimental environment. This, conversely, could have caused the same mental representation emerging as noticeably different phonetic representations at the surface level. All this suggests that it is a challenge to correctly grasp their mental representations, unless we interview each participant about what sound they intended to pronounce, as Nogita (2010b) did, or adopt some other methods, such as psycholinguistic methods, but these are beyond the scope of this study.

Although there were such limitations, the following phonetic characteristics can be clues for the participants’ mental representations:

- Differences between monophthongal [o:] and diphthongal [o^ʊ]
- One-mora production if it is obvious (explained below)
- Hyper rhotacization (explained below)

Firstly, according to Nogita and Lin’s (2016) perception study, both Japa/o:/ and /ou/ are perceived as the Canadian English [o^ʊ] although the latter is a better exemplar, so the difference between [o:] and [o^ʊ] at least in Canadian English is not phonemic. However, these are phonemic in Japanese, as in *sō* 層 /so:/ ‘layer’ versus *sou* 沿 っ /sou/ ‘go along’ (although the functional load of the Japa/o:/-/ou/ contrast is low). In fact, depending on the spellings of the stimuli, some Japanese participants used this L1 contrast which is irrelevant in L2. I consider that using L2 irrelevant contrasts is problematic, just as contrasting /l/ and /ɹ/ in Japanese is problematic. L2 learners would not want to do such unnecessary extra work for efficient learning. So I examined the participants’ [o:]-[o^ʊ] contrast. Incidentally, as for the

front counterparts [e:] and [e^l], the former was regarded as the equivalent of Eng/ε/ as in *bed* and the latter was regarded as Eng/e/ as in *bade* according to the results of Nogita and Lin (2016).

Secondly, although vowel length *is* relevant in phonemic contrasts in English to some extent, it is not in the same way as Japanese, as discussed in §2.2.1. Again, it is expected that Japanese EAL learners may transfer L1 vowel length contrast that is irrelevant in L2. However, it is not straightforward to judge whether participants transferred vowel length contrast or not by only observing their interlanguage productions. Moreover, when coding the data, I noticed that many participants seemed to attempt the more English-like syllable-based rhythm, instead of the L1 mora-based rhythm, that is, they attempted to pronounce all the one-syllable stimuli with more or less the same duration²⁰. The problem is that even if they did transfer L1-like vowel length contrasts in their mental representations at the segmental level, such as /i:/ versus /i/, their L2-like syllable-based rhythm at the prosodic level almost neutralized their length contrasts in their surface representations, which made it very difficult to judge their intended vowel length. To solve this problem, we relied more on presence or absence of 1) a pitch contour and 2) a glottal stop (for word-final vowels) to judge their length contrast, rather than duration. As mentioned in §2.2.2, Japanese two-mora vowels can show a pitch contour, while one-mora vowels do not. If a participant produced a falling pitch contour in some stimuli but did not produce it at all in others, he/she most likely transferred the L1 one-mora-two-mora contrasts into L2. For example, Figure 33 shows the *sta* and *stoh* by a female Japanese participant with three weeks of LOR; *sta* was pronounced with no pitch contour followed by a glottal stop [ʔ], which is characterized as an utterance-final one-mora

²⁰ English is known to have the stress-timed rhythm, but the stimuli in this present experiment consist of only one syllable, so stress is not relevant unless participants chose to pronounce them with two syllables, such as *zobe* as [zo^o.biⁱ].

vowel in Japanese, while *stoh* was pronounced with a pitch contour without a glottal stop, which is characterized as a Japanese two-mora vowel.

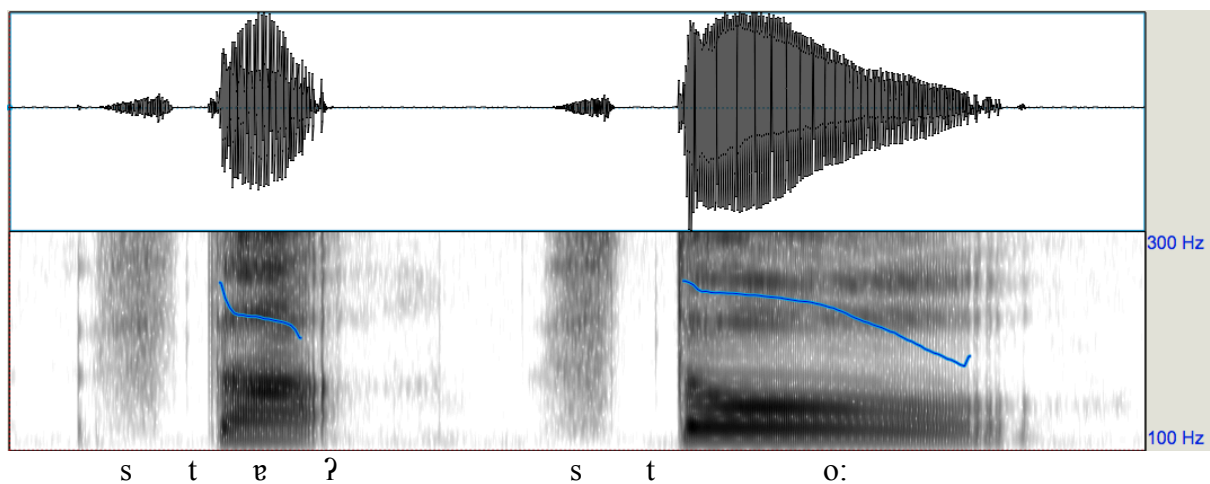


Figure 33. pitch curves (blue lines) of <sta> and <stoh> by a female Japanese participant with three weeks of LOR

Aside from a pitch contour and glottal stop, only if the participants obviously intended to shorten vowel duration in some vowels than in other vowels, we judged it as a one-mora vowel, as the participant of Figure 33 did.

Thirdly, as for hyper rhotacization, impressionistically, it is generally said that some Asian EAL learners tend to randomly pronounce [ɹ], or “curl their tongues”. However, to my knowledge, there is little formal research about hyper rhotacization by Japanese EAL learners. According to Nogita’s (2010a) informal interview with Japanese ESL learners, many Japanese ESL learners have a stereotype that the more rhotacized (or the more “tongue curling”), the more English-like. If the Japanese participants rhotacized vowels to some extent even though the letter <ɹ> was not present in the spelling, we transcribed it. Figure 34 shows rhotacized vowel in *sta* pronounced by a Japanese male participant: low F3 is shown around the horizontal line marked with the yellow oval, which is an acoustic characteristic of [ɹ].

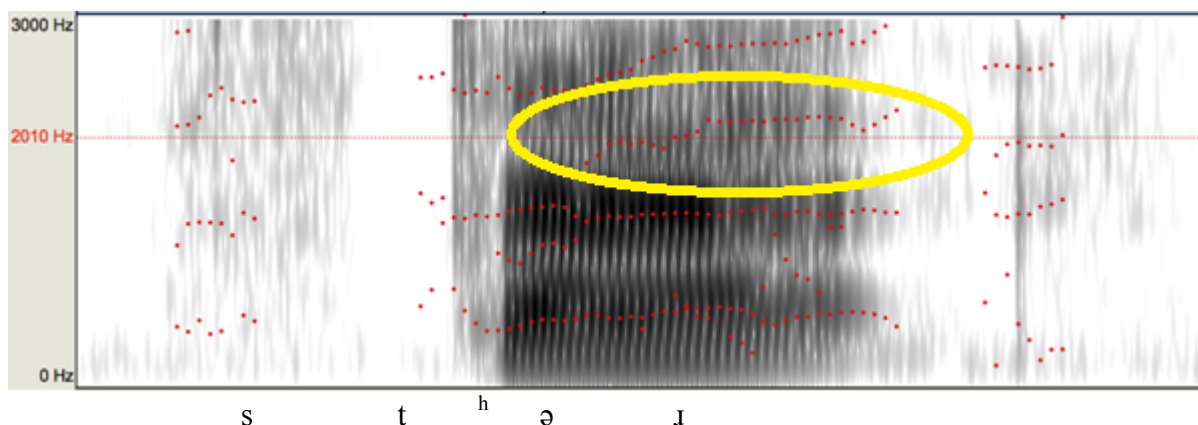


Figure 34. <sta> by a male Japanese participant with six years of LOR

Both raters transcribed individually. Since the Japanese participants' target language was most likely North American English, our transcription was based on North American English vowel phonemes along with some phonetic characteristics including above three characteristics. The inter-rater reliability for the Japanese participants' productions was 90.9%. When there were disagreements, I mainly followed the second rater, who is a native speaker of North American English, or I asked another phonetically trained Canadian English speaker.

The goal of this study is to examine how similarly native Canadian English speaking participants and EAL learners performed in the reading task, but not necessarily which group was more correct or incorrect. I made the 2-point scale to evaluate EAL participants on the basis from the results of the Canadian participants. Table 26 explains the details.

Table 26. Criteria for evaluating Japanese/Chinese EAL participants' performance in the reading task

<p>2 points – The 1st (the most frequent) choices by the Canadian participants</p> <p>e.g., [e^ɪ] for <skay> chosen by 14 out of 14 Canadians [aʊ] for <koun> by 7 out of 14 Canadians (the most frequent choice)</p>
<p>1 points – The 2nd or 3rd choices by the Canadian participants</p> <p>e.g., [ju:] for <pude> chosen by 5 out of 14 Canadians (the 2nd most frequent choice) [u:] and [o^ʊ] for <koun> chosen by 4 and 3 out of 14 Canadians respectively (the 2nd and the 3rd most frequent choices)</p>

For example, if an EAL participant pronounced <ay> in *skay* as [e¹], which was most frequently chosen by the Canadian participants, s/he gained 2 points.

3.4.2 Results of the Japanese participants

Overall productions from 44 Japanese participants' in the reading task are shown in Table 27; note that one of the 45 Japanese participants could not participate in the reading task due to his schedule. The transcription is based on English phonemic symbols with some phonetic adjustment if needed. The productions which match the Canadian participants' most frequent choices are displayed with bolded letters in red thick double line frames. The productions that match the Canadian participants' second and third most frequent choices are displayed in thin red double line frames. The productions that the Canadian participants never chose are displayed in shaded boxes.

To make the criteria more lenient and give the EAL participants more points, I also adopted two more criteria: [o:] or similar sounds for *faud/staw* and [ju:] for *nupe* (displayed in blue triple line frames) are worth 2 points. These criteria are for taking British accents into consideration. As I will discuss in §3.5.2, many Chinese participants showed these patterns presumably because they may have taken a British English-based education in China, so it would be unreasonable not to give any points for these productions. Although the English education in Japan mainly focuses on American English (Kumadaki, 2008), I made Japanese EAL learners' criteria consistent with the Chinese participants'.

Table 27. Results of the Japanese participants' productions in the reading task

	Grapheme and stimuli								
Graph. Stimuli	<ay#> <i>skay</i>	<a_e> <i>tate</i>	<ai> <i>paip</i>	<ee> <i>peest</i>	<ea> <i>skeap</i>	<e_e> <i>pede</i>	<y#> <i>smy</i>	<i_e> <i>mibe</i>	<ie#> <i>kie</i>
Response #	[e¹] 23	[e¹] 40	[e¹] 34	[i:] 43	[i:] 30	[i:] 26	[aɪ] 22	[aɪ] 33	[i:] 34
(%)	(52%)	(91%)	(77%)	(97%)	(68%)	(59%)	(50%)	(75%)	(77%)
Response #	[aɪ] 20	[aɪ] 1	[aɪ] 10	[ɛ] 1	[ɛ~ɛ:] 6	[ɛ] 8	[i:] 18	[i:_ɛ] 4	[jɛ] 4
(%)	(45%)	(2%)	(23%)	(2%)	(14%)	(18%)	(41%)	(9%)	(9%)
Response	[i:]	[ɛ]			[ɛa~ɛə]	[e ¹]	[iʔ]	[i_ɛ]	[aɪ]

# (%)	1 (2%)	1 (2%)			2 (5%)	4 (9%)	2 (5%)	2 (5%)	3(7%)
Response # (%)		[a:] 1 (2%)			[e'] 2 (5%)	[ε ε̄] 3 (7%)	[ɪ] 1 (2%)	[i:] 1 (2%)	[e'] 1 (2%)
Response # (%)		[ʌ] 1 (2%)			[æ:] 1 (2%)	[e'Cɪ] 1 (2%)	[y] 1 (2%)	[aɪ_ε] 1 (2%)	[ε] 1 (2%)
Response # (%)					[jε] 1 (2%)	[ε_i] 1 (2%)		[i_i] 1 (2%)	[εo] 1 (2%)
Response # (%)					[a:~ʌ:] 1 (2%)	[jε] 1 (2%)		[e'] 1 (2%)	
Response # (%)					[ʌ] 1 (2%)			[i] 1 (2%)	
Tota;	44	44	44	44	44	44	44	44	44

44 Japanese participants

Grapheme and stimuli						
<oa> <i>poad</i>	<o_e> <i>zobe</i>	<o#> <i>zo</i>	<oe> <i>stoe</i>	<oh> <i>stoh</i>	<oo> <i>spoo</i>	<ooC#> <i>pook</i>
[o:~ɔ:] 16(34%)	[o^o~ɔ^o] 18(41%)	[o^o~ɔ^o] 20 (45%)	[o^o~ɔ^o] 13 (30%)	[o^o~ɔ^o] 17 (39%)	[u:] 35 (79%)	[u:] 31 (70%)
[o^o~ɔ^o] 13(27%)	[o:~ɔ:] 18 (41%)	[o:~ɔ:] 7 (16%)	[o:~ɔ:] 8 (18%)	[o:~ɔ:] 17 (39%)	[o ^o] 4 (9%)	[o:~ɔ:] 9 (20%)
[oɪ] 7 (16%)	[a:] 2 (5%)	[u:] 5 (11%)	[oɪ] 8 (18%)	[o:f~o:φ] 3 (7%)	[o:~ɔ:] 2 (5%)	[o ^o] 1 (2%)
[a:~a:] 3 (7%)	[o:_i:] 2 (5%)	[ðʔ~ɔʔ] 4 (9%)	[u:] 5 (11%)	[ðʔ] 3 (7%)	[oɪ] 1 (2%)	[oɪ] 1 (2%)
[oa~oə] 2 (5%)	[o^o_i:] 1 (2%)	[ũʔ] 4 (9%)	[oj~ɔɪ] 3 (7%)	[u:] 2 (5%)	[uɪ] 1 (2%)	[ð] 1 (2%)
[qa:] 2 (5%)	[u:] 1 (2%)	[oɪ] 1 (2%)	[oa~oə] 2 (5%)	[oɪ] 1 (2%)	[u:d] 1 (2%)	[ũ] 1 (2%)
[on] 1 (2%)	[ð_ε] 1 (2%)	[ɔ] 1 (2%)	[oε] 1 (2%)	[o:θ] 1 (2%)		[ɔ] 0 (0%)
	[ũ_ε] 1 (2%)	[ðʔ] 1 (2%)	[o:i:] 1 (2%)			
		[a:] 1 (2%)	[aɔ] 1 (2%)			
			[ɹ] 1 (2%)			
			null 1 (2%)			
44	44	44	44	44	44	44

Note. “Null” indicates that the participant forgot to read this word. [˘] indicates “extra short”. [ʔ] indicates a glottal stop. [φ] indicates a bilabial stop.

44 Japanese participants

Grapheme and stimuli							
<cor. C + u_e> <i>nupe</i>	<non-cor. C + u_e> <i>pude</i>	<non-cor. C + ew> <i>bew</i>	<aC#> <i>snad</i>	<eC#> <i>teb</i>	<iC#> <i>tib</i>	<uC#> <i>spug</i>	<uh> <i>tuh</i>
[u:]	[u:]	[εɔ]	[a:]	[ε~ě]	[i:]	[a:~a:]	[u:]

33 (75%)	27 (61%)	22 (50%)	22 (50%)	31 (89%)	22 (50%)	13 (30%)	20 (45%)
[ʌ] 3 (7%)	[ju:] 12 (27%)	[ju:] 18 (41%)	[ǎ~ʌ] 9 (20%)	[ɪ] 2 (5%)	[ɪ] 11 (25%)	[ʌ] 9 (20%)	[ʌ] 4 (9%)
[ũ] 2 (5%)	[uɪ] 1 (2%)	[εəʊ] 2 (5%)	[æ:] 8 (18%)	[i:] 1 (2%)	[ĩ] 10 (23%)	[ǎ] 4 (9%)	[ǎʔ] 1 (2%)
[a~ɑ] 2 (5%)	[u:_ε] 1 (2%)	[aʊ] 1 (2%)	[ǎ̃] 1 (2%)	[jε] 1 (2%)	[aɪ] 1 (2%)	[ũ] 8 (18%)	[u:θ] 4 (9%)
[ju:] 1 (2%)	[ε_ε] 1 (2%)	[ε] 1 (2%)	[e'] 1 (2%)	[ĩ] 1 (2%)		[u:] 4(9%)	[u:s] 2 (5%)
[o:] 1 (2%)	[ũ_ε] 1 (2%)	[u:] 0 (0%)	[ē] 1 (2%)			[o] 3(7%)	[u:f~u:φ] 2 (5%)
[ju:_ε] 1 (2%)	[i:] 1 (2%)		[ε:] 1 (2%)			[ö] 1(2%)	[ɔ:] 2 (5%)
[jε] 1 (2%)			[ɑɪ] 1 (2%)			[ɪ] 1(2%)	[a:~ɑ:] 2 (5%)
						[ʌn] 1(2%)	[ũʔ] 1 (2%)
							[öʔ] 1 (2%)
							[ʌh] 1 (2%)
							[æ:x] 1 (2%)
							[æ:] 1 (2%)
							[ɑɪ] 1 (2%)
							[ɪ] 1 (2%)
44	44	44	44	44	44	44	44

44 Japanese participants

Grapheme and stimuli				
<oC#> <i>tob</i>	<aw#> <i>staw</i>	<au> <i>faud</i>	<a#> <i>sta</i>	<ah> <i>kah</i>
[o:~ɔ:] 21 (48%)	[æʊ~aʊ~ɑʊ] 26 (59%)	[æʊ~aʊ~ɑʊ] 32 (73%)	[ǎʔ~ʌʔ] 19 (43%)	[a:] 12 (27%)
[a:] 9 (20%)	[o ^ʊ ~ɔ ^ʊ] 11 (25%)	[o ^ʊ ~ɔ ^ʊ] 6 (14%)	[a:] 12 (27%)	[a:] 12 (27%)
[a:] 2 (5%)	[a:~ɔ:] 2 (5%)	[a:] 1 (2%)	[a:] 3 (7%)	[ǎʔ] 4 (9%)
[ö] 8 (18%)	[u:] 2 (5%)	[o:] 1 (2%)	[e'] 3 (7%)	[aʊ~ɑʊ] 4 (9%)

[ʌ] 2 (5%)	[ɑɪ ^o ~ɑʊɪ] 2 (5%)	[wa:] 1 (2%)	[ǣʔ] 2 (5%)	[a:f~a:ɸ] 3 (7%)
[ǣ] 1 (2%)	[ju:] 1 (2%)	[a:] 1 (2%)	[ʌɪ~ɪ] 2 (5%)	[ʌ] 1 (2%)
[ʊ] 1 (2%)		[an] 1 (2%)	[æ:] 1 (2%)	[æ:] 1 (2%)
		[o ^o n] 1 (2%)	[ʌɪʔ] 1 (2%)	[a:x] 1 (2%)
			[ɑɪ] 1 (2%)	[ʌh] 1 (2%)
				[ǣɸ] 1 (2%)
				[aθ] 1 (2%)
				[ɑ:~h:] 1 (2%)
				[ǣʔ] 1 (2%)
				[ɑɪ] 1 (2%)
44	44	44	44	44

Note. [ǣ:] indicates voiceless [a:].

44 Japanese participants

Grapheme and stimuli			
<oy#> <i>noy</i>	<oi> <i>poid</i>	<ow#> <i>fow</i>	<ou> <i>koun</i>
[oɪ~ɔɪ~ɑɪ] 41 (93%)	[oɪ~ɔɪ~ɑɪ] 44 (100%)	[o^o~ɔ^o] 30 (68%)	[o^o~ɔ^o] 34 (77%)
[o ^o] 2 (5%)		[aʊ] 6 (14%)	[aʊ] 5 (11%)
[ɑɪ] 1 (2%)		[o:] 5 (11%)	[o:] 2 (5%)
		[oɪ] 2 (5%)	[u:] 1 (2%)
		[o ^o ɪ] 1 (2%)	[ɑ:] 1 (2%)
			[ɔɪ~ɑɪ] 1 (2%)
44	44	44	44

Note. The thick red double line boxes are worth 2 points. The thin red double line boxes are worth 1 point. The blue triple line boxes are worth 2 points. [C] indicates a consonant.

3.4.3 Discussion

3.4.3.1 General discussion

Overall, the number of 0-point productions (or the productions that the Canadian participants never chose) was 582 out of 1452 (33 stimuli × 44 participants) tokens, which becomes 40.1%. This implies that when Japanese EAL learners encounter a new one-syllable word, around 40% of the time they may read it differently from native (Canadian) English speakers. If consonants are added, this percentage will rise. I consider that this number needs to be lowered. As well, the overall average score based on the 2-point scale was 36.8 points out of 66 (33 stimuli × 2 points), or in other words 1.12 points out of 2. I consider that this score also needs to be improved.

The good news is that for 22 out of the 33 stimuli, the most frequent productions by the Japanese participants matched those by the Canadian participants. The bad news is that among these 22 stimuli, five of them were only 50% or less in consistency: *smv* (50%), *zo* (45%), *zobe* (41%), *stoh* (39%), and *stoe* (30%). Moreover, for 11 out of 33 stimuli, specifically *poad*, *bew*, *snad*, *tib*, *tob*, *staw*, *faud*, *sta*, *spug*, *tuh*, and *koun*, the most frequent productions by the Japanese participants were different from those by the Canadian participants. Interestingly, as can be observed, all the graphemes that correspond to “alphabet O” ([o^u]) and “relative O” ([ɑ:]) were not consistently read in the same way as the Canadian participants did (below 50%). As well, all the graphemes that correspond to “relative sounds” except for “relative E” (i.e., [æ:, ɪ, ɑ:, ʌ]) were not consistently read like the Canadian participants. In addition, *koun* was read as [ʌv] only 11% of the time. At this moment, what exactly makes it so difficult for the Japanese participants to acquire these correspondences is unknown, but as mentioned in §2.5.7, according to my loanword rōmaji data in Nogita (2016c), at least the connection between <o> and [ō, ɔ:] seems fairly tight in native Japanese

speakers' psychology, so this may impede acquisition of other corresponding sounds of <o>, like “alphabet O” ([o^u]) and “relative O” ([ɑ:]). I will come back to this topic in §3.4.3.2.4.

To sum up, among 13 vowels (or 12 excluding [o] that lacks the default corresponding grapheme), six of them, specifically graphemes corresponding to “alphabet O”, all the “relative sounds” but “relative E”, and [ɑo], can be regarded as weaknesses of the Japanese participants.

3.4.3.2 Difficult and easy stimuli for the Japanese participants

Some stimuli seem extremely challenging while others seem relatively easy for the Japanese participants. In this section, I will classify the stimuli depending on the Japanese participants' reading patterns. First, I calculated the average score of each stimulus by all the 44 Japanese participants. Then, I used the K-Means Cluster Analysis to divide the stimuli into three clusters based on each participant's score. Figure 35 shows the three clusters based on the K-Means Cluster Analysis.

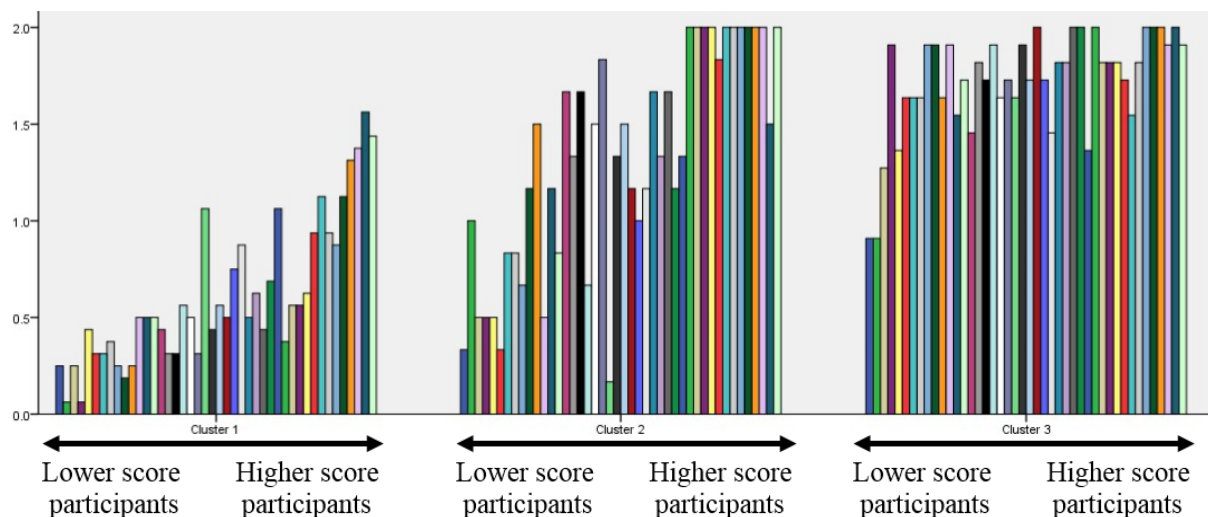


Figure 35. Clustered nonsense word stimuli based on the Japanese participants' performance

Each of the three graphs in Figure 35 represents each of the three clusters. In these three graphs, each bar represents each of the 44 participants' score in the particular cluster. On the X-axis, each cluster consists of the 44 participants who are aligned in ascending order in their overall scores, meaning that “higher score participants” are on the right hand side and “lower

score participants” are on the left hand side. The Y-axis indicates average scores (based on the 2-point scale) by each participant for the stimuli in each cluster: for example, if one of the bars in cluster 1 indicates 1.5, this particular participant’s average score for the cluster 1 stimuli is 1.5 out of 2.

For cluster 1 and 2 stimuli, as can be observed, higher score participants simply gained higher scores. For cluster 1 stimuli, overall, their points were relatively low, meaning that these stimuli were fairly challenging particularly for lower score participants. For cluster 2 stimuli, several higher score participants gained 2 points, suggesting that these higher score participants had fully acquired cluster 2 stimuli. For cluster 3 stimuli, most participants gained nearly 2 points regardless of whether they were higher or lower score participants, meaning that cluster 3 stimuli were the easiest for most of the participants. Table 28 to Table 30 show stimuli in each cluster along with average scores.

Table 28. Cluster 1 (most challenging particularly for lower score participants) stimuli and average scores

Stimuli	Score	Stimuli	Score	Stimuli	Score	Stimuli	Score
<i>staw</i>	0.09	<i>tib</i>	0.50	<i>sta</i>	0.61	<i>zobe</i>	0.82
<i>faud</i>	0.23	<i>stoe</i>	0.59	<i>tuh</i>	0.68	<i>kah</i>	0.82
<i>snad</i>	0.36	<i>poad</i>	0.59	<i>stoh</i>	0.77	<i>zo</i>	0.91
<i>tob</i>	0.41	<i>spug</i>	0.59	<i>bew</i>	0.82	<i>koun</i>	1.02

Note. Scores are out of 2.

Table 29. Cluster 2 (moderately challenging) stimuli and average scores

Stimuli	Score	Stimuli	Score	Stimuli	Score
<i>skay</i>	1.05	<i>skeap</i>	1.36	<i>smy</i>	1.41
<i>pede</i>	1.18	<i>pook</i>	1.41	<i>mibe</i>	1.52

Table 30. Cluster 3 (easiest) stimuli and average scores

Stimuli	Score	Stimuli	Score	Stimuli	Score	Stimuli	Score
<i>pude</i>	1.50	<i>spoo</i>	1.59	<i>teb</i>	1.77	<i>peest</i>	1.95
<i>fow</i>	1.50	<i>kie</i>	1.68	<i>tate</i>	1.82	<i>poid</i>	2.00
<i>nupe</i>	1.55	<i>paip</i>	1.77	<i>noy</i>	1.86		

3.4.3.2.1 Cluster 1 stimuli by the Japanese participants

- <au, aw>-[ɑ:]

The Japanese participants had most difficulty with the <au/aw>-to-[ɑ:] conversion. As discussed in §2.1.2, Takakuwa (2012) mentions that <w> in <aw> can often trigger the off-glide [u~ʊ~w]. As expected, most Japanese participants pronounced both <aw> in *staw* and <au> in *faud* as [aʊ] or similar sounds. In addition, according to Takakuwa (2012), real words like *saw* are commonly pronounced as [so^ʊ] by Japanese EAL learners, instead of [saʊ]. Likewise, the second most frequent pronunciation by the Japanese participants for <aw> and <au> were also [o^ʊ], suggesting that <au/aw> was mostly associated to [aʊ], followed by [o^ʊ] by the Japanese participants. Fortunately, <au> in the stimulus *faud* was pronounced as [o^ʊ] by five out of 14 Canadian participants, so six Japanese participants who read <au> in *faud* as [o^ʊ] or similar sounds earned 1 point. However, it would be better for the Japanese participants to learn the default <au/aw>-[ɑ:] correspondence.

My interest is whether the Japanese participants' productions in English are influenced by loanword rōmaji discussed in §2.5 as well as regular rōmaji discussed in §2.4. First, the digraphs <aw> and <au> read as [aʊ] or a similar sound is clearly a transfer from regular rōmaji, <au>-Japa/au/. In comparison with my loanword rōmaji data in Nogita (2016c), there is one occasion that <aw> corresponds to Japa/a:/, which presumably imitates the North American English <aw>-to-Eng[ɑ:] correspondence (see §2.5.7), but this loanword rōmaji <aw>-Japa/a:/ correspondence can be considered as an exceptional case, and does not seem to be transferred to the Japanese participants' English. In my loanword rōmaji data, both <aw> and <au> are also read as the monophthong Japa/o:/, but this was also not transferred to the Japanese participants' L2.

- <a>-[æ:], <o>-[ɑ:], <i>-[ɪ]

The monographs <a>, <o>, <i> in *snad*, *tib*, and *tob* were most frequently pronounced as [a:], [o:], [i:] (or similar sounds) respectively by the Japanese participants. Recall that in my loanword rōmaji data, these three monographs are by far the most frequently read as

Japa/a, o, i/ respectively (see §2.5.7), which is the same way as regular rōmaji. If the Japanese participants had been misconceiving that loanword rōmaji and English were the same entity, the loanword rōmaji way had been transferred. However, notice that the Japanese participants' productions [a:], [o:], [i:] in the reading task were often longer than the typical Japanese one-mora monophthongs /a, o, i/. This is likely because, as mentioned above, these Japanese participants attempted to imitate the English syllable-based rhythm rather than the Japanese mora-based rhythm. This could be interpreted as being because their phonetic length manipulation occurred at the prosodic level but the mental representations at the segmental level by many of them were the same or almost the same as Japa/a, o, i/, although this needs further research.

One might argue that Eng[æ:, α:, ɪ] are difficult to articulate by the Japanese participants, so articulation was the main cause of their mispronunciations and this may be partially true. However, as Nogita and Lin (2016) mentioned, Eng[æ:, α:, ɪ] can be substituted with Japa/ea, a:, e/ respectively and we argue that articulation-wise Eng[æ:, α:, ɪ] should not be difficult (although a native-like manner is a different story). Moreover, for <o>, I accepted Japa/a:/-like [a:] (rather than more back [ɑ:]) since in some American dialects, [ɑ:] is more central (or closer to [a:]) than Canadian [ɑ:]. However, their score for <o> is still low, suggesting that participants' GPC knowledge better explains their low scores for <o>, rather than articulation.

The good news is that <a>, <o>, and <i> were still pronounced correctly by around 10 participants. Some of those productions may have been accidental, but others may have been a sign of their acquisition.

- <oe, oa, oh, o_e, o>-[o^ʊ]

Unexpectedly, these spellings in *stoe*, *poad*, *stoh*, *zobe*, and *zo* were pronounced as [o^ʊ] with the [ʊ~w] off-glide quite a few times (ranging from 13 for <oa> to 20 for <o#> out

of 44), suggesting that reading these spellings as [o^u] had been acquired by some participants. At the same time, there were quite a few realizations of monophthongal [o:]. I will come back to this issue in the section of <ow> and <ou>.

As for *zo* and *stoh*, as expected, the monograph <o> was pronounced with a Japanese one-mora monophthong-like sound followed by a glottal stop, such as [ǒʔ] (˘ = extra short) by nine participants. In contrast, whilst <oh> was still pronounced with a Japanese one-mora monophthong-like sound [ǒʔ] by three participants, it was much more frequently pronounced as Japanese two-mora monophthong-like sound [o:]. This is clearly interference of the L1 regular rōmaji rule in which <o> corresponds to Japa/o/ (typically [ǒʔ] in pre-pausal position) and <oh> in some rōmaji varieties corresponds to Japa/o:/. The problem of this contrast is that these participants used the irrelevant [o:]-[ǒʔ] contrast in L2. Another interesting issue to note about <oh> is that four participants assumed that <h> represents a coda consonant, and pronounced [o:f~o:ɸ]. According to Goad and Kang (2003), Japanese EAL learners, including advanced learners, tend to pronounce an English coda obstruent as /Cu/ at the underlying level and then devoice/delete /u/ at the surface level in a Japanese high vowel devoicing/deletion-like manner. So these participants pronounced <oh> as /ohu/ or /o:hu/ underlyingly, but in Japanese /hu/ is neutralized with /ɸu/ due to the phonotactic constraint of *[hǎ], and therefore, /o:hu/ was realised as [o:ɸ] or similar variations at the surface level. The problem is that they mistook word-final <h> for a coda consonant, as well as that they did not know that /h/ is not allowed in coda position in English. Finally, one participant pronounced [o:θ] likely because she mistook <stoh> for <stoth>.

Another issue is that there were several rhotacized realizations. Since [ɹ] is a stereotypical English-like sound for Japanese EAL learners, they were tempted to rhotacize vocalic parts. This is regarded as a type of hyper-correction, and is going to be discussed in §3.4.3.4. Another type of hyper-correction is that many of them pronounced Eng[o^u] as [ɔ^u]

with a quite open nucleus, which is different from either L1 or L2. This may be because these Japanese participants did not believe the similarity between L1 and L2 and attempted to phonetically differentiate Eng[o^o] from Japa/ou/. As a result, their production became more deviant from native English speakers' versions. However, since the focus of this experiment is not phonetic details, [ɔ^o] was regarded as correct.

The good news is that there were only a few occasions of complete regular rōmaji ways, specifically [oɑ̃] and [ɔɑ:] (̃ = non-syllabic) for <oa> by four participants, [oɛ] for <oe> by one participant, and [o_ɛ] for <o_e> by one participant, suggesting that the Japanese participants recognize these spellings as different entities from regular rōmaji.

- <u>-[ʌ]

Apparently, more than half of the Japanese participants intended to pronounce <u> in *spug* as [ʌ], rather than the regular rōmaji way [ũ]. This may be in part because in my loanword rōmaji data, <u> is almost equally pronounced as either Japa/a/ or /u/ (see §2.5.7). The problem is that 13 of their productions were too long or too open and sounded like foreign (a) [a:]. I suspect that these participants' mental representation was the one-mora Japanese monophthong /a/, which is perceptually and acoustically similar to Eng[ʌ] (Nogita and Lin, 2016; Nishi et al., 2008), but at the prosodic level, they attempted the syllable-based rhythm, rather than the mora-based rhythm, which added length. This lengthening may also have added openness just as Japa/a:/ is more open than Japa/a/ (see §2.2.2.1). As a result, their production became deviant from both Eng[ʌ] and the original Japa/a/. This could be interpreted as another type of hyper-correction, which occurs at the prosodic level rather than the segmental level. This means that although Eng[ʌ] and Japa/a/ are phonetically similar, if the prosodic level is intertwined, Eng[ʌ] may not necessarily be easy for the Japanese participants, at least in one syllable words in isolation.

Another phonetic issue to note is that a few of their productions were too front, which were deviant from Japa/a:/ but closer to Eng[æ:]. I suspect that this is also a type of hyper-correction, that is, they were tempted to pronounce another stereotypical English-like sound [æ:], besides [ɪ]. Some participants added [æ:] -like flavour (or phonologically speaking the [+front] feature) to Japa/a/ and produced somewhere between Eng[æ:] and [ʌ], like fronted [a:] (., = advanced tongue root).

A more purely GPC-based problem is that nine Japanese participants pronounced both <a> and <u> in the same way ([a:] by 7 and [ʌ] by 2). In my loanword rōmaji data, both <a> and <u> are commonly pronounced as Japa/a/, so many Japanese participants may have had a false concept that both English <a> and <u> corresponded to the same sound.

Meanwhile, there were nine realizations of [ʌ] (but including these two participants who also pronounced <a> as [ʌ]). As well, there were four realizations of short [ǎ], which I regarded as correct, since their intention was likely the same as those nine who pronounced [ʌ]. This is a good sign for acquisition of the <u>-to-[ʌ] conversion.

Overall, the <u>-to-[ʌ] conversion per se does not seem very challenging. If they reduce phonetic hyper-correction, the number of correct realization of <u> would abruptly rise.

- **<uh>-[ʌ]**

As opposed to <u>-to-[ʌ] conversion, the <uh>-to-[ʌ] conversion in *tuh* seems much more severely problematic. The most frequent realization was [u:] (20/44), which is clearly a transfer from the <uh>-Japa/u:/ correspondence in one of the (non-standard) regular rōmaji variations. Two of the Canadian participants also chose [u:], so Japanese participants' [u:] is not an error, but it would be better if they learn the most frequent correspondence [ʌ]. Other frequent errors were from the participants' misinterpretation of <h> as a coda consonant, as

seen in <oh>, resulting in word-final [h, x, φ, f]. This means that these participants did not know that /h/ is not allowed in coda positions in English.

- **<ew>-[ju:]**

Eighteen out of 44 Japanese participants read <ew> in *bew* as [ju:], so the <ew>-[ju:] correspondence is not very difficult for them. However, more participants (22/44) read it as [ɛʊ] or similar variations in a regular rōmaji-like way. These participants need to learn not only avoidance of this L1 transfer, but also the fact that a diphthong like [ɛʊ] does not exist in the English vowel inventory.

- **<ah>-[a:], [ɑ:]**

Twelve out of 44 participants pronounced <ah> in *kah* as [a:]. Since one of the regular rōmaji varieties has the <ah>-Japa/a:/ correspondence, this must be easy. Another 12 pronounced more back [ɑ:], which was the second most frequent realization by the Canadian participants. A problem is that some of them misconceived this <h> as a coda consonant, as seen in <oh> and <uh>.

- **<ou>-[aʊ]**

While the Canadian participants most frequently read <ou> in *koun* as [aʊ] (7/14) and least frequently read it as [o^ʊ] (3/14), the Japanese participants most frequently pronounced <ou> as [o^ʊ~ɔ^ʊ] or similar variations with the [ʌ~ʊ] off-glide (34/44). This is clearly a transfer from the regular rōmaji <ou>-Japa/ou/ correspondence. In comparison with the vowels in *stoe*, *poad*, *stoh*, *zobe*, and *zo* pronounced as [o^ʊ] by 13 to 20 participants, *koun* is much more frequently pronounced as [o^ʊ] (34/44). This is considered as <u> triggering the off-glide [ʌ~ʊ]. Since native Japanese speakers have a strong intuition of mora-based division, these 34 participants likely assigned <o> to [o] and <u> to [ʌ~ʊ] rather than assigning <ou> as a whole to [o^ʊ] as a whole. They did not know that the off-glide [ʌ~ʊ] in

Eng[o^u] does not come from the spelling <u> in <ou>, but the phoneme “alphabet O” ([o^u]) includes [u~ʊ], and the graphemes <oe, oa, oh, o_e, o> as a whole correspond to [o^u].

The good news is that five Japanese participants pronounced <ou> as [aʊ], despite my loanword rōmaji data having no occasions of <ou>-Japa/au/ correspondence (see §2.5.7).

3.4.3.2.2 Cluster 2 stimuli by the Japanese participants

Unlike cluster 1 vowel graphemes, cluster 2 graphemes had been already acquired by some higher score participants, so I will focus on differences between higher score participants and lower score participants.

- <ay>-[e^ɪ]

The grapheme <ay> in *skay* was read as [aɪ] like the regular Japanese rōmaji way by most of the bottom half Japanese participants, while it was read as [e^ɪ] by most of the top half participants. According to my loanword rōmaji data, <ay> was read as Japa/ei/ five out of six occurrences (see §2.5.7), which may have helped learn the English <ay>-[e^ɪ] correspondence.

- <e_e>-[i:]

Most of the bottom nine Japanese participants read <e_e> in *pede* in regular rōmaji-like ways ([ɛ_ɛ] etc.), but most of the rest read it as [i:]. Despite my loanword rōmaji data having no <e_e>-Japa/i:/ occurrences (see §2.5.7), the English <e_e>-[i:] correspondence may not be difficult to acquire.

- <ea>-[i:]

All the top 18 Japanese participants read <ea> in *skeap* as [i:], so for higher score participants, this seems easy to acquire. However, most of the bottom third participants read it differently. In my loanword rōmaji data, <ea> corresponds to Japa/i:/ only three out of six occurrences (see §2.5.7), which could explain why lower score participants had trouble.

- <oo>-[u:] in a closed syllable

All the bottom seven Japanese participants pronounced <oo> in *pook* as [o:] or similar variations in the regular rōmaji-like way, but most of the rest read it as [u:]. In my loanword rōmaji data, the <oo>-Japa/u:/ correspondence is fairly solid (see §2.5.7), which could have helped the Japanese participants. There was no realizations of [ʊ] by the Japanese participants, but this may be in part because according to Nogita and Lin (2016), although Japanese one-mora/u/ can be perceived as Eng[ʊ], if participants attempted to imitate the English syllable-based rhythm, Japa/u/ was phonetically lengthened, which in turn resulted in Japa/u:/-like qualities, and therefore, deviant from Eng[ʊ].

- **Stressed word-final <y>-[aɪ]**

On one hand, 12 out of 14 Canadian participants pronounced stressed <y#> (# = word-final) in *smɪ* as [aɪ] and only two pronounced it as [i:], so there is a preference to [aɪ]. On the other hand, the Japanese participants almost evenly chose [aɪ] and [i:] (22 for [aɪ] vs. 18 for [i:]). However, most of the top 18 participants chose [aɪ] and many of the rest chose [i:], suggesting that higher score Japanese participants tended to have the same preference as the Canadian participants.

- **<i_e>-[aɪ]**

Most of the top 30 Japanese participants read <i_e> in *mibe* as [aɪ]. In my loanword rōmaji data, <i_e> is the most frequent combination with silent-E among the five vowel letters, so the English <i_e>-[i:] could be the easiest silent-E digraph for Japanese EAL learners.

3.4.3.2.3 Cluster 3 stimuli by the Japanese participants

- **<u_e> after coronal and non-coronal consonants**

Recall that all the Canadian participants read <u_e> in *nupe* (after a coronal consonant) as [u:], while five of them read <u_e> in *pude* (after a non-coronal consonant) as [ju:] with [j]. This is likely because the sequence of a coronal consonant followed by [j] in the

onset position is limited in many North American dialects. Interestingly, the Japanese participants showed a very similar pattern ([u:] by 33 and [ju:] by one for *nupe* versus [u:] by 27 and [ju:] by 12 for *pude*). Although Japanese allows the /nj/ onset sequence, the Japanese participants adopted this English */nj/ constraint whether explicitly or implicitly.

- **<ow>-[o^ʊ, aʊ]**

Ten out of 14 Canadian participants read <ow> in *fow* as [o^ʊ] and four read it as [aʊ]. As for the Japanese participants, 30 pronounced it as [o^ʊ~ɔ^ʊ] or similar variations. Again, recall that vowels in *stoe*, *poad*, *stoh*, *zobe*, and *zo* were pronounced as [o^ʊ~ɔ^ʊ] by much fewer participants (13 to 20). Just as <u> in <ou> in *koun* triggered the [ɥ~ʊ] off-glide, <w> in <ow> also triggered [ɥ~ʊ]. These participants' misconception of <o>-to-[o] and <w>-to-[ɥ~ʊ] correspondences must be corrected, and they need to learn that "alphabet O" ([o^ʊ]) has the [ɥ~ʊ] off-glide regardless of its spelling. In other words, these participants need to learn that the stimuli *zo* and *fow* must rhyme (if *fow* is pronounced as [o^ʊ]).

The good news is that six Japanese participants read <ow> as [aʊ] or similar variations, suggesting that these six had acquired the English <ow>-[aʊ] correspondence, although <ow>-[o^ʊ] is much more preferred. In my loanword rōmaji data, <ow>-Japa/au/ correspondence occurred only in one word, so loanword rōmaji may not help Japanese EAL learners acquire the English <ow>-[aʊ] correspondence.

- **Word-final <oo>**

Thirty-five out of 44 Japanese participants read <oo> in *spoo* as [u:], so the English word-final <oo>-[u:] correspondence seems easy for Japanese EAL learners. In my loanword rōmaji data, the <oo>-Japa/u:/ correspondence is fairly solid, so loanword rōmaji was positively transferred. Still, seven of them read <oo> as [o^ʊ], [o:~ɔ:], or [oɪ], which need to be corrected.

- **Word-final <ie>-[i:, aɪ]**

On one hand, the Canadian participants evenly pronounced word-final <ie> in *kie* as [i:] and [ai] (7 vs. 7). On the other hand, the Japanese participants' productions were lopsided (34 for [i:] vs. 3 for [ai]). Although [i:] is correct and this is not at all influenced by the L1 regular rōmaji way (c.f., regular rōmaji <ie>-Japa/ie/), if the Japanese participants also learn the other variation [ai], that would be even better. Interestingly, all three of the Japanese participants who pronounced <ie> as [ai] were in the top six participants. Just as seen in word-final <y>, higher score Japanese participants tend to have a similar preference to the Canadian participants

- <ai>-[e^ɪ]

I predicted that most Japanese participants would read <ai> as [ai] in the regular rōmaji way, rather than English-like [e^ɪ] on the basis of my loanword rōmaji data in which <ai> corresponds to Japa/ai/ 11 out of 13 occasions (see §2.5.7). However, it turned out that 34 Japanese participants read it as [e^ɪ] and only 10 read it as [ai]. In addition, all the top 11 participants read it as [e^ɪ]. This means that the English <ai>-[e^ɪ] correspondence may not be difficult despite loanword rōmaji.

- <e>-[ɛ]

Thirty-nine out of 44 Japanese participants read <e> in *teb* as [ɛ~ɛ̃]. This is clearly a positive transfer from the regular/loanword rōmaji <e>-Japa/e/ correspondence. A potential problem is that two of them pronounced it as [ɪ]. I suspect that they intended to pronounce a sound like Japa/e/, but it sounded like Eng[ɪ]. The phonetic difference between [ɛ] and [ɪ] may need to be taught.

- <a_e>-[e^ɪ]

Forty out of 44 Japanese participants pronounced <a_e> as [e^ɪ]. Although in my loanword rōmaji data, the occasions of <a_e> is few, the English <a_e>-[e^ɪ] correspondence seems easy.

- <ee>-[i:]

Forty-three out of 44 Japanese participants read <ee> as [i:]. Despite the regular rōmaji <ee>-Japa/e:/ and /ee/ correspondences, the English <ee>-[i:] correspondence had been almost perfectly acquired. In my loanword rōmaji data, the <ee>-Japa/i:/ correspondence is very solid, and there are some modified variations, like <eeee>-Japa/i:/ or <eeeeeeee>-Japa/i:/ ([i::]). Japanese EAL learners would not have much trouble with <ee>-Eng[i:].

- <oy, oi>-[ɔɪ]

All the Japanese participants pronounced <oi> in *foid* correctly, and 41 out of 44 pronounced <oy> in *noy* correctly, so <oi> and <oy> would not be a problem for Japanese EAL learners. The slightly better performance with <oi> is likely because the <oi>-Eng[ɔɪ] correspondence is almost the same as the Japanese regular rōmaji <oi>-Japa/oi/ correspondence.

A potential problem is that many Japanese participants pronounced both <oi> and <oy> as [ɔɪ] or even [ɑɪ] with a fairly open nucleus. These realizations are different from both L1 and L2. As seen in [ɔ⁰] for <o>, this seems another hyper-correction, that is, these Japanese participants did not believe the similarity between L1 and L2 and attempted to phonetically differentiate Eng[ɔɪ] from Japa/oi/. As a result, their productions became more deviant from native English speakers' versions. However, since the focus of this experiment is not phonetic details, sounds like [ɔɪ~ɑɪ] were regarded as correct, unless openness of [ɑɪ] does not go as far as it is perceived as Eng/aj/.

3.4.3.2.4 Possible explanation for the difficulties

Some vowel graphemes are easily acquired despite the difference from L1 regular rōmaji, such as the correspondences <ai>-[e^ɪ], <ie>-[i:] (but not [ɑɪ]), <ee>-[i:], <a_e>-[e^ɪ], and so forth (c.f., the regular rōmaji correspondences <ai>-Japa/ai/, <ie>-Japa/ie/, <ee>-

Japa/e:/ and /ee/, and <a_e>-Japa/a_e/). In contrast, for some graphemes, L1 regular rōmaji ways stubbornly remain and impede L2 GPC acquisition, such as the correspondences <au, aw>-[ɑ:], <ow, ou>-[aʊ], <o#>-[o^ʊ#] (# = word-final), <o>-[ɑ:], <a>-[æ:], <i>-[ɪ], and so forth (c.f., the regular rōmaji correspondences <au>-Japa/au/, <ou>-Japa/ou/, <o>-Japa/o/ ([ɔ̃]), <a>-Japa/a/ ([ɛ̃]), and <i>-Japa/i/ ([ĩ])).

As mentioned in §2.5.7, there may be a native Japanese speakers' certain psychological factor that tolerates non-regular-rōmaji GPC patterns in certain spellings/sounds but not in other spellings/sounds. One of the possible explanations for difficulty in acquisition of particular English GPC patterns is perceptual saliency. As mentioned in §2.1.2, Rafat (2011) states that for native English speakers learning Spanish, the Spanish <ll>-[j] (as opposed to English <ll>-[l]) correspondence is much more easily acquired than the Spanish <d>-[ð] (as opposed to English <d>-[d]) correspondence because the latter L1-L2 difference is perceptually less salient. The same logic may apply to English vowel GPC by Japanese EAL learners. The English [o^ʊ#] for <o#> may not be perceptually too different from the commonly mispronounced [o:] or [ɔ̃?] by the Japanese participants. The same may be true for Eng[ɑ:] for <o> as opposed to commonly mispronounced [o:], as well as Eng[ɪ] for <i> as opposed to commonly mispronounced [ĩ]. However, whether the saliency of the phonetic difference between Eng[aʊ] and regular rōmaji-like [o^ʊ] (for <ow, ou>) is insufficient is questionable. Another possible explanation may be frequency in usage. However, <aw>-[ɑ:] and <ow>-[aʊ] occur in very frequent words, such as *saw* and *how*, so frequency also cannot explain the whole story. Alternative explanations can be that as mentioned above, *saw* is commonly mispronounced as [so^ʊ] by Japanese EAL learners and it may be already fossilized. In the case of <ow, ou>, words like *how* and *out* are so frequently used that these are likely to be read logographically rather than phonographically and

Japanese EAL learners do not pay attention to the GPC patterns. Still, further research will be needed why some English GPC rules are not likely to be acquired.

3.4.3.3 Silent-E by the Japanese participants

In this section, I will discuss how the Japanese participants dealt with the function of silent-E as an “alphabet sound” marker. There are two types of errors: reading <VCe> (V = vowel, C = consonant) as a “relative sound”, and <VC#> (# = word-final) as an “alphabet sound”²¹. I analyzed 11 stimuli that can involve silent-E errors: *tate*, *pede*, *mibe*, *zobe*, *nupe*, *pude*, *snad*, *teb*, *tib*, *tob*, and *spug*. Table 31 shows the number of participants who read an “alphabet sound” and a “relative sound” oppositely.

Table 31. The number of silent-E errors and correct productions by 44 Japanese participants

Stimulus	Error type	# of participants who made errors	# of participants who were correct
		(Out of 44)	(Out of 44)
Alphabet sounds			
<i>tate</i>	Read as [æ:], instead of [e ^l]	0	23
<i>pede</i>	Read as [ɛ], instead of [i:]	8	26
<i>mibe</i>	Read as [ɪ], instead of [aɪ]	0	33
<i>zobe</i>	Read as [ɑ:], instead of [o ^o]	2	18
<i>nupe</i>	Read as [ʌ], instead of [u:]	3	33
<i>pude</i>	Read as [ʌ], instead of [(j)u:]	0	39
Relative sounds			
<i>snad</i>	Read as [e ^l], instead of [æ:]	1	8
<i>teb</i>	Read as [i:], instead of [ɛ]	1	39
<i>tib</i>	Read as [aɪ], instead of [ɪ]	1	11
<i>tob</i>	Read as [o ^o], instead of [ɑ:]	0	11
<i>spug</i>	Read as [u:], instead of [ʌ]	4	13

Notice that the Japanese participants made much more correct productions than incorrect productions. This suggests that acquisition of silent-E as an “alphabet sound” marker does not seem challenging for the Japanese participants.

²¹ Each of the vowel letters <a, e, i, o, u> has an “alphabet sound” (more commonly called “long sound”) [e^l, i:, aɪ, o^o, ju:] and a “relative sound” (more commonly called “short sound”) [æ:, ɛ, ɪ, ɑ:, ʌ] respectively as discussed in §2.3.1.2.

3.4.3.4 [ɹ] insertion by the Japanese participants

Rhotacization seems to make a stereotypical English-like sound to many Japanese EAL learners. I examined the number of hyper rhotacization in the reading task. The results are shown in Table 32.

Table 32. The number of [ɹ] insertion/hyper rhotacization by 44 Japanese participants

Stimulus	#	Stimulus	#	Stimulus	#
<i>stoe</i>	9	<i>spoo</i>	2	<i>pook</i>	1
<i>poad</i>	7	<i>tuh</i>	2	<i>stoh</i>	1
<i>sta</i>	4	<i>snad</i>	1	<i>pude</i>	1
<i>fow</i>	3	<i>spug</i>	1	<i>koun</i>	1
<i>staw</i>	2	<i>zo</i>	1	<i>kah</i>	1

Note. The numbers are out of 44 (participants).

Hyper rhotacization is concentrated in mid back vowels, and it never occurred in front vowels. As well, among the total of 37 occasions, 21 were [oɹ]. This may be in part because tongue movement from a back vowel to [ɹ] is smaller than that from a front vowel to [ɹ]. For *stoe* and *poad*, the occurrence of hyper rhotacization was much higher than *koun*, *stoh* and *fow*, which were also commonly pronounced as [o^ʊ] or [o:]. A possible factor is that *stoe* and *poad* appeared early in the randomized order of the stimuli (see Appendix 1). I suspect that for those Japanese participants who did hyper rhotacization, postvocalic [ɹ] was not a phoneme or a linguistic sound, but a phonetic sound that adds English-like flavour to their pronunciation. They may have read earlier stimuli with more enthusiasm and attempted to put more stereotypical English-like flavour into their productions, and then their enthusiasm gradually petered out as they went to later stimuli.

By the way, if [ɹ] is in fact not a phonemic sound for these Japanese participants, [o:] and [oɹ] must be free variations of the same underlying form in their interlanguage, such as /o:/. My focus in this study is on correspondences between graphemes and participants' underlying representations, rather than the surface representations, so in this sense, [o:] and [oɹ] must be treated as the same category. However, I decided to regard [o:] and [oɹ]

separately since I believe that the participants' false concept of postvocalic [ɹ] needs to be taken seriously. Firstly, this can affect their word recognition, such as *bone* versus *born*, *cod* versus *card*, *betta* (fish) versus *better*, and so forth, at least in sound forms. Secondly, if they recognize prevocalic/onset [ɹ] (as in *rat*) as a similar type of consonant phoneme to the Japanese flap /ɾ/, but postvocalic/coda [ɹ] (as in *car*) as a non-linguistic sound, this false concept should be one of the factors that make it difficult for Japanese EAL learners to acquire [ɹ]. The participants who did hyper rhotacization would need to learn the very simple rule that in rhotic dialects, if there is <r> in spelling, [ɹ] is supposed to be pronounced, and otherwise it is not.

3.4.3.5 Consistency and word-likeness

Recall that there is a moderate negative correlation ($r = -0.455$) between the number of sound variations for each stimulus by the Canadian participants and its word-likeness. However, the number of sound variations by the Japanese participants does not have a significant relationship with word-likeness ($r = -0.24$, $p = 0.171$). This is in part because phonetic realizations of interlanguage productions, especially by Japanese EAL learners who had taken only very limited instruction of the English sound system, show much more interspeaker and intraspeaker variations than those by native English speakers. Therefore, the number of variations of the Japanese participants' productions will vary depending on how coders phonologically interpret the phonetic realizations. Still, there are remarkable differences from one variation for *poïd* to 15 variations for *tuh* by the Japanese participants. A large number of variations can be interpreted that there are many choices to read and participants may have become indecisive. While native speakers' indecisiveness was correlated with word-likeness, the Japanese participants' indecisiveness seemed to be related to other factors, which have not been found. Table 33 shows the number of variation and word-likeness.

Table 33. Word-likeness and the number of production variations by the Japanese participants

stimulus	varia- tions	like- ness	stimulus	varia- tions	like- ness	stimulus	varia- tions	like- ness
<i>poïd</i>	1	3.2	<i>staw</i>	6	6	<i>snad</i>	8	3.6
<i>peest</i>	2	4.4	<i>spoo</i>	6	2.2	<i>skeap</i>	8	3.4
<i>paip</i>	2	3.4	<i>pook</i>	6	5.6	<i>faud</i>	8	3.6
<i>skay</i>	3	4.2	<i>kie</i>	6	2.6	<i>mibe</i>	8	2.6
<i>noy</i>	3	2.4	<i>koun</i>	6	2.6	<i>zobe</i>	8	2.2
<i>tib</i>	4	4.6	<i>poad</i>	7	5.8	<i>spug</i>	9	5.4
<i>tate</i>	5	6.4	<i>tob</i>	7	4.6	<i>zo</i>	9	2.2
<i>teb</i>	5	3.4	<i>stoh</i>	7	3.6	<i>sta</i>	9	2.4
<i>bew</i>	5	4.2	<i>pude</i>	7	4.6	<i>stoe</i>	11	4.2
<i>fow</i>	5	3.4	<i>pede</i>	7	3.8	<i>kah</i>	14	2
<i>smy</i>	5	1.8	<i>nupe</i>	8	4.8	<i>tuh</i>	15	1.8

Note. Word-likeness is out of 7 judged by five native English speakers of the Linguistics Department

3.4.3.6 Relationship between scores and LOR/AOA/self-evaluation

In this section, I will discuss participants' performances depending on length of residence in Canada (LOR), age of acquisition of English (AOA), and self-evaluation of their English proficiency. Based on the aforementioned 2-point scale, I calculated the average score of all the stimuli (the maximum score is 2 points \times 33 stimuli = 66 points) by all the participants, by those whose length of residence in Canada (LOR) is one year or longer, and by those whose LOR is shorter than one year. Table 34 shows the summary.

Table 34. Average scores by longer and shorter LOR Japanese EAL participants

	All the participants	LOR 1+ years	LOR < 1 year	Significance
Overall score (Score per stimulus)	36.8/66 (1.12/2)	39.6/66 (1.20/2)	32.6/66 (0.99/2)	* p < 0.05
Range	16 ~ 56	16 ~ 56	17 ~ 55	

Note. * indicates that the difference between those with LOR 1+ years and those with LOR < 1 year is significant at the p < 0.05 level.

36.8/66, for example, indicates that the overall average score is 36.8 points out of 66.

1.12/2, for example, indicates that the average score per stimulus is 1.12 points out of 2.

The two-tailed two-sample t-test shows that the longer LOR group scored significantly higher than the shorter LOR group. This suggests that long LOR can help Japanese EAL learners improve their skills of reading unfamiliar words.

I also examined how the three factors, LOR, AOA, and self-evaluation of their own overall English proficiency, related to their scores in the reading task. I used the Linear Regression by assigning the score of the reading task to the dependent variable and the three factors to the independent variables, in order to examine correlation between the overall score and these three factors. Overall, there is a significant correlation ($p < 0.001$). This means that all of these three factors together contribute to the score of the reading task. Standardized coefficients of the score and the three factors are shown in Table 35, which explains that which of the three factors better predict the score.

Table 35. Standardized coefficients of the score and the three factors of the Japanese participants

Dependent Variable: Score of the spelling task		
Independent variables	Beta	Significance
Length of residence in Canada (LOR)	2.915	** $p < 0.01$
Age of acquisition (AOA)	-1.771	$p = 0.084$
Self evaluation of their English proficiency	3.345	** $p < 0.005$

Note. ** indicates that it is significant at the $p < 0.01$ (or more) level.

First, self-evaluation has a significant moderate correlation with the score, suggesting that their self-evaluation can predict their grapheme-to-phoneme conversion skills to some extent. Or conversely, this could be interpreted that if their grapheme-to-phoneme conversion skills are high, their self-evaluation tends to be high. Second, LOR is another factor that can predict the score, but its correlation is not as high as self-evaluation. Third, AOA has the weakest relationship with the score, meaning that starting English at an early age does not guarantee high performance in the reading task.

I also analyzed relationships between error types and LOR/AOA/self-evaluation. With regard to silent-E related errors (e.g., <nupe> read as [nʌp] or <spug> read as [spu:g]), between the shorter LOR and longer LOR groups, the two-tailed two-sample t-test shows that the shorter LOR participants significantly ($p < 0.05$) made more silent-E errors (0.67 out of 11 stimuli vs. 0.31, overall 0.45). As for relationship with LOR, AOA, and self-evaluation of their English proficiency, the Linear Regression shows that only LOR alone has a significant

weak negative correlation with the number of silent-E errors ($r = -0.288$, $p < 0.05$), suggesting that long LOR can somewhat help them acquire the silent-E rule. It is interesting to note that their self-evaluation does not have a significant relationship.

With regard to [ɹ] insertion errors or hyper rhotacization (e.g., <stoe> read as [stoɹ]), the Linear Regression shows that only LOR alone has a significant weak negative correlation with the number of [ɹ] insertion ($r = -0.259$, $p < 0.05$), suggesting that the longer their LOR is, the slightly fewer [ɹ] insertion errors they make. However, the relationship is weak, meaning that long LOR does not necessarily help. Again, it is interesting to note that their self-evaluation has only a marginally significant relationship ($r = -0.235$, $p = 0.063$). A possible reason is that hyper rhotacization may give learners an erroneous impression that their English sounds good, which, in turn, could raise their self-evaluation.

3.4.3.7 Brief teaching implication regarding pronunciation

In this experiment, I adopted 33 different spellings, some of which were same vowel graphemes but in different environments. However, this does not mean that participants need to pronounce 33 contrastive vowels. If their target language is Canadian English, there must be only 13 contrasts regardless of the number of vowel graphemes (or if [ju:] and [u:] are regarded as different, there will be 14, and if the extraphoneme [a:] is regarded as different from [æ:] and [ɑ:], there will be 15). However, in the Japanese participants' productions, there were so many irrelevant contrasts in the English sound system as it can be seen in Table 27, such as [ĩ] versus [i:], [õ] versus [o:], [oɪ] versus [oɛ], ([ɿ] = non-syllabic) and so forth, non-existing diphthongs, such as [ɛʊ], [oɔ], [ɔa:] and so forth, and non-existing coda consonants [h] and [x]. There is a general belief that the English 13 vowel contrasts (or at least 10 so-called monophthongs) are reduced to five vowel contrasts in Japanese EAL learners' interlanguage phoneme inventory, but the truth is the opposite. Japanese EAL learners need to limit their interlanguage vowel contrasts to 13 despite the much larger

number of vowel graphemes. For example, they must not contrast <o> in *zo*, <oe> in *stow*, and <oh> in *stoh*.

Another piece of advice would be avoidance of hyper-correction. Rhotacization as well as fronting (and lengthening) of Japa/a/ (for targeting Eng[ʌ]) caused multiple point losses in the reading task. As well, lowering of the nuclei of Eng[ɔɪ] and [o^u] (i.e., [aɪ] and [ɔ^u] respectively) caused more “accented” productions although these productions were still within the target phonemes. In these cases, if Japanese EAL learners simply substitute Japanese sounds without hyper-correction, their productions would be more accurate.

3.5 The Chinese participants: how they compare with the native speakers

3.5.1 Background

The English education in China seems to give far greater weight to pronunciation than that in Japan, so Chinese EAL learners are expected to have more explicit knowledge about the phonological system of English than Japanese EAL learners do. Moreover, educations for other languages in China also seem to put a lot of weight on pronunciation. For example, Mandarin-as-an-additional-language courses begin with the thorough Mandarin sound system, as a sound system is the foundation of a language. As I have experienced both Mandarin-as-a-second/foreign-language courses in China and Canada, and English-as-a-foreign-language courses in Japan, I noticed that the approach in the Chinese education (in both Canada and China) is antithetical to that of the English education in Japan in which most middle school English courses virtually skip lessons of the basic sound system. Note that there are Japanese teachers of English who teach pronunciation properly, but not many (Teshima, 2011). Likewise, Japanese-as-a-foreign-language textbooks sold in China have explicit descriptions of the Japanese phonemic pitch accent system (e.g., あ か /áka/ ‘red’ versus あ か /aká/ ‘scum’) at the very beginning, whereas Japanese-as-a-second-language textbooks sold in

Japan do not (Minematsu, 2015): for example, see Rénmín jiàoyù chūbǎnshè (2014) *ZhōngRì jiāoliú biāozhǔn Riběnyǔ* ‘China-Japan interchange standard Japanese’. Moreover, some native Japanese-speaking teachers have difficulty consciously identifying Japanese phonemic pitch accent, while some Chinese Japanese-as-an-additional-language learners could be more sensitive to the Japanese pitch accent than teachers (Minematsu, 2015) (also see Goss, 2015). In terms of language pronunciation, I have an impression that Japan and China’s perspectives are almost antitheses²².

Despite that, GPC knowledge may be a different story. As mentioned in §2.1.5, previous studies show that both Japanese and Chinese EAL learners tend to read English spelling logographically, and therefore, they read English less efficiently than those who use both top-down and bottom-up processes. Moreover, if Chinese EAL learners tend to mainly depend on IPA symbols when memorizing phonological forms of lexical items without paying much attention to GPC rules, just like *pinyin* phonetic notations along with *hanzi* Chinese characters (shown in Figure 36), their explicit knowledge about English GPC rules may not necessarily be sufficient.

Word:	Canada	加拿大
Phonetic notation:	/kæ.nə.də/	jiā ná dà

Figure 36. Orthographic representations and phonetic notations with IPA for an English word and pinyin for a Chinese word

Moreover, even if the English education in China prioritises pronunciation, not all the learners would keenly practice pronunciation, especially in EFL environments. So it would be worth examining whether the Chinese participants perform differently from the Japanese participants.

²² Teshima (2011) mentions that in Japan, English phonetics is not a required course to become an English teacher. Teshima (2011) continues that this situation can be analogous to becoming a music teacher without a skill of reading music notes.

3.5.2 Coding for the Chinese participants

For coding, the same phonetically trained native English speaker from Utah and myself transcribed the Chinese participants' productions. Again, since this study focuses on which graphemes correspond to which (interlanguage) phonemes, we transcribed categorically, rather than phonetically. Both raters transcribed individually and the inter-rater reliability was 94.9%. The higher inter-rater reliability for the Chinese participants' productions than that for the Japanese participants is because according to our impression, the Chinese participants' productions more consistently fit into English phonemic categories and there were fewer non-existing phones as English.

The English education in China traditionally sets the Received Pronunciation (RP) as the model (Yong & Campbell, 1995), although recently General American may be becoming popular. In consideration of this background, the Chinese participants may distinguish the LOT, THOUGHT, and PALM²³ vowels in accordance with Received Pronunciation: for example, see BěijīngShì wàiwén yīnxiàng chūbǎnshè (2014) *xīngàiniàn xiǎoxuésheng Yīngyǔ - kuàilè pīndú* 'new concept elementary school student English – happy phonetic reading'. In fact, in the reading task, many Chinese participants pronounced vowels like [o:] which were presumably intended for the British THOUGHT vowel, so I regarded [o:] for the stimuli *faud* and *staw* (the <au, aw>-[o:] correspondence) as correct, as I did it for the Japanese participants to be consistent. Another example of their RP-like pronunciation is vowels like [ə^u] as (opposed to [o^u]) for the GOAT vowel, which was regarded as correct. As well, the

²³ As of 2015, to my knowledge, except for recent editions of GENIUS English-Japanese dictionary, other English-Japanese dictionaries transcribe these three vowels as /ɑ/, /ɔ:/ and /ɑ:/ or similar symbols respectively for American English pronunciation, in addition to British English pronunciation. Makino (2006) questions whether these three distinctions should be on dictionaries for American pronunciation for the purpose of teaching English to Japanese EAL learners. I have the same perspective as him, but I will discuss this issue in other time.

stimulus *nupe* pronounced as [nju:p], as opposed to the Canadian participants [nu:p], was regarded as correct.

3.5.3 Results of the Chinese participants

Table 36 shows the overall results. Again, I used the 2-point scale as explained in Table 26. The Canadian participants' most frequent choices are worth 2 points, displayed in thick red frames in Table 36. The Canadian participants' second and third most frequent choices are worth 1 point, displayed in thin red boxes. In consideration of the participants' British background, [o:] for <au, aw> and [ju:] for *nupe* are worth 2 points, displayed in blue triple line frames. Sounds that the Canadian participants never chose are worth 0 points, displayed in shaded boxes.

Table 36. Results of the Chinese participants' responses in the reading task

Graph. Stimuli	Grapheme and stimuli								
	<ay#> <i>skay</i>	<a_e> <i>tate</i>	<ai> <i>paip</i>	<ee> <i>peest</i>	<ea> <i>skeap</i>	<e_e> <i>pede</i>	<y#> <i>smy</i>	<i_e> <i>mibe</i>	<ie#> <i>kie</i>
Response # (%)	[e'] 20 (83%)	[e'] 18 (75%)	[aɪ] 15 (63%)	[i:] 21 (88%)	[i:] 20 (83%)	[ɛ] 12 (50%)	[aɪ] 12 (50%)	[aɪ] 11 (46%)	[aɪ] 13 (54%)
Response # (%)	[aɪ] 2 (8%)	[æ:] 2 (8%)	[e'] 6 (25%)	[ɛ] 2 (8%)	[ɛ] 4 (17%)	[i:] 11 (46%)	[i:] 11 (46%)	[i:] 3 (13%)	[i:] 10 (42%)
Response # (%)	[i:] 2 (8%)	[ɛ] 2 (8%)	[ɛ] 3 (13%)	[ɪ] 1 (4%)		[e'] 1 (4%)	[u:] 1 (4%)	[ɪ] 3 (13%)	[ɛ] 1 (4%)
Response # (%)		[æ:_i] 1 (4%)						[æ:] 3 (13%)	
Response # (%)		[a:] 1 (4%)						[ɛ] 1 (4%)	
Response # (%)								[ɪ] 1 (4%)	
Response # (%)								[aɪ_i:] 1 (4%)	
Response # (%)								[i:_e'] 1 (4%)	
Total	24	24	24	24	24	24	24	24	24

24 Chinese participants

Grapheme and stimuli						
<oa> <i>poad</i>	<o_e> <i>zobe</i>	<o#> <i>zo</i>	<oe> <i>stoe</i>	<oh> <i>stoh</i>	<oo> <i>spoo</i>	<ooC#> <i>pook</i>
[o^o~ə^o]	[o^o~ə^o]	[o^o~ə^o]	[o^o~ə^o]	[o^o~ə^o]	[u:]	[u:]

17(71%)	9 (38%)	11 (46%)	13 (54%)	10 (42%)	21 (88%)	13 (54%)
[o:~ɔ:] 4 (17%)	[u:] 5 (21%)	[u:] 7 (29%)	[u:] 3 (13%)	[o:~ɔ:] 10 (42%)	[u:n~u:m] 2 (8%)	[a:~ɔ:] 4 (17%)
[ɑ:] 2 (8%)	[o:~ɔ:] 3 (13%)	[o:~ɔ:] 5 (21%)	[ɔɪ] 3 (13%)	[ɑ:] 1 (4%)	[o ^o] 1 (4%)	[ʊ] 3 (13%)
[aʊ] 1 (4%)	[a:~ɔ:] 2 (8%)	[ɔʔ] 1 (4%)	[o ^o .i:] 1 (4%)	[oɪ] 1 (4%)		[o:~ɔ:] 2 (8%)
	[o ^o .i:] 1 (4%)		[jo ^o] 1 (4%)	[o ^o n] 1 (4%)		[o ^o] 2 (8%)
	[u:.i:] 1 (4%)		[o:] 1 (4%)	[o ^o s] 1 (4%)		
	[o:.i:] 1 (4%)		[oɪ] 1 (4%)			
	[ɔ:_e ^l] 1 (4%)		[ɔ̃] 1 (4%)			
	[ʌ] 1 (4%)					
24	24	24	24	24	24	24

24 Chinese participants

Grapheme and stimuli							
<cor. C + u_e> <i>nupe</i>	<non-cor. C + u_e> <i>pude</i>	<non-cor. C + ew> <i>bew</i>	<aC#> <i>snad</i>	<eC#> <i>teb</i>	<iC#> <i>tib</i>	<uC#> <i>spug</i>	<uh> <i>tuh</i>
[ju:] 9 (38%)	[ju:] 12 (50%)	[ju:] 13 (54%)	[æ:] 14 (58%)	[ɛ] 18 (75%)	[i:] 13 (54%)	[ʌ] 11 (46%)	[u:] 9 (38%)
[u:] 8 (33%)	[u:] 11 (46%)	[u:] 3 (13%)	[a:] 5 (21%)	[æ:] 3 (13%)	[ɪ] 7 (29%)	[a:] 7 (29%)	[a:] 5 (29%)
[ʌ] 5 (21%)	[a:] 1 (4%)	[ɛʊ] 3 (13%)	[ɛ] 3 (13%)	[ɪ] 1 (4%)	[ĩ] 3 (13%)	[ɑ:] 4 (17%)	[ʌ] 4 (17%)
[ɛ] 2 (8%)		[o ^o] 1 (4%)	[ɛn] 1 (4%)	[e ^l] 1 (4%)	[e ^l] 1 (4%)	[æ:] 1 (4%)	[ʌ:] 1 (4%)
		[ɛ] 1 (4%)	[e ^l] 1 (4%)	[i:] 1 (4%)		[aʊ] 1 (4%)	[ʌs] 1 (4%)
		[ʊ] 1 (4%)					[ʌŋ~ɑ:ŋ] 2 (8%)
		[i:] 1 (4%)					[ju:] 1 (4%)
		[jɔ:] 1 (4%)					[ɑ:] 1 (4%)
24	24	24	24	24	24	24	24

24 Chinese participants

Grapheme and stimuli				
<oC#> <i>tob</i>	<aw#> <i>staw</i>	<au> <i>faud</i>	<a#> <i>sta</i>	<ah> <i>kah</i>

[ɑ:] 14 (58%)	[o:~ɔ:] 18 (75%)	[o:~ɔ:] 11 (46%)	[ɑ:] 13 (54%)	[ɑ:] 13 (54%)
[o:~ɔ:] 4 (17%)	[o ^ʊ ~ə ^ʊ] 4 (17%)	[aʊ~ɑʊ] 6 (25%)	[æ:] 3 (13%)	[æ:] 4 (17%)
[o ^ʊ ~ə ^ʊ] 2 (8%)	[aʊ] 1 (4%)	[o ^ʊ ~ə ^ʊ] 5 (21%)	[ʌ] 2 (8%)	[ɑ:] 3 (13%)
[ʊ] 2 (8%)	[ɔɪ] 1 (4%)	[ɑ:] 1 (4%)	[ǎʔ] 1 (4%)	[ʌ] 1 (4%)
[u:] 1 (4%)		[ʌ:~ʊ:] 1 (4%)	[ɑ:] 1 (4%)	[ǎ] 1 (4%)
[ʌ] 1 (4%)			[eʰ] 1 (4%)	[a:ŋ] 1 (4%)
			[ɛ] 1 (4%)	[eʰθ] 1 (4%)
			[ɪ] 1 (4%)	
			[im] 1 (4%)	
24	24	24	24	24

24 Chinese participants

Grapheme and stimuli			
<oy#> <i>noy</i>	<oi> <i>poïd</i>	<ow#> <i>fow</i>	<ou> <i>koun</i>
[ɔɪ] 23 (96%)	[ɔɪ] 23 (96%)	[o^ʊ~ə^ʊ] 18 (75%)	[o ^ʊ ~ə ^ʊ] 9 (38%)
[o ^ʊ] 1 (4%)	[o ^ʊ] 1 (4%)	[o:~ɔ:] 4 (17%)	[aʊ] 7 (29%)
		[aʊ] 2 (8%)	[u:] 5 (21%)
			[o:~ɔ:] 2 (8%)
			[ɔɪ] 1 (4%)
24	24	24	24

Note. The thick red double line boxes are worth 2 points. The thin red double line boxes are worth 1 point. The blue triple line boxes are worth 2 points. [C] indicates a consonant.

3.5.4 Discussion

3.5.4.1 General discussion

The number of the 0-point productions (or the productions that the Canadian participants never chose) was 245 out of 792 (33 stimuli × 24 participants), which becomes 30.9%. This is lower than the Japanese participants' (40.1%). As well, the overall average

score based on the 2-point scale was 44.1 points out of 66 (33 stimuli × 2 points), or in other words 1.32 points out of 2. This is also better than the Japanese participants' (36.8/66 or 1.12/2).

For nine of the 33 stimuli, specifically *paip*, *pede*, *nupe*, *pude*, *tib*, *tuh*, *staw*, *faud*, and *koun*, the most frequent productions by the Chinese participants were different from those by the Canadian participants. However, the Chinese participants distinguished the [ɑ:]-[ɔ:] contrast unlike the Canadian participants, so if *staw* and *faud* pronounced as [o:~ɔ:] are regarded as the same as [ɑ:], it becomes seven out of the 33 stimuli, which is fewer than the Japanese participants' 11. However, among the rest of the stimuli, for which the most frequent productions by the Chinese participants matched those by the Canadian participants, six of them were 50% or below in consistency: *smy* (50%), *mibe* (46%), *spug* (46%), *zo* (46%), *stoh* (42%), and *zobe* (38%) (as well as *faud* as [o:~ɔ:] (46%) and as [ɑ:] (4%)). Notice that three of these involve the graphemes corresponding to “alphabet O” ([o^o]), suggesting that for both Japanese and Chinese participants, graphemes corresponding to [o^o] seemed challenging. Likewise, *tib*, *tuh*, *spug*, and *koun*, were also challenging for both Japanese and Chinese participants; <u> in *spug* was often too open or too long (such as [a:]) by both Japanese and Chinese participants, indicating a possibility of a phonetic problem rather than a GPC problem.

3.5.4.2 Difficult and easy stimuli for the Chinese participants

I used the K-Means Cluster Analysis to divide the stimuli into three clusters based on each Chinese participant's reading patterns. Figure 37 shows the three clusters based on the K-Means Cluster Analysis.

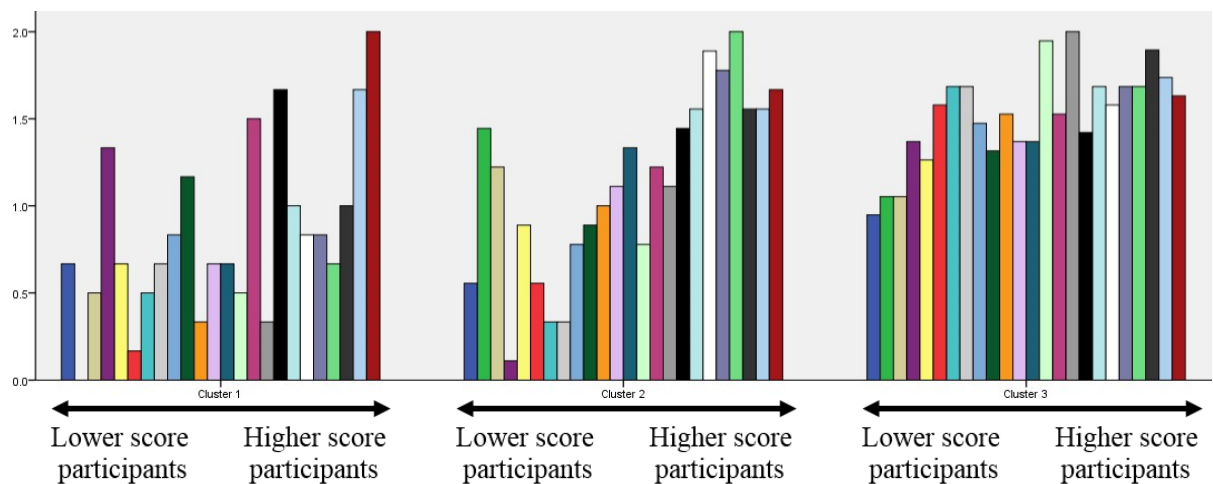


Figure 37. Clustered nonsense word stimuli based on the Chinese participants' performance

In these graphs, each bar represents each of the 24 participants' average score in the particular cluster. On the X-axis, each cluster consists of the participants who are aligned in ascending order in their overall scores, meaning that "higher score participants" are on the right hand side and "lower score participants" are on the left hand side. The Y-axis indicates average scores (based on the 2-point scale) by each participant for the stimuli in each cluster: for example, if a bar in cluster 1 indicates 1.5, this particular participant's average score for the cluster 1 stimuli is 1.5 out of 2.

In all the clusters, higher score participants performed better, but overall, the participants performed well with the cluster 3 stimuli and not well with the cluster 1 stimuli.

Table 37. Cluster 1 stimuli and average scores

Stimuli	Score	Stimuli	Score
<i>tib</i>	0.58	<i>zobe</i>	0.83
<i>tuh</i>	0.79	<i>stoh</i>	0.83
<i>spug</i>	0.83	<i>snad</i>	1.17

Table 38. Cluster 2 stimuli and average scores

Stimuli	Score	Stimuli	Score	Stimuli	Score
<i>pede</i>	0.92	<i>sta</i>	1.13	<i>kah</i>	1.21
<i>zo</i>	0.92	<i>paip</i>	1.13	<i>bew</i>	1.21
<i>stoe</i>	1.08	<i>koun</i>	1.17	<i>poad</i>	1.42

Table 39. Cluster 3 stimuli and average scores

Stimuli	Score	Stimuli	Score	Stimuli	Score	Stimuli	Score
<i>mibe</i>	1.04	<i>pude</i>	1.42	<i>fow</i>	1.58	<i>noy</i>	1.92
<i>tob</i>	1.17	<i>smv</i>	1.42	<i>skay</i>	1.67	<i>kie</i>	1.92
<i>pook</i>	1.25	<i>staw</i>	1.50	<i>skeap</i>	1.67	<i>poid</i>	1.96
<i>faud</i>	1.29	<i>teb</i>	1.50	<i>spoo</i>	1.75		
<i>nupe</i>	1.42	<i>tate</i>	1.50	<i>peest</i>	1.75		

Three of the “relative vowel sounds” [ɪ, ʌ, æ:] (*tib*, *spug*, and *snad*) were grouped in cluster 1, suggesting that the Chinese participants had more trouble reading “relative sound” letters than “alphabet sound” letters in general, which is similar to the Japanese participants. Aside from GPC knowledge, articulation difficulties may also be involved in these three vowels. Especially, the Chinese participants had the most trouble with <i>. As discussed in Wang and Munro (2004), Mandarin speakers tend to have a false concept that Eng[ɪ] is phonetically a short version of Eng[i:] (i.e., [i] vs. [i:]). This contributed the low score of <i>. As for <uh> in *tuh*, just as the Japanese participants did, <uh> in *tuh* was also most frequently read as [u:] by the Chinese participants (9/24). This may be interference from the Mandarin pinyin <u>-Mand/u/ correspondence. The difference from the Japanese participants regarding <uh> was that the Chinese participants never pronounced word-final /h/ as a coda consonant, except that one participant mistook <h> for <th> and pronounced [tʌs] with [s] substitution for /θ/. Incidentally, for *kah* and *stoh*, the Chinese participants also never pronounced word-final /h/, unlike the Japanese participants. This means that the Chinese participants knew the English phonotactic constraint that /h/ does not occur in a coda position. As for <oh> in *stoh*, 10 out of 24 participants correctly pronounced it as [o^u~ə^u], but another 10 incorrectly pronounced it as [o:~ɔ:]. These errors may be due to interference from the Mandarin pinyin <o>-Mand/o/ correspondence

Regarding cluster 2 stimuli, *zo* was most frequently pronounced as [o^u~ə^u] (11/24), but seven participants pronounced it as [u:]. Their [u:] is not a transfer from the L1 pinyin <o>-Mand/o/, but possibly from words like *do* or *to*. An L1 pinyin transfer was observed in

<ai> (c.f., <ai>-Mand/aj/) in *paip*, which was most frequently pronounced as [aɪ] (15/24), followed by [e^ɪ] (6/24). While <ai>-Eng[aɪ] was also observed in the Canadian participants' results, it would be better for the Chinese participants to learn the most frequent [e^ɪ]. Another L1 pinyin transfer was observed in <ou> (c.f., <ou>-Mand/ow/) in *koun*, which was most frequently pronounced as [o^ʊ~ə^ʊ] (9/24), followed by [aʊ] (7/24), followed by [u:] (5/24). Interestingly, that unlike <ai> with a quite strong preference to [aɪ], <ou> showed more even distribution among [o^ʊ, aʊ, u:], which is somewhat similar to the Canadian participants' patterns.

Regarding cluster 3 stimuli, the Chinese participants' <aw> and <au> were grouped in cluster 3 although their pronunciation was in a British way. Recall that the Japanese participants had a severe problem with <aw> and <au>, which is a notable difference between these two L1 groups. Interestingly, <oi> was the easiest for both Japanese and the Chinese participants, despite a lack of the digraph <oi> in Mandarin pinyin spelling.

3.5.4.3 Silent-E by the Chinese participants

In this section, I will discuss how the Chinese participants dealt with the function of silent-E as an “alphabet sound” marker. Table 40 shows the number of silent-E errors for each stimulus.

Table 40. The number of silent-E errors and correct productions by 24 Chinese participants

Stimulus	Error type	# of participants who made errors	# of participants who were correct
Alphabet sounds		(Out of 24)	(Out of 24)
<i>tate</i>	Read as [æ:], instead of [e]	2	18
<i>pede</i>	Read as [ɛ], instead of [i:]	12	11
<i>mibe</i>	Read as [ɪ], instead of [aɪ]	3	11
<i>zobe</i>	Read as [ɑ:], instead of [o ^ʊ]	2	9
<i>nupe</i>	Read as [ʌ], instead of [u:]	5	17
<i>pude</i>	Read as [ʌ], instead of [(j)u:]	0	23
Relative sounds		(Out of 24)	(Out of 24)
<i>snad</i>	Read as [e ^ɪ], instead of [æ:]	1	14
<i>teb</i>	Read as [i:], instead of [ɛ]	1	18
<i>tib</i>	Read as [aɪ], instead of [ɪ]	0	7

<i>tob</i>	Read as [o ^ʊ], instead of [ɑ:]	2	14
<i>spug</i>	Read as [u:], instead of [ʌ]	1	11

The Chinese participants' errors were mostly concentrated in *pede*. Other than *pede*, they chose correct pronunciations more frequently than incorrect ones.

3.5.4.4 [ɹ] insertion by the Chinese participants

Impressionistically, Chinese EAL learners are generally said to hyper rhotacize English vowels, like Japanese EAL learners. However, in this present word-reading task, there were only three occasions of hyper rhotacization by two participants, meaning that the problem of hyper rhotacization was much less serious than by the Japanese participants. Specifically, *sta* pronounced as [stɹ] by an EFL participant from Shandong, and both *stoe* and *stoh* as [stɹ] by another EFL participant from Shengsi. The case of the participant from Shandong may be a transfer from L1 *erhuayin*, in which *er* (ɹ) is often added. The other participant's L1 is not *erhuayin*, so it may not be L1 transfer. What is interesting is that the participant from Shengsi's rhotacization occurred only as [ɹ], similar to the Japanese participants.

3.5.4.5 Consistency and word-likeness

Recall that there is a moderate negative correlation ($r = -0.455$) between the number of sound variations for each stimulus by the Canadian participants and its average word-likeness. However, the number of sound variations by the Chinese participants does not have a significant relationship with word-likeness ($r = -0.153$, $p = 0.387$), and the correlation is even weaker than that by the Japanese participants. Table 41 shows the number of variations and word-likeness.

Table 41. Word-likeness and spelling variations by the Chinese participants

stimulus	varia- tions	like- ness	stimulus	varia- tions	like- ness	stimulus	varia- tions	like- ness
<i>poïd</i>	2	3.2	<i>pede</i>	3	3.8	<i>fauđ</i>	5	3.6
<i>skay</i>	2	4.2	<i>tib</i>	4	4.6	<i>spug</i>	5	5.4

<i>noy</i>	2	2.4	<i>staw</i>	4	6	<i>tob</i>	6	4.6
<i>skeap</i>	2	3.4	<i>poad</i>	4	5.8	<i>stoh</i>	6	3.6
<i>peest</i>	3	4.4	<i>nupe</i>	4	4.8	<i>kah</i>	7	2
<i>paip</i>	3	3.4	<i>zo</i>	4	2.2	<i>bew</i>	8	4.2
<i>fow</i>	3	3.4	<i>tate</i>	5	6.4	<i>mibe</i>	8	2.6
<i>smy</i>	3	1.8	<i>teb</i>	5	3.4	<i>stoe</i>	8	4.2
<i>spoo</i>	3	2.2	<i>pook</i>	5	5.6	<i>tuh</i>	8	1.8
<i>kie</i>	3	2.6	<i>koun</i>	5	2.6	<i>zobe</i>	9	2.2
<i>pude</i>	3	4.6	<i>snad</i>	5	3.6	<i>sta</i>	9	2.4

Note. Word-likeness is out of 7 judged by five native English speakers of the Linguistics Department

3.5.4.6 Relationship between scores and LOR/AOA

Based on the aforementioned 2-point scale, I calculated the average scores of all the stimuli (the maximum score is 2 points \times 33 stimuli = 66 points) for all the participants, only ESL participants, and only EFL participants. Then, I compared Chinese ESL and EFL participants by using the two-tailed two-sample t-test. Table 42 shows the results of the Chinese participants.

Table 42. Average scores by Chinese ESL and EFL participants

The Chinese participants				
	All the participants	ESL	EFL	Significance
Overall score (Score per stimulus)	44.1/66 (1.34/2)	44.0/66 (1.33/2)	44.1/66 (1.34/2)	N.S. $p = 0.97$
Range	27 ~ 58	27 ~ 57	34 ~ 58	

Note. N.S. = not significant

As it is displayed, unexpectedly the average scores by Chinese ESL and EFL participants were almost exactly the same. As for the relationship with LOR and AOA, surprisingly, the Linear Regression shows that only AOA alone has a significant moderate correlation with the score but *positively* ($r = 0.370$, $p < 0.05$), meaning that the later their AOA is, the better their score is. This result is opposite to our general belief that the earlier their AOA is, the better they learn an additional language. A possible explanation could be that younger children tend to learn English rules more implicitly while older children tend to learn them more explicitly, but further research is needed.

I also examined a relationship between the number of silent-E related errors (e.g., <zobe> pronounced as [za:b] or <tob> pronounced as [to^ub]) and LOR/AOA. The Linear Regression shows that only LOR alone has a significant negative correlation with the number of silent-E errors ($r = -0.346$, $p < 0.05$), and AOA does not have any role, meaning that the longer their LOR is, the less likely to make silent-E errors to some extent. This is consistent with the Japanese participants.

3.6 Comparison between Japanese and the Chinese participants

In this section, I compare the Japanese and Chinese participants.

3.6.1 Overall results

Table 43 organizes first (most frequent) and second (second most frequent) choices by Canadians, Japanese, and the Chinese participants. In the Japanese and Chinese participants' columns, red frames indicate the productions that match the Canadian participants' most frequent choices. Note that these percentages are of 14 Canadian participants, 44 Japanese participants, and 24 Chinese participants.

Table 43. First (most frequent) and second (the second most frequent) choices by the Canadian, Japanese, and Chinese participants in the reading task

Target graph.	Stimulus	Canadian participant (control)		Japanese participant		Chinese participant	
		1st	2nd	1st	2nd	1st	2nd
<ay#>	<i>skay</i>	[e'] 100%		[e'] 52%	[aɪ] 45%	[e'] 83%	[i:] [aɪ] 8%
<a_e>	<i>tate</i>	[e'] 100%		[e'] 91%	[aɪ] [ɛ] [a:] [ʌ] 2%	[e'] 75%	[æ:] 8%
<ai>	<i>paip</i>	[e'] 86%	[aɪ] 14%	[e'] 77%	[aɪ] 23%	[aɪ] 63%	[e'] 25%
<ee>	<i>peest</i>	[i:] 100%		[i:] 97%	[ɛ] 2%	[i:] 88%	[ɛ] 8%
<ea>	<i>skeap</i>	[i:] 100%		[i:] 68%	[ɛ~ɛ:] 14%	[i:] 83%	[ɛ] 17%

<e_e>	<i>pede</i>	[i:] 93%	*[ɛ] 7%	[i:] 59%	[ɛ] 18%	[ɛ] 50%	[i:] 46%
<y#>	<i>smy</i>	[aɪ] 86%	[i:] 14%	[aɪ] 50%	[i:] 41%	[aɪ] 50%	[i:] 46%
<i_e>	<i>mibe</i>	[aɪ] 79%	[i:] 21%	[aɪ] 75%	[i:_ɛ] 9%	[aɪ] 46%	[i:] 13%
<ie#>	<i>kie</i>	[aɪ] [i:] 50%		[i:] 77%	[jɛ] 9%	[aɪ] 54%	[i:] 42%
<oa>	<i>poad</i>	[o ^u] 100%		[o:~ɔ:] 34%	[o ^u ~ɔ ^u] 27%	[o ^u ~ə ^u] 71%	[o:~ɔ:] 17%
<o_e>	<i>zobe</i>	[o ^u] 86%	[o ^u _i:] 14%	[o ^u ~ɔ ^u] [o:~ɔ:] 41%		[o ^u ~ə ^u] 38%	[u:] 21%
<o#>	<i>zo</i>	[o ^u] 100%		[o ^u ~ɔ ^u] 45%	[o:~ɔ:] 16%	[o ^u ~ə ^u] 46%	[u:] 29%
<oe>	<i>stoe</i>	[o ^u] 100%		[o ^u ~ɔ ^u] 30%	[o:~ɔ:] 18%	[o ^u ~ə ^u] 54%	[u:] [oɪ] 13%
<oh>	<i>stoh</i>	[o ^u] 100%		[o ^u ~ɔ ^u] [o:~ɔ:] 39%		[o ^u ~ə ^u] [o:~ɔ:] 42%	
<oo#>	<i>spoo</i>	[u:] 100%		[u:] 79%	[o ^u ~ɔ ^u] 9%	[u:] 88%	[u:n~u:m] 8%
<ooC#>	<i>pook</i>	[u:] 93%	[ʊ] 7%	[u:] 70%	[o:~ɔ:] 20%	[u:] 54%	[a:~ɔ:] 17%
<cor. C + u_e>	<i>nupe</i>	[u:] 100%		[u:] 75%	[ʌ] 7%	[ju:] 38%	[u:] 33%
<non-cor. C + u_e>	<i>pude</i>	[u:] 64%	[ju:] 36%	[u:] 61%	[ju:] 27%	[ju:] 50%	[u:] 46%
<non-cor. C + ew>	<i>bew</i>	[ju:] 93%	[u:] 7%	[ɛʊ] 50%	[ju:] 41%	[ju:] 54%	[u:] [ɛʊ] 13%
<aC#>	<i>snad</i>	[æ:] 100%		[a:] 50%	[ǎ~ʌ] 20%	[æ:] 58%	[a:] 21%
<eC#>	<i>teb</i>	[ɛ] 100%		[ɛ~ɛ̃] 89%	[ɪ] 5%	[ɛ] 75%	[æ:] 13%
<iC#>	<i>tib</i>	[ɪ] 100%		[i:] 50%	[ɪ] 23%	[i:] 54%	[ɪ] 29%

<oC#>	<i>tob</i>	[ɑ:] 100%		[o:~ɔ:] 48%	[ɑ:] 20%	[ɑ:] 58%	[o:~ɔ:] 17%
<aw#>	<i>staw</i>	[ɑ:] 100%		[æʊ~ɑʊ] 59%	[o ^ʊ ~ɔ ^ʊ] 25%	[o:~ɔ:] 75%	[o ^ʊ ~ə ^ʊ] 17%
<au>	<i>fau</i>	[ɑ:] 64%	[o ^ʊ] 36%	[æʊ~ɑʊ] 73%	[o ^ʊ ~ɔ ^ʊ] 14%	[o:~ɔ:] 46%	[aʊ] 25%
<a#>	<i>sta</i>	[ɑ:] 64%	[ɑ:] 29%	[ǣ?~ʌ?] 43%	[ɑ:] 27%	[ɑ:] 54%	[æ:] 13%
<ah>	<i>kah</i>	[ɑ:] 64%	[ɑ:] 21%	[ɑ:] 27%		[ɑ:] 54%	[æ:] 17%
<uC#>	<i>spug</i>	[ʌ] 100%		[ɑ:~ǣ] 30%	[ʌ] 20%	[ʌ] 46%	[ɑ:] 29%
<uh>	<i>tuh</i>	[ʌ] 86%	[u:] 14%	[u:] 45%	[ʌ] 9%	[u:] 38%	[ɑ:] 29%
<oy#>	<i>noy</i>	[ɔɪ] 100%		[oɪ~ɑɪ] 93%	[o ^ʊ] 5%	[oɪ] 96%	[o ^ʊ] 4%
<oi>	<i>poid</i>	[ɔɪ] 100%		[oɪ~ɑɪ] 100%		[oɪ] 96%	[o ^ʊ] 4%
<ow#>	<i>fow</i>	[o ^ʊ] 71%	[aʊ] 29%	[o ^ʊ ~ɔ ^ʊ] 68%	[aʊ] 14%	[o^ʊ~ə^ʊ] 75%	[o:~ɔ:] 17%
<ou>	<i>koun</i>	[aʊ] 50%	[u:] 29%	[o^ʊ~ɔ^ʊ] 77%	[aʊ] 11%	[o^ʊ~ə^ʊ] 38%	[aʊ] 29%

Note. Productions by the Canadian participants with over 80% consistency and those by EAL participants with over 70% consistency are bolded. The thick red double line boxes are worth 2 points. The plain boxes with no shading are worth 1 point. Shaded boxes are worth 0 points. The blue triple line boxes are worth 2 points.

3.6.2 Discussion

3.6.2.1 Score difference between the Japanese and Chinese participants

Table 44 shows the overall scores of both Japanese and Chinese participants.

Table 44. Average scores by longer and shorter LOR Japanese EAL participants plus Chinese ESL and EFL participants

The Japanese participants				
	All the participants	LOR 1+ years	LOR < 1 year	Significance
Overall score (Score per stimulus)	36.8/66 (1.12/2)	39.6/66 (1.20/2)	32.6/66 (0.99/2)	* p < 0.05
Range	16 ~ 56	16 ~ 56	17 ~ 55	
The Chinese participants				
	All the participants	ESL	EFL	Significance

Overall score (Score per stimulus)	44.1/66 (1.34/2)	44.0/66 (1.33/2)	44.1/66 (1.34/2)	N.S. p = 0.97
Range	27 ~ 58	27 ~ 57	34 ~ 58	
Significance C vs. J	** p < 0.005			

Note. N.S. = not significant * indicates that it is significant at the $p < 0.05$ level. ** indicates that it is significant at the $p < 0.01$ (or more) level.

As it is displayed, both Chinese ESL and EFL participants performed better than the Japanese participants in terms of overall scores. As for 0-point productions, or the sounds that the Canadian participants never chose, the Chinese participants produced 30.9% of those, which is also better than the Japanese participants' 40.1%. This means that although according to previous studies, both Chinese and Japanese EAL learners tend to read English words logographically, the Chinese participants' phonological decoding (or the bottom-up process) is better than the Japanese participants'. This may be in part because of different attitudes towards pronunciation in language educations in China and Japan.

3.6.2.2 Silent-E by the Japanese and the Chinese participants

In terms of errors regarding silent-E as an “alphabet sound” marker, the two-sample t-test shows that the Chinese participants made significantly ($p < 0.005$) more errors than the Japanese participants (overall 1.21 vs. 0.45 stimuli out of 11 stimuli), although the number of errors was relatively small in both groups.

3.6.2.3 [ɹ] insertion by the Japanese and Chinese participants

In this present word-reading task, there were only three occasions of hyper rhotacization by the Chinese participants, while there were the total of 37 occasions by the Japanese participants. This means that hyper rhotacization is a much less serious problem by the Chinese participants than by the Japanese participants.

3.6.2.4 Other differences and similarities

There were some differences between Japanese and the Chinese participants. In terms of graphemes, the Japanese participants showed a severe L1 transfer for <ou, au, aw>, but

this was not the case by the Chinese participants. Especially, the Chinese participants' <aw> and <au> were grouped in cluster 3 (the easiest graphemes) although their pronunciation was in a British way, while the Japanese participants' <aw> and <au> were grouped in cluster 1 (the most difficult graphemes). A possible explanation is that since Mandarin pinyin does not have the digraphs <aw> and <au>, there was no L1 transfer in the Chinese participants' productions. Meanwhile, in the case of <ou>, despite the pinyin <ou>-Chi/ow/ correspondence, the productions of Chinese participants' <ou> showed almost even distribution among [o⁰, aʊ, u:], which is somewhat similar to the Canadian participants' pattern, suggesting that at least some Chinese participants had overcome L1 transfer.

On the other hand, interestingly, the Japanese participants performed in a more Canadian participant-like way with <ai> than Chinese participants who were tempted to read <ai> as [aɪ] in the L1 pinyin-like way rather than [e^ɪ]. In other words, the Japanese participants showed a stronger L1 transfer with <ou> than with <ai>, while Chinese participants showed the reverse. This means that difficulty in English <ou> and <ai> seems to be L1 specific. As to silent-E errors, those were more frequent by Chinese participants. In contrast, hyper rhotacization was much fewer by Chinese participants. About <h>, Chinese participants did not recognize word-final <h> as a coda consonant, presumably because they knew the English phonotactic constraint */hσ/ (σ = syllable boundary), whereas some Japanese participants pronounced word-final <h> as a word-final consonant, suggesting that those Japanese participants did not know the English phonotactic constraint */hσ/.

Aside from graphemes, longer LOR contributed to the Japanese participants' performance to some extent, while LOR did not play a big role for Chinese participants' performance in this reading task.

As for similarities between the Japanese and Chinese participants, one of the similarities is that both groups had more trouble reading "relative sound" letters than

“alphabet sound” letters in general, and especially both groups were strongly tempted to read <i> as [i:] or [i]. Another similarity is that hyper rhotacization tended to occur in [oɪ]. Last but not least, the easiest grapheme for both Japanese and Chinese participants was <oi>.

Chapter 4 Experiments of phoneme-to-grapheme correspondence

In this chapter, I will attempt to answer the second research question: how do Japanese EAL learners spell out English vowel sounds in unfamiliar words? In other words, I will examine their phoneme-to-grapheme conversion patterns. To answer this question, I conducted a word-spelling task, in which the participants were instructed to spell out auditorily presented one-syllable nonsense English words. The participants were the same as those in the previous experiment, 14 native Canadian English speakers, 45 Japanese EAL learners, and 24 Chinese EAL learners.

One may ask why the phoneme-to-grapheme conversion skill in English is important. One of the great benefits of this skill is that when an EAL learner hears a new word, s/he can guess the spelling and can look it up in a dictionary, except for very irregularly spelled words. Conversely, if s/he does not have this skill, there would be a great inconvenience in searching for the word in a dictionary.

One may also argue that Japanese has only five vowels, so 13 English vowel contrasts (or at least 10 so-called monophthongs) would be reduced to five in Japanese EAL learners' perception, which in turn would affect their spellings. However, as mentioned in §2.2.3, this popular 13-versus-5 presupposition is a fallacy. Besides, Strange, Akahane-Yamada, Kubo, Trent, and Nishi (2001) report that native Japanese speaking college students who have never lived in an English-speaking country can perceptually distinguish all the English vowels (not including true diphthongs [aɪ, aʊ, ɔɪ]), and none of the pairs of English vowels are perceived in the same pattern, although Eng[ɪ] and [ɛ] between labial consonants may be difficult to differentiate for some Japanese speakers. Compare the vowel contrasts with the notorious /l/ and /ɪ/ contrast; for example, Aoyama and Flege (2011) reveal that Eng/l/ and /ɪ/ perceived by Japanese ESL learners show what Best (1994) calls the Single Category Assimilation (two L2 categories can equally match a single L1 category) by using the same method as Strange

et al. (2001). On the basis of these previous studies, I assume that Japanese EAL learners have a sufficient vowel perception ability to deal with this nonsense word-spelling task.

4.1 Stimuli and procedure for the spelling task

4.1.1 Audio stimuli

The audio stimuli are phonotactically possible one-syllable English nonsense words. In total, there are 86 stimuli. The stimuli were created based on two variables: 1) dialects and 2) speech rates. I will discuss the details in the next few sections. Table 45 and Table 46 show the stimuli, and Table 47 shows distracters.

Table 45. BC accent stimuli

Target phoneme	Sound stimulus (normal)	Sound stimulus (slow or synthetically lengthened)	Example of expected spellings
[e ¹ #]	[sne ¹]	[ske ¹]	snay, skay
[e ¹]	[ke ¹ b]	[te ¹ b]	cabe, tabe
[i:#]	[sni:]	[spi:]	snee, spee
[i:]	[ʃi:b]	[sni:b]	cheeb, sneab, etc.
[aɪ#]	[snaɪ]	[zaɪ]	snye, zigh, etc.
[aɪ]	[maɪb]	[naɪb]	mibe, nibe
[o ⁰ #]	[po ⁰]	[sko ⁰]	poe, sko, etc.
[o ⁰]	[mo ⁰ z]	[spo ⁰ z]	moze, spoze
[u:#]	[sku:]	[spu:]	skoo, spoo
[u:]	[tu:d]	[snu:b]	tude, snoob, etc.
[labial C + ju:#]	[bju:]	[bju:]	bew, bue, etc.
[labial C + ju:]	[bju:d]	[pju:d]	bude, pude
[æ:]	[dæ:z]	[pæ:z]	daz, paz
[ɛ]	[smɛz]	[mɛz]	smez, mez
[ɪ]	[dɪz]	[stɪz]	diz, stiz
[ɑ:#]	[tɑ:]	[dɑ:]	taw, daw
[ɑ:]	[zɑ:d]	[stɑ:d]	zod, stod
[ʌ#]	[bʌ]	[mʌ]	buh, muh
[ʌ]	[fʌd]	[zʌd]	fud, zud
[ʊ]	[pʊd]	[sʊd]	pood, sood
[ɔɪ#]	[spɔɪ]	[pɔɪ]	spoy, poy
[ɔɪ]	[fɔɪd]	[pɔɪd]	foid, poid
[aʊ#]	[gəʊ]	[fəʊ]	gow, fow
[aʊ]	[fəʊz]	[pəʊz]	fouz, pouz

Table 46. Mississippi accent stimuli

Target phoneme	Sound stimulus	Sound stimulus	Example of the
----------------	----------------	----------------	----------------

	(normal)	(slow or synthetically lengthened)	target spellings
[o ^u #]	[ʃo ^u]	^a	cho etc.
[ɔ:#]	[stɔ:]	[smɔ:]	staw, smaw
[ɔ:]	[smɔ:d]	[stɔ:d]	smaud, staud
[ɑ:#]	[sna:]	[sta:]	sna, stah, etc.
[ɑ:]	[dʒɑ:d]	[ʃɑ:d]	jod, chod
[ʌ]	[mʌz]	[nʌz]	muz, nuz
[æ:]	[stæ:z]	[pæ:z]	staz, paz
[æ:] ([æə(m)])	[stæ:m]	[snæ:m]	stam, snam
[ɛ]	[ʃɛz]	[stɛz]	chez, stez
[ɛ] ([ɛə(m)])	[sem]	[spem]	sem, spem
[ɪ]	[spɪz]	[pɪz]	spiz, piz
[ɪ] ([ɪə(m)])	[pɪm]	[bɪm]	pim, bim

Note. ^a Originally prepared Mississippi lengthened stimulus [zo^u] was mostly misperceived as the real word *though* even by native English-speaking participants because the speaker's pronunciation was not clear enough. Therefore, I discarded Mississippi slow [o^u].

Table 47. Distractors

	Mississippi English	BC English
Distractor	[rɛθ], [flɛv], [plam], [tram], [ve ^l m], [θe ^t], [lu:v]	[zi:v], [dʒi:ð], [ʃi:ʃ], [si:θ], [si:v] ²⁴ , [zi:d], [pru:ð]

The BC stimuli were pronounced by a phonetically trained male native BC Canadian English speaker in his forties from the Linguistics Department at the University of Victoria, and the Mississippi stimuli were pronounced by a male native Mississippi English-speaking experienced ESL teacher in his forties living in BC at the time. Recording was done in the soundproof booth in the Phonetics Lab in the Linguistics Department of the University of Victoria.

4.1.2 Dialectal differences

For dialectal differences, British Columbia (in Canada) (henceforth BC) and Mississippi (in the U.S.) English were used. For the BC accented stimuli, the targets were all the 13 vowel contrasts, [i:, ɪ, e^l, ɛ, æ:, ɑ:, o^u, ʊ, u:, ʌ, aɪ, aʊ, ɔɪ] (excluding the aforementioned foreign (a)). For the Mississippi accented stimuli, I added the 14th vowel [ɔ:] of the 14 vowel

²⁴ One Canadian participant pointed out that [si:v] can be a real word *sieve* which has two possible sounds, [sɪv] as well as [si:v].

system. The purpose of including dialectal differences is to examine how spelling patterns by the participants, including native Canadian English speakers, reflect dialectal differences. Specifically, I focused on 1) the [ɑ:-ɔ:] contrast as in *cot* and *caught*, which most Canadian English speakers do not contrast, and 2) diphthongization in [ɪ, ε, æ:] before [m], unlike Canadian English [ɪ, ε, æ:] with minimal diphthongization.

First, with regard to the [ɑ:-ɔ:] contrast, phonetic differences among the three stimuli²⁵ MS (MS = Mississippi) [smɔ:], BC[da:], and MS[sta:] are shown in Figure 38.

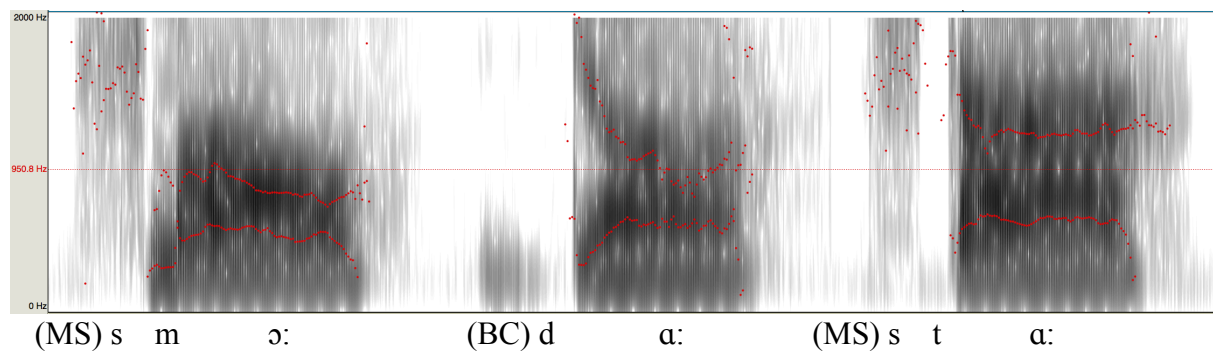


Figure 38. F2 comparison of MS[smɔ:], BC[da:], and MS[sta:]

The rough F2 value of BC[(d)ɑ:] is indicated with the red horizontal broken line. MS[(sm)ɔ:] is lower in F2 value (meaning that the tongue is more back), and also F2 and F1 are both moving downwards, indicating that this vowel is diphthongized. Therefore, its phonetic transcription can be [ɔə] with a schwa off-glide or probably slightly rounded [ɔʊ]. As for MS[(st)ɑ:], its F2 is much higher than BC[(d)ɑ:] (meaning that the tongue is more front). Therefore, its phonetic transcription can be [ɑ:] or [ɑ̟:] ([̟] = advanced tongue root).

Second, with regard to diphthongization, Mississippi English front checked vowels [ɪ, ε, æ:] before [m] are relatively diphthongized like [ɪə, εə, æə] while Canadian English checked vowels are relatively monophthongal, so I examined how the participants spelled these diphthongized [ɪ, ε, æ:] as opposed to relatively monophthongal counterparts. As seen

²⁵ Fundamental frequency in this figure was adjusted in order to compare the formants from different speakers on the spectrogram.

in Figure 39, F2 lines in Mississippi vowels are noticeably curving, whereas as seen in Figure 40, F2 lines in BC vowels are relatively straight.

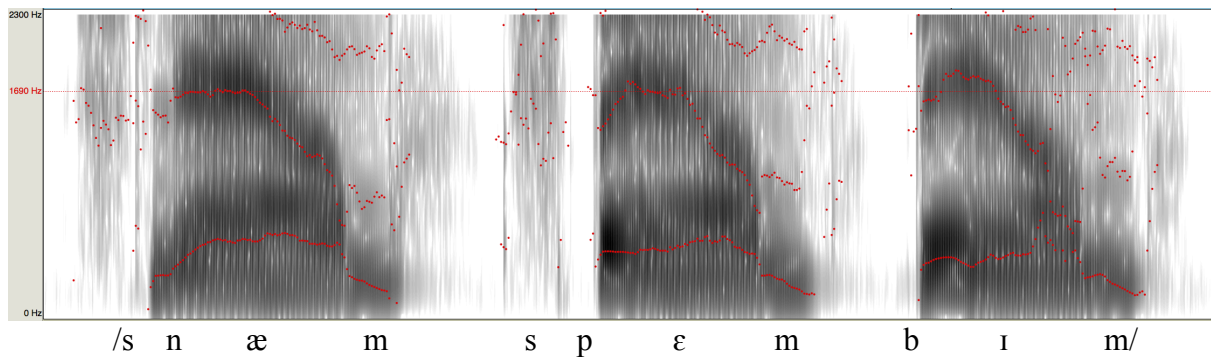


Figure 39. Diphthongized Mississippi [snæəm], [spɛəm], and [bɪəm]

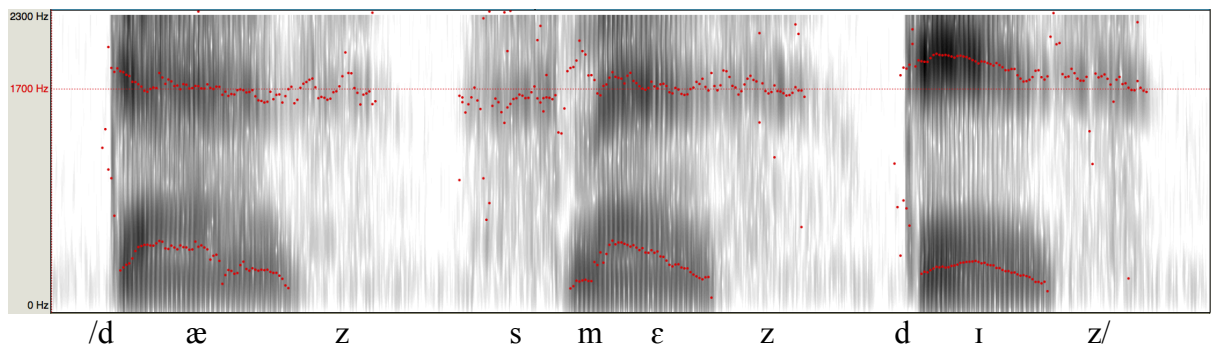


Figure 40. Relatively monophthongal BC [dæ:z], [smɛz], and [dɪz]

I also included Mississippi [o^o] and [ʌ], which are adjacent vowels to Mississippi [ɔ:] and [ɑ:]. In total, I examined seven Mississippi vowel phonemes, [ɪ, ε, æ:, ɑ:, ɔ:, o^o, ʌ], including two allophones of /ɪ, ε, æ/: before [m] (i.e., [ɪəm, εəm, æəm]) versus before obstruents (i.e., [ɪz, εz, æ:z]).

4.1.3 Speech rate differences

With regard to speech rates, there were 1) normal and 2) slow (or synthetically lengthened) rates. The purpose of including speech rate differences is that since vowel length is phonemic in Japanese, the Japanese participants may perceive such phonetic vowel length variations phonemically and their spellings may reflect length differences. For each target vowel, both normal speed stimulus and slow speed stimulus were created. For the normal speed stimuli, the aforementioned two speakers were instructed to pronounce each stimulus at

normal speed. For the slow speed stimuli, the speakers were instructed to pronounce them slowly. After that, the vowel part of each stimulus was synthetically manipulated to double the length of the normal speed counterpart by using the phonetic software PRAAT. This is because in Japanese, two-mora vowels are roughly twice longer than the one-mora counterparts (see §2.2.2 for more details). For example, if the duration of [ʊ] in the normal speed stimulus [pʊd] was 153ms (ms = millisecond), that of [ʊ] in the slow speed stimulus [sʊd] was synthetically lengthened to 306ms, as shown in Figure 41.

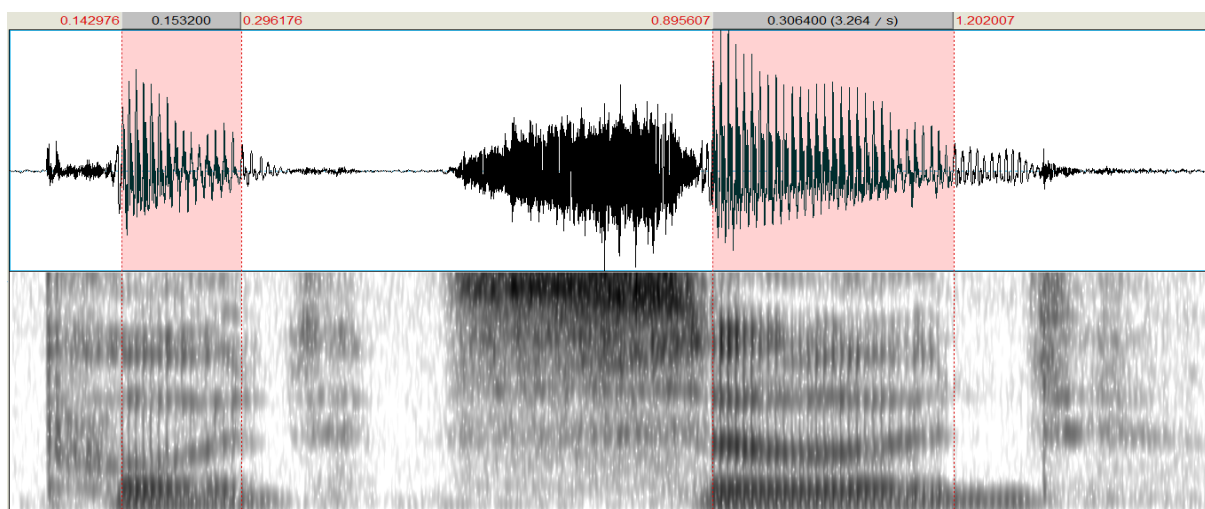


Figure 41. Vowel durations of the normal speed stimulus [pʊd] (left) and the slow speed counterpart of [sʊd] (right)

To be consistent with the target stimuli, half of the distractors were also synthetically lengthened while the other half were left at the original speed.

4.1.4 Other conditions

With regard to surrounding consonants, as was the case with the reading experiment, the target stimuli did not contain the consonants [l, ɾ, θ, ð, v, ʒ], which do not have the counterpart phonemes in standard Japanese, whereas most of the distractors included these consonants in order to have the Japanese participants make efforts to identify non-L1 consonants and to distract their attention from vowels.

For the stimuli with free vowels and true diphthongs, I created both open syllable words (e.g., [sne^l] and [ske^l] for the vowel [e^l]) and closed syllable words (e.g., [ke^lb] and [te^lb] for the vowel [e^l]), while for the stimuli with checked vowels, I created only closed syllables (e.g., [smɛz] and [mɛz] for the vowel [ɛ]), except that I included words finishing in [ʌ] (i.e., [bʌ] and [mʌ]) in order to examine the [ʌ(#)]-<uh> correspondence.

Coda consonants of closed syllables in the stimuli are all voiced obstruents, except for the Mississippi stimuli with [ɪəm, ɛəm, æəm], in order to avoid the aforementioned allophonic Canadian Raising as well as allophonic vowel shortening (see §2.2.1.4 for more details) and nasalization. For both normal and slow stimuli for the same target vowel, the same coda consonant was chosen in consideration of coarticulatory effects on the vowels: for example, for the target vowel [e^l], the coda consonant was [b] in both normal and slow stimuli (i.e., [ke^lb] and [te^lb]). For the onset consonants, I used [sC] clusters in addition to single onsets. Phonologically, Japanese does not have [sC] onsets, but phonetically, word-initial [sC] sequence is fairly common in Japanese due to high vowel devoicing/deletion²⁶ (e.g., Japa/suteki/ ‘splendid’ → Japa[st̚ɛki]). Moreover, as mentioned in §2.2.2.3, native Japanese speakers have a strong tendency to divide speech sounds into morae as a linguistic unit, rather than syllables (e.g., [smɛz] divided into [s-mɛ-z] not necessarily with vowel epenthesis (c.f., Guo & Nogita, 2013; Nogita & Fan, 2012)). Due to these reasons, I consider that syllable structure differences among stimuli would not affect the results of spellings for the target vowels by the Japanese participants.

²⁶ A common generalization is that Japanese high vowel devoicing/deletion regularly occurs between voiceless consonants, but according to my colleague’s and my informal observation, /s̚/ before a voiced consonant can be occasionally devoiced, such as /sumapp̚/ pronounced as [smapp̚] at least by some native Japanese speakers, so I consider that the English /sC/ onsets are not phonetically unfamiliar to Japanese speakers, although it needs more research.

4.1.5 Procedure of the experiment

The BC normal, BC slow, Mississippi normal, and Mississippi slow stimuli were saved as wav files and were embedded in PowerPoint slides in a randomized order displayed on a computer screen, as show in Figure 42.

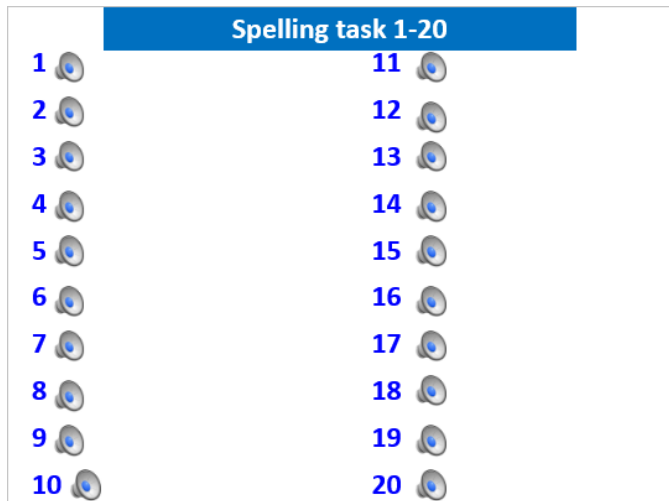


Figure 42. The screen for the spelling task

Participants were instructed to click speaker icons to listen to the stimuli with headphones and spelled out what they heard on the answer sheet at their own pace. They were allowed to listen to stimuli as many times as they wanted. They were instructed to choose only one spelling even if they associated multiple spellings with one stimulus (e.g., [te'b] for <taib> and <tabe>). The participants were informed that there were normal and slow speech rates. This was an indirect notification that stretched vowels were not phonemically long vowels. They were also informed that there were a Canadian speaker and an American speaker, although the speakers' province/state were not stated. This was another indirect notification that the participants need to be ready for different vowel phoneme inventories and different phonetic vowel qualities. This information also indirectly notified that the stimuli were most likely rhotic dialects, in which <r> is spelled only when [ɹ] is present in pronunciation. By giving this indirect information, I tested the participants' knowledge about this characteristic

of rhotic dialects. For example, participants who spelled the sound [a:] as <ar> most likely did not know this characteristic of rhotic dialects.

The experiment was done immediately after the word-reading task in the same place. The participants' first languages were used through the whole process of the data elicitation, including instructions (see Appendix 2), in order not to give them a chance to learn or recall GPC rules from any English materials; i.e., English for the Canadian participants, Japanese for the Japanese participants, and Mandarin for the Chinese participants.

4.2 The Canadian participants

4.2.1 Results of the Canadian participants

Like the reading task, the Canadian participants' results were used as the model for EAL participants. EAL participants' spellings that deviated from the Canadian participants' are identified as "different" (but not necessarily incorrect). Table 48 shows the results for British Columbia normal speed stimuli perceived by 14 Canadian participants. Stimuli with only one spelling variation (except for misperception-related variations) are bolded. The stimuli whose most frequent spelling is under 70% and the stimuli with three or more spelling variations are shaded. For the spellings that only one Canadian participant chose (e.g., <ae> for [sne^l]), three phonetically trained native English speaking graduate students in the Linguistics Department judged whether these spellings were acceptable; see the notes below the tables and §4.3.1.2 for more details.

Table 48. The Canadian participants' spellings for British Columbia normal speed stimuli

	BC normal stimuli							
Phoneme Stimuli	[e ^l #] [sne ^l]	[e ^l] [ke ^l b]	[i:#] [sni:]	[i:] [ʃi:b]	[aɪ#] [snaɪ]	[aɪ] [maɪb]	[o ^u #] [po ^u]	[o ^u] [mo ^u z]
Spelling #	ay 13	a_e 13	ee 13	ee 10	y 3	i_e 12	oe 8	o_e 14
Spelling #	ae 1	*ay# 1	*e 1	ea 2	ye 3	?y# 2	oh 3	
Spelling				*e	igh		o	

#				1	3		2	
Spelling #				*ee# 1	ai 1		→oa 1	
Spelling #					→ie 1			
Spelling #					→i 1			
Spelling #					*a 1			
Spelling #					*ae 1			
Total	14	14	14	14	14	14	14	14

14 Canadian participants

BC normal stimuli

[u:#]	[u:]	[labial C + ju:#]	[labial C + ju:#]	[æ:]	[ɛ]	[ɪ]	[ɑ:#]	[ɑ:]
[sku:]	[tu:d]	[bjɜ:]	[bjɜ:d]	[dæ:z]	[smɛz]	[dɪz]	[tɑ:]	[zɑ:d]
oo 11	oo 10	ew 8	ew 7	a 14	e 14	i 14	aw 9	o 11
→ew 1	u_e 3	eu 2	ue 2				ah 5	aw 2
*uh 1	oo_e 1	ue 2	u_e 1					*u_e 1
*un 1		iew 1	eu 1					
			iu_e 1					
			ewe 1					
			→eu_e 1					
14	14	14	14	14	14	14	14	14

14 Canadian participants

BC normal stimuli

[ʌ#]	[ʌ]	[ʊ]	[ɔɪ#]	[ɔɪ]	[aʊ#]	[aʊ]
[bʌ]	[fʌd]	[pʊd]	[spɔɪ]	[fɔɪd]	[gʌʊ]	[fʌʊz]
uh 12	u 14	u 9	oy 8	oi 14	ow 11	ow 5
→ah 1		oo 3	oi 6		→aoo 1	ou_e 3
*ouh 1		→oul 1			*oun 1	ou 2
		→eu 1			*owm 1	au 2
						au_e 2
14	14	14	14	14	14	14

Note. Boxes are shaded in grey when the consistency of the most frequent spelling is below 70% and there are three or more spelling variations.

indicates that a coda consonant letter is missing when it is expected.

* indicates spellings that were considered as errors or not good as “models” by three linguistically trained American and Canadian native speakers (see §4.3.1.2).

→ indicates one direction; the phoneme-to-grapheme conversion is acceptable but the grapheme-to-phoneme conversion is not always acceptable (see §4.3.1.2).

? indicates spellings that were presumably perception-related errors, but were considered as acceptable by three judges as well as the fact that more than one participant came up with the same spelling (see §4.3.1.2).

Table 49 shows the results for Mississippi normal speed stimuli.

Table 49. The Canadian participants’ spellings for Mississippi normal speed stimuli

Phoneme Stimuli	Mississippi normal stimuli					
	[o ^u #] [ʃo ^u]	[ɔ:#] ([ɔʊ]) [sto:]	[ɔ:] ([ɔʊ]) [smɔ:d]	[ɑ:#] ([ɑ:]) [sna:]	[ɑ:] ([ɑ:]) [dʒɑ:d]	[ʌ] [mʌz]
Spelling #	o 8	?all 10	au 5	ah 5	o 6	u 12
Spelling #	oe 4	a 1	o 4	a 4	aw 3	*au 1
Spelling #	→ou 1	aw 1	aw 2	aw 4	ah 2	*o_e 1
Spelling #	*ew 1	?ahl 1	?al 2	*aa 1	au_e 1	
Spelling #		?ol 1	?ow 1		→aa 1	
Spelling #					*a_e 1	
Total	14	14	14	14	14	14

14 Canadian participants

Mississippi normal stimuli					
[æ:] [stæ:z]	[æ:(m)] ([æə]) [stæ:m]	[ɛ] [ʃɛz]	[ɛ(m)] ([ɛə]) [sem]	[ɪ] [spɪz]	[ɪ(m)] ([ɪə]) [pɪm]
a 13	a 14	e 14	e 7	i 12	?a 10
→ah 1			?a 5	?e 2	?ou 2
			?i 1		*auw# 1
			*il 1		*aw 1
14	14	14	14	14	14

Note. Boxes are shaded in grey when the consistency of the most frequent spelling is below 70% and there are three or more spelling variations.

indicates that a coda consonant letter is missing when it is expected.

* indicates spellings that were considered as errors or not good as “models” by three linguistically trained American and Canadian native speakers (see §4.3.1.2).

→ indicates one direction; the phoneme-to-grapheme conversion is acceptable but the grapheme-to-phoneme conversion is not always acceptable (see §4.3.1.2).

? indicates spellings that were presumably perception-related errors, but were considered as acceptable by three judges as well as the fact that more than one participant came up with the same spelling (see §4.3.1.2).

For the slow or synthetically lengthened stimuli, I had four Canadian participants listen to the original stimuli that were before the manipulation, and had the rest of 10 listen to the synthetically lengthened ones, in order to examine if length manipulation causes misperception. Table 50 shows the results for British Columbia slow speed stimuli.

Table 50. The Canadian participants' spellings for British Columbia normal and slow speed stimuli (4 participants listened to the original stimuli and 10 listened to synthetically lengthened stimuli.)

Phoneme Stimuli Rate	BC slow stimuli							
	[eʰ#] [skeʰ]		[eʰ] [teʰb]		[i:#] [spi:]		[i:] [sni:b]	
	Origin.	Slow	Origin.	Slow	Origin.	Slow	Origin.	Slow
Spelling #	ay 4	ay 9	a_e 3	a_e 10	ee 4	ee 10	ee 3	ee 8
Spelling #		?ane 1	ay 1				ea 1	e_e 1
Spelling #								*i_e 1
Total	4	10	4	10	4	10	4	10

14 Canadian participants

BC slow stimuli							
[aɪ#] [zai]		[aɪ] [naɪb]		[oʊ#] [skoʊ]		[oʊ] [spoʊz]	
Origin.	Slow	Origin.	Slow	Origin.	Slow	Origin.	Slow
ai 2	ye 3	i_e 3	i_e 9	o 4	oh 4	o_e 4	o_e 9
ie 1	igh 2	y_e 1	→ai 1		o 3		*ound 1
→y 1	ie 1				ow 2		
	yhe 1				*oo 1		
	*ine 1						
4	10	4	10	4	10	4	10

14 Canadian participants

BC slow stimuli							
[u:#] [spu:]		[u:] [snu:b]		[labial C + ju:#] [bjɪ:]		[labial C + ju:] [pju:d]	
Origin.	Slow	Origin.	Slow	Origin.	Slow	Origin.	Slow
oo	oo	oo	oo	ew	ew	u_e	u_e

4	9	4	9	3	5	4	4
	ou 1		u_e 1	iew 1	ue 2		ew 4
					ieu 1		ewe 1
					→yew 1		→eu_e 1
					*eau 1		
4	10	4	10	4	10	4	10

14 Canadian participants

BC slow stimuli

[æ:] [pæ:z]		[ɛ] [mɛz]		[ɪ] [strɪz]		[ɑ:#] [dɑ:]		[ɑ:] [stɑ:d]	
Origin.	Slow	Origin.	Slow	Origin.	Slow	Origin.	Slow	Origin.	Slow
a 4	a 9	e 4	e 10	i 4	i 4	aw 4	aw 6	o 1	o 5
	→aa 1				?ay 4		a 1	aw 1	aw 1
					?e 1		awe 1	au 1	au 1
					*i_e 1		aah 1	awe 1	ah 1
							→auh 1		au_e 1
									→aa 1
4	10	4	10	4	10	4	10	4	10

14 Canadian participants

BC slow stimuli

[ʌ#] [mʌ]		[ʌ] [zʌd]		[ʊ] [sʊd]		[ɔɪ#] [pɔɪ]		[ɔɪ] [pɔɪd]	
Origin.	Slow	Origin.	Slow	Origin.	Slow	Origin.	Slow	Origin.	Slow
uh 4	?aw 3	u 4	u 8	u 3	oo 5	oi 4	oi 8	oi 4	oi 8
	?a 2		?un 1	eu 1	u 3		oy 2		oy 2
	?ah 2		?uhn 1		eu 1				
	uh 1				→oul 1				
	?aah 1								
	*aaw 1								
4	10	4	10	4	10	4	10	4	10

14 Canadian participants

BC slow stimuli

[aʊ#] [faʊ]		[aʊ] [paʊz]	
Origin.	Slow	Origin.	Slow
ow 2	ow 8	ow 3	ow 6
aow 1	?owl 1	→au 1	ou 2
→au 1	?oul 1		ow_e 1
			ou_e 1
4	10	4	10

Note. Boxes are shaded in grey when the consistency of the most frequent spelling is below 70% and there are three or more spelling variations.

indicates that a coda consonant letter is missing when it is expected.

* indicates spellings that were considered as errors or not good as “models” by three linguistically trained American and Canadian native speakers (see §4.3.1.2).

→ indicates one direction; the phoneme-to-grapheme conversion is acceptable but the grapheme-to-phoneme conversion is not always acceptable (see §4.3.1.2).

? indicates spellings that were presumably perception-related errors, but were considered as acceptable by three judges as well as the fact that more than one participant came up with the same spelling (see §4.3.1.2).

Table 51 shows the results for British Columbia slow speed stimuli.

Table 51. The Canadian participants’ spellings for Mississippi normal and slow speed stimuli (4 participants listened to the normal stimuli and 10 listened to synthetically lengthened stimuli.)

Phoneme Stimuli Rate	Mississippi slow stimuli							
	[ɔ:#] ([ɔʊ]) [smɔ:]		[ɔ:] ([ɔʊ]) [stɔ:d]		[ɑ:#] ([ɑ:]) [sta:]		[ɑ:] ([ɑ:]) [ʃɑ:d]	
	Origin.	Slow	Origin.	Slow	Origin.	Slow	Origin.	Slow
Spelling #	?all 2	?all 8	aw 2	aw 3	a 2	a 4	aw 2	o 4
Spelling #	aw 1	?aow 1	au 2	o 2	ah 2	ah 3	o 1	aw 1
Spelling #	?awl 1	→?al 1		au 2		aah 1	ah 1	ah 1
Spelling #				awe 1		→aa 1		awe 1
Spelling #				?alle 1		*aw 1		au_e 1
Spelling #				*o_e 1				→aa 1
Spelling #								*u 1
Total	4	10	4	10	4	10	4	10

14 Canadian participants

Mississippi slow stimuli					
[ʌ] [nʌz]		[æ:] [pæ:z]		[æ:(m)] ([æə]) [snæ:m]	
Origin.	Slow	Origin.	Slow	Origin.	Slow
u	u	a	a	a	a
4	8	4	5	4	8
	?aw 1		aa 5		aa 2
	*aa 1				
4	10	4	10	4	10

14 Canadian participants

Mississippi slow stimuli							
[ɛ] [stɛz]		[ɛ(m)] ([ɛə]) [spɛm]		[ɪ] [pɪz]		[ɪ(m)] ([ɪə]) [bɪm]	
Origin.	Slow	Origin.	Slow	Origin.	Slow	Origin.	Slow
e	e	?a	?a	i	i	?a	?a
4	10	4	10	4	8	3	9
					?e 1	i 1	?ayu 1
					?eh 1		
4	10	4	10	4	10	4	10

Note. Boxes are shaded in grey when the consistency of the most frequent spelling is below 70% and there are three or more spelling variations.

indicates that a coda consonant letter is missing when it is expected.

* indicates spellings that were considered as errors or not good as “models” by three linguistically trained American and Canadian native speakers (see §4.3.1.2).

→ indicates one direction; the phoneme-to-grapheme conversion is acceptable but the grapheme-to-phoneme conversion is not always acceptable (see §4.3.1.2).

? indicates spellings that were presumably perception-related errors, but were considered as acceptable by three judges as well as the fact that more than one participant came up with the same spelling (see §4.3.1.2).

4.2.2 Discussion

4.2.2.1 Perception-related errors by the Canadian participants

As Rollings (2004) mentions, it is much more difficult to distinguish auditory signals from human speech than to identify visual signals. Even perception of native language sounds can be difficult in some cases. For example, BC normal speed [maɪb] was spelled as <my> by two Canadian participants, most likely because they missed perceiving the final [b]. Another example is that BC slow speed [zaɪ] was spelled as <zine> by one Canadian

participant, most likely because she misperceived this open syllable as a closed syllable. The number of such perception-related errors of the normal speed stimuli by the Canadian participants is summarized in Table 52.

Table 52. The number of errors in normal speed stimuli by the Canadian participants

Stimuli	Perception-related errors
All the BC normal stimuli	10/336 (3.0%)
All the Mississippi normal stimuli	41/168 (24.4%)
Mississippi normal stimuli excluding [ɔ:, ε(m), ɪ(m)]	5/112 (4.5%)

For the synthetically lengthened stimuli, 10 participants who listened to the synthetically manipulated stimuli and four participants who listened the original stimuli before manipulation were separately analyzed. The summary is shown in Table 53.

Table 53. Errors in synthetically lengthened (or slow) stimuli by the Canadian participants

Stimuli	Speed	# of perception-related errors
BC	Original	0/96 (0.0%)
	Slow	22/240 (9.2%)
Mississippi	Original	10/44 (22.7%)
	Slow	37/110 (33.6%)
Mississippi excluding [ɔ:, ε(m), ɪ(m)]	Original	0/28 (0.0%)
	Slow	5/70 (7.1%)

According to Table 52, perception-related errors in BC normal stimuli were only 3.0%, which is reasonably low. Interestingly, in Mississippi Normal stimuli, the perception-related error rate rose up to 24.4%. This indicates that even native North American English speakers have difficulty perceiving vowels in an unfamiliar dialect. Nevertheless, the errors were concentrated only around [ɔ:] (especially word-finally), [ε(m)] and [ɪ(m)]. More specifically, the off-glide of Mississippi word-final [ɔ:] in [stɔ:] (or the [ʊ] part in [ɔʊ]) tended to be misperceived as /l/ by the Canadian participants; this misperception may also be an influence of the real word *stall*. Word-medial [ɔ:] in [smɔ:d] was much more accurately perceived, but in one occasion, it was spelled as <smald>, and in another occasion, it was spelled as <smowd> in which [ɔ:] ([ɔʊ]) was likely perceived as the “true” diphthong /aw/.

Note that there is also a possibility that these participants added silent-L. However, silent-L in real words occurs in the contexts of <alm> (e.g., *calm* word-finally and *salmon* word-medially), <alf> (e.g., *half*), <alk> (e.g., *walk*), <olk> (e.g., *folk*), <ould> (e.g., *could*), and so forth (examples are from spellzone, n.d.). In contrast, the Canadian participants' <l>-insertion occurred only word-finally, except for one occasion of [smɔ:d] spelled as <smald>, so at least these word-final <l>s are unlikely to be silent-L. As well, [ɪ] in [pɪm] ([pɪəm]) and [ɛ] in [spɛm] ([spɛəm]) tended to be perceived as [æ:]; note that there is a well-known meat product named *Spam*, which may also have influenced the perception of [spɛəm]. It is noteworthy that none of the Canadian participants correctly perceived Mississippi normal speed [ɪm] ([ɪəm]). When these [ɔ:] (in both open and closed syllables) and [ɛ(m)] and [ɪ(m)] are excluded (but including [ɛ] and [ɪ] before obstruents), the number of errors drops to 4.5%, which is a reasonably low rate.

When it comes to synthetically lengthened stimuli, those who listened to synthetically lengthened versions made noticeably more errors than those who listened to the original stimuli. Interestingly, in BC stimuli, errors were concentrated on lengthened [ɪ] and lengthened word-final [ʌ]. Lengthened [ɪ] (in [stɪz]) was spelled as <ay> four times out of 10, and as <e> once, meaning that lengthened [ɪ] was most likely perceived as [e^l] or to a lesser extent as [ɛ]. As mentioned in §2.2.1.2, Strange et al.'s (1998) acoustic analysis shows that the mid points of F1 and F2 of [ɪ] and [e^l] overlap. As well, recall that I mentioned in §2.2.3.2 that [ɛ] is phonetically longer than [ɪ]. Based on these, if [ɪ] is lengthened and loses its characteristic of short duration, it tends to be misperceived as spectrally overlapping [e^l] or as spectrally adjacent [ɛ]. As for lengthened word-final [ʌ] (in [mʌ]), it was spelled as <aw>, <ah>, <a>, <aah>, and <aaw>. At least some of these spellings likely came from misperception of [ʌ] as [ɑ:]. Compare the results of the original stimuli where all word-final [ʌ]s were spelt as <uh> shown in Table 53. Again, as mentioned in §2.2.1.2, Strange et al.'s

(1998) acoustic analysis shows that the mid point sound qualities of [ɑ:] and [ʌ] overlap, and according to Hillenbrand et al. (2000), lengthened [ʌ] is likely to be misidentified as [ɑ:] by native American English speakers. These studies explain the results of this present study. Interestingly, at least in the BC stimuli, lengthened [ʌ] followed by a coda (in the stimulus [zʌd]) was not spelled as <o> or <aw>, meaning that it was not perceived as [ɑ:], which in turn means that lengthened word-final [ʌ] is much more likely to be misperceived than lengthened word-medial [ʌ].

Aside from lengthened [ɪ] and lengthened word-final [ʌ], there were a few other perception-related errors. These few errors mostly involved misperceived “phantom” [ŋ] or [l], but did not involve vowel misidentification: for example, lengthened [zʌd] spelled as <zund> (1/10) and <zuhnd> (1/10), lengthened [skeʰ] spelled as <skane> (1/10), and lengthened [faʊ] spelled as <fowl> (1/10) and <foul> (1/10). Note that <fowl> and <foul> may be an influence from the existing words *fowl/foul* rather than pure perception errors. In any case, the overall error rate was still relatively low, 9.2%.

In Mississippi lengthened stimuli, again, the off-glide of word-final [ɔ:] tended to be misperceived as [l], and both [ɛ(m)] and [ɪ(m)] tended to be misperceived as [æ:(m)]. An interesting misperception regarding [ɪ] is that Mississippi lengthened [ɪ(m)] (in [bɪm]) was spelled as <bayum> although by only one participant. It is most likely that [bɪm] ([bɪəm]) was perceived as [beʰ.ʌm] with two syllables. The stimulus [smɔ:] with lengthened word-final [ɔ:] was mostly spelled as <small> like the real word *small*. In one occasion, it was spelled as <smaow> in which [ɔ:] ([ɔʊ]) was likely perceived as [aʊ]. Word-medial [ɔ:] (in [stɔ:d]) was much more accurately perceived, but on one occasion, it was spelled as <stalled> like the real word *stalled*, and on another occasion, it was spelled as <stole> like the real word *stole*, in which [ɔ:] ([ɔʊ]) was most likely perceived as [oʊ].

Again, if [ɔ:], [ɛ(m)], and [ɪ(m)] are excluded (but including [ɛ] and [ɪ] before obstruents), the overall error rate in the Mississippi slow stimuli is 7.1%, which is reasonably low.

Overall, misperception-related errors were concentrated on Mississippi [ɔ:], especially word-finally, and Mississippi [ɛ(m)], [ɪ(m)] in both normal and lengthened rates, as well as lengthened [ʌ] and [ɪ] in both dialects (but not normal [ʌ, ɪ]).

4.2.2.2 Transcription of phonetic vowel length by the Canadian participants

I predicted that native English speakers would listen to vowels phonemically, but not phonetically, so they would not change their spelling patterns regardless of the speed of the stimuli. However, the results show that in some cases their spellings reflected non-phonemic phonetic length, as seen in the comparison between original and lengthened stimuli shown in Table 50 and Table 51. Specifically, obvious cases are Mississippi lengthened [pæ:z] spelled with <aa> (5/10) and [spæ:m] with <aa> (5/10). These <a> doublings were never observed in the original (before lengthened) [pæ:z] or [spæ:m] as well as normal speed [æ:] in either BC or Mississippi accents, suggesting that these participants attempted to transcribe phonetic length.

To a lesser extent, BC lengthened [pæ:z] spelled with <aa> (once (1/10)), BC lengthened [dɑ:] with <aah> and <auh> (1/10 for each), Mississippi lengthened [sta:] with <aa> and <aah> (1/10 for each), Mississippi lengthened [ʃɑ:d] with <aa> (1/10) all seem to reflect length. As well, possibly Mississippi lengthened [pɪz] spelled with <eh> (1/10), as well as BC lengthened [zaɪ] with <yhe> (1/10) may reflect phonetic length. Again, <a> doubling as well as digraphs and trigraphs are used. Adding an extra letter may reflect phonetic length. Another possible transcription of length can be observed in spelling variations between <o> and <aw> for [ɑ:]. BC normal [za:d] was spelled with <o> by 11 participants and with <aw> by only 2 (and one error) out of 14, whereas BC slow [sta:d] was

spelled with <o> by only one participant (out of 4) even in the original version and by five (out of 10) in the lengthened version. Recall that the originals of the slow stimuli were pronounced slower than the normal ones. The preference for the monograph <o> for the normal speed [ɑ:] and that for the digraphs <aw/au> or the trigraph <awe> for the lengthened [ɑ:] may possibly be due to durational differences.

Intriguingly, phonetic length was represented mainly with graphemes involving <a>. Interestingly, in actual English writing, other vowel letters can be duplicated, as in “yippee”, “shiiiiit”, “I miss yooooou”, or “I miss youuuu”, but in the data of this present study, it was not observed. This means that except for [æ:] and to a lesser extent [ɑ:], and the aforementioned misperceived [ʌ] and [ɪ], pure vowel length differences generally did not affect the spellings by the Canadian participants.

4.2.2.3 Revisiting corresponding graphemes of [ʊ] and [aʊ]

Recall that in the reading task, I discussed that [ʊ] and [aʊ], especially [ʊ], do not have stable corresponding graphemes (see §3.3.3.2). This is also explained by the results of the spelling task. For example, one participant who spelled both BC normal [pʊd] and slow [sʊd] as <pould> and <sould> respectively commented after the experiment that she had a hard time deciding on the spelling of [ʊ] because one of the possible candidates <pood> and <sood> would be read as [pu:d] and [su:d] respectively, and another candidate <pud> and <sud> would be read as [pʌd] and [sʌd]. Her final decision was <pould> and <sould> in accordance with the real words *would* or *should* in which <ould> sounds [ʊd]. However, according to the aforementioned three judges (phonetically trained native English speaking graduate students), if readers see <pould> and <sould>, they would probably read in different ways, such as [paʊld] or [poʊld], unless there is a note that these spellings rhyme with *would*. As well, a couple of participants chose <eu> for [ʊ] instead. Again, although [ʊ] can be spelled as <eu> such as in *neuron*, native speakers would probably read <peud> and <seud>

in different ways, such as [pju:d] and [su:d] respectively. Moreover, even the most frequently chosen <u> and the second most frequently spelled <oo> cannot necessarily recover the original [ʊ]. In other words, all <u>, <oo>, <eu>, and <oul> work in grapheme-to-phoneme conversion, but do not in the other direction. The fact that [ʊ] does not have its own corresponding grapheme in both directions is considered as one of the characteristics of the English writing system.

Unlike [ʊ], the phoneme [aʊ] has the default graphemes <ow> and <ou>. In fact, BC normal [gao] and slow [fao] were mostly spelled as <gow> and <fow> respectively, which confirms that the default grapheme of word-final [aʊ] is <ow>. Moreover, <ou> was never chosen since otherwise they would have word-final <u>. However, this apparent one-to-one relationship also works only in one direction. In fact, as seen in the reading task, the stimulus <fow> with word-final <ow> was more frequently read as [foʊ] (by 10 Canadian participants out of 14) than as [fao] (by 4) (see §3.3.2.) Regarding [aʊ] followed by a coda consonant (in BC normal [faʊz] and slow [paʊz]), it was most frequently spelled as <ow> again, followed by <ou>. There were a few occasions of <fouse> and <powse/pouse> with a silent-E, but these were probably for the purpose of making <s> sound [z], but not for the vowel quality, so these silent-Es can be ignored in this case. Again, from the speller's point of view, [aʊ] has fairly stable corresponding graphemes <ow> and <ou>, but as shown in the reading task, <ou> in <koun> was read as [aʊ] only seven out of 14 participants, although [aʊ] was still the most frequent choice.

Interestingly, [fao] was spelled as <faow> by one participant, which was accepted by the judges in terms of both [fao]-to-<faow> and <faow>-to-[fao] directions. Although <aow> is not a usual spelling in existing words, this could be one of the solutions to spell [aʊ]. As well, [gao] was spelled as <gao> in another unusual way by another participant, but this can be read differently, such as [gæ.u:] in a phonotactically unusual way, so this may be

an only-one-direction correspondence. As well, [faʊz], [paʊz], and [faʊ] (but not [gɑʊ]) were spelled as <au> a few times: [aʊ] in [faʊ] was particularly frequently spelled as <au> (4 participants out of 14). In fact, there are foreign originating real words like *Audi, cum laude, Saudi Arabia*, and so on in which <au> can be read as [aʊ] (although <au> in *laude* and *Saudi* can also be read with the Anglicized sound [ɑ:]). However, again, in the reading task, <au> in <fau> was never read as [aʊ], so <au> is another only-one-direction correspondence. Given these patterns, possibly the best bidirectional correspondence is [aʊ]-<aow> although <aow> is an unusual spelling.

To sum up, [ʊ] lacks its own corresponding grapheme. On the other hand, [aʊ] has the default corresponding graphemes <ow> in both word-final and word-medial positions, and <ou> in word-medial positions. However, <ow> and <ou> are not guaranteed to be read as [aʊ]. Therefore, compared to the rest of the 11 phonemes, the [aʊ]-<ow/ou> relationship is less stable.

4.2.2.4 Spelling of BC [ɑ:], Mississippi [ɑ:], and [ɔ:] ([ɔʊ])

Another interesting issue to examine is how BC English speakers who lack the [ɑ:]-[ɔ:] contrast in their dialect spell the Mississippi [ɑ:]-[ɔ:] contrast. As mentioned above, Mississippi [ɑ:] and [ɔ:] can be transcribed as [ɑ:] ([ɑ:]) and [ɔʊ] respectively with more phonetic details, as opposed to BC low back [ɑ:]. The spellings for these vowels in my data can be divided into three types as shown in Table 54.

Table 54. Spelling types for the low back vowels

Type	Spellings by the Canadian participants
<o>-type	<o>
<aw>-type	<aw>, <awe>, <au>, <au e>, <auh>
<a>-type	<a>, <aa>, <ah>, <aah>

In American dialects with the [ɑ:]-[ɔ:] contrast, the distribution of these vowels varies depending on the region to some extent, but to make a long story short, the <aw>-type generally corresponds to [ɔ:], as in *law* and *taut*, and the <a>-type generally corresponds to

[ɑ:], as in *spa*. The <o>-type is more complex due to the so-called *lot-cloth* split. The monograph <o> generally corresponds to either [ɔ:] or [ɑ:]; the former sound is generally in the CLOTH-class words in which the following consonant is a voiceless fricative like [f, s, θ] or a velar like [k, g, ŋ], as in *dog, long, cross*, and so forth, whereas the latter sound is generally in the LOT-class words in which the following consonant is anything else, as in *hot, stop, not*, and so forth (Gómez, 2009). The <o>-type does not occur word-finally since word-final <o> sounds [o^h] as in *go*. In dialects that lack the [ɑ:]-[ɔ:] contrast, including the BC dialect, the <a>-type could correspond to the foreign (a) [ɑ:] by some speakers, but generally all of the three spelling types correspond to [ɑ:].

I examined how these 3 types of spellings were distributed in the spelling results of Canadian participants. I analyzed the following five environments: BC /Ca#/ (in both normal and slow stimuli [ta:, da:]), BC /CaC/ ([za:d, sta:d]), MS /CɔC/ ([smɔd, stɔd]), MS /Ca#/ ([sna:, sta:]), and MS /CaC/ ([dʒa:d, fʃa:d]). Note that since Mississippi word-final [ɔ:] was predominantly misperceived as [ɑ:l] (or [aʊ]), I excluded it in this examination. I also ignored the speech rate, otherwise the number would be too small to do a statistical test.

Misperception-related errors for a statistical analysis, such as MS [smɔ:d] spelled as <smald> and <smowd> were discarded. Statistical significance of uneven distribution of these three types calculated by the chi-square test is shown in Table 55.

Table 55. The Canadian participants' spelling patterns in BC /a/ ([ɑ:]), Mississippi /a/ ([ɑ:]), and /ɔ/ ([ɔʊ])

Environment	Stimuli	<o>-type	<aw>-type	<a>-type	Significance
BC /Ca#/	[ta:, da:]		20	8	* p < 0.05
BC /CaC/	[za:d, sta:d]	17	8	2	** p < 0.005
MS /CɔC/	[smɔd, stɔd]	6	17	0	* p < 0.05 ^a
MS /Ca#/	[sna:, sta:]		5	23	** p < 0.005
MS /CaC/	[dʒa:d, fʃa:d]	11	9	7	N.S. p = 0.641

Note. ^a Since the occurrence of the <a>-type is 0, only the <o>-type and <aw/au>-type were compared. N.S. indicates not significant.

* and ** indicate significant.

As Table 55 shows, the default spellings for BC[a:] can be interpreted as the <aw>-type (or simply <aw>) word-finally, and the <o>-type (or simply <o>) before a coda. In other words, the <o>-type and <aw>-type are nearly in a complementary relationship. What is interesting is that in Mississippi [Cɔ:C], the default spelling can be interpreted as the <aw>-type, rather than <o>, even in a closed-syllable environment, which is distinguished from the BC closed-syllable environment. However, this difference may simply be due to vowel duration based on the speakers' speech rates, rather than vowel qualities; although both BC and Mississippi speakers were instructed to pronounce the normal stimuli at a natural speech rate, the duration of [a:] in BC normal [za:d] was shorter than that of [ɔ:] in Mississippi normal [smɔ:d] (305 ms vs. 379 ms respectively) due to speakers' interpretation of normal speed, so the Canadian participants may have been tempted to use a monograph for a faster vowel and a digraph for a slower vowel. Further research is needed to make a conclusion. The default spelling for Mississippi [Ca:#] can be interpreted as the <a>-type, but not the <aw>-type, which is distinguished from BC [Ca:#]. This may be because the phonetic quality of MS [a:] ([a:]) is associated with the foreign (a). As for Mississippi [Ca:C], <o> was most preferred, just like BC [Ca:C], but the chi-square test still retains the null hypothesis that the three types of spellings were evenly distributed. This may also be because the foreign (a)-like phonetic quality of Mississippi [a:] attracts the <a>-type, so the <a>-type was almost equally preferred with the <o>-type, unlike the case of BC [Ca:C].

To sum up, the Canadian participants spelt the Mississippi [ɔ:] and [a:] differently by assigning the <aw>-type to [ɔ:] at least in the closed syllable environment, and the <a>-type to [a:] at least in the open-syllable environment.

4.3 The Japanese participants: how they compare with the native speakers

In this section, I will compare the results of the Canadian participants and that of the Japanese EAL participants.

4.3.1 Evaluation criteria for non-native participants

4.3.1.1 Points for the Japanese/Chinese EAL participants' spellings

The goal of this chapter is to examine how similar native Canadian English-speaking participants and Japanese/Chinese EAL participants are in their performance of the spelling task. In other words, the criteria are not necessarily whether the spelling was correct or incorrect. While I adopted the 2-point scale for the reading task, I used the 4-point scale for the spelling task to evaluate EAL participants because there were more spelling variations by the Canadian participants in the spelling task than sound variations in the reading task. The criteria are explained in Table 56 on the basis of the Canadian participants' productions shown from Table 48 to Table 51.

Table 56. Criteria for evaluating the Japanese/Chinese participants' performance in the spelling task

<p>4 points - The 1st (the most frequent) choices by the Canadian participants</p> <p>e.g., <ay> for [sne^l] chosen by 13 out of 14 Canadians <ee> for [ʃi:b] chosen by 10 out of 14 Canadians <oe> for [po^ʊ] chosen by 8 out of 14 Canadians <y>, <ye>, <igh> for [snaɪ] by 3 Canadians for each</p>
<p>3 points - Choices by more than one Canadian participants but not most frequently</p> <p>e.g., <oi> for [spɔɪ] chosen by 6 out of 14 Canadians <oh> and <o> for [po^ʊ] by 3 and 2 Canadians respectively <ea> for [sni:b] chosen by 2 out of 14 Canadians</p>
<p>2 points - Choices by only one Canadian with bidirectional consistency</p> <p>e.g., <u_e> and <eu> for [bjɜ:d] by one Canadian (<bude> and <beud> can be read as [bjɜ:d].)</p>
<p>1 point - Choices by only one Canadian with no bidirectional consistency</p>

(Ones with → in Table 48 - Table 51)

e.g., <ou> for [ʃo^o] by one Canadian
([ʃo^o] can be spelled as <chou>, but <chou> can be read with other sounds, like [ʃu:].)

**0 point - Choices by no Canadians or judged as errors
(Ones with * in Table 48 - Table 51)**

e.g., <ei> for [te^hb]
<i> for [ʃi:b]

If there was more than one most frequent spelling by the Canadian participants, all of these spellings were worth 4 points. For example, <y>, <ye>, and <igh> for [aɪ] were all spelled by three participants, so all of these spellings are 4 points. In slow stimuli, the most frequent spelling for both synthetically lengthened one and original one is worth 4 points to make the criteria lenient. For example, <oh> for lengthened [sko^o] was the most frequent spelling (4 out of 10), which is 4 points. As well, although <o> for lengthened [sko^o] was chosen by three (out of 10) Canadian participants, <o> for original [sko^o] was chosen by four (out of 4), so in total, <o> was spelled by seven participants, which surpasses <oh>. In this case, both <oh> and <o> are worth 4 points.

According to these criteria, apparent discrepancies or asymmetries can be explained in most cases. For example, based on phonics textbooks, both <ee> and <ea> may be correct for [i:] in the stimulus [ʃi:b]. However, the Canadian participants chose <ee> much more frequently than <ea> (10 vs. 2), suggesting that according to native speakers' intuition, <ee> is better than <ea>, or <ee> could be interpreted as more native-like. In fact, in actual words, <ea> can be read as [e^l] as in *break* or *steak*, or as [ɛ] as in *head* or *ready*, or with two syllables as in *idea* or *reality*. These patterns in real words may have resulted in the popularity of <ee> over <ea>. Another apparent discrepancy is that for [aɪ], that is, for [zaɪ], the spelling <y> is 1 point, while for [snaɪ], <y> is 4 points. The spelling <zy> for [zaɪ] is 1 point because <zy> does not satisfy the bidirectional consistency (<zy> can also be read as

[zi:]), which will be discussed in the next section. However, <sny> can also be read as either [sni:] or [snaɪ], which does not satisfy the bidirectional consistency, but <sny> was one of the most frequently chosen spellings that are worth 4 points. This apparent discrepancy can be explained by an aversion to two-letter words in English, which probably resulted in the lower popularity of <zy>. The same logic goes to [po^u] and [ʃo^u]. The spelling <o> for [ʃo^u] is 4 points because <cho> satisfies the more than two letter preference, while <o> for [po^u] is 3 points probably because <po> does not satisfy the more than two letter preference.

On the contrary, a few discrepancies may not be theoretically explained, as will be discussed in the next section. In such cases, I simply followed native speakers' intuition. Nevertheless, such unexplainable discrepancies were very few, so it would not affect the overall results.

4.3.1.2 Coding: acceptable spellings and bidirectional consistency

There may be GPC errors even by the Canadian participants. To judge whether their spellings can be the model spellings or not, I made the following criteria. First, a vowel grapheme that more than one Canadian participant spelled is regarded as correct or acceptable. Second, for a vowel grapheme that only one Canadian participant spelled, I asked three native English-speaking graduate students in the Linguistics Department at the University of Victoria to judge its acceptability. Graphemes which at least two of these three judges accepted were regarded as acceptable. For example, the sound [ʃi:b] was spelled as <cheb> by only one Canadian participant, but these three judges regarded it as an error since <cheb> is likely to correspond to [ʃɛb]. From Table 48 to Table 51, an asterisk (*) is added to errors or graphemes that are not good as a model²⁷.

²⁷ Based on these criteria, error spellings (excluding perception-related errors) were only nine in total (4 in BC normal, 2 in Mississippi normal, 2 in BC slow, and one in Mississippi slow) out of all the 944 tokens (1%), meaning that their spellings are fairly reliable.

An important criterion for the spellings chosen by only one Canadian participants is bidirectional consistency, which is whether the phoneme-to-grapheme conversion and the grapheme-to-phoneme conversion are consistent or not. An ideal spelling is that a spelling that someone writes can be read in the same way by others. For example, if the sound [snaɪ] is spelled as <snigh>, it can recover the sound [snaɪ], which satisfies bidirectional consistency. In contrast, [snaɪ] spelled as <snie> is also acceptable from a speller's point of view, but the spelling <snie> can also be read as [sni:], that is, recoverability of the original sound is not guaranteed. Therefore, <snigh> is considered a better spelling than <snie>. Such bidirectional consistency was also judged by the same three judges. In Table 48 to Table 51, arrows (→) are added to graphemes that work in one direction but not in the other. Arrows are also added when the spelling is fine from a speller's point of view but not from a reader's point of view. For example, in the case of <aa> for Mississippi lengthened [sta:], it is acceptable to spell <staa> if the participant attempted to express the phonetic duration. However, when a reader sees <staa> without a sound, he/she would think that word-final <aa> is very unlikely as English.

I also made criteria regarding acceptability of aforementioned misperception-related spellings. I regarded spellings of the stimuli which more than one participant misperceived as acceptable, although errors are errors. For example, Mississippi normal [pɪm] ([pɪəm]) was most frequently spelled as <pam> by the Canadian participants (10/14), so <pam> is regarded as an acceptable error. This means that even if the Japanese/Chinese participants spelled [pɪm] as <pam>, this is worth 4 points. For misperception-related spellings by only one participant, the same three judges decided their acceptability. For example, on one hand, Mississippi lengthened [pɪz] was spelled as <pez> by one participant, and it was judged as an acceptable mistake since [ɪ] is usually not long in duration. On the other hand, BC normal [ke'b] was spelled as <kay> without [b] by one participant, but since the three judges

considered that [b] in the stimulus was not imperceptible, <kay> for [ke'b] was judged as a careless mistake, and therefore, it is worth 0 points. Note that judging from the spelling <kay>, the vowel in [ke'b] was correctly perceived. However, since whether the vowel is word-final or non-final can make a difference in spelling, I regarded this as an error. As well, Mississippi lengthened [nʌz] was spelled as <nawz> and <naaz> by one participant for each, but the former was accepted but the latter was not. This is because lengthened [ʌ] could be perceived as [ɑ:] so the default spelling <aw> for [ɑ:] is acceptable. However, indeed [ɑ:] could be spelled as <aa>, but <aa> could be read differently, such as [æ:]. Since <aa> for [nʌz] made both perception and bidirectional consistency errors, it was regarded as an error. These judgements regarding misperception may be rather subjective and cannot always be theoretically explained, but since the number of errors made by only one participant is very limited, it would not affect the overall result. From Table 48 to Table 51, a small question mark (?) was added to acceptable perception-related errors, but an asterisk (*) is added to unacceptable perception-related errors.

The limitation of this method is that there are a few discrepancies. For example, Mississippi normal [sna:] was spelled as <snaw> by more than one participants (4/14), so this should be categorized as an acceptable grapheme (3 points). However, Mississippi slow [sta:] was spelled as <staw> by only one participant, and it was judged as unacceptable by all the three judges (0 points). Although these three judges do not contrast [ɑ:] and [ɔ:] as in *cot* and *caught*, they judged that Mississippi [ɑ:] ([a:]) sounded like the extra phoneme foreign (a), which should be spelled as <a> or an equivalent, but not <aw>. There may not be a solid theoretical explanation for why <aw> is accepted for normal [sna:] but not for lengthened [sta:], but I only followed what the participants and judges did in this study. More importantly, such unexplainable patterns occurred only few times, so this is marginal in the whole results.

4.3.2 Results of the Japanese participants

The overall results of all the stimuli by Japanese EAL learners are shown in tables below. In these tables, the boxes with thick red frames contain results that scored 4 points in coding. The ones with thin red frames indicate 3 points. Plain boxes indicate 2 points. Plain boxes with an arrow indicate 1 point. Shaded boxes indicate 0 points. Ones with a small question mark (?) are “acceptable” perception-related errors. Although the participants were notified that all the stimuli were nonsense words, when a large number of the Japanese participants mistakenly perceived nonsense stimuli as real words or near real words (e.g., [bju:] as <view>, [bju:d] as <viewed> or misspelled <viewd>, [dæ:z] as <dance>, etc.), I noted them at the bottom row(s).

Since the Japanese participants, except for one, were recruited in British Columbia in Canada, their target English was likely BC English. So I made a separate table for the results of BC normal speed stimuli, as shown in Table 57.

Table 57. The Japanese participants’ spellings for British Columbia normal speed stimuli

	BC normal stimuli							
Phoneme Stimuli	[eʰ#] [sneʰ]	[eʰ] [keʰb]	[i:ʰ#] [sni:]	[i:] [ʃi:b]	[aɪ#] [snaɪ]	[aɪ] [maɪb]	[oʊ#] [poʊ]	[oʊ] [moʊz]
Spelling # (%)	ay 8 (18%)	e 27 (60%)	ee 20 (44%)	i 19 (42%)	y 8 (18%)	i_e 17 (38%)	ow 10 (22%)	o_e 15 (33%)
Spelling # (%)	e 6 (13%)	a_e 10 (22%)	ie 6 (13%)	ee 6 (13%)	ine 8 (18%)	ai 8 (18%)	oe 4 (9%)	ou 11 (24%)
Spelling # (%)	ey 4 (9%)	a 3 (7%)	i 4 (9%)	ea 4 (9%)	ai 7(15%)	i 6(13%)	om 4 (9%)	o 9(20%)
Spelling # (%)	ee 4 (9%)	ei 1 (2%)	y 2 (4%)	ie_e 4 (9%)	igh 6(13%)	y_e 3 (7%)	o 3 (7%)	ou_e 5
Spelling # (%)	ei 3 (7%)	ei_e 1 (2%)	e 1 (2%)	e_e 3 (7%)	ay 4 (9%)	y 2 (4%)	oh 3 (7%)	oo 2 (4%)
Spelling # (%)	ain 3 (7%)	i 1 (2%)	ea 1 (2%)	e 3 (7%)	→i 2 (4%)	u 2 (4%)	ou 3 (7%)	oe 1 (2%)
Spelling # (%)	ai 2 (4%)	igh 1 (2%)	ey 1 (2%)	i_e 2 (4%)	aigh 2 (4%)	igh 1 (2%)	oo 3 (7%)	oou_e 1 (2%)
Spelling # (%)	ae 2 (4%)	u 1 (2%)	ei 1 (2%)	i_en 2 (4%)	ain 2 (4%)	ighn 1 (2%)	one 2 (4%)	au 1 (2%)

Spelling # (%)	eh 2 (4%)		ene 1 (2%)	ie 1 (2%)	→ie 1 (2%)	igh# 1 (2%)	on 2 (4%)	
Spelling # (%)	ein 2 (4%)		eth 1 (2%)	ee_e 1 (2%)	ight 1 (2%)	i# 1 (2%)	ough 1 (2%)	
Spelling # (%)	a 1 (2%)		ek 1 (2%)		ign 1 (2%)	ai_e 1 (2%)	owe 1 (2%)	
Spelling # (%)	aigh 1 (2%)		ay 1 (2%)		in 1 (2%)	ai# 1 (2%)	oeu 1 (2%)	
Spelling # (%)	eigh 1 (2%)		a 1 (2%)		ith 1 (2%)	oi# 1 (2%)	oem 1 (2%)	
Spelling # (%)	ih 1 (2%)		ih 1 (2%)		ad 1 (2%)		ome 1 (2%)	
Spelling # (%)	in 1 (2%)		ig 1 (2%)		ye 0 (0%)		oomh 1 (2%)	
Spelling # (%)	i 1 (2%)		iy 1 (2%)				owm 1 (2%)	
Spelling # (%)	ig 1 (2%)		yg 1 (2%)				ool 1 (2%)	
Spelling # (%)	ak 1 (2%)						oun 1 (2%)	
Spelling # (%)	eil 1 (2%)						oth 1 (2%)	
Spelling # (%)							aul 1 (2%)	
Total	45	45	45	45	45	45	45	45

45 Japanese participants

BC normal stimuli

[u:#]	[u:]	[labial C + ju:#]	[labial C + ju:#]	[æ:]	[ɛ]	[ɪ]	[ɑ:#]	[ɑ:]
[sku:]	[tu:d]	[bju:]	[bju:d]	[dæ:z]	[smɛz]	[dɪz]	[ta:]	[za:d]
ue 11 (24%)	u_e 17 (38%)	iew 16 (36%)	iew 14 (31%)	a 19 (42%)	e 29 (64%)	e 20 (44%)	oe 8 (18%)	a 19 (42%)
oon 6 (13%)	oo 10 (22%)	ew 12 (26%)	u_e 8 (18%)	an_e 6 (13%)	i 8 (18%)	i 9 (20%)	ah 4 (9%)	o 17 (38%)
→ew 4 (9%)	u 7 (15%)	iw 6 (13%)	ew 5 (11%)	a_e 4 (9%)	e_e 5 (11%)	ea 6 (13%)	ou 4 (9%)	ar 4 (9%)
u 3 (7%)	ou 3 (7%)	eu 3 (7%)	eau 3 (7%)	oe 4 (9%)	a_e 2 (4%)	ee 2 (4%)	ow 3 (7%)	ou 2 (4%)
oom 3 (7%)	ue 1 (2%)	yu 2 (4%)	ea 2 (4%)	an 3 (7%)	a 1 (2%)	e_e 2 (4%)	a 2 (4%)	ah 1 (2%)
oo 2 (4%)	oo_e 1 (2%)	u 1 (2%)	iewe 2 (4%)	e 2 (4%)		ea_e 2 (4%)	au 2 (4%)	o_e 1 (2%)
uu 2 (4%)	ewe 1 (2%)	ue 1 (2%)	ue 1 (2%)	ea_e 2 (4%)		ei 1 (2%)	oa 2 (4%)	er 1 (2%)
um	oow	uu	eu	o_e		ei_e	ogh	aw

2 (4%)	1 (2%)	1 (2%)	1 (2%)	2 (4%)		1 (2%)	2 (4%)	0 (0%)
uw	yu	iu	→eu_e	ea		ee_e	ong	
1 (2%)	1 (2%)	1 (2%)	1 (2%)	1 (2%)		1 (2%)	2 (4%)	
ow	vwoo	eaw	eau_e	oe_e		a	on	
1 (2%)	1 (2%)	1 (2%)	1 (2%)	1 (2%)		1 (2%)	2 (4%)	
oomb	o	eum	ieu	or_e			augh	
1 (2%)	1 (2%)	1 (2%)	1 (2%)	1 (2%)			2 (4%)	
oong	o_e		iwe				aa	
1 (2%)	1 (2%)		1 (2%)				1 (2%)	
ume			iew_e				ar	
1 (2%)			1 (2%)				1 (2%)	
oum			uewe				ao	
1 (2%)			1 (2%)				1 (2%)	
oune			yu				ough	
1 (2%)			1 (2%)				1 (2%)	
oob			u(Cu)				oh	
1 (2%)			1 (2%)				1 (2%)	
uth			ea_e				ooh	
1 (2%)			1 (2%)				1 (2%)	
au							o	
1 (2%)							1 (2%)	
wen							ongue	
1 (2%)							1 (2%)	
w							om	
1 (2%)							1 (2%)	
							all	
							1 (2%)	
							un	
							1 (2%)	
							of	
							1 (2%)	
							aw	
							0 (0%)	
45	45	45	45	45	45	45	45	45
			(viewd)	(dance)		(death)	(toe)	
			12	4		4	8	
			(viewed)	(does)				
			2	4				

45 Japanese participants

BC normal stimuli

[ʌ#]	[ʌ]	[ʊ]	[ɔɪ#]	[ɔɪ]	[aʊ#]	[aʊ]
[bʌ]	[fʌd]	[pʊd]	[spɔɪ]	[fɔɪd]	[gʌʊ]	[faʊz]
a	a	u	oi	oi	aw	au_e
20 (44%)	36 (80%)	33 (73%)	16 (36%)	40 (88%)	11 (24%)	17 (38%)
o	u	o	oy	oy	awn	au
4 (9%)	6 (13%)	8 (18%)	13 (29%)	1 (4%)	6 (13%)	13 (29%)
ah	un	oo	oin	oye	au	ou

3 (7%)	1 (2%)	1 (2%)	8 (18%)	1 (2%)	5 (11%)	3 (7%)
oh	ou	ou	oe	o	am	ou_e
3 (7%)	1 (2%)	1 (2%)	3 (7%)	1 (2%)	4 (9%)	3 (7%)
uh	i	u_e	oil	oin	aun	aw
2 (4%)	1 (2%)	1 (2%)	2 (4%)	1 (2%)	3 (7%)	2 (4%)
ou		o(du)	oid	ai	aum	ao
2 (4%)		1 (2%)	2 (4%)	1 (2%)	2 (4%)	2 (4%)
or			oine		um	ow
2 (4%)			1 (2%)		2 (4%)	1 (2%)
u					un	aou_e
1 (2%)					2 (4%)	1 (2%)
ua					ough	aul
1 (2%)					1 (2%)	1 (2%)
oo					oum	aul_e
1 (2%)					1 (2%)	1 (2%)
oa					an	awn
1 (2%)					1 (2%)	1 (2%)
oe					amb	
1 (2%)					1 (2%)	
ow					auw	
1 (2%)					1 (2%)	
od					al	
1 (2%)					1 (2%)	
ock					ab	
1 (2%)					1 (2%)	
ar					aone	
1 (2%)					1 (2%)	
					uan	
					1 (2%)	
					uo	
					1 (2%)	
					ow	
					0 (0%)	
45	45	45	45	45	45	45

Note. The boxes with thick red frames are 4 points. The ones with thin red frames are 3 points. Plain boxes are 2 points. Plain boxes with an arrow are 1 point. Shaded boxes are 0 points. “_” indicates that there is a consonant letter.

Table 58 shows overall results including BC normal and slow, and Mississippi normal and slow.

Table 58. The Japanese participants’ spellings for all the stimuli

Phoneme	[eʰ#]		[eʰ]		[i:#]		[i:]	
Dialect	BC		BC		BC		BC	
Speed Stimuli	Normal [sneʰ]	Slow [skeʰ]	Normal [keʰb]	Slow [teʰb]	Normal [sni:]	Slow [spi:]	Normal [ʃi:b]	Slow [sni:b]
Spelling # (%)	ay 8 (18%)	ay 10 (22%)	e 27 (60%)	a_e 22 (49%)	ee 20 (44%)	ee 25 (56%)	i 19 (42%)	ee 17 (38%)
Spelling # (%)	e 6 (13%)	[?] ane 8 (18%)	a_e 10 (22%)	ei 5 (11%)	ie 6 (13%)	een 6 (13%)	ee 6 (13%)	ee_e 7 (16%)
Spelling # (%)	ey 4 (9%)	ey 4 (9%)	a 3 (7%)	ai 4 (9%)	i 4 (9%)	eem 3 (7%)	ea 4 (9%)	e_e 5 (11%)
Spelling # (%)	ee 4 (9%)	ei 4 (9%)	ei 1 (2%)	e 4 (9%)	y 2 (4%)	ea 1 (2%)	ie_e 4 (9%)	i_e 5 (11%)
Spelling # (%)	ei 3 (7%)	ain 4 (9%)	ei_e 1 (2%)	ea 3 (7%)	e 1 (2%)	ii 1 (2%)	e_e 3 (7%)	ea_e 3 (7%)
Spelling # (%)	ain 3 (7%)	am 3 (7%)	i 1 (2%)	ei_e 3 (7%)	ea 1 (2%)	iy 1 (2%)	e 3 (7%)	e 2 (4%)
Spelling # (%)	ae 2 (4%)	ein 2 (4%)	igh 1 (2%)	a(bu) 2 (4%)	ey 1 (2%)	eegh 1 (2%)	i_e 2 (4%)	ea 1 (2%)
Spelling # (%)	ai 2 (4%)	ai 1 (2%)	u 1 (2%)	a 1 (2%)	ei 1 (2%)	eeth 1 (2%)	i_en 2 (4%)	ie 1 (2%)
Spelling # (%)	eh 2 (4%)	aye 1 (2%)		ai_e 1 (2%)	ene 1 (2%)	eel 1 (2%)	ie 1 (2%)	ie_e 1 (2%)
Spelling # (%)	ein 2 (4%)	aigh 1 (2%)			eth 1 (2%)	in 1 (2%)	ee_e 1 (2%)	i 1 (2%)
Spelling # (%)	a 1 (2%)	eigh 1 (2%)			ek 1 (2%)	eein 1 (2%)		eeh 1 (2%)
Spelling # (%)	aigh 1 (2%)	e 1 (2%)			ay 1 (2%)	inne 1 (2%)		yee 1 (2%)
Spelling # (%)	eigh 1 (2%)	aign 1 (2%)			a 1 (2%)	ing 1 (2%)		
Spelling # (%)	ih 1 (2%)	in 1 (2%)			ih 1 (2%)	ebe 1 (2%)		
Spelling # (%)	in 1 (2%)	age 1 (2%)			ig 1 (2%)			
Spelling # (%)	i 1 (2%)	en 1 (2%)			iy 1 (2%)			
Spelling # (%)	ig 1 (2%)	een 1 (2%)			yg 1 (2%)			
Spelling # (%)	ak 1 (2%)							
Spelling # (%)	eil 1 (2%)							
Total	45	45	45	45	45	45	45	45
Speed Stimuli	Normal [sneʰ]	Slow [skeʰ]	Normal [keʰb]	Slow [teʰb]	Normal [sni:]	Slow [spi:]	Normal [ʃi:b]	Slow [sni:b]
Dialect	BC		BC		BC		BC	

45 Japanese participants

[ai#]		[ai]		[o ^u #]		[o ^u]		
BC		BC		BC		Mississippi	BC	
Normal [snaɪ]	Slow [zaɪ]	Normal [maɪb]	Slow [naɪb]	Normal [po ^u]	Slow [sko ^u]	Normal [ʃo ^u]	Normal [mo ^u z]	Slow [spo ^u z]
y 8 (18%)	ain 10 (22%)	i_e 17 (38%)	i_e 23 (51%)	ow 10 (22%)	ow 12 (26%)	ou 17 (38%)	o_e 15 (33%)	o_e 13 (29%)
ine 8 (18%)	ai 7 (16%)	ai 8 (18%)	→ai 9 (20%)	oe 4 (9%)	ou 6 (13%)	ow 9 (20%)	ou 11 (24%)	ou_e 11 (24%)
ai 7(16%)	ine 4(9%)	i 6(13%)	ai_e 8	om 4 (9%)	or 4 (9%)	o 4 (9%)	o 9(20%)	ou 11(24%)
igh 6(13%)	ay 3(7%)	y_e 3 (7%)	igh 2(4%)	o 3 (7%)	ough 3 (7%)	oe 2 (4%)	ou_e 5 (11%)	oo 2 (4%)
ay 4 (9%)	ign 3(7%)	y 2 (4%)	igh_e 1(2%)	oh 3 (7%)	o 2 (4%)	ough 2 (4%)	oo 2 (4%)	oo_e 2 (4%)
→i 2 (4%)	ighn 2(4%)	u 2 (4%)	i(Co) 1(2%)	ou 3 (7%)	oh 2(4%)	oo 2 (4%)	oe 1 (2%)	au_e 2 (4%)
aigh 2 (4%)	aine 2(4%)	igh 1 (2%)	ig_e 1(2%)	oo 3 (7%)	au 2 (4%)	or 2 (4%)	oou_e 1 (2%)	o 1 (2%)
ain 2 (4%)	ey 2(4%)	ighn 1 (2%)		one 2 (4%)	aw 2 (4%)	aw 2 (4%)	au 1 (2%)	or 1 (2%)
→ie 1 (2%)	ie 1(2%)	igh# 1 (2%)		on 2 (4%)	ol 2 (4%)	ogh 1 (2%)		orn 1 (2%)
ight 1 (2%)	eye 1(2%)	i# 1 (2%)		ough 1 (2%)	oe 1 (2%)	ob 1 (2%)		
ign 1 (2%)	igh 1(2%)	ai_e 1 (2%)		owe 1 (2%)	oo 1 (2%)	ov 1 (2%)		
in 1 (2%)	ei 1(2%)	ai# 1 (2%)		oEU 1 (2%)	oue 1 (2%)	of 1 (2%)		
ith 1 (2%)	oy 1(2%)	oi# 1 (2%)		oem 1 (2%)	orw 1 (2%)	u 1 (2%)		
ad 1 (2%)	in 1(2%)			ome 1 (2%)	ore 1 (2%)			
ye 0 (0%)	ine 1(2%)			oomh 1 (2%)	oan 1 (2%)			
	ime 1(2%)			owm 1 (2%)	oon 1 (2%)			
	ayn 1(2%)			ool 1 (2%)	ol 1 (2%)			
	aime 1(2%)			oun 1 (2%)	oll 1 (2%)			
	ein 1(2%)			oth 1 (2%)	ould 1 (2%)			
	yne			aul				

	1(2%)			1 (2%)				
	ye 0(0%)							
45	45	45	45	45	45	45	45	45
								(spouse) 12
Normal [snar]	Slow [zar]	Normal [marb]	Slow [narb]	Normal [po ^u]	Slow [sko ^u]	Normal [ʃo ^u]	Normal [mo ^u z]	Slow [spo ^u z]
BC		BC		BC		Mississippi	BC	

45 Japanese participants

[u:#]		[u:]		[labial C + ju:#]		[labial C + ju:#]		[o]	
BC		BC		BC		BC		BC	
Normal [sku:]	Slow [spu:]	Normal [tu:d]	Slow [snu:b]	Normal [bju:]	Slow [bju:]	Normal [bju:d]	Slow [pju:d]	Normal [pud]	Slow [sod]
ue 11 (24%)	oo 25 (56%)	u_e 17 (38%)	oo 17 (38%)	iew 16 (36%)	iew 15 (33%)	iew 14 (31%)	u_e 28 (62%)	u 33 (73%)	u 16 (36%)
oon 6 (13%)	oon 4 (9%)	oo 10 (22%)	oo_e 8 (18%)	ew 12 (26%)	ew 7 (16%)	u_e 8 (18%)	eu 6 (13%)	o 8 (18%)	oo 7 (7%)
→ew 4 (9%)	ooh 3(7%)	u 7(16%)	u_e 6(13%)	iw 6(13%)	eaw 3(7%)	ew 5 (11%)	ew 3(7%)	oo 1 (2%)	ou 4(9%)
u 3 (7%)	ue 2(4%)	ou 3 (7%)	u 4 (9%)	eu 3 (7%)	eau 2(4%)	eau 3 (7%)	ue 3(7%)	ou 1 (2%)	o 4(9%)
oom 3 (7%)	oe 2(4%)	oo_e 1 (2%)	ew 3 (7%)	yu 2 (4%)	eu 2(4%)	ea 2 (4%)	yoo 1(2%)	uC_e 1 (2%)	u_e 4(9%)
oo 2 (4%)	u 1(2%)	ue 1 (2%)	ue_e 1 (2%)	ue 1 (2%)	yew 2(4%)	iewe 2 (4%)	yue 1(2%)	o(du) 1 (2%)	ue 2(4%)
uu 2 (4%)	ou 1(2%)	ewe 1 (2%)	ou_e 1 (2%)	u 1 (2%)	iewn 2(4%)	ue 1 (2%)	ou 1(2%)		u(du) 1(2%)
um 2 (4%)	oou 1(2%)	oow 1 (2%)	yu_e 1 (2%)	uu 1 (2%)	u 1(2%)	eu 1 (2%)	u 1(2%)		ua 1(2%)
uw 1 (2%)	uw 1(2%)	yu 1 (2%)	o_e 1 (2%)	iu 1 (2%)	ieu 1(2%)	→eu_e 1 (2%)	yur 1(2%)		oe 1(2%)
ow 1 (2%)	ow 1(2%)	vwoo 1 (2%)	o 1 (2%)	eaw 1 (2%)	eiw 1(2%)	eau_e 1 (2%)			oa 1(2%)
oomb 1 (2%)	oone 1(2%)	o 1 (2%)	um 1 (2%)	eum 1 (2%)	eiu 1(2%)	ieu 1 (2%)			o_e 1(2%)
oong 1 (2%)	oor 1(2%)	o_e 1 (2%)	unyu 1 (2%)		iu 1(2%)	iwe 1 (2%)			a 1(2%)
ume 1 (2%)	ooz 1(2%)				iuw 1(2%)	iew_e 1 (2%)			uew 1(2%)
oum 1 (2%)	oom 1(2%)				iaw 1(2%)	uewe 1 (2%)			or 1(2%)
oune 1 (2%)					ieyu 1(2%)	yu 1 (2%)			eu 0(0%)

oob 1 (2%)					eum 1(2%)	u(Cu) 1 (2%)			
uth 1 (2%)					eume 1(2%)	ea_e 1 (2%)			
au 1 (2%)					erum 1(2%)				
wen 1 (2%)					yun 1(2%)				
w 1 (2%)					ue 0(0%)				
45	45	45	45	45	45	45	45	45	45
					(view) 8	(viewd) 12			
						(viewed) 2			
Normal [sku:]	Slow [spu:]	Normal [tu:d]	Slow [snu:b]	Normal [bju:]	Slow [bju:]	Normal [bju:d]	Slow [pju:d]	Normal [pod]	Slow [sod]
BC		BC		BC		BC		BC	

45 Japanese participants

[æ:]		[æ:] ([æə(m)])			
BC		Mississippi		Mississippi	
Normal [dæ:z]	Slow [pæ:z]	Normal [stæ:z]	Slow [pæ:z]	Normal [stæ:m]	Slow [snæ:m]
a 19 (42%)	a 20 (44%)	a 27 (60%)	a 11 (24%)	a 33 (73%)	a 15 (33%)
an_e 6 (13%)	a_e 5 (11%)	ar 6 (13%)	ar 11 (24%)	ar 6 (13%)	ea 6 (13%)
a_e 4 (9%)	au_e 4 (9%)	a_e 5 (11%)	aa 5 (11%)	ah 1 (2%)	a_e 4 (9%)
oe 4 (9%)	ar 4 (9%)	e 2 (4%)	ah 4 (9%)	ea 1 (2%)	aw 4 (9%)
an 3 (7%)	au 3 (7%)	u 2 (4%)	aa_e 2 (4%)	aw 1 (2%)	ar 4 (9%)
e 2 (4%)	→aa 2 (4%)	aa 2 (4%)	au 2 (4%)	au 1 (2%)	ae 2 (4%)
ea_e 2 (4%)	aa_e 2 (4%)	u_e 1 (2%)	u 2 (4%)	e 1 (2%)	aa 1 (2%)
o_e 2 (4%)	e 1 (2%)		ah 1 (2%)	a_e 1 (2%)	aa_e 1 (2%)
ea 1 (2%)	u 1 (2%)		ea 1 (2%)		au 1 (2%)
oe_e 1 (2%)	ah_e 1 (2%)		ae 1 (2%)		ee 1 (2%)
or_e 1 (2%)	aw_e 1 (2%)		oa 1 (2%)		eau 1 (2%)
	e_e 1 (2%)		au_e 1 (2%)		u 1 (2%)

			ar_e 1 (2%)		u_e 1 (2%)
			arr 1 (2%)		ear 1 (2%)
			arl 1 (2%)		er 1 (2%)
					al 1 (2%)
45	45	45	45	45	45
(dance) 4					
(does) 4					
Normal [dæ:z]	Slow [pæ:z]	Normal [stæ:z]	Slow [pæ:z]	Normal [stæ:m]	Slow [snæ:m]
BC		Mississippi		Mississippi	
45 Japanese participants					
[ɛ]			[ɛ] ([ɛə(m)])		
BC		Mississippi		Mississippi	
Normal [smɛz]	Slow [mɛz]	Normal [ʃfɛz]	Slow [stɛz]	Normal [sem]	Slow [spɛm]
e 29 (64%)	e 33 (73%)	e 28 (62%)	e 11 (24%)	?a 9 (20%)	?a 18 (40%)
i 8 (18%)	e_e 4 (9%)	a 7 (16%)	a 7 (16%)	ea 7 (16%)	ea 7 (16%)
e_e 5 (11%)	ee 2 (4%)	ue 4 (9%)	ea 7 (16%)	e 6 (13%)	e 3 (7%)^a
a_e 2 (4%)	e(zu) 1 (2%)	u 2 (4%)	e_e 6 (13%)	el 4 (9%)	au 3 (7%)
a 1 (2%)	ae 1 (2%)	ee 1 (2%)	a_e 3 (7%)	u 4 (9%)	er 3 (7%)
	ei 1 (2%)	ar_e 1 (2%)	ee 2 (4%)	er 2 (4%)	ar 3 (7%)
	en 1 (2%)	ir 1 (2%)	eh 1 (2%)	au 2 (4%)	aw 2 (4%)
	an 1 (2%)	ie 1 (2%)	aa 1 (2%)	aw 1 (2%)	ee 1 (2%)
	ea_e 1 (2%)		au 1 (2%)	eo 1 (2%)	el 1 (2%)
			ea_e 1 (2%)	eu 1 (2%)	ah 1 (2%)
			ee_e 1 (2%)	ew 1 (2%)	aa 1 (2%)
			air 1 (2%)	ee 1 (2%)	e_e 1 (2%)
			er 1 (2%)	ia 1 (2%)	a_e 1 (2%)
			ear 1 (2%)	ie 1 (2%)	

			1 (2%)	1 (2%)	
			ar_e 1 (2%)	il 1 (2%)	
				ai 1 (2%)	
				an 1 (2%)	
				a_e 1 (2%)	
45	45	45	45	45	45
Normal [smɛz]	Slow [mɛz]	Normal [ʃfɛz]	Slow [stɛz]	Normal [sem]	Slow [spɛm]
BC		Mississippi		Mississippi	

Note. ^a Although none of the Canadian participants spelled [ɛ] in [spɛm] as <e>, I regarded <e> spelled by Japanese participants as correct, since <e> is the correct spelling in Mississippi English.

45 Japanese participants

BC		Mississippi		Mississippi	
[ɪ]		[ɪ]		[ɪ] ([ɪə(m)])	
Normal [dɪz]	Slow [stɪz]	Normal [spɪz]	Slow [pɪz]	Normal [pɪm]	Slow [bɪm]
e 20 (44%)	a_e 9 (20%)	?e 19 (42%)	?e 11 (24%)	?a 7 (16%)	ea 10 (22%)
i 9 (20%)	?e 6 (13%)	ee 9 (20%)	ee 9 (20%)	ea 7 (16%)	?a 7 (16%)
ea 6 (13%)	ee_e 5 (11%)	i 5 (11%)	ea 7 (16%)	eo 5 (11%)	ear 5 (11%)
ee 2 (4%)	ee 3 (7%)	a_e 3 (7%)	i 5 (11%)	aw 3 (7%)	ea_e 4 (9%)
e_e 2 (4%)	ea 3 (7%)	e_e 3 (7%)	ei 2 (4%)	el 3 (7%)	e 3 (7%)
ea_e 2 (4%)	i 2 (4%)	ea 2 (4%)	i_e 2 (4%)	e 2 (4%)	au 2 (4%)
ei 1 (2%)	a 2 (4%)	eu 1 (2%)	ea_e 2 (4%)	ew 2 (4%)	ar 2 (4%)
ei_e 1 (2%)	ai 2 (4%)	eau 1 (2%)	a 1 (2%)	er 2 (4%)	ah 2 (4%)
ee_e 1 (2%)	ei_e 2 (4%)	ea_e 1 (2%)	ie 1 (2%)	au 2 (4%)	aa 1 (2%)
a 1 (2%)	e_e 2 (4%)	a 1 (2%)	eau 1 (2%)	al 2 (4%)	ae 1 (2%)
	ea_e 2 (4%)		e_e 1 (2%)	eu 1 (2%)	ia 1 (2%)
	?ay 1 (2%)		ee_e 1 (2%)	eau 1 (2%)	iea 1 (2%)
	ay_e 1 (2%)		a_e 1 (2%)	ea_e 1 (2%)	eu 1 (2%)

	ai_e 1 (2%)		eel 1 (2%)	ieo 1 (2%)	ew 1 (2%)
	i_e 1 (2%)			ao 1 (2%)	eau 1 (2%)
	air 1 (2%)			ai 1 (2%)	eow 1 (2%)
	en 1 (2%)			ar 1 (2%)	ou 1 (2%)
	el 1 (2%)			erl 1 (2%)	era 1 (2%)
				[?] ou 1 (2%)	i 0 (0%)
				u 1 (2%)	
				i 0 (0%)	
45	45	45	45	45	45
(death) 4					
Normal [diz]	Slow [stiz]	Normal [spiz]	Slow [piz]	Normal [pim]	Slow [bim]
BC		Mississippi		Mississippi	

45 Japanese participants

[a:#]		[a:#] ([a:#])		[a:]		[a:] ([a:])	
BC		Mississippi		BC		Mississippi	
Normal [ta:]	Slow [da:]	Normal [sna:]	Slow [sta:]	Normal [za:d]	Slow [sta:d]	Normal [dʒa:d]	Slow [ʃa:d]
oe 8 (18%)	ah 6 (9%)	ah 17(38%)	ar 22(49%)	a 19 (42%)	a 13(29%)	a 22 (49%)	a 15(33%)
ah 4 (9%)	a 4 (9%)	a 7 (16%)	a 6 (13%)	o 17(38%)	ar 13(29%)	ar 6 (13%)	ar 9 (20%)
ou 4 (9%)	au 4 (9%)	ar 6 (13%)	ah 6 (13%)	ar 4 (9%)	au 7 (16%)	au 3 (7%)	→aa 4 (9%)
ow 3 (7%)	aa 3 (7%)	aw 2 (4%)	→aa 2 (4%)	ou 2 (4%)	o 3 (7%)	aa 3 (7%)	au 3 (7%)
a 2 (4%)	ou 3 (7%)	au 2 (4%)	aar 2 (4%)	ah 1 (2%)	oa 2 (4%)	ah 2 (4%)	ir 3 (7%)
au 2 (4%)	oah 2 (4%)	ough 1 (2%)	au 1 (2%)	o_e 1 (2%)	ou 2 (4%)	u 2 (4%)	a_e 2 (4%)
oa 2 (4%)	oa 2 (4%)	oh 1 (2%)	augh 1 (2%)	er 1 (2%)	→aa 1 (2%)	o 1 (2%)	e 2 (4%)
ogh 2 (4%)	oh 2 (4%)	ow 1 (2%)	aah 1 (2%)	aw 0 (0%)	a_e 1 (2%)	a(da) 1 (2%)	ah 1 (2%)
ong 2 (4%)	ar 2 (4%)	al 1 (2%)	ear 1 (2%)		u 1 (2%)	er 1 (2%)	ough 1 (2%)
on 2 (4%)	or 2 (4%)	ath 1 (2%)	are 1 (2%)		oo 1 (2%)	oa 1 (2%)	oo 1 (2%)

2 (4%)	2 (4%)	1 (2%)	1 (2%)		1 (2%)	1 (2%)	1 (2%)
augh	aw	aur	arr		ir	ou	ua
2 (4%)	1(2%)	1 (2%)	1 (2%)		1 (2%)	1 (2%)	1 (2%)
aa	aah	or	ath		aw	al	ur
1 (2%)	1 (2%)	1 (2%)	1 (2%)		0 (0%)	1 (2%)	1 (2%)
ar	augh	ur				ee	arw
1 (2%)	1 (2%)	1 (2%)				1 (2%)	1 (2%)
ao	ough	ad				aw	arl
1 (2%)	1 (2%)	1 (2%)				0 (0%)	1 (2%)
ough	uh	af					o
1 (2%)	1 (2%)	1 (2%)					0 (0%)
oh	oo	ea					aw
1 (2%)	1 (2%)	1 (2%)					0 (0%)
ooh	uo						
1 (2%)	1 (2%)						
o	ooh						
1 (2%)	1 (2%)						
ongue	ae						
1 (2%)	1 (2%)						
om	oue						
1 (2%)	1 (2%)						
all	uah						
1 (2%)	1 (2%)						
un	oor						
1 (2%)	1 (2%)						
of	orn						
1 (2%)	1 (2%)						
aw	oar						
0 (0%)	1 (2%)						
	uhr						
	1 (2%)						
45	45	45	45	45	45	45	45
(toe)			(star)				
8			19				
Normal	Slow	Normal	Slow	Normal	Slow	Normal	Slow
[ta:]	[da:]	[sna:]	[sta:]	[za:d]	[sta:d]	[dʒa:d]	[ʃa:d]
BC		Mississippi		BC		Mississippi	

45 Japanese participants

[ɔ:#] ([ɔʊ#])		[ɔ:] ([ɔʊ])		[ʌ]				[ʌ#]	
Mississippi		Mississippi		BC		Mississippi		BC	
Normal	Slow	Normal	Slow	Normal	Slow	Normal	Slow	Normal	Slow
[stɔ:]	[smɔ:]	[smɔ:d]	[stɔ:d]	[fʌd]	[zʌd]	[mʌz]	[nʌz]	[bʌ]	[mʌ]
ow	?all	ou	au	a	a	a	a	a	?a
6	11	11	7	36	28	25	11	20	11
(13%)	(24%)	(24%)	(16%)	(80%)	(62%)	(56%)	(24%)	(44%)	(24%)
ool	oll	o	oo	u	u	u	ar	o	?ah

6 (13%)	4 (9%)	8 (18%)	5 (11%)	6 (13%)	5 (11%)	7 (16%)	7 (16%)	4 (9%)	9 (20%)
or 5(11%)	ou 3 (7%)	o_e 6(13%)	ou 4(9%)	un 1 (2%)	an 4(9%)	au 4 (9%)	a_e 3(7%)	→ah 3 (7%)	ar 8(18%)
au 3 (7%)	aul 2 (4%)	au 5(11%)	oa 3(7%)	ou 1 (2%)	aa 1(2%)	a_e 3 (7%)	u 2(4%)	oh 3 (7%)	aa 3(7%)
?all 3 (7%)	ow 2 (4%)	ar 3 (7%)	ole 3(7%)	i 1 (2%)	e 1(2%)	o 2 (4%)	o 2(4%)	uh 2(4%)	o 3(7%)
ole 3 (7%)	oh 2 (4%)	or 3 (7%)	ool 3(7%)		ai 1(2%)	au_e 1 (2%)	au 2(4%)	ou 2 (4%)	au 2(4%)
ough 2 (4%)	or 2 (4%)	au_e 2 (4%)	al 2(4%)		ah_e 1(2%)	o_e 1 (2%)	au_e 2(4%)	or 2 (4%)	oau 1(2%)
o 2 (4%)	oor 2 (4%)	oo 2 (4%)	o 2(4%)		on 1(2%)	ou 1 (2%)	ou 2(4%)	u 1 (2%)	uah 1(2%)
oe 2 (4%)	a 1 (2%)	oa 2 (4%)	o_e 2(4%)		ar 1(2%)	u_e 1 (2%)	ar_e 2(4%)	ua 1 (2%)	er 1(2%)
oh 2 (4%)	aw 1(2%)^b	?al 1 (2%)	or 2(4%)		arme 1(2%)		ur 2(4%)	oo 1 (2%)	oar 1(2%)
oo 2 (4%)	au 1 (2%)	all 1 (2%)	orl 2(4%)		er 1(2%)		oo 1(2%)	oa 1 (2%)	or 1(2%)
ool 2 (4%)	aoh 1 (2%)	a 1 (2%)	aw 1(2%)				aa 1(2%)	oe 1 (2%)	ore 1(2%)
aw 1(2%)^b	o 1 (2%)	aw 0 (0%)	aa 1(2%)				ah 1(2%)	ow 1 (2%)	am 1(2%)
aal 1 (2%)	oe 1 (2%)		ow 1(2%)				ae 1(2%)	od 1 (2%)	ad 1(2%)
?ol 1 (2%)	oo 1 (2%)		oo_e 1(2%)				oa 1(2%)	ock 1 (2%)	aph 1(2%)
our 1 (2%)	awl 1 (2%)		aul 1(2%)				o_e 1(2%)	ar 1 (2%)	uh 0(0%)
uw 1 (2%)	aal 1 (2%)		aule 1(2%)				er 1(2%)		?aw 0(0%)
of 1 (2%)	ale 1 (2%)		aull 1(2%)				or 1(2%)		
off 1 (2%)	aule 1 (2%)		oal 1(2%)				ear 1(2%)		
	arve 1 (2%)		owl 1(2%)				ur_e 1(2%)		
	ol 1 (2%)		ar 1(2%)						
	ool 1 (2%)								
	oole 1 (2%)								
	orn 1 (2%)								

	oon 1 (2%)								
45	45	45	45	45	45	45	45	45	45
	(small) 9								
Normal [stɔ:]	Slow [smɔ:]	Normal [smɔ:d]	Slow [stɔ:d]	Normal [fʌd]	Slow [zʌd]	Normal [mʌz]	Slow [nʌz]	Normal [bʌ]	Slow [mʌ]
Mississippi		Mississippi		BC		Mississippi		BC	

Note. ^b For Mississippi normal [stɔ:], <aw> was not the most frequently chosen one by the Canadian participants since they most frequently misperceived [ɔ:] as [ɔ:l]. However, <aw> is the default spelling in the Mississippi accent, so I gave 4 points.

45 Japanese participants

[ɔɪ#]		[ɔɪ]		[aʊ#]		[aʊ]	
BC		BC		BC		BC	
Normal [spɔɪ]	Slow [pɔɪ]	Normal [fɔɪd]	Slow [pɔɪd]	Normal [gaʊ]	Slow [faʊ]	Normal [faʊz]	Slow [paʊz]
oi 16 (36%)	oi 17 (38%)	oi 40 (88%)	oi 40 (88%)	aw 11 (24%)	aw 16 (36%)	au_e 17 (38%)	au 15 (33%)
oy 13 (29%)	oy 12 (26%)	oy 1 (4%)	oy 2 (4%)	awn 6 (13%)	→au 7 (16%)	au 13 (29%)	au_e 13 (29%)
oin 8	oin 3 (7%)	oye 1 (2%)	oie 2 (4%)	au 5 (11%)	ao 7 (16%)	ou 3 (7%)	ou_e 4 (9%)
oe 3 (7%)	oye 2 (4%)	o 1 (2%)	oin 1 (2%)	am 4 (9%)	[?] aow 4 (9%)	ou_e 3 (7%)	aw 3 (7%)
oil 2 (4%)	oid 2 (4%)	oin 1 (2%)		aun 3 (7%)	aul 2 (4%)	aw 2 (4%)	oun 2 (4%)
oid 2 (4%)	ouy 1 (2%)	ai 1 (2%)		aum 2 (4%)	ow 1 (2%)	ao 2 (4%)	awn 2 (4%)
oine 1 (2%)	oay 1 (2%)			um 2 (4%)	aue 1 (2%)	ow 1 (2%)	ow 1 (2%)
	oigh 1 (2%)			un 2 (4%)	ah 1 (2%)	au_e 1 (2%)	ou 1 (2%)
	oint 1 (2%)			ough 1 (2%)	aowl 1 (2%)	aul 1 (2%)	ao 1 (2%)
	oem 1 (2%)			oum 1 (2%)	aun 1 (2%)	aul_e 1 (2%)	ao_e 1 (2%)
	orn 1 (2%)			an 1 (2%)	awl 1 (2%)	awn 1 (2%)	aou 1 (2%)
	orin 1 (2%)			amb 1 (2%)	awm 1 (2%)		aun 1 (2%)
	oil 1 (2%)			auw 1 (2%)	aowl 1 (2%)		
	oli 1 (2%)			al 1 (2%)	all 1 (2%)		
				ab			

				1 (2%)			
				aone 1 (2%)			
				uan 1 (2%)			
				uo 1 (2%)			
				ow 0 (0%)			
45	45	45	45	45	45	45	45
							(pause) 10
Normal [spɔɪ]	Slow [pɔɪ]	Normal [fɔɪd]	Slow [pɔɪd]	Normal [gɑʊ]	Slow [fɑʊ]	Normal [faʊz]	Slow [paʊz]
BC		BC		BC		BC	

Note. The boxes with thick red frames are 4 points. The ones with thin red frames are 3 points. Plain boxes are 2 points. Plain boxes with an arrow are 1 point. Shaded boxes are 0 points. [?] indicates “acceptable” perception-related errors. “_” indicates that there is a consonant letter.

Based on the 4-point scale, I calculated the average score of all the stimuli (the maximum score is 4 points × 71 stimuli = 284 points), that of only BC normal stimuli, or the stimuli in the participants’ target dialect (max. 4 points × 24 stimuli = 96 points), and that of the rest (i.e., BC slow, Mississippi norm, and Mississippi slow stimuli) (max. 4 points × 47 stimuli = 188 points). I also analyzed the average number of 0-point spellings (or the spellings the Canadian participants never chose) of all the stimuli (the maximum number is 71), that of only BC normal stimuli (max. 24), and that of the rest (max. 47). Then, I compared BC normal stimuli and the rest with the two-tailed two-sample t-test. Table 59 shows the summary.

Table 59. Average scores and the numbers of 0-point spellings by the Japanese participants

Overall score (Score per stimulus)	BC normal score (Score per stimulus)	BC slow & MS score (Score per stimulus)	Significance BC vs. others
Range	Range	Range	
99.2/284 (1.40/4)	33.8/96 (1.41/4)	65.4/188 (1.40/4)	N.S. p = 0.86
51 ~ 190	8 ~ 54	28~136	
# of overall 0-point spellings	# of BC normal 0-point spellings	# of BC slow & MS 0-point score	Significance BC vs. others

Range	Range	Range	
42.6/71 (60%)	14.4/24 (60%)	28.2/47 (60%)	N.S. p = 0.93
24% ~ 79%	33% ~ 88%	19% ~ 83%	

Note. N.S. = not significant. * = significant at the $p < 0.05$ level, ** = significant at the $p < 0.01$ level

4.3.3 Discussion

4.3.3.1 General discussion

Overall, the average score of the Japanese participants is 99.2 out of 284, or 1.4 points out of 4 per stimulus. The average number of 0-point spellings is 42.6 (60%). This suggests that the Japanese EAL learners may spell unfamiliar one-syllable words in native-like manners only 40% of the time. If consonants are involved, the percentage of native-like spelling is expected to become lower. Such a low percentage of their sound-to-spelling conversion accuracy can cause a great deal of inconvenience in actual usage of English; for example, if learners hear a new word but cannot guess its spelling correctly, it would be difficult to look up a dictionary even if the word has a regular or near regular spelling.

The good news is that for 33 out of the 71 stimuli, the most frequent spellings by the Japanese participants matched those by the Canadian participants. However, among these 33 stimuli, only 12 of them were 50% or above in consistency: specifically, BC normal [fɔɪd] (88%), BC slow [pɔɪd] (88%), BC slow [mɛz] (73%), BC normal [pʊd] (73%), MS normal [stæ:m] (73%), BC normal [smɛz] (64%), MS normal [tʃɛz] (62%), BC slow [pju:d] (62%), MS normal [stæ:z] (64%), BC normal [spu:] (56%), BC slow [spi:] (56%), and BC slow [naɪb] (51%).

One of the major problems is that the Japanese participants spelled <r> when there was no [ɹ] in sound forms (e.g., <stor> for [sko^u]) even though the participants were indirectly informed that the stimuli were pronounced with rhotic accents. This will be discussed in §4.3.3.4. Another problem is that durational differences changed the Japanese

participants' spellings in some cases. Straightforward examples are [i:] in a closed syllable (<i> for normal [i:] and <ee> for slow [i:]) and [e'] in a closed syllable (<e> for normal [e'] and <a_e> for slow [e']).

4.3.3.2 Difficult and easy BC Normal stimuli for the Japanese participants

In this section, I will discuss details of stimuli in relation to how they are spelt. Some stimuli were extremely challenging while others were relatively easy for the Japanese participants. I used the K-Means Cluster Analysis to divide the stimuli into four clusters based on each participant's score. First, I analyzed only 24 BC (their target dialect) normal stimuli, and then analyzed the whole stimuli with more variables. Figure 43 shows the four clusters according to the K-Means Cluster Analysis.

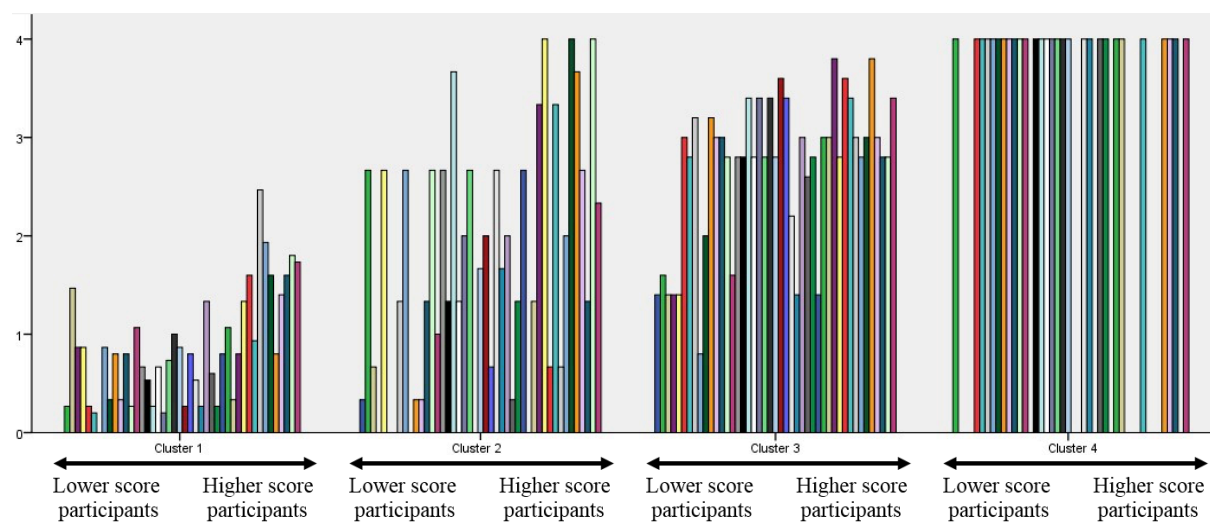


Figure 43. Clustered BC normal stimuli based on the Japanese participants' performance

Each of the four graphs in Figure 43 represents each of the four clusters. In these four graphs, each bar represents each of the 45 participants' score in a particular cluster. On the X-axis, each cluster consists of the 45 participants who are aligned in ascending order in their overall scores, meaning that "higher score participants" are on the right hand side and "lower score participants" are on the left hand side. The Y-axis indicates average scores (based on the 4-point scale mentioned in §4.3.1) by each participant for the stimuli in each cluster: for

example, if one of the bars in cluster 1 indicates 2.5, this particular participant's average score for the cluster 1 stimuli is 2.5 out of 4.

From cluster 1 to 3, higher score participant simply performed better. For the cluster 1 stimuli, their overall points were relatively low whereas for the cluster 3 stimuli, their overall points were relatively high. For cluster 4 stimuli, most participants gained 4 points regardless of whether they were higher score participants or lower score participants, except that a few participants, especially among higher score participants, got 0 points.

Table 60. Cluster 1 (most challenging) BC stimuli for 45 Japanese participants

Stimuli	Score (out of 4)	# of 0-point spellings (out of 45)	Stimuli	Score (out of 4)	# of 0-point spellings (out of 45)
[gaʊ]	0.00	45	[ʃi:b]	0.80	35
[bʌ]	0.24	40	[ke'b]	0.89	35
[tɑ:]	0.27	41	[bjʊ:d]	0.93	29
[sku:]	0.27	39	[moʊz]	1.33	30
[fʌd]	0.53	39	[mɑ:b]	1.60	27
[poʊ]	0.76	35	[snaɪ]	1.62	21
[sneɪ]	0.80	35	[dæ:z]	1.69	26
[dɪz]	0.80	36			

Note. “Score” is out of 4 for each stimulus. “# of 0-point spellings” means that the number of the Japanese participants (out of 45) who chose spellings that the Canadian participants never chose (e.g., <aw> for [aʊ]).

Table 61. Cluster 2 (2nd most challenging) BC stimuli for 45 Japanese participants

Stimuli	Score (out of 4)	# of 0-point spellings (out of 45)	Stimuli	Score (out of 4)	# of 0-point spellings (out of 45)
[za:d]	1.51	28	[bjʊ:]	1.91	13
[sni:]	1.78	25			

Table 62. Cluster 3 (3rd most challenging) BC stimuli for 45 Japanese participants

Stimuli	Score (out of 4)	# of 0-point spellings (out of 45)	Stimuli	Score (out of 4)	# of 0-point spellings (out of 45)
[tu:d]	2.07	17	[pɒd]	3.00	11
[spɔɪ]	2.22	16	[fɔɪd]	3.64	4
[faʊz]	2.56	7			

Table 63. Cluster 4 (least challenging) BC stimuli for 45 Japanese participants

Stimuli	Score	# of 0-point
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	(out of 4)	spellings (out of 45)
[smɛz]	2.58	16

4.3.3.2.1 Spelling on BC normal stimuli in cluster 1

Some cluster 1 stimuli are severely problematic for Japanese EAL learners. I will discuss details of cluster 1 stimuli by referring to the results of the Japanese loanword rōmaji data in Nogita (2016c) mentioned in §2.5.7 if needed.

- **[aʊ]-<ow> (word-final)**

As mentioned earlier, the Canadian participants fairly consistently spelled word-final [aʊ] in [gəʊ] as <ow>. In contrast, not even a single Japanese participant spelled [aʊ] as <ow>, suggesting that Japanese EAL learners have a severe problem associating [aʊ] with <ow>. They were most strongly tempted to spell <aw> (17/45 including the misperception-related spelling <awn>), followed by <au> (11/45 including misperception-related spelling <aun> or similar variations). Overall, 37 out of 45 participants started with <a> to spell [aʊ]. Similarly, in the stimulus [fəʊz], which will be discussed below, participants were by far the most strongly tempted to spell <au>, although non-final [aʊ]-<ou/ow> correspondence seems to be slightly easily acquired. The closest spellings for [gəʊ] were <ough> and <oum> by one participant for each. Interestingly, quite a few basic real words have the [aʊ]-<ow> correspondence, such as *how*, *now*, *cow*, *wow*, and non-final *down*, *town*, and so forth. Moreover, in my L1 loanword rōmaji data, among the six occasions of <ow>, two of them correspond to Japa/au/ (and the rest correspond to /o:/) (see §2.5.7), so there could be a positive L1 transfer. Nevertheless, the Japanese participants had a hard time acquiring it. A possible explanation is that Japanese EAL learners read words like *how*, *now*, and *cow* logographically without paying attention to GPC.

Recall that in the reading task, while 38/44 Japanese participants read <fow> as [fo^o], the rest of the six read it as [æʊ ~ aʊ]. The discrepancy between the reading and spelling

tasks suggests that the [aʊ]-to-<ow> conversion is even more challenging than the <ow>-to-[aʊ] conversion.

- **[ɑ:]-<aw> (word-final)**

Another severe problem is the word-final [ɑ:]-<aw> correspondence. The Canadian participants spelled [ɑ:] in [tɑ:] as <aw> (9/14) and <ah> (5/14). In contrast, not even a single Japanese participant spelled [ɑ:] as <aw>. This is related to the problem that the Japanese participants were strongly tempted to spell [aʊ] as <aw>. Moreover, recall that in the reading task, <staw> was read most frequently as [aʊ] (27/44 in total), followed by [o^ʊ] (12/44) by the Japanese participants. As mentioned in §2.1.2, Japanese EAL learners tend to misinterpret <aw> in words like *law*, *raw*, *saw*, *draw*, *awful*, and so forth, as [o^ʊ]. In addition, impressionistically, <aw> in more peripheral words, such as *Shaw* [ʃɑ:] (a cable TV company in Western Canada), tends to be pronounced as [aʊ]. Such a habituated misinterpretation of <aw> seems to strongly impede the acquisition of [ɑ:]-<aw>. Close spellings for [tɑ:] were <au> and <augh> by two participants for each. Meanwhile, four Japanese participants spelled <ah> (the other acceptable spelling for [ɑ:]), which is a positive transfer of one of the possible spellings of Japa/a:/ if they associated Eng[ɑ:] with Japa/a:/. There were also quite a few spellings with <o> in the Japanese participants, presumably because Eng[ɑ:] is phonetically somewhere between Japa/a:/ and /o:/.

- **[ʌ]-<uh/u>**

After [aʊ]-<ow> and [ɑ:]-<aw>, another severely challenging spelling is for [ʌ] in both word-final and word-medial positions. First, the Canadian participants quite consistently spelled word-final [ʌ] in [bʌ] as <uh>. In contrast, only two Japanese participants spelled it as <uh>. As mentioned in §2.3.1.3, the majority of Japanese EAL learners seem unfamiliar with phonetic spellings/pronunciation respellings. As well, [ʌ#]-<uh#> (# = word-final) correspondence occurs only in a few peripheral words in real words, such as *duh*, *uh-oh*, *uh-*

huh, and so forth. So it is expected difficult to acquire this correspondence without formal instruction. Overall, word-final [ʌ] was most frequently spelled as <a>, followed by <ah>, followed by <ar> (24/45 in total) by the Japanese participants. The rest seem phonetic transcriptions in the participants' own ways, such as <ou>, <ua>, <oa>, and so on.

As for [fʌd], which the Canadian participants unanimously spelled as <u>, the Japanese participants were strongly tempted to spell <fad> (36/45). As mentioned above, the Japanese one-mora /a/ and English [ʌ] are perceptually similar, at least for (Canadian) English speakers' ears (see §2.2.3.2). The L1 regular rōmaji Japa/a/-<a> correspondence seems to severely impede acquisition of the Eng[ʌ]-<u> correspondence although many basic English words have this correspondence, such as *but*, *cut*, *lunch*, *under*, *up*, and so forth. Moreover, at least in my L1 loanword rōmaji data in Nogita (2016c), Japa/a/-<u> and Japa/a/-<a> correspondences are statistically equally common, so a positive transfer from L1 loanword rōmaji Japa/a/-<u> correspondence to Eng[ʌ]-<u> could be expected, but this is not the case. Still, six Japanese participants spelled <u> and one spelled a misperception-related <un>, so it seems learnable to some extent.

- [ɪ]-<i>

The [ɪ]-<i> correspondence is also one of the most difficult ones for the Japanese spellers. Recall that the Canadian participants unanimously spelled [ɪ] in [dɪz] as <i>. In contrast, although nine Japanese participants spelled [ɪ] as <i>, 20 spelled it as <e> and all the others spelled it in digraphs/trigraphs starting with <e>, such as <ea>, <ee>, <ea_e> and so forth except one who spelled it as <a>. As mentioned in §2.2.3.2, Eng[ɪ] is perceptually similar to Japa/e/, so the Japanese participants were strongly tempted to spell <e>-related graphemes based on their L1 rōmaji Japa/e/([ĕ])-<e> correspondence. The reason that the Japanese participants cannot associate [ɪ] with <i> may be mainly because they had been misinterpreting that <i> corresponded to [i], not [ɪ]. This false concept is likely from the L1

loanword rōmaji Japa/i/-<i> correspondence. Impressionistically, since the [ɪ]-<i> correspondence is used in many basic English words, such as *it, is, this, his, miss*, and so forth, it is possible for Japanese ESL learners to notice that English <i> does not correspond to [ɪ]. This may be why nine participants spelled <i>. Conversely, there is also a possibility that some of these nine participants associated Eng[ɪ] with Japa/i/ rather than Japa/e/ and converted it to <i> based on regular rōmaji.

Incidentally, [ɪ] being spelled as <e> implies that the perceptual distinction between [ɪ] and [ɛ] may have been difficult for the Japanese participants to some extent, as Strange et al. (2001) mentioned.

- **[u:]-<oo> (word-final)**

Although the stimulus [sku:] is statistically classified into cluster 1, this is not as problematic as others. While the Canadian participants predominantly chose <oo> for [sku:], only two Japanese participants chose <oo>, but other 12 Japanese participants chose perception-related error spellings with <oo>, such as <oom>, <oomb>, <oob> and so forth, which could be regarded as nearly native-like. The most frequent spelling by the Japanese participants was <ue> (11/45), which could be correct, as in words with coronal consonants like *sue, due*, and so forth, but, <ue> may be more likely read as [ju:] in non-coronal contexts as in *cue, hue*, and so forth. This is probably why the Canadian participants did not choose <ue> for [sku:].

- **[i:]-<ee/ea> (in a closed syllable)**

The spellings for [i:] seem less severely problematic than several aforementioned correspondences. The Canadian participants most frequently spelled [i:] in [ʃi:b] as <ee> (10/14) followed by <ea> (2/14). In contrast, the Japanese participants most frequently spelled <i> (19/45). This is obviously a transfer from the regular rōmaji Japa/i/-<i> correspondence. This also explains why the Japanese participants had difficulty in the Eng[ɪ]-

<i> correspondence. However, six Japanese participants spelled <ee>, and four spelled <ea>. In addition, there were some possibly acceptable spellings for Eng[i:], such as <ie_e> (4/45), <e_e> (3/45), <ie> (1/45), and <ee_e> (1/45) although the Canadian participants did not choose these spellings. These indicate that the Japanese participants had acquired English spellings for [i:] to some extent. Note that in my loanword rōmaji data in Nogita (2016c), 12 out of 70 of Japa/i:/ are spelled as <ee> (see Table 20), which is expected to help Japanese EAL learners. However, <i> was the most frequent spelling by the Japanese participants, probably because the duration of the stimulus [ʃi:b] was not long enough for them to associate Japa/i:/.

- [e']-<ay/a_e>

The spellings for [e'] also seem less severely problematic than several aforementioned correspondences. As for word-final [e'] in [sne'], 13 Canadian spelled <ay> and one spelled <ae>. On the other hand, although many Japanese participants were tempted to spell it as <e>-related spellings based on the L1 rōmaji <e>-Japa/e/ correspondence, such as <e>, <ey>, <ei>, <eigh> and so forth, eight Japanese participants chose the default <ay>. This could be partially a positive transfer from loanword rōmaji, in which <ay> corresponds more frequently to Japa/ei/ than to Japa/ai/ (see §2.5.7). Moreover, even in 0 point spellings, three Japanese participants spelled <ain>, two spelled <ai>, and one spelled <aigh>, suggesting that some of them had acquired the English-like <ai>-[e'] correspondence. Interestingly, in my loanword rōmaji data, <ai> more frequently corresponds to Japa/ai/ than to Japa/ei/ (see §2.5.7), but still some Japanese participants had acquired the <ai>-Eng[e'] correspondence. As for word-medial [e'] in [ke'b], it was most frequently spelled as <e> (27/45) as well as <ei> and <ei_e> by one for each. As mentioned above, Canadian [e'] is not very diphthongized. Besides, if its duration is relatively short, Japanese speakers may associate it with the Japanese one-mora /e/. Still, 10 Japanese participants correctly spelled it as <a_e>

with a silent-E as a marker of “alphabet sounds”. In my loanword rōmaji data, the <a_e>-Japa/ei/ correspondence occurred only once (see §2.5.7), which is much fewer than <i_e>, <o_e>, and <u_e>. Despite a lack of the source of positive L1 transfer, the English <a_e>-[e^l] correspondence can be acquired to some extent. Furthermore, two Japanese participants chose another correct spelling <ae>. With regard to <ae>, aside from relatively peripheral words like *Rae*, *Shae*, and so forth, I have seen the word *edamamae* [ɛdāmæ:(a:)me^l] with the <ae>-[e^l] correspondence, as an alternative spelling for *edamame*, presumably for avoidance of the mispronunciation [ɛdāmē^lm] by native English speakers. So it may be beneficial to know the <ae>-[e^l] correspondence in case Japanese EAL learners encounter alternative spellings in English loanwords from Japanese.

- [o^ʊ]-<oe>

One may recall that the spellings of word-final [o^ʊ] in [po^ʊ] were relatively inconsistent by the Canadian participants at first sight (<oe>-8/14, <oh>-3/14, <o>-2/14, <oa>-1/14), but fundamentally, these are “alphabet O” with or without a following silent letter. The Canadian participants’ preference of digraphs <oe> and <oh> over <o> for [po^ʊ] may be due to an aversion to two-letter words. In contrast, the Japanese participants’ preference was the 0-point spelling <ow> (10/45). There were also other variations with <u> or <w>, specifically <owe>, <ou>, <ough>, and <oeu> (6/45 in total). Also, there were quite a few misperception-related errors involving <u> or <w>, such as <owm>, <oun>, and <aul> (1 for each). Overall, these Japanese participants were tempted to spell the [ʊ~w] off-glide of [o^ʊ] with <u> or <w>. This also implies that since native Japanese speakers have a strong intuition of morae rather than syllables, they likely recognized the single phoneme [o^ʊ] as two units. Recall that in the reading task, 10 Canadian participants read <ow> as [o^ʊ], so the <ow>-[o^ʊ] correspondence is apparently not a wrong choice. However, four Canadian participants read <ow> as [aʊ] in the reading task, so <ow> for [o^ʊ] is not the best choice in

consideration of bidirectional consistency. A few other choices by the Japanese participants, such as <owe> and <ough>, could be acceptable, but these were never chosen by the Canadian participants.

The good news is that four Japanese participants chose <oe>, three chose <o>, and three chose <oh>. The choice of <oh> is likely a positive transfer from regular rōmaji <oh>-Japa/o:/. However, even in my loanword rōmaji data, <oe> and <o> generally correspond to Japa/oe/ and /o/ respectively, so their choices of <oe> and <o> for Eng[o^o] are acquisition of L2 spelling rules without relying on L1 regular/loanword rōmaji.

As for [o^o] in [spo^oz], again, the problem is that quite a few Japanese participants (18/45) added <u>, such as <ou>, <ou_e> and so on, suggesting that they were tempted to spell <u> for the [ʊ~w] off-glide of [o^o]. Still, one third of the Japanese participants (15/45) spelled <o_e> with a silent-E as a maker of “alphabet sounds”. This could partially be a benefit from the occasionally occurring loanword rōmaji correspondence <o_e>-Japa/o:/ (see §2.5.7).

- **[aɪ]-<i_e, ye, igh, y>**

For [aɪ] in the closed syllable [maɪb], the Canadian participants consistently spelled <i_e>. As for the Japanese participants, as expected, eight of them spelled <maib> based on the L1 regular/loanword rōmaji way. As well, one participant spelled <maibe> and another spelled misperceived <mai>. However, the good news is that more participants spelled <i_e> with a silent-E as an “alphabet sound” marker (17/45) than those who spelled <ai> (10/17). In my loanword rōmaji data, <i_e>-Japa/ai/ occurs more frequently than the other silent-E digraphs, so their acquisition of <i_e>-Eng[aɪ] can be in part because of a benefit from loanword rōmaji. There were also other possibly acceptable spellings for Eng[aɪ] by the Japanese participants, specifically <y_e> (3/45) and <igh> (1/45), although no Canadian

participants chose these spellings. This suggests that the spellings of [aɪ] had been acquired to some extent.

While [aɪ] in a closed syllable was spelled with only one variation by the Canadian participants, specifically <i_e>, word-final [aɪ] in [snaɪ] was spelled with six variations: <ye, igh, y> by three for each, and <ai, ie, i> by one for each (and two perception-related errors). However, if <i> and <y> are regarded as the equivalent, these variations are all fundamentally “alphabet I” with or without a following silent letter(s), except for the foreign looking <ai>. As for the Japanese participants, the total of 17 Japanese participants spelled one of <y, igh, i, ie>. None of these variations match the Japanese regular rōmaji <ai>-Japa/ai/ correspondence. Moreover, even in my loanword rōmaji data, <igh>-Japa/ai/ and <ie>-Japa/ai/ do not occur. All this suggests that these participants had acquired the L2 GPC rule without positive/negative L1 transfer. Meanwhile, seven Japanese participants chose <ai>. The Japanese participants’ <ai> for Eng[aɪ] is obviously a transfer from the L1 regular rōmaji <ai>-Japa/ai/ correspondence. There were also <aigh> and <ain>, which were similar variations, by two Japanese participants for each. Furthermore, four Japanese participants spelled <ay>, which is another similar variation but would be unacceptable in English. Note that in my loanword rōmaji data, the <ay>-Japa/ai/ correspondence occurred only once. Whether positively or negatively, a transfer of the L1 <ai/ay>-Japa/ai/ correspondence was observed in 15 participants. Another thing to note is that the Eng[aɪ]-to-<ye> correspondence in the <Cye> context, as seen in *rye*, *dye*, and so on, was never chosen by the Japanese participants. To sum up, the difference between the Japanese and Canadian participants is that the Japanese participants preferred <ai> while the Canadian participants preferred <ye> or other “alphabet I”-related variations.

- [æ:]-<a> (in a closed syllable)

The Canadian participants unanimously spelled [æ:] in [dæ:z] as <a>, as one may recall. As for the Japanese participants, my prediction was that they would spell it more phonetically, rather than phonemically, such as <ea>. In fact, two Japanese participants spelled <ea_e>, and one spelled <ea>. As well, four spelled <oe>, and one spelled <oe_e>, which were also considered as their own ways to phonetically transcribe [æ:]. In contrast, 19 Japanese participants correctly spelled <a>. This suggests that these participants have acquired at least the English [æ:]-to-<a> conversion, even though neither regular rōmaji nor loanword rōmaji can help this. There is further evidence that they assigned Eng[æ:] to <a> phonemically rather than phonetically, which will be discussed in §4.3.3.3. Recall that in the reading task, the Japanese participants had a severe problem with the <a>-to-[æ:] conversion. In addition, they were also strongly tempted to spell [ʌ] as <a>. This means that many Japanese participants had not fully acquired the <a>-[æ:] correspondence. However, at least the [æ:]-to-<a> direction seems to be relatively easy to acquire.

There is a possible explanation for such asymmetrical acquisition process. Impressionistically and empirically, there are very few Japanese EAL learners who can fully utilize IPA symbols for English learning, supposedly in part because of problems of IPA used in Japan, as Makino (unpublished) claimed that IPA used in Japan must be called “defect transcription”. Nevertheless, it seems well-known among Japanese EAL learners that <a> in *apple* is not Japa/a/ ([ẽ]), but [æ] (note that the longer duration of Eng/æ/ than Japa/a/ is typically not mentioned in Japan), and many of them may be able to associate the letter <a> in *apple* with the visual image of the IPA symbol <æ>. This ligature symbol <æ> seems visually easy to remain in Japanese EAL learners’ minds, and it enables them to associate with the sound combination of Japa/a/ and Japa/e/. So when the Japanese participants heard Eng[æ:] in the stimuli, some of them may have associated it with the ligature <æ>, which in turn was associated with <a> in *apple*.

However, there is also a possibility that some participants associated Eng[æ:] with Japa/a/ rather than Japa/ea/, /e:/, /a:/, or any other Japanese sounds and spelled it as <a> based on regular rōmaji.

Incidentally, four participants seemed to have misheard the stimulus [dæ:z] as *dance*, and another four did so as *does*. These were perception problems, or they had incorrectly memorized the sound forms of the lexical items *dance* and *does*. This needs to be corrected.

- **Summary of results on cluster 1 BC normal stimuli**

To sum up, none of the Japanese participants had acquired the [aʊ]-to-<ow> and [ɑ:] to-<aw> conversions. To a lesser extent, [ʌ#]-to-<uh>, [ʌ]-to-<u> and [ɪ]-to-<i> conversions were also severely problematic. Spellings for the rest of [o^u], [i:], [e^l], [aɪ], and [æ:] also showed some negative transfer from L1 rōmaji, but were less problematic. Spellings of [u:] showed the smallest negative L1 transfer.

4.3.3.2.2 Spelling on BC normal stimuli in cluster 2

Cluster 2 stimuli were less problematic than Cluster 1 stimuli, and the difference from Cluster 1 is that lower score participants performed relatively well.

- **[ɑ:]-<o> (in closed syllable)**

For [ɑ:] in [zɑ:d], recall that 11 Canadian participants spelled <zod> and two spelled <zawd> (and one spelled <zude> by mistake). As for the Japanese participants, again, none of them spelled [ɑ:] as <aw>, by which their difficulty in the acquisition of the [ɑ:] to-<aw> conversion is further evidenced. In contrast, 17 Japanese spelled <o>, so the [ɑ:] to-<o> conversion seems less problematic. This may be in part because in loanword rōmaji, <o> is occasionally read as Japa/a/, which could help acquire the Eng[ɑ:] to-<o> conversion. However, loanword rōmaji <o> never integrates the duration of Eng[ɑ:], so it does not help Japanese EAL learners notice the length of Eng[ɑ:], which will be discussed in §4.3.3.1 and §4.3.3.4. Another possibility of their apparently correct Eng[ɑ:] to-<o> conversion is that

they associated Eng[ɑ:] with Japa/o:/ (or Japa/o/), rather than Japa/a:/, and spelled <o> in one of the regular rōmaji ways of /o/ or /o:/, since Eng[ɑ:] is phonetically somewhere between Japa/a:/ and /o:/. If this is the case, the fact is that they had not acquired the Eng[ɑ:]-to-<o> conversion.

The problem for the Japanese participants is that 19 of them spelled Eng[ɑ:] as <a>, four spelled <ar>, one spelled <ah>, and one spelled <er>, all of which can correspond to Japa/a/ or /a:/ in loanword rōmaji. Recall that all the participants were indirectly instructed that the stimuli were from rhotic dialects, in which if there is no phoneme [ɹ] in the sound form, there is no letter <r> in its spelling. However, five participants spelled <r>, meaning that they may have been misinterpreting <r> in English spelling for a vowel length marker.

- **[i:]-<ee> (word-final)**

The Canadian participants almost unanimously chose <ee> for [i:] in [sni:]. As for the Japanese participants, 20 of them also chose <ee> for [i:] in [sni:], so nearly half of the participants had acquired the Eng[i:]-to-<ee> conversion. This may be in part because in my loanword rōmaji data, 12 out of 70 of Japa/i:/ are spelled as <ee>, which can help Japanese EAL learners. There were also possibly acceptable variations by the Japanese participants, such as <ie> (6/45), <y> (2/45), <ea> (1/45), and <ey> (1/45), suggesting that they were acquiring the L2 spellings for [i:]. However, notice that the Canadian participants never chose these variants, and in fact, these are not the best choices due to their other possible readings (e.g., <ie>-[ai]). A much more serious problem is that seven Japanese participants spelled <i>-related graphemes, <i> (4/45), <ih> (1/45), <iy> (1/45), and <ig> (1/45). The first two are clearly regular rōmaji interference, and <iy> for Japa/i:/ occasionally occurred in my loanword rōmaji data (see §2.5.7), so this may be loanword rōmaji interference. The good news is the number of L1-like spellings is relatively small.

- **[ju:]-<ew> (in a closed syllable)**

The sound [ju:] in the stimulus [bju:d] has seven variations by 14 Canadian participants: <ew> by seven, <ue> by two, <u_e> by one, <eu> by one <iu_e> by one, <ewe> by one, and <eu_e> by one, but <eu_e> may not be good in the grapheme-to-phoneme conversion since <beude> can be read in other ways, such as [bo^ud]. Fundamentally, these variations can be divided into only two: variations of “alphabet U” ([ju:]) and variations of <ew>. As for the Japanese participants, 14 out of 45 chose <iew>, which could be acceptable, but none of the Canadian participants chose it. The reason for the Japanese participants’ preference of <iew> is that many of them seem to have misperceived the nonsense word stimulus [bju:d] as the real word *viewed* due to a lack of the [b]-[v] contrast in Japanese. Still, five Japanese participants spelled <ew>, which was the most frequently chosen one by the Canadian participants. As well, seven Japanese participants chose <u_e> with a silent-E as an “alphabet sound” marker. This may partially be a benefit from the loanword rōmaji <u_e>-Japa/ju:/ or /ju/ correspondence (see §2.5.7). Only one Japanese participant spelled <yu>, which is an obvious L1 regular rōmaji transfer, suggesting that negative L1 transfer of Eng[ju:] is minimal.

- **Summary of results on cluster 2 BC normal stimuli**

While whether the spellings for [ɑ:] had actually been learned is still questionable, [i:] and [u:] had been learned or were in the process of being learned.

4.3.3.2.3 Spelling on BC normal stimuli in cluster 3

The Japanese participants apparently performed well with Cluster 3 stimuli, but there are stories that scores cannot tell.

- **[u:]-<oo>**

The Canadian participants spelled [u:] in the stimulus [tu:d] in three ways, <oo> (10/14), <u_e> (3/14), and <oo_e> (1/14). As for the Japanese participants, 17 out of 45 spelled <u_e> and 10 spelled <oo>, and one spelled <oo_e>. Except that preference of <u_e>

and <oo> is opposite between the Canadian and Japanese participants, 28 out of 45 Japanese participants had acquired a native-like manner. Their acquisition of <oo> may be in part because of loanword rōmaji. In my loanword rōmaji data, 13 out of 24 occurrences of Japa/u:/ are spelled as <oo>, which is the most frequent correspondence. The problem is that seven spelled [tu:d] as <tud>, suggesting that they had not acquired that the silent-E function as a marker of “alphabet sounds”, as will be discussed in §4.3.3.6.

- **[ɔɪ]-<oy/oi>**

The Canadian participants spelled word-final [ɔɪ] in [spɔɪ] as <oy> (8/14) and as <oi> (6/14), and all the 14 spelled [ɔɪ] in the closed syllable [fɔɪd] as <oi>. Notice that although English tends to avoid word-final <i>, quite a few Canadian participants chose word-final <oi>. As for the Japanese participants, they were also more consistent with [ɔɪ] in [fɔɪd]; 40 out of 45 chose <oi> for [fɔɪd] and one chose <oy>. This means that [ɔɪ]-<oi> had been acquired by most Japanese participants. In Japanese regular rōmaji, <oi> corresponds to Japa/oi/, so this is a positive L1 transfer. As for word-final [ɔɪ] in [spɔɪ], 16 out of 45 Japanese participants chose <oi> and 13 chose <oy>. There is a slight preference for <oi>, but these 29 participants’ performance was close to the Canadian participants. Moreover, these 13 occurrences of <oy> indicate that these Japanese participants also avoided word-final <i>, like some of the Canadian participants. As for the rest, 13 Japanese participants misperceived a phantom coda consonant, specifically <oin>, <oine>, <oil>, and <oid>. Only three participants spelled <oe> for [spɔɪ], possibly because they associated Eng[ɔɪ] with Japa/oe/.

- **[aʊ]-<ow/ou>**

The Canadian participants’ spellings had five variants for [aʊ] in [faʊz], but the most frequent one was <ow>, and the others were <ou> and <au> with or without a silent-E. The purpose of those silent-Es was likely for voicing of <s> (e.g., <fouse> for [faʊz] rather than

<fous> for [faʊs]), but not for the vowel quality. If these silent-Es are ignored, there were five <ow>s, five <ou>s, and four <au>s. As for the Japanese participants, the good news is that one participant spelled <ow>, three spelled <ou> and three spelled <ou_e>. There were many more <ou>s than <ow>, suggesting that the [aʊ]-to-<ou> conversion may be slightly easily acquired than the [aʊ]-to-<ow> conversion. In my loanword rōmaji data, there are no occasions of <ou>-Japa/au/ correspondence. Despite this, these six participants may have acquired Eng[aʊ]-to-<ou> perhaps because there are many basic English words that have this correspondence, such as *out*, *count*, *sound*, *house*, *mouse*, and so forth. Nevertheless, except for these seven participants, all the others spelled <a>-starting graphemes, specifically <au_e> (17/45), <au> (13/45), <aw> (2/45), <ao> (2/45) and so forth. Good news is that although <au> for [aʊ] is clearly a transfer from L1 regular rōmaji <au>-Japa/au/, it is acceptable by native speakers. Still, <au> is the least frequent one among <ow>, <ou>, and <au>, and the other direction, <au>-to-[aʊ] conversion, is not preferable, so the Japanese participants would need to learn the more frequent spellings <ow> and <ou>. Other good news is that the Japanese participants spelled <aw> for word-final [aʊ] in [gaw] much more frequently than for [aʊ] before a coda consonant in [faʊz], indicating that the Japanese participants had at least partially acquired avoidance of word-final <u> although <aw> for [aʊ] is not acceptable.

- [ʊ]-<u>

As mentioned above, Eng[ʊ] is a peculiar vowel in the sense that it lacks its own corresponding grapheme partner. The most frequently spelled grapheme by the Canadian participants was <u> (9/14), followed by <oo> (3/14), followed by <eu> and <oul> (1/14 for each). Acoustically, according to Nishi et al. (2008), Eng[ʊ] is different from any Japanese monophthongs except that it somewhat overlaps with Japa/a/ and is close to Japa/o/ in certain conditions, and interestingly not with Japa/u/ at least in their data. However, according to

Strange et al. (2001), Eng[ʊ] was perceived as Japanese one-mora /u/ 50% of the time by native Japanese speakers. In this present study, the Japanese participants may have taken advantage of this moderate perceptual similarity; 33 out of 45 Japanese participants spelled it as <u>, which may be a positive transfer from L1 regular rōmaji <u>-Japa/u/ correspondence. More importantly, their spelling patterns for Eng[ʊ] were sufficiently different from the acoustically adjacent English phonemes [u:], [o^u] and [ʌ], suggesting that acquisition of the Eng[ʊ]-to-<u> conversion is not difficult for Japanese EAL learners. Still, eight Japanese participants spelled <o>. This may be because they associated Eng[ʊ] with Japa/o/. This is a potential problem.

- **Summary of results on cluster 3 BC normal**

The spellings for [u:] does not seem to be much of a problem, despite the difference between Eng[u:]-<oo> correspondence and that of Japanese regular rōmaji Japa/u:/-<ū, u, uh, uu>. As for [ɔɪ] and [ʊ], they took advantage of the L1 regular rōmaji <oi>-Japa/oi/ and <u>-Japa/u/ correspondences. Moreover, they had acquired English-like avoidance of word-final <i> and <u> to some extent. A problem is Eng[əʊ]. The Japanese participants were much more inclined to <au> or <aw> than to <ow> or <ou> due to a transfer from the regular rōmaji <au>-Japa/au/ correspondence. While <au>-Eng[əʊ] is acceptable in closed syllables, Canadian speakers preferred <ow> and <ou>. There is room for improvement for the Japanese participants about Eng[əʊ].

4.3.3.2.4 Spelling on BC normal stimuli in cluster 4

There is only one stimulus, [smɛz], classified into this cluster. Although the overall score and the number of 0-point spellings were not the best among all the stimuli, the different characteristic from the other stimuli is that there was no difference between lower score participants and higher score participants, or possibly a few higher score participants may have had more difficulty.

- [ɛ]-<e>

The Canadian participants unanimously spelled <e> for [ɛ] in [smɛz]. As for the Japanese participants, 29 of them spelled <e>. They may have associated Eng[ɛ] with Japa/e/ ([ĕ]) and positively transferred the regular rōmaji <e>-Japa/e/ correspondence. A potential problem is that eight Japanese participants spelled <i>. This may be a hyper-correction affected by the Eng[ɪ]-<i> correspondence, or they may have misperceived [ɛ] as [ɪ]. Another error is that five of them spelled <e_e>, which may be another hyper-correction related to silent-E; they know the existence of silent-E but did not know the function of a marker of “alphabet sounds”. Or, four of them may have used the voicing function of silent-E to make <s> voiced (i.e., <smese>) whether they had explicit knowledge of it or not, at the expense of overlooking the “alphabet sound” marker function. If these were a type of hyper-correction, it is understandable why higher score participants, rather than lower score participants, had trouble with Eng[ɛ].

- **Summary of results on cluster 4 BC normal stimulus**

The Eng[ɛ]-<e> correspondence seems easy for lower score participants, but there are potential hyper-corrections for higher score participants.

4.3.3.2.5 Summary of results on BC normal stimuli

To sum up, for the Japanese participants, the least likely to be acquired correspondences were [aʊ]-to-<ow> and [ɑ:] -to-<aw> conversions. To a lesser extent, [ʌ#]-to-<uh>, [ʌ]-to-<u>, [ɪ]-to-<i>, [aʊ]-to-<ou> and [ɑ:] -to-<o> conversions were also severely problematic. Due to L1 rōmaji interference, there were tendencies of [aʊ]-to-<au>, [ɑ:] -to-<a>, [ʌ]-to-<a>, and [ɪ]-to-<e> conversions. The conversions of [o^u]-to-<o_e>, [aɪ]-to-<i_e/igh/y>, [e^ɪ]-to-<ay/a_e>, [i:] -to-<ee>, and [æ:] -to-<a> seemed partially acquired, but there were also L1 rōmaji-like conversions, [o^u]-to-<ou>, [aɪ]-to-<ai>, [e^ɪ]-to-<ei> (in open

syllables) or <e> (in closed syllables), [i:]<-i> (in closed syllables), and [æ:]<-ea>. The silent-E rule as an alphabet sound marker had been relatively easily acquired.

4.3.3.3 Difficult and easy stimuli (the whole set) for the Japanese participants

In this section, I will discuss details of all the stimuli, including BC normal and slow and Mississippi (MS) normal and slow stimuli, in relation to how they are spelt. Again, the K-Means Cluster Analysis divided all the stimuli into four clusters based on each participant's score, as shown in Figure 44.

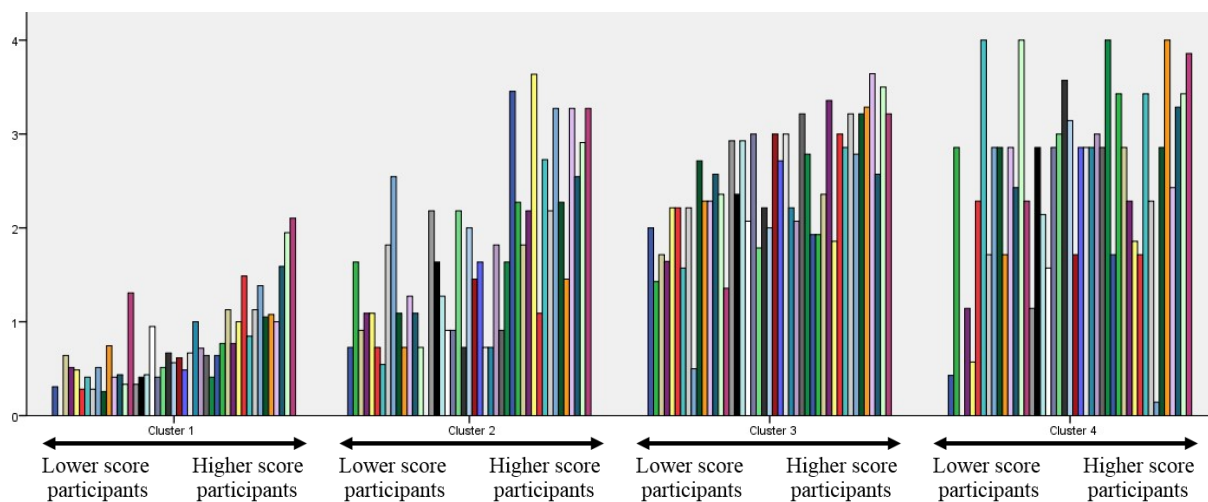


Figure 44. All the clustered stimuli based on the Japanese participants' performance

Again, in these graphs, each bar represents each of the 45 participants' score in each cluster. On the X-axis, each cluster consists of the participants who are aligned in ascending order in their overall scores, meaning that "higher score participants" are on the right hand side and "lower score participants" are on the left hand side. The Y-axis indicates average scores (based on the 4-point scale mentioned) by each participant for the stimuli in each cluster: for example, if one of the bars in cluster 2 indicates 2.5, this particular participant's average score for the cluster 2 stimuli is 2.5 out of 4.

Again, from cluster 1 to 3, it seems that higher score participant simply performed better. For cluster 1 stimuli, overall their points are relatively low, meaning that cluster 1 stimuli are the most challenging. Cluster 4 stimuli were performed well regardless of whether

they were higher or lower score participants. Table 64 to Table 67 show stimuli that belong to each cluster.

Table 64. Cluster 1 (most challenging) stimuli for 45 Japanese participants

Stimuli	Score	# of 0-point spellings (out of 45)	Stimuli	Score	# of 0-point spellings (out of 45)
BC norm [gao]	0.00	45	BC norm [sne ¹]	0.80	35
MS slow [nʌz]	0.18	43	BC norm [dɪz]	0.80	36
MS slow [ʃɑ:d]	0.18	40	BC norm [ʃi:b]	0.80	35
BC norm [bʌ]	0.24	40	BC slow [zai]	0.84	33
BC norm [tɑ:]	0.27	41	BC norm [ke'b]	0.89	35
BC norm [sku:]	0.27	39	MS slow [pɪz]	0.93	29
BC slow [dɑ:]	0.31	39	BC norm [b'u:d]	0.93	29
MS norm [stɑ:]	0.40	40	MS norm [smɑ:d]	0.98	32
BC slow [faʊ]	0.42	33	MS slow [stɛz]	0.98	34
MS norm [dʒɑ:d]	0.42	36	BC slow [paʊz]	1.00	24
BC slow [zʌd]	0.44	40	MS slow [stɑ:]	1.02	30
BC slow [stɪz]	0.51	36	MS slow [smɑ:]	1.11	32
BC norm [fʌd]	0.53	39	BC slow [spɔ ^o z]	1.16	32
MS slow [bɪm]	0.53	39	BC slow [skɔ ^o]	1.16	29
MS norm [mʌz]	0.62	38	MS norm [sem]	1.20	29
MS norm [pɪm]	0.69	37	BC slow [ske ¹]	1.24	27
BC slow [stɑ:d]	0.73	35	BC norm [smɔ ^o z]	1.33	30
MS slow [stɑ:d]	0.76	34	BC slow [mʌ]	1.33	25
BC norm [pɔ ^o]	0.76	35	BC norm [snaɪ]	1.62	21
MS norm [ʃɔ ^o]	0.78	23			

Note. “Score” is out of 4 for each stimulus. “# of 0-point spellings” means that the number of the Japanese participants (out of 45) who chose spellings that the Canadian participants never chose (e.g., <aw> for [aʊ]).

Table 65. Cluster 2 (the second most challenging) stimuli for 45 Japanese participants

Stimuli	Score	# of 0-point spellings (out of 45)	Stimuli	Score	# of 0-point spellings (out of 45)
BC slow [bjɜ:]	1.36	21	BC slow [sni:b]	1.73	23
MS slow [snæ:m]	1.40	29	BC slow [pæ:z]	1.73	24
MS slow [pæ:z]	1.42	29	BC norm [sni:]	1.78	25
BC norm [zɑ:d]	1.51	28	BC slow [te ¹ b]	1.96	23
BC norm [maɪb]	1.60	27	BC slow [spu:]	2.18	20
BC norm [dæ:z]	1.69	26			

Table 66. Cluster 3 (the third most challenging) stimuli for 45 Japanese participants

Stimuli	Score	# of 0-point spellings (out of 45)	Stimuli	Score	# of 0-point spellings (out of 45)
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MS norm [spɪz]	1.71	21	BC slow [pɔɪ]	2.31	16
BC slow [snu:b]	1.78	22	MS norm [ʃɛz]	2.49	17
BC norm [bjɪ:]	1.91	13	BC norm [fəʊz]	2.56	7
MS slow [spɛm]	1.96	23	BC slow [pju:d]	2.76	14
BC norm [tu:d]	2.07	17	MS norm [stæ:m]	2.93	12
BC slow [spi:]	2.22	20	BC norm [fɔɪd]	3.64	4
BC norm [spɔɪ]	2.22	16	BC slow [pɔɪd]	3.69	3

Table 67. Cluster 4 (the least challenging) stimuli for 45 Japanese participants

Stimuli	Score	# of 0-point spellings (out of 45)	Stimuli	Score	# of 0-point spellings (out of 45)
MS norm [sna:]	2.11	19	BC norm [smɛz]	2.58	16
BC slow [sɒd]	2.13	21	BC norm [pɒd]	3.00	11
BC slow [naɪb]	2.24	13	BC slow [mɛz]	3.02	11
MS norm [stæ:z]	2.33	18			

4.3.3.3.1 Spelling on cluster 1 stimuli

Aside from the severely challenging vowel-to-grapheme conversion seen in the cluster 1 BC normal stimuli and its slow and Mississippi counterparts, I will discuss some new members. I will also discuss some differences between BC normal stimuli and the rest.

- **Mississippi normal/slow [ɑ:]-<o/aw> (in a closed syllable)**

As mentioned in §4.2.2.4, the Canadian participants spelled Mississippi [ɑ:] in closed syllables (i.e., slow [ʃɑ:d] and normal [dʒɑ:d]) as the <o>-type, the <aw>-type, and the <a>-type with no significant uneven preference. On the other hand, again, the Japanese participants never spelled <aw>, and only one spelled <o> in normal [dʒɑ:d], and a few spelled <au>, but the majority of them chose spellings starting with <a>. This may be because since the tongue position of Mississippi [ɑ:] is more central than BC [ɑ:], Mississippi [ɑ:] is perceptually similar to Japa/a:/. They spelled the monograph <a> more often in the normal stimulus (22/45) than the slow counterpart (15/45). As well, the letter <r> was added more frequently in the slow stimulus (14/45) than in the normal one (7/45). This suggests that when the duration of

the stimulus is long, they were more tempted to associate Mississippi [ɑ:] as the Japanese two-mora /a:/ and add <r> in the spelling.

- **Mississippi normal/slow [ɔ:]-<aw>**

For word-final [ɔ:], most Canadian participants misperceived Mississippi normal [stɔ:] as *stall* and slow [smɔ:] as *small* in part because they lack the [ɔ:]-[ɑ:] contrast in their dialect. In contrast, for [ɔ:] in closed syllables in normal [smɔ:d] and slow [stɔ:d], they most frequently spelled <aw> or <au> followed by <o> as discussed in §4.2.2.4. As for the Japanese participants, again, they almost never spelled <aw> for both closed syllable and word-final ones. Interestingly, some Japanese participants also misperceived [stɔ:] as *stall* (3/45) and slow [smɔ:] as *small* (11/45). Aside from such “Canadian-like” perception errors, [ɔ:] in normal [smɔ:d] and slow [stɔ:d] was spelled as <o> by the Japanese participants (8/45 and 2/45 respectively); <o> is worth 3 points. Note that although the Canadian participants spelled <o> (4/14 and 2/10 respectively), according to Kessler and Treiman (2001), in dialects that have the [ɔ:]-[ɑ:] contrast, the default spellings in closed syllables of [ɔ:] is <au>, as opposed to [ɑ:] corresponding to <o>, meaning that [ɔ:] for <o> is not optimal in dialects with the [ɔ:]-[ɑ:] contrast (except for [ɔ:] before a voiceless fricative and a velar (Gómez, 2009)). Still, <o> for [ɔ:] can be a “Canadian-like” spelling. Interestingly, five Japanese participants spelled <au> and another two spelled <au_e> for normal [smɔ:d], and seven spelled <au> for slow [stɔ:d]. There is a slight possibility that they had acquired the [ɔ:]-to-<au> conversion. However, there is also a possibility that they phonetically transcribed the diphthongization of [ɔ:] ([ɔə~ɔʊ]) and accidentally spelled native-like <au>. Aside from these, there were many spelling variations that the Canadian participants never chose, so the spelling of [ɔ:] can be concluded as severely problematic.

- **Mississippi normal/slow [ɪ(m)]([ɪə(m)])-<i/(a)>**

For diphthongized Mississippi [ɪ] before [m] in normal [pɪm] and slow [bɪm], most Canadian participants misperceived [æ:] and spelled <a>. As for the Japanese participants, not even a single Japanese participant spelled <i> for either normal [pɪm] or slow [bɪm]. My prediction was that they would spell it phonetically, such as <ea> or similar variations. In fact, <ea> and similar spellings were quite frequent. However, intriguingly, both normal [pɪm] and slow [bɪm] were most frequently spelled as <a> (7/45 and 7/45 respectively), which were Canadian-like errors. This means that these Japanese participants associated these phonetically diphthongized [ɪə] with the monograph <a>. As mentioned in §4.3.3.2.1, this is perhaps a benefit from the visual image of the famous IPA symbol, the ligature <æ>, and this is another piece of evidence that they perceived the phoneme [æ:] categorically. Nevertheless, seven out of 45 should be considered as few.

- **Mississippi normal [ɛ(m)] ([ɛə(m)])-<e/(a)>**

The Canadian participants correctly spelled [ɛ] in normal [sɛm] as <e> by seven participants and incorrectly spelled <a> by five. However, all of them incorrectly spelled slow [ɛ] in [spɛm] as <a>. This is consistent with Hillenbrand et al.'s (2000) report that duration has an important role for the [æ:]-[ɛ] contrast, that is, lengthened [ɛ] tends to be perceived as [æ:] by native American English speakers to some extent (see §2.2.1.2). Interestingly, the Japanese participants also made Canadian-like errors by misperceiving slow [ɛ] in [spɛm] as [æ:] and spelled <a> (18/45), and only 3 correctly spelled <e>, as will be discussed in the cluster 3 section. This is another piece of evidence for their categorical perception of [æ:]. Moreover, normal [ɛ] in [sɛm] was incorrectly spelled as <a> only by nine out of 45 Japanese participants, but correctly spelled as <e> by six. This suggests that Mississippi normal [ɛ(m)] ([ɛə]) is much more likely spelled as <e> by both Canadian and Japanese participants than synthetically lengthened [ɛ(m)]. Still, while some Japanese

participants seemed to behave like the Canadian participants, other Japanese participants spelled graphemes that the Canadian participants never spelled.

- **Mississippi slow [ɛ] (before an obstruent)**

The Canadian participants unanimously spelled it as <e> as expected. In contrast, only 11 out of 45 Japanese participants spelled it as <e>, which is notably inconsistent compared to normal BC[smeɪz] (29/45), BC slow [meɪz] (33/45), and Mississippi normal [ʃfeɪz] (28/45). A possible reason is duration. The durations of [ɛ] in BC[smeɪz], BC slow [meɪz], and Mississippi normal [ʃfeɪz] are 232ms, 464ms, 378ms respectively, and that in Mississippi slow [steɪz] is 756ms. Mississippi normal [ʃfeɪz] was already fairly long, and the synthetically lengthened counterpart was twice as long. If the Japanese participants had assumed that the duration of Eng[ɛ] should be short, they may have misconceived that such a long duration of [ɛ] should be spelled differently, such as <ea> (7/45), <e_e> (6/45) and so on. In other words, the Japanese participants were sensitive to irrelevant duration information for [ɛ], as expected.

- **BC/Mississippi normal/slow [ʌ]-<u/uh>**

All the six stimuli with [ʌ], BC normal [fʌd], BC slow [zʌd], MS normal [mʌz], MS slow [nʌz], BC normal [bʌ], and BC slow [mʌ] were in cluster 1, suggesting that the Japanese participants had a severe problem with [ʌ]-to-<u/uh> conversion. They were strongly tempted to involve <a> in their spellings. As mentioned above, this vowel is duration sensitive to native English speakers. While the Canadian participants quite consistently spelled <u> for normal closed syllable [ʌ]s and spelled <uh> for normal open syllable [ʌ], for BC slow [zʌd] two participants spelled <un> and <uhn> with <n>, for MS slow [nʌz] two out of 10 Canadian participants spelled <aw> and <aa>, and for BC slow [mʌ] nine out of 10 Canadian participants spelled <aw>, <a>, <ah>, <aah>, and <aaw> probably because they misperceived it as [ɑ:].

Likewise, as expected, the Japanese participants were also sensitive to duration but in different ways. For both BC and Mississippi normal [fʌd] and [mʌz], the Japanese participants never involved <r> or <h> and never doubled a vowel letter in their spellings, whereas in slow stimuli, for BC slow [zʌd], three added <r>, one added <h>, and one used <aa>, and more noticeably, for Mississippi slow [mʌz], as many as 15 added <r> (e.g., <ar> (7/45), <ar_e> (2/45), <ur> (2/45)), and one added <h>, and two doubled a vowel letter. As for BC normal [bʌ], there were <r> (3/45), <h> (8/45), and a vowel letter doubling (1/45), and for BC slow [mʌ], there were <r> (12/45), <h> (10/45), and vowel letter doublings (3/45). While Canadian participants also added <h> (but not necessarily for indicating phonetic length) and doubled vowel letters, they never added <r> as expected. This <r>-adding for lengthening by Japanese EAL learners needs to be corrected.

- **BC slow [ɪ]-<i>**

This is the other duration sensitive vowel by native English speakers. As mentioned above, the synthetically lengthened [ɪ] in BC [stɪz] was misperceived as [e^l] by four out of 10 Canadian participants, and spelled as <ay>. Likewise, nine Japanese participants spelled <a_e>, two spelled <ai>, one spelled <ai_e>, one spelled <ay_e>, and one spelled <ai_e>. These indicate that they also misperceived lengthened [ɪ] as [e^l]. In addition, two Japanese participants spelled <ei_e>, and this is also likely because they heard [e^l], although the spelling of <ei_e> reflect a transfer from the regular rōmaji <ei>-Japa/ei/ correspondence. Although the Japanese participants who spelled [ɪ] in BC slow [stɪz] as <i> were only two, the good news is that Canadian-like errors were observed.

- **BC/Mississippi normal/slow [o^u]-<o>**

There are five stimuli that include [o^u], specifically BC normal [po^u], [smo^uz] and slow [sko^u], [spo^uz], and Mississippi normal [tfo^u] (and Mississippi slow [zo^u] was discarded). The Canadian participants unanimously spelled [o^u] in closed syllables as <o_e>, and word-

final [o^u] as <o>, <oh>, or <oe>. Only two Canadian participants spelled BC slow [sko^u] as <skow> and one spelled Mississippi normal [tʃo^u] as <chou>, meaning that <ow> and <ou> are possible but rare. In contrast, while the Japanese participants most frequently spelled BC normal [smo^uz] and slow [spo^uz] as <o_e> (15/45 and 13/45 respectively), they were also strongly tempted to spell <ow>, <ou> or similar variations by representing the [ʊ~w] off-glide of [o^u] with <u> or <w>. Specifically, 18 Japanese participants spelled <u/w> in the latter part the spelling for BC normal [po^u], 18 did so for BC normal [smo^uz], 28 did so for BC slow [sko^u], 24 did so for BC slow [spo^uz], and 30 did so for Mississippi normal [tʃo^u]. In slow stimuli, in which the [ʊ~w] glide was perceptually more salient, they seemed to be more tempted to add <u/w>; note that although Mississippi normal [tʃo^u] is not synthetically lengthened, the duration of its [o^u] is 352ms, while that in BC normal [po^u] is 254ms, meaning that Mississippi normal [tʃo^u] may have been long enough to entice Japanese participants into adding <u/w>. These participants need to be taught that the letter <o> in English (or “alphabet O”) alone can represent [o^u].

- **Summary of results on cluster 1 stimuli from all the stimuli**

In addition to BC [ɑ:]→<aw/o>, Mississippi [ɑ:]([ɑ:])→<o> and [ɔ:]([ɔə~ɔʊ])→<aw/au> conversion were severely problematic for the Japanese participants. To make a long story short, spellings related to the low back region were problematic. Unsurprisingly, Mississippi [ɪ(m)]([ɪə(m)])→<i> was severely problematic, but despite its diphthongization, it was spelled with the monograph <a> by some Japanese participants, like the Canadian participants. Mississippi normal [ɛ] (before [m]) was also problematic, but more importantly, if the duration of [ɛ] (before an obstruent) exceeds certain length, some Japanese EAL learners could not associate it with the monograph <e>. Regardless of whether BC or Mississippi, the [ʌ]→<u/uh> conversion was a big challenge for the Japanese participants. To make matters worse, for lengthened [ʌ], the Japanese participants tended to add <r>. As

for [o^u], especially with long duration, it tended to be spelled as <ou>, <ow>, or similar variations with <u/w> that reflected the [ʊ~w] off-glide, meaning that the [o^u]-to-<o> conversion was also a severe problem.

4.3.3.3.2 Spelling on cluster 2 stimuli

Stimuli in cluster 2 are the second most challenging for the Japanese participants.

- **BC/Mississippi slow [æ:]-<a>**

The sound [æ:] appeared in six different conditions, BC norm [dæ:z], slow [pæ:z], Mississippi normal [stæ:z], slow [pæ:z], and the before-nasal condition normal [stæ:m] and slow [snæ:m]. The Canadian participants almost consistently spelled <a> except that in slow stimuli they occasionally spelled <aa>. In contrast, the Japanese participants spelled <a> noticeably more frequently with normal speed [æ:]: Mississippi normal [stæ:z] (27/45) versus slow [pæ:z] (11/45), Mississippi normal [stæ:m] (33/45) versus slow [snæ:m] (14/45), except for BC normal [dæ:z] (19/45) versus slow [pæ:z] (20/45) but BC normal [dæ:z] spelled <an> (3/45) may need to be included. The good news is that phonetically different [æ:]s in both duration and diphthongization were all most frequently spelled as <a>, suggesting that at least some Japanese participants perceived [æ:] phonemically rather than phonetically, on the contrary to my prediction. To improve the consistency of their [æ:]-to-<a> conversion even more, they would need to learn not to be tempted to spell two or more letters for slow [æ:], such as <ar>, <ae>, <aw>, <au>, <ea>, <er>, <eau>, <arr>, <arl>, and so forth.

- **BC slow [i:]-<ee> (in a closed syllable)**

Recall that the Canadian participants most frequently spelled [i:] as <ee> regardless of speed. In contrast, as mentioned above, the Japanese participants most frequently spelled normal [i:] in [ʃi:b] as <i> (19/45), but they spelled slow [i:] in [sni:b] as <ee> (17/45). The good news is that if the duration of [i:] was long enough, they spelled [i:] as <ee>. This may be in part owing to the Japanese loanword rōmaji Japa/i:-<ee> correspondence (see §2.5.7).

The bad news is that if the duration of [i:] was not long enough, they were tempted to spell <i> likely due to the L1 regular/loanword rōmaji Japa/i/-<i> correspondence. This is also related to the problem that many of them could not spell Eng[ɪ] as <i>. Their [i]-<i> and [i:]-<ee> correspondences need to be corrected.

- **BC slow [eʰ]-<a_e> (in a closed syllable)**

The relationship between normal and slow [eʰ] and that of normal and slow [i:] are similar. While the Canadian participants almost consistently spelled [eʰ] in closed syllables as <a_e> regardless of speed, the Japanese participants most consistently spelled normal [eʰ] in [keʰb] as <e> while spelling slow [eʰ] in [teʰb] as <a_e>. The good news is that if the duration of [eʰ] was long enough, they associated [eʰ] with <a_e>. Unlike the case of [i:]-<ee>, in my loanword rōmaji data in Nogita (2016c), Japa/ei/-to-<a_e> conversion occurs only once; Japa/ei/ more frequently corresponds to <a>, <ay>, <ei>, <ai>, and <ey> (see §2.5.7). Nevertheless, the Japanese participants still had acquired the [eʰ]-to-<a_e> conversion to some extent. The bad news is that if the duration of [eʰ] was not long enough, they were tempted to spell <e> likely due to the L1 regular/loanword rōmaji Japa/e/-<e> correspondence. Their [eʰ]-<e> and [e:ʰ]-<a_e> correspondences need to be corrected.

- **BC slow [u:]-<oo> (word-final)**

Duration sensitivity for the [u:]-<oo> conversion by the Japanese participants may also be somewhat similar to [i:]-<ee> and <eʰ>-<a_e>, although it was not as straightforward. The Canadian participants almost consistently spelled [u:] as <oo> regardless of speed. In contrast, the Japanese participants most frequently spelled normal [u:] in [sku:] as <ue> (11/45) and in many occasions with <u>-starting spellings, like <u> (3/45), <uu> (2/45), <uw> (1/45) and so on, whereas they spelled slow [u:] in [spu:] as <oo> (25/45) and with only four <u>-starting spellings, <ue> (2/45), <u> (1/45), and <uw> (1/45). Since the normal speed [u:] was mostly spelled with two letters, these spelling patterns may not be due to

durational differences, but due to other factors, such as non-phonemic phonetic qualities; [u:] in the slow stimulus [spu:] sounds more rounded than [u:] in the normal stimulus [sku:] possibly due to a coarticulation effect with [p] as well as a clear enunciation for a slow stimulus, which may have been associated with the visually round grapheme <oo>. If they were overly sensitive to non-phonemic vowel qualities like a degree of roundness, this needs to be corrected.

- **Summary of results on cluster 2 stimuli from all the stimuli**

This cluster mainly shows problems of duration. When [æ:] was lengthened, the Japanese participants had more trouble spelling it as <a>, while when [i:] and [e'] were lengthened, they more easily spelled <ee> and <a_e> respectively. Also possibly when [u:] was more rounded, the Japanese participants tended to choose <oo>. At least some Japanese participants were overly sensitive to non-phonemic phonetic qualities with these vowels.

4.3.3.3 Spelling on cluster 3 stimuli

Cluster 3 is the third most challenging stimuli. In this category, there is a spelling that is luckily classified here when it is supposed to be in cluster 1 or 2, which is [spɪz].

- **Mississippi slow [ɛ(m)]([ɛə])-<e/(a)>**

Recall that the Canadian participants unanimously spelled Mississippi synthetically lengthened [ɛ] before [m] ([ɛə]) as <a>: i.e., Mississippi slow [spɛ(ə)m] as <spam>. This result is consistent with aforementioned Hillenbrand et al.'s (2000) report. The Japanese participants also most frequently spelled it as <a> (18/45). This is another piece of evidence that they perceived [æ:] categorically. Still, seven Japanese participants spelled <ea>, which seems to be phonetic transcription based on Japanese regular rōmaji. The spelling <er> (3/45) may be a variation of phonetic transcription when they erroneously assumed that after-vowel <r> corresponds to [ɐ] or similar off-glide sounds.

- **Mississippi normal [æ:(m)]([æə])-<a>**

The Canadian participants unanimously spelled Mississippi normal [æ:] before [m] ([æə]) as <a>. Likewise, the Japanese participants most frequently spelled [æə] as <a> despite its diphthongized quality. As mentioned above, this may be owing to the visual image of the famous ligature IPA symbol <æ>, which can enable Japanese EAL learners to associate phonetic qualities of the combination of Japa/a/ and Japa/e/.

- **BC slow [ju:]-<u_e> (in a closed syllable)**

The most frequent spellings of lengthened [ju:] in [pju:d] by the Canadian participants were <u_e> and <ew> (4/10 for each). As for the Japanese participants, they most frequently spelled normal [ju:] in [bju:d] as <iew> (14/45), while they most frequently spelled slow [ju:] in [pju:d] as <u_e> (28/45). This difference may not be because of durational differences, but because they misperceived [bju:d] as the real word *viewed* due to a lack of L1 [b]-[v] contrast. In [pju:d], they were less distracted by real words. Their acquisition of [ju:]-to-<u_e> conversion in closed syllable may be in part owing to the loanword *rōmaji* <u_e>-Japa/ju:/ correspondence (see §2.5.7). For the next level, they need to acquire the overall more common [ju:]-<ew> correspondence chosen by the Canadian participants.

- **Mississippi normal [ɪ]-<i>**

Many Japanese participants were tempted to spell [ɪ] as <e> due to a negative transfer from the regular/loanword *rōmaji* Japa/e/-to-<e> conversion. In fact, they most frequently spelled Mississippi normal [ɪ] in [spɪz] as <e> (19/45), followed by <ee> (9/45). Nevertheless, Mississippi normal [ɪ] is statistically classified into cluster 3, instead of the most challenging cluster 1. This is merely due to luck. Because two Canadian participants spelled Mississippi normal [ɪ] in [spɪz] as <e> likely due to misperception, even when the Japanese participants spelled <e> due to a negative L1 transfer, they were still given 3 points. A possible reason for the Canadian participants' occasional misperception was duration; BC normal [ɪ] in [dɪz] is 240ms long while that in Mississippi normal [spɪz] is 348ms long.

- **Mississippi normal [ɛ]-<e>**

The Canadian participants unanimously spelled [ɛ] in Mississippi normal [tʃɛz] as <e>. Although this is classified into cluster 3 as opposed to 4, the Japanese participants most frequently spelled [ɛ] in Mississippi normal [tʃɛz] as <e> (28/45), which is not largely different from cluster 4 stimuli BC normal [smɛz] (29/45) and slow [mɛz] (33/45). Only the statistical difference may be that these cluster 4 stimuli were performed well even by lower score participants, but this statistical difference is probably linguistically marginal.

- **Summary of results on cluster 3 stimuli from all the stimuli**

Cluster 3 stimuli had been acquired by the Japanese participants to some extent, except for the luckily classified [spɪz]. For further improvement for [ju:], the Japanese participants are encouraged to learn more common spelling <ew>.

4.3.3.3.4 Spelling on cluster 4 stimuli

In terms of scores, cluster 4 stimuli were performed well regardless of whether the participants were higher or lower score participants. However, statistics does not tell whether their apparent native-like spellings demonstrate their actual acquisition or merely flukes. I will discuss more details of each stimulus.

- **Mississippi normal [ɑ:] (word-final)**

The Canadian participants most frequently spelled Mississippi normal [ɑ:] ([ɑ:]) in [sna:] as <ah> (5/14), followed by <a> (4/14) and <aw> (4/14). The Japanese participants also most frequently spelled it as <ah> (17/45) followed by <a> (7/45). However, it would be too hasty to conclude that their behaviour is Canadian-like. Since Mississippi [ɑ:] ([ɑ:]) is perceptually similar to Japa/a:/, they positively transferred the L1 regular rōmaji Japa/a:-<ah> (or <a> in Passport rōmaji mentioned in §2.4.3). Considering the other cases of the vowels in the low back region, it is highly unlikely that the Japanese participants had explicit knowledge of English spelling rules of word-final [ɑ:]-<ah/a> correspondence, possibly

except for a few excellent participants; it is even more unlikely that they had explicit knowledge about a complicated phonological status of foreign (a) and [ɑ:] and [ɔ:] as well as these corresponding spellings. However, even if they did not have such explicit knowledge at that moment, when they are fortunate enough to be taught explicitly, the [ɑ: (ɑ:)]-to-<ah/a> correspondence is expected to be easily acquired. The problem is that six Japanese participants spelled it as <ar>, likely due to the common loanword rōmaji Japa/a:/-to-<ar> conversion (see §2.5.7).

- **BC normal/slow [ʊ]-<u/oo>**

Interestingly, the Canadian participants most frequently spelled normal [ʊ] in [pʊd] as <u> (9/14) followed by <oo> (3/14), but their preference was reversed for slow [ʊ] in [sʊd] (<oo> (5/10) and <u> (3/10)). This may be because the Canadian participants also preferred monographs for phonetically shorter vowels, and digraphs for phonetically longer vowels. The Japanese participants also showed the same tendency to some extent, that is, they most frequently spelled [ʊ] in normal [pʊd] as <u> (33/45) and only one spelled it as <oo>, while they also most frequently spelled it in slow [sʊd] as <u> (16/45) but seven spelled it as <oo>. However, it would be too hasty to conclude that their behaviour is Canadian-like. As mentioned above, acoustically Eng[ʊ] does not clearly overlap with any Japanese monophthongs, but this “uncategorized” Eng[ʊ] for these seven Japanese speakers may have been merged with Eng[u:] when Eng[ʊ] was lengthened. A further study will be needed to understand this fully. The good news is that 16 Japanese participants spelled [ʊ] and [u:] differently regardless of length; [ʊ] was most frequently spelled as <u> while [u:] was most frequently spelled as <u_e> (BC normal) and <oo> (BC slow) in closed syllables, as well as <ue> (BC normal) and <oo> (BC slow) in open syllables.

- **BC slow [aɪ]-<i_e> (in a closed syllable)**

Nine out of 10 Canadian participants spelled slow [aɪ] in [naɪb] as <i_e> and one spelled <ai>, which was judged as acceptable for [aɪ]-to-<ai> conversion but not necessarily for the other direction. As for the Japanese participants, while they most frequently spelled [aɪ] in [naɪb] as <i_e> (23/45), some were tempted to spell <ai> (9/45) and its similar variation <ai_e> (8/45), influenced by the regular/loanword rōmaji <ai>-Japa/ai/ correspondence (see §2.5.7). Since <ai> deserves 1 point, the total score of slow [aɪ] was relatively high, but their preference to <ai> needs to be corrected.

- **Mississippi normal [æ:]-<a>**

The Canadian participants almost consistently spelled Mississippi normal [æ:] in [stæ:z] as <a> (13/14) and only one spelled <ah>. As for the Japanese participants, they also most frequently spelled it as <a> (27/45). The reason why they performed better with [æ:] in Mississippi normal [stæ:z] than in the other conditions is unknown. The problem is that 6 Japanese participants spelled it as <ar>.

- **Summary of results on cluster 4 stimuli from all the stimuli**

Although lower score participants performed well with cluster 4 stimuli, whether they in fact had explicit knowledge about these correspondences is a different story. Specifically, Mississippi normal word-final [ɑ:]-<ah/a>, slow [ʊ]-<oo>, and [aɪ]-<ai> in a closed syllable may be accidentally Canadian-like.

- **Summary of results on all the stimuli**

Overall, again, the severe problems are [aʊ]-<ow/ou>, [ʌ]-<u/uh>, [ɑ:]-<o/aw>, [ɪ]-<e>, [oʊ]-<o>, and Mississippi [ɔ:]-<aw>. As well, durational differences can completely change the Japanese participants' spellings of [i:] and [e^l], and possibly phonetic (spectral) qualities could change their spellings of [u:].

4.3.3.4 <r>-insertion by the Japanese participants

One of the major problems is that the Japanese participants were tempted to spell <r> when there was no [ɹ] in sound forms in rhotic dialects (e.g., <stor> for [sko^o]). Overall, 36 out of 45 participants added <r> at least once when it was not supposed to. The overall average <r> insertion per participant was in five out of 71 stimuli.

The details of <r> insertion are organized in Table 68.

Table 68. The number of <r>-insertion by 45 Japanese participants

Stimuli	#	Stimuli	#	Stimuli	#	Stimuli	#
MS slow [sta:]	27	MS norm [dʒɑ:d]	7	MS slow [stɔ:d]	5	MS norm [tʃo ^o]	2
MS slow [nʌz]	15	MS slow [smɔ:]	6	BC norm [zɑ:d]	5	BC slow [spo ^o z]	2
MS slow [tʃɑ:d]	15	MS norm [stɔ:]	6	BC slow [pæ:z]	4	BC slow [pɔɪ]	2
MS slow [pæ:z]	14	MS norm [smɔ:d]	6	MS norm [pɪm]	4	BC norm [tɑ:]	1
BC slow [stɑ:d]	14	MS norm [stæ:z]	6	MS slow [stɛz]	4	BC norm [dæ:z]	1
BC slow [mʌ]	12	MS slow [snæ:m]	6	BC slow [zʌd]	3	BC slow [stɪz]	1
MS norm [sna:]	9	MS norm [stæ:m]	6	BC norm [bʌ]	3	BC slow [pju:d]	1
MS slow [bɪm]	8	MS slow [spɛm]	6	MS norm [sem]	2	BC slow [spu:]	1
BC slow [da:]	8	BC slow [sko ^o]	6	MS norm [tʃɛz]	2	BC slow [sɒd]	1

Note. The numbers are out of 45 (participants).

First, frequent <r> insertion was mostly observed in slow stimuli. Second, <r> insertion was concentrated in [ɑ:, ʌ, ɔ:, æ:] which are acoustically similar or adjacent to Japa/a:/. These suggest that when [ɑ:, ʌ, ɔ:, æ:] have long duration, the Japanese participants were tempted to spell <r> as a lengthening marker. Note that high occurrences of <r> in Mississippi slow [sta:] is in part because it was mistaken for the real word *star* and spelled as <star> by 19 participants (likely due to the English loanword in Japanese Japa[stɔ:] (Japa/suta:/)). For Mississippi [æ:(m), ɛ(m), ɪ(m)] ([æə, ɛə, ɪə]), the schwa-off-glides were spelled as <r>. Interestingly, [e^l, i:, aɪ, aʊ] never involved <r> insertion in any conditions. It can be generalized that Japa/a/-like off-glides tend to be spelled as <r> by Japanese EAL learners. There were participants' individual differences in frequency of <r> insertion. Specifically, nine participants never inserted <r>, while the one who most frequently inserted

<r> (length of residence (LOR) 1 year, age of acquisition (AOA) 12 years old, self-evaluation 2) added <r> in 21 stimuli out of 71.

4.3.3.5 <h>-insertion by the Japanese participants

In this section, I will discuss in which stimuli the Japanese participants tended to spell <h>. Note that adding <h> is not necessarily errors unlike <r>-insertion, although whether they knew proper usage of <h> is a different story.

Table 69. The number of <h>-insertion by 45 Japanese participants

Stimuli	#	Stimuli	#	Stimuli	#	Stimuli	#
MS norm [sna:]	18	BC slow [spu:]	3	MS slow [ʃɑ:d]	1	BC slow [pæ:z]	1
BC slow [da:]	12	MS slow [smo:]	3	MS slow [nʌz]	1	BC slow [fao]	1
BC slow [mʌ]	10	BC norm [po ^o]	3	MS slow [spem]	1	BC norm [za:d]	1
BC norm [bʌ]	8	BC norm [sne ^l]	3	MS slow [bim]	1	BC norm [sni:]	1
MS slow [sta:]	7	BC slow [sko ^o]	2	MS norm [stæ:m]	1		
BC norm [ta:]	7	MS norm [sto:]	2	MS norm [stæ:z]	1		
MS slow [pæ:z]	5	MS norm [dʒɑ:d]	2	BC slow [zʌd]	1		

Note. The numbers are out of 45 (participants).

Most of the frequent <h>-insertion-involving stimuli are open syllables, indicating that they had acquired English-like spelling to some extent. The digraph <ah> was most frequent, especially in Mississippi normal [sna:] ([sna:]) and BC slow [mʌ]. Notice that Mississippi slow [sta:] was not spelled as <ah> as frequently since it was mistaken for *star* by 19 participants. Since the Japanese participants positively transferred the Japanese rōmaji <ah>-/a:/ correspondence, the Mississippi [ɑ:](/a:)-to-<ah> conversion was not challenging. BC slow [mʌ] was misperceived as [ɑ:] even by the Canadian participants, so <ah> for slow [ʌ#] spelled by the Japanese participants is acceptable, although they still need to be taught the [ʌ#]-to-<uh> conversion. As for <oh>, I predicted that the spelling <oh> would be the most frequent since in one of the regular rōmaji variations, <oh> is the most frequent <h>-involving vowel digraph in Japanese as mentioned in §2.4.3, and this could be positively transferred to the English [o^o]-<oh> correspondence. However, it turned out not the case. Infrequent occurrences of <oh> may be because BC and Mississippi dialects lack a phoneme that is perceptually similar to Japa/o:/ ([o:]) to Japanese ears. Instead, the Japanese

participants associated Eng[o^ʊ] with Japa/ou/, but not with Japa/o:/. The good news is that they spelled <oh> one to three times for BC normal and slow [o^ʊ], but the bad news is that they also incorrectly spelled <oh> for BC normal and slow [ɑ:#], Mississippi normal [ɑ:#] ([a:#]), normal and slow [ɔ:], and BC normal [ʌ].

4.3.3.6 Silent-E by the Japanese participants

In this section, I will discuss whether the Japanese participants had acquired the function of silent-E as an “alphabet sound” marker. There were two types of errors: missing-E errors, in which they missed <e> when they needed it (e.g., <cab> for [ke^hb], instead of <cabe>), and adding-E errors, in which they added <e> when they were not supposed to (e.g., <daze> for [dæ:z], instead of <daz>). I analyzed 12 stimuli that can involve missing-E errors and 20 that can involve adding-E errors. Note that this error analysis involves only errors with relevant vowel letters: for example, errors like <nase> for [nʌz] (which is supposed to be <nuz>) are not counted even though <nase> has an incorrect silent-E, since <a> is already incorrect. I excluded Mississippi [æ:, ε, ɪ] before [m] for this analysis since even the Canadian participants made so many perception errors. Table 70 shows the overall summary.

Table 70. Silent-E-related errors by 45 Japanese participants

# of missing-E error per participant	# of missing-E error per participant	# of both errors per participant
0.89 (out of 12 stimuli)	0.76 (out of 20 stimuli)	1.64 (out of 32 stimuli)

Table 71 shows the number of missing-E errors for each of the 12 stimulus by 45 participants. For example, “3” for “BC normal [ke^hb]” in Table 71 means that three (out of 45) Japanese participants spelled <kab> or equivalent spellings.

Table 71. The number of missing-E errors by 45 Japanese participants for each stimulus

Stimuli	missed <e>	Stimuli	missed <e>
BC norm [ke ^h b]	3	BC norm [mo ^ʊ z]	9
BC slow [te ^h b]	1	BC slow [spo ^ʊ z]	0
BC norm [tʃi:b]	3	BC norm [tu:d]	8
BC slow [sni:b]	2	BC slow [snu:b]	5
BC norm [maɪb]	8	BC norm [bjɜ:d]	0

BC slow [naɪb]	0	BC slow [pju:d]	1
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Note. The numbers are out of 45 (participants).

As can be seen, the Japanese participants tended to miss silent-E in normal stimuli than in slow stimuli. This implies that the Japanese participants may have used silent-E for transcribing long duration.

With regard to adding-E errors for each of the 20 stimuli, the results are shown in Table 72.

Table 72. The number of adding-E errors by 45 Japanese participants for each stimulus

Stimuli	added <e>	Stimuli	added <e>	Stimuli	added <e>
BC norm [dæ:z]	4	BC norm [dɪz]	0	BC norm [fʌd]	0
BC slow [pæ:z]	5	BC slow [stɪz]	1	BC slow [zʌd]	0
MS norm [stæ:z]	5	MS norm [spɪz]	0	MS norm [mʌz]	1
MS slow [pæ:z]	0	MS slow [pɪz]	2	MS slow [nʌz]	0
BC norm [smɛz]	5	BC norm [zɑ:d]	1		
BC slow [mɛz]	4	BC slow [stɑ:d]	0		
MS norm [tʃɛz]	0	MS norm [dʒɑ:d]	0		
MS slow [stɛz]	6	MS slow [tʃɑ:d]	0		

Note. The numbers are out of 45 (participants).

As can be seen, adding-E errors can occur in normal stimuli, which is a difference from missing-E errors.

Overall, silent-E-related errors were relatively few, which may be in part owing to loanword rōmaji (see §2.5.7).

4.3.3.7 <l, m, n, ng>-insertion by the Japanese participants

In some stimuli, the letters <l, m, n, ng> were incorrectly added in spellings. There is a possibility is that they added a silent-L by referring to words like *talk* or *walk*, or a silent nasal letter by referring to words like *condemn* or *mnemonics*. Another possibility is that they misperceived a “phantom” [l, m, n, ŋ]. If these insertions were due to misperception of phantom sounds, this is understandable since even the Canadian participants occasionally did so, but clearly the Japanese participants did more frequently. Table 73 shows average <l, m, n, ng>-insertion for 71 stimuli.

Table 73. Average <l, m, n, ng>-insertion per participant

<l>-insertion	Adding-Nasal			
	<m>-insertion	<n>-insertion	<ng>-insertion	Nasal total
2.07/71	1/71	3.49/71	0.07/71	4.6/71

Table 74 shows <l>-insertion for each stimulus by 45 participants.

Table 74. The number of <l>-insertion by 45 Japanese participants

Stimuli	L	Stimuli	L	Stimuli	L
MS slow [smɔ:]	24	MS norm [smɔ:d]	2	MS slow [pɪz]	1
MS slow [stɔ:d]	15	MS slow [tʃɑ:d]	2	BC slow [spi:]	1
MS norm [stɔ:]	10	BC slow [pɔɪ]	2	BC slow [stɪz]	1
MS norm [pɪm]	6	BC norm [pɔ ⁰]	2	MS norm [sna:]	1
MS norm [sem]	5	BC norm [spɔɪ]	2	MS norm [dʒɑ:d]	1
BC slow [faʊ]	5	MS slow [spem]	1	BC norm [ta:]	1
BC slow [sko ⁰]	4	MS slow [snæ:m]	1	BC norm [sne ¹]	1
BC norm [faʊz]	3	MS slow [pæ:z]	1	BC norm [gəʊ]	1

Note. The numbers are out of 45 (participants).

Most <l>-insertions were the Japanese participants' misperception of schwa off-glides in Mississippi [ɔ:, ɪ, ε] as [l]. As well, occasionally they misperceived [ʊ~w] off-glides of [o⁰, aʊ] as [l]. Other <l>-insertions may be marginal. Table 75 shows nasal letter insertion.

Table 75. The number of nasal letter insertion by 45 Japanese participants

	M	N	NG	Total		M	N	NG	Total
BC slow [zai]	3	24	0	27	BC slow [faʊ]	1	1	0	2
BC norm [gəʊ]	10	14	0	24	BC slow [mɛz]	0	2	0	2
BC slow [ske ¹]	3	18	0	21	MS slow [smɔ:]	0	2	0	2
BC norm [sku:]	8	8	1	17	BC slow [spɔ ⁰ z]	0	1	0	1
BC slow [spi:]	3	9	1	13	BC slow [stɪz]	0	1	0	1
BC norm [pɔ ⁰]	8	5	0	13	BC norm [ke ¹ b]	0	1	0	1
BC norm [snaɪ]	0	12	0	12	BC norm [tʃi:b]	1	0	0	1
BC norm [dæ:z]	0	9	0	9	BC norm [maɪb]	0	1	0	1
BC norm [spɔɪ]	0	9	0	9	BC norm [bjɪ:]	1	0	0	1
BC norm [sne ¹]	0	6	0	6	BC norm [fɛd]	0	1	0	1
BC slow [spu:]	1	5	0	6	BC norm [fɔɪd]	0	1	0	1
BC slow [zɛd]	1	5	0	6	BC norm [faʊz]	0	1	0	1
BC slow [pɔɪ]	0	6	0	6	BC slow [snu:b]	1	0	0	1
BC slow [paʊz]	0	5	0	5	BC slow [da:]	0	1	0	1
BC norm [ta:]	1	3	1	5	BC slow [mʌ]	1	0	0	1
BC slow [bjɪ:]	2	3	0	5	BC slow [pɔɪd]	0	1	0	1
BC slow [sko ⁰]	0	2	0	2					

Note. The numbers are out of 45 (participants).

Common misperceptions were in open syllable stimuli where they heard “phantom” nasal codas. The letter <n> is most frequently added, but it does not necessarily mean that they misperceived “phantom” Eng[n]. If they misconceived that English coda /n/ was the same entity as the Japanese moraic /N/ as Teshima (2011) mentions, the phantom nasal sound may have been the Japanese moraic nasal /N/. Word-final Japanese /N/ is traditionally regarded as a uvular nasal, or a nasal vowel/glide [ũ], but recent studies demonstrate that Japa/N/ is also realized as unreleased dorsalized bilabial nasal stop such as [m̠̚, m̠̚̚] (Nogita & Yamane, 2015; Matsui, 2015). Regardless of the word-final Japa/N/’s phonetic realization is, it is always spelled as <n> in most regular rōmaji varieties. Since Japa/N/ always lacks an audible release, if the Japanese participants felt an extra mora in the stimuli, they may have misperceived phantom Japa/N/, which was spelled as <n>. Such misperceptions need to be corrected. In some occasions, they spelled <m>, instead of <n>, which may be a sign of the midway of their learning process of English coda nasals, if they heard phantom [m].

4.3.3.8 Relationship between scores and LOR/AOA/self-evaluation

In this section, I will discuss participants’ performances depending on length of residence in Canada (LOR), age of acquisition of English (AOA), and self-evaluation of their English proficiency. First, I compared those whose length of residence in Canada (LOR) is one year or longer and those whose LOR is shorter than one year by using the two-tailed two-sample t-test in terms of their average scores and average number of 0-point spellings (or the spellings the Canadian participants never chose). Table 76 shows the summary.

Table 76. Scores and the numbers of 0-point spellings by longer and shorter LOR Japanese EAL participants

	All the participants	LOR 1+ years	LOR < 1 year	Significance LOR1+vs.<1
Overall score (Score per stimulus)	99.2/284 (1.40/4)	107.6/284 (1.52/4)	86.6/284 (1.22/4)	* p < 0.05
Range	51 ~ 190	58 ~ 190	51 ~ 106	
BC normal score (Score per stimulus)	33.8/96 (1.41/4)	37.8/96 (1.58/4)	27.8/96 (1.16/4)	** p < 0.005
Range	8 ~ 54	24 ~ 54	8 ~ 35	

BC slow & MS score (Score per stimulus)	65.4/188 (1.40/4)	69.8/188 (1.49/4)	58.8/188 (1.25/4)	N.S. p = 0.099
Range	28~136	28~136	43~78	
Significance BC vs. others	N.S. p = 0.86	N.S. p = 0.32	N.S. p = 0.51	
# of overall 0-point spellings	42.6/71 (60%)	40.3/71 (56.8%)	46.1/71 (64.9%)	* p < 0.05
Range	24% ~ 79%	58% ~ 79%	24% ~ 79%	
# of BC normal 0-point spellings	14.4/24 (60%)	13.3/24 (55.4%)	16.1/24 (67.1%)	** p < 0.005
Range	33% ~ 88%	33% ~ 75%	54% ~ 88%	
# of BC slow & MS 0-point spellings	28.2/47 (60%)	27/47 (57.4%)	30/47 (63.8%)	N.S. p = 0.1
Range	19% ~ 83%	19% ~ 83%	49% ~ 74%	
Significance BC vs. others	N.S. p = 0.93	N.S. p = 0.64	N.S. p = 0.20	

Note. N.S. = not significant. * = significant at the $p < 0.05$ level, ** = significant at the $p < 0.01$ level

The longer LOR participants significantly performed better than the shorter LOR participants. This implies that longer LOR contributes to Japanese EAL learners' grapheme-to-phoneme conversion skills. For BC normal stimuli, the longer LOR participants significantly performed better, but for the rest of the stimuli, although the longer LOR participants performed better, the difference was not statistically significant, implying that for unfamiliar directs and synthetically manipulated sounds, the difference between two LOR groups becomes smaller. Overall, the difference between BC normal stimuli and the rest was not significant. The longer LOR group performed better with BC normal stimuli than the rest, but the difference was not significant. In contrast, the shorter LOR group perform poorer with the BC stimuli, but the difference was also not significant. All this suggests that Japanese EAL learners' grapheme-to-phoneme conversion skills can be better in their familiar dialect but this effect is marginal.

I also examined correlation between the overall score and LOR/AOA/self-evaluation of their overall English proficiency with the Linear Regression by assigning the score of the spelling task to the dependent variable and the three factors to the independent variables. Overall, there is a significant correlation ($p < 0.001$), meaning that all of these three factors

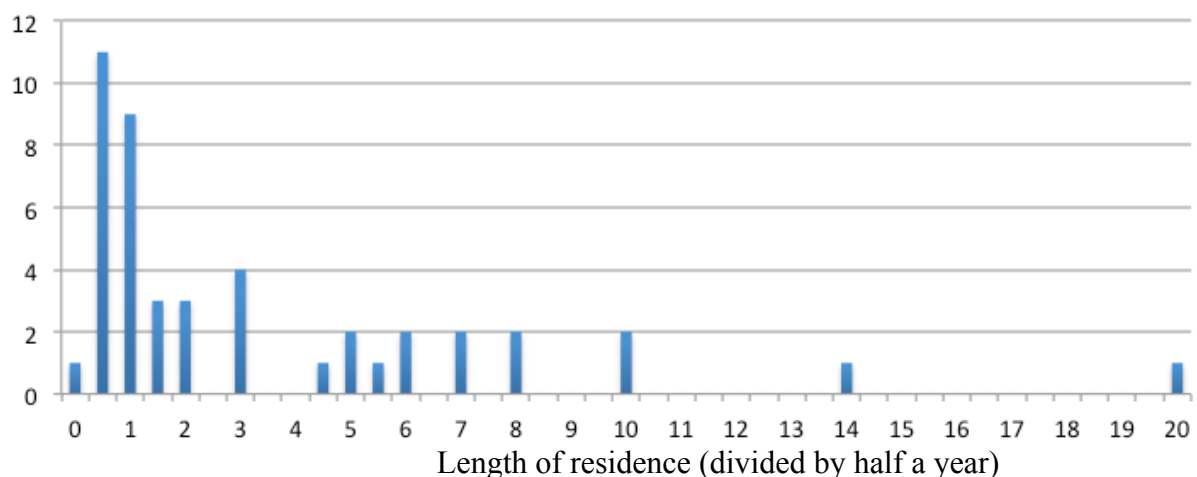
together contribute to their scores of the spelling task. Standardized coefficients of the score and the three factors are shown in Table 77, which shows that which of the three factors predict their scores the most.

Table 77. Standardized coefficients of the score and the three factors of the Japanese participants

Dependent variable: Score of the spelling task		
Independent variables	Beta	Significance
Length of residence in Canada (LOR)	0.158	N.S. p = 0.224
Age of acquisition (AOA)	-0.212	N.S. p = 0.105
Self-evaluation of their English proficiency	0.500	** p < 0.001

Note. N.S. = not significant

First, self-evaluation has a significant moderate correlation with the score, suggesting that their self-evaluation can predict their phoneme-to-grapheme conversion skills to some extent. Conversely, as discussed in the reading task (see §3.4.3.6), this can be interpreted as meaning that if their phoneme-to-grapheme conversion skill is high, their self-evaluation tends to be high as well. Second, while the longer LOR participants performed better than the shorter counterparts to some extent, there is no statistically significant relationship with the scores. One of the reasons may be because the distribution of their LOR is skewed as shown in Figure 45.



Note. The Y axis is the number of participants

Figure 45. Distribution of LOR of the Japanese participants

Interestingly, the participant whose LOR was the second longest (14 years, AOA = 12 years old, self-evaluation = 2.5) scored 63, which is below the average (99.2), while the participant whose LOR is four months (AOA = 12 years old, self-evaluation = 3) scored 101. The extreme case is the one who scored the highest (190) has only one year of LOR (AOA = 5 years old, self-evaluation = 4.2 (highest)). This implies that while long LOR helps to some extent, it does not guarantee high performance in the spelling task.

Between AOA and scores, there is no significant relationship, but again, this may also be the skewed distribution of AOA. To solve this, I separated 34 participants whose AOA is 12 years old from the other 11 participants whose AOA is earlier. The average score of those whose AOA is 12 years old is 93 while those with earlier AOA is 115. However, in the early AOA group, there were 2 extremely good participants; the one in 1st place (score = 190, LOR = 1 year, AOA = 4 years old, self-evaluation = 4.2) and the one in 2nd place (score = 181, LOR = 7 years, self-evaluation = 4) as opposed to the one in 3rd place (score = 148, LOR = 7, AOA = 12, self-evaluation = 3) and the rest. If these 2 extreme participants are excluded, the rest of the nine early AOA participants' average score is 101. Due to the small number of the early AOA participants, the t-test cannot be run, but still the early AOA group scored somewhat higher (101 vs. 93), suggesting that AOA could matter to some extent. Still, in the early AOA group, there is the one in 41st place (AOA = 5 years old, LOR = 5 years, self-evaluation = 2) who scored 66, or the one in 39th place (AOA = 4 years old, LOR = 3 months, self-evaluation = 2) who scored 72, while in the late AOA group there are the one in 3rd place (LOR = 7, AOA = 12, self-evaluation = 3) who scored 148 as well as the one in the 4th place (LOR = 3, AOA = 12, self-evaluation = 3.8) who scored 143. All this means that early AOA does not guarantee high scores while late AOA can still make it possible to gain high scores.

Overall, if all the three factors are combined, there is a highly significant correlation with the score, but LOR and AOA alone cannot explain the whole story.

As for the relationship between specific errors and LOR/AOA/self-evaluation, about <r>-insertion errors, the average of the shorter LOR group (less than 1 year) was 6.4 stimuli, while that of the longer LOR group was four stimuli, but the t-test showed that there was no significant difference ($p = 0.16$) between longer and shorter LOR groups, suggesting that staying in a rhotic dialect speaking country for a long time does not guarantee their acquisition of the <r>-[ɹ] correspondence. Among LOR, AOA, and self-evaluation of their English proficiency, in order to examine which factor can predict the number of <r> insertion well, I used the Linear Regression. Overall, there is a significant correlation ($p < 0.01$), meaning that all the three factors together contribute to the number of <r> insertion. As well, Table 78 shows standardized coefficients of <r> insertion and the three factors.

Table 78. Standardized coefficients of <r> insertion and the three factors of the Japanese participants

Dependent Variable: <r> insertion by the Japanese participants		
Independent variables	Beta	Significance
Length of residence in Canada (LOR)	-0.146	N.S. $p = 0.297$
Age of acquisition (AOA)	0.218	N.S. $p = 0.124$
Self-evaluation of their English proficiency	-0.394	** $p < 0.01$

Note. N.S. = not significant

Self-evaluation of their English proficiency plays the biggest role; the higher their self-evaluation is, the less frequent they insert <r>.

About missing and adding-E errors, the average of the shorter LOR group (less than 1 year) is 1.44 (out of 32 stimuli), while that of the longer LOR group is 1.78. The longer LOR group made more silent-E related errors. However, the t-test showed that there is no significant difference ($p = 0.35$), suggesting that staying in an English-speaking country for a long time does not help acquire silent-E as an “alphabet sound” marker. Among LOR, AOA, and self-evaluation of their English proficiency, in order to examine which factor can predict the number of silent-E errors well, I used the Linear Regression. Overall, there is a significant

correlation ($p < 0.01$). Table 79 shows standardized coefficients of silent-E-related errors and the three factors.

Table 79. Standardized coefficients of silent-E-related errors and the three factors of the Japanese participants

Dependent Variable: silent-E-related errors by the Japanese participants		
Independent variables	Beta	Significance
Length of residence in Canada (LOR)	0.123	N.S. $p = 0.368$
Age of acquisition (AOA)	0.234	N.S. $p = 0.091$
Self-evaluation of their English proficiency	-0.448	** $p < 0.005$

Note. N.S. = not significant

Again, self-evaluation of their English proficiency plays the biggest role; the higher their self-evaluation is, the less frequent they silent-E-related errors, to some extent.

As for <l, m, n, ng>-insertion errors, the longer LOR group tended to insert both <l> and nasal letters slightly more frequently than the shorter LOR group but the difference was not significant according to the two-sample t-test ($p > 0.4$ for <l>, nasals, and both), suggesting that a longer LOR does not help them reduce [l, m, n, ŋ] misperceptions. As for the relationship with LOR, AOA, and self-evaluation of their English proficiency calculated by the Linear Regression, interestingly, there was no significant correlation ($p = 0.85$). Table 80 shows standardized coefficients of the number of <l, m, n, ng>-insertion and the three factors.

Table 80. Standardized coefficients of <l, m, n, ng>-insertion errors and the three factors of the Japanese participants

Dependent Variable: <l, m, n, ng> insertion by the Japanese participants		
Independent variables	Beta	Significance
Length of residence in Canada (LOR)	0.075	N.S. $p = 0.638$
Age of acquisition (AOA)	-0.081	N.S. $p = 0.615$
Self-evaluation of their English proficiency	-0.121	N.S. $p = 0.451$

Note. N.S. = not significant

While other spelling errors, such as silent-E errors, are highly significantly correlated with self-evaluation of their English proficiency, this is not the case with <l, m, n, ng>-insertion. This may be because <l, m, n, ng>-insertion most likely came from their perceptual sound

identification skills, rather than GPC skills, and perception skills can be more challenging even for confident learners than pure GPC skills.

Finally, <h>-insertion is not necessarily incorrect, so I did not calculate correlation of its performance results with the participants' backgrounds.

4.3.3.9 L1-L2 Dual correspondence in <a> and <ai/ay>

L1 and L2 GPC seem to coexist in some Japanese participants' interlanguage GPC systems, at least regarding <a> and to a lesser extent <ai/ay>. For instance, when they heard [æ:], [æə] and even [ɛə] and [ɪə], they spelled <a> by using their L2 knowledge. At the same time, when they heard perceptually noticeably different [ʌ], they also spelled <a> by using their L1 regular/loanword rōmaji knowledge (Japa[ẽ]-to-<a> conversion). Specifically, 25 out of 45 Japanese participants spelled both Mississippi normal [æ:(m)] ([æə]) and BC normal [ʌ] as <a>. Such dual correspondence is also empirically true; when I tutor Japanese EAL learners for teaching the English phoneme inventory and basic GPC rules, in spelling drills, if they hear fairly diphthongized American English [æə] (e.g., from Iowa, Utah, and Mississippi), they can mostly spell it as <a> without hesitation, but at the same time, if they hear [ʌ], some of them struggle with a dilemma between <a> (L1) and <u> (L2), or simply L1 <a> gets the better of them when they are careless. This suggests that the letter <a> is linked to both [æə] and [ʌ] in their interlanguages. One might argue that Eng/æ/ and /ʌ/ are both perceived as Japa/a/, but it is very unlikely that diphthongized Eng[æə], [ɛə], and [ɪə] are perceived as the one-mora monophthong Japa/a/([ẽ]) by native Japanese speakers. The same logic applies to <ai/ay> to a lesser extent; when the Japanese participants heard [e¹], some of them spelled <ai> or <ay> by using their L2 knowledge, but at the same time, when they heard perceptually noticeably different [aɪ], they also spelled <ai/ay> by using their L1 knowledge (Japa[ai]-to-<ai> conversion). While <ai> linking to both [e¹] and [aɪ] is

acceptable since this is also the case by native English speakers, <ay> linking to both [e^ɪ] and [aɪ] needs to be corrected.

This can be analogous to the Spanish [x]-<j> and [dʒ]-<y, ll> correspondences in some dialects (c.f., Moreno, C. 2012, May 21) for English speakers learning Spanish; at the very beginning stage, English-speaking learners may already be able to associate the Spanish sound [x] with <j> based on the L2 rule, but at the same time they may also be tempted to associate the sound [dʒ] with <j> based on the L1 rule, instead of <y, ll>. Such a dual correspondence may not be unusual at the beginning stage of learning an additional language with a shared script. The problem for the Japanese participants is that even those with longer LOR still have this problem. Specifically, 13 participants out of 27 (48.1%) in the longer LOR group spelled both Mississippi normal [æ:(m)] ([æə]) and BC normal [ʌ] as <a> (and so did 12 out of 18 (66.7%) in the shorter LOR group). Likewise, BC normal and slow [e[#]] and [a[#]] were spelled as <ai/ay> by 13.0% of the longer LOR participants (and by 19.4% of the shorter LOR participants). This may be because in Japan, rōmaji and English spelling are generally not explicitly taught to be different entities, and learners may not even notice which correspondence is L1 or L2. Figure 46 shows the problematic L1-L2 dual correspondence, in which the L1 mode must be disconnected when using L2.

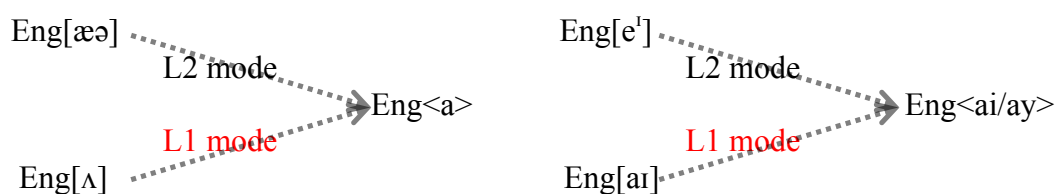


Figure 46. Dual sound-to-spelling correspondence: examples of <a> and <ai/ay>

There are also some other potential dual correspondence problems, such as <ee> used for both [i:] (L2) and [ɛ], [e^ɪ] or lengthened [ɪ] (L1, c.f., Japa/e/-<ee>), or <oe> for both [o^ʊ] (L2) and [ɔɪ] (L1, c.f., Japa/oe/-<oe>), although at least in the data from this present study, these problems seem less serious.

4.4 The Chinese participants: how they compare with the native speakers

4.4.1 Results of the Chinese participants

The overall spelling results of the 24 Chinese EAL learners are shown in the tables below. In these tables, the same criteria for the Japanese participants are used (see §4.3.1). In Table 81 and Table 82, the boxes with thick red frames contain results that scored 4 points in coding. The ones with thin red frames contain results that scored 3 points. Plain boxes indicate 2 points. Plain boxes with an arrow indicate 1 point. Grey ones indicate 0 points. The spellings with a small question mark ? indicate “acceptable” perception-related errors.

Although the participants were notified that all the stimuli were nonsense words, when a large number of participants mistakenly perceived nonsense stimuli as real words (e.g., [dæ:z] as *death*, [bju:d] as *build*), I noted them at the bottom row(s). Since only nine Chinese participants were recruited in British Columbia in Canada, not all the participants’ target English was BC English. However, in order to be consistent with the results of the Japanese participants, I made a separate table for the results of BC normal stimuli in Table 81. The results of all the stimuli are shown in Table 82.

Table 81. The Chinese participants’ spellings for British Columbia normal speed stimuli

	BC normal stimuli							
Phoneme Stimuli	[eʰ#] [sneʰ]	[eʰ] [keʰb]	[i:ʰ#] [sni:]	[i:] [ʃi:b]	[aɪ#] [snaɪ]	[aɪ] [marb]	[oʊ#] [poʊ]	[oʊ] [moʊz]
Spelling # (%)	ay 5 (21%)	i 14 (58%)	ee 11 (46%)	i 9 (38%)	y 6 (25%)	i_e 12 (50%)	ou 5 (21%)	o 10 (42%)
Spelling # (%)	5 a (21%)	a_e 4 (17%)	i 6 (25%)	ee 6 (25%)	igh 3 (13%)	y 5 (21%)	o 4 (17%)	o_e 5 (21%)
Spelling # (%)	ae 2 (8%)	a 3 (13%)	y 2 (8%)	ea 5 (21%)	ai 3 (13%)	ai 2 (8%)	oe 2 (8%)	ou 4 (17%)
Spelling # (%)	e 2 (8%)	ae 1 (4%)	ey 2 (8%)	ie 2 (8%)	→i 3(13%)	igh 1 (4%)	ow 2 (8%)	oa 2 (8%)
Spelling	ue	ei	e	ie_e	ine	i	ool	ow

# (%)	2 (8%)	1 (4%)	1 (4%)	1 (4%)	3(13%)	1 (4%)	2 (8%)	2 (8%)
Spelling # (%)	i 1 (4%)	e 1 (4%)	ing 1 (4%)	e 1 (4%)	an 2 (8%)	ye 1 (4%)	oem 2 (8%)	oo 1 (4%)
Spelling # (%)	ah 1 (4%)		ith 1 (4%)		id 2 (8%)	ai 1 (4%)	oo 1 (4%)	
Spelling # (%)	ee 1 (4%)				ye 0 (0%)	a 1 (4%)	oal 1 (4%)	
Spelling # (%)	ail 1 (4%)						oll 1 (4%)	
Spelling # (%)	en 1 (4%)						ull 1 (4%)	
Spelling # (%)	ing 1 (4%)						ome 1 (4%)	
Spelling # (%)	imb 1 (4%)						ode 1 (4%)	
Spelling # (%)	ef 1 (4%)						aul 1 (4%)	
Spelling # (%)							oh 0 (0%)	
Total	24	24	24	24	24	24	24	24

24 Chinese participants

BC normal stimuli								
[u:#]	[u:]	[labial C + ju:#]	[labial C + ju:#]	[æ:]	[ɛ]	[ɪ]	[a:#]	[ɑ:]
[sku:]	[tu:d]	[bju:]	[bju:d]	[dæ:z]	[smɛz]	[dɪz]	[ta:]	[za:d]
ool 8 (33%)	u_e 13 (54%)	ew 5 (21%)	uil 9 (38%)	ea 11 (46%)	a 8 (33%)	i 11 (46%)	all 5 (21%)	u 6 (25%)
oo 7 (29%)	u 5 (21%)	ue 4 (17%)	u_e 4 (17%)	a 5 (21%)	e 7 (29%)	e 5 (21%)	au 3 (13%)	o 5 (21%)
u 4 (17%)	oo 3 (13%)	iu 4 (17%)	eau 3 (13%)	e 4 (17%)	i 6 (25%)	a 2 (8%)	ar 3 (13%)	a 4 (17%)
→ew 2 (8%)	u(Cu) 1 (4%)	eu 3 (13%)	ui 2 (8%)	a_e 2 (8%)	e_e 1 (4%)	ee 1 (4%)	ah 2 (8%)	ar 4
ow 1 (4%)	uu_e 1 (4%)	eau 1 (4%)	ui_e 2 (8%)	i 1 (4%)	i_e 1 (4%)	ea 1 (4%)	al 2 (8%)	aa 1 (4%)
ol 1 (4%)	wo_e 1 (4%)	eaw 1 (4%)	eau_e 1 (4%)	an 1 (4%)	ea_e 1 (4%)	a_e 1 (4%)	om 2 (8%)	au 1 (4%)
ime 1 (4%)		ieu 1 (4%)	iu 1 (4%)			i_e 1 (4%)	a 1 (4%)	ou 1 (4%)
		iew 1 (4%)	en 1 (4%)			ee_e 1 (4%)	awn 1 (4%)	a_e 1 (4%)
		yu 1 (4%)	ul 1 (4%)			ir 1 (4%)	on 1 (4%)	ul_e 1 (4%)
		uw	ew			i	oe	aw

		1 (4%)	0 (0%)			11/24	1 (4%)	0 (0%)
		eo 1 (4%)	ue 0 (0%)				ow 1 (4%)	
		ill 1 (4%)					oun 1 (4%)	
							orl 1 (4%)	
							aw 0 (0%)	
24	24	24	24	24	24	24	24	24
(school)			(build)	(death)			(tall)	
8			9	11			5	

24 Chinese participants

BC normal stimuli

[ʌ#]	[ʌ]	[ʊ]	[ɔɪ#]	[ɔɪ]	[aʊ#]	[aʊ]
[bʌ]	[fʌd]	[pʊd]	[spɔɪ]	[fɔɪd]	[gʌʊ]	[fʌʊz]
o 5 (21%)	u 11 (46%)	u 11 (46%)	oy 10 (42%)	oi 16 (67%)	un 3 (13%)	au 6 (25%)
al 3 (13%)	u_e 3 (13%)	o 4 (17%)	oil 6 (25%)	oe 1 (4%) (4%)	ao 2 (8%)	ou 4 (17%)
au 2 (8%)	a 3 (13%)	u_e 3 (13%)	oi 4 (17%)	io 1 (4%)	au 2 (8%)	ow 2 (8%)
a 2 (8%)	o 2 (8%)	o(#) 1 (4%)	oie 1 (4%)	o_e 1 (4%)	al 2 (8%)	au_e 2 (8%)
er 2 (8%)	ar 2 (8%)	o_e 1 (4%)	oe 1 (4%)	oin 1 (4%)	arl 2 (8%)	auo 2 (8%)
u 1 (4%)	ae 1 (4%)	oo 1 (4%)	orn 1 (4%)	oal 1 (4%)	own 1 (4%)	ou_e 1 (4%)
uh 1 (4%)	a_e 1 (4%)	au 1 (4%)	oob 1 (4%)	ol_e 1 (4%)	iew 1 (4%)	owl 1 (4%)
→ah 1 (4%)	ul 1 (4%)	oi 1 (4%)		orai 1 (4%)	ale 1 (4%)	a 1 (4%)
aw 1 (4%)		on 1 (4%)		ore 1 (4%)	awl 1 (4%)	oa 1 (4%)
eh 1 (4%)					aul 1 (4%)	el 1 (4%)
ung 1 (4%)					unh 1 (4%)	il_e 1 (4%)
ar 1 (4%)					one 1 (4%)	ail_e 1 (4%)
er 1 (4%)					um 1 (4%)	ar 1 (4%)
all 1 (4%)					aun 1 (4%)	

ebe 1 (4%)					ealth 1 (4%)	
					ump 1 (4%)	
					ong 1 (4%)	
					ape 1 (4%)	
					ow 0 (0%)	
24	24	24	24	24	24	24
			(<i>spoil</i>) 5			

Note. The boxes with thick red frames are 4 points. The ones with thin red frames are 3 points. Plain boxes are 2 points. Plain boxes with an arrow are 1 point. Grey ones are 0 points. “_” indicates a consonant letter.

Table 82 shows the results of all the stimuli.

Table 82. The Chinese participants’ spellings for all the stimuli

Phoneme	[eʰ]		[eʰ]		[i:ʰ]		[i:]	
	BC		BC		BC		BC	
Dialect	Normal	Slow	Normal	Slow	Normal	Slow	Normal	Slow
Stimuli	[sneʰ]	[skeʰ]	[keʰb]	[teʰb]	[sni:]	[spi:]	[ʃi:b]	[sni:b]
Spelling # (%)	ay 5 (21%)	ay 9 (38%)	i 14 (58%)	a_e 14 (58%)	ee 11 (46%)	ee 11 (46%)	i 9 (38%)	ee 14 (58%)
Spelling # (%)	5 a (21%)	a 3 (13%)	a_e 4 (17%)	a 6 (25%)	i 6 (25%)	e 2 (8%)	ee 6 (25%)	i 6 (25%)
Spelling # (%)	ae 2 (8%)	?ane 3(13%)	a 3(13%)	e 3(13%)	y 2 (8%)	in 2 (8%)	ea 5(21%)	i_e 2 (8%)
Spelling # (%)	e 2 (8%)	ein 2 (8%)	ae 1 (4%)	ay 1 (4%)	ey 2 (8%)	eaing 2 (8%)	ie 2 (8%)	ea 1 (4%)
Spelling # (%)	ue 2 (8%)	an 2 (8%)	ei 1 (4%)		e 1 (4%)	ea 1 (4%)	ie_e 1 (4%)	e 1 (4%)
Spelling # (%)	i 1 (4%)	in 2 (8%)	e 1 (4%)		ing 1 (4%)	i 1 (4%)	e 1 (4%)	
Spelling # (%)	ah 1 (4%)	ae 1 (4%)			ith 1 (4%)	een 1 (4%)		
Spelling # (%)	ee 1 (4%)	eih 1 (4%)				eed 1 (4%)		
Spelling # (%)	ail 1 (4%)	i 1 (4%)				eein 1 (4%)		
Spelling # (%)	en 1 (4%)					iv 1 (4%)		
Spelling	ing					uw		

# (%)	1 (4%)					1 (4%)		
Spelling # (%)	imb 1 (4%)							
Spelling # (%)	ef 1 (4%)							
Total	24	24	24	24	24	24	24	24
Speed Stimuli	Normal [sne ^l]	Slow [ske ^l]	Normal [ke ^b]	Slow [te ^b]	Normal [sni:]	Slow [spi:]	Normal [ʃi:b]	Slow [sni:b]
Dialect	BC		BC		BC		BC	

24 Chinese participants

[a#]		[a]		[o ^u #]		[o ^u]		
BC		BC		BC		Mississippi	BC	
Normal [sna ^r]	Slow [za ^r]	Normal [ma ^r b]	Slow [na ^r b]	Normal [po ^u]	Slow [sko ^u]	Normal [ʃo ^u]	Normal [mo ^u z]	Slow [spo ^u z]
y 6 (25%)	ai 7 (29%)	i_e 12 (50%)	i_e 11 (46%)	ou 5 (21%)	o 9 (38%)	o 5 (21%)	o 10 (42%)	o_e 4 (17%)
igh 3 (13%)	ine 4 (17%)	y 5 (21%)	i 3 (13%)	o 4 (17%)	oal 3 (13%)	ow 5 (21%)	o_e 5 (21%)	o 4 (17%)
ai 3 (13%)	ign 4 (17%)	ai 2 (8%)	igh 3 (13%)	oe 2 (8%)	ow 2 (8%)	oe 4 (17%)	ou 4 (17%)	ow 3 (13%)
→i 3(13%)	an 2(8%)	igh 1(4%)	→ai 2(8%)	ow 2(8%)	oh 2(8%)	→ou 3(13%)	oa 2(8%)	ou 3(13%)
ine 3	ye 1(4%)	i 1(4%)	y_e 1(4%)	ool 2(8%)	ole 2(8%)	ough 1(4%)	ow 2(8%)	ou_e 3(13%)
an 2(8%)	ie 1(4%)	ye 1(4%)	y 1(4%)	oem 2(8%)	ol 2(8%)	oa 1(4%)	oo 1(4%)	ao 2(8%)
id 2(8%)	→y 1(4%)	ai 1(4%)	igh_e 1(4%)	oo 1(4%)	ou 1(4%)	ew 1(4%)		oo_e 2(8%)
ye 0(0%)	en 1(4%)	a 1(4%)	a 1(4%)	oal 1(4%)	oo 1(4%)	oul 1(4%)		ow_e 1(4%)
	ann 1(4%)		in 1(4%)	oll 1(4%)	eu 1(4%)	or 1(4%)		oo 1(4%)
	aime 1(4%)			ull 1(4%)	ore 1(4%)	ill 1(4%)		eu 1(4%)
	ynn 1(4%)			ome 1(4%)		ang 1(4%)		
				ode 1(4%)				
				aul 1(4%)				
				oh 0(0%)				
24	24	24	24	24	24	24	24	24

Normal [snaɪ]	Slow [zaɪ]	Normal [maɪb]	Slow [naɪb]	Normal [poʊ]	Slow [skoʊ]	Normal [ʃoʊ]	Normal [moʊz]	Slow [spoʊz]
BC		BC		BC		Mississippi	BC	

24 Chinese participants

[u:#]		[u:]		[labial C + ju:#]		[labial C + ju:#]		[ɔ]	
BC		BC		BC		BC		BC	
Normal [sku:]	Slow [spu:]	Normal [tu:d]	Slow [snu:b]	Normal [bjɜ:]	Slow [bjɜ:]	Normal [bjɜ:d]	Slow [pju:d]	Normal [pod]	Slow [sod]
ool 8 (33%)	oo 18 (75%)	u_e 13 (54%)	oo 8 (33%)	ew 5 (21%)	ew 6 (25%)	uil 9 (38%)	u_e 15 (63%)	u 11 (46%)	oo 4 (17%)
oo 7 (29%)	ooh 2 (8%)	u 5 (21%)	u 7 (29%)	ue 4 (17%)	u 3 (13%)	u_e 4 (17%)	u 2 (8%)	o 4 (17%)	u_e 3 (13%)
u 4 (17%)	ooe 1 (4%)	oo 3 (13%)	u_e 4 (17%)	iu 4 (17%)	iu 3 (13%)	eau 3 (13%)	uu 2 (8%)	u_e 3 (13%)	ir 3 (13%)
→ew 2 (8%)	uu 1(4%)	u(Cu) 1 (4%)	ew 2 (8%)	eu 3(13%)	ue 2(8%)	ui 2 (8%)	ew 1(4%)	o(#) 1 (4%)	o 2(8%)
ow 1 (4%)	oon 1(4%)	uu_e 1 (4%)	oo_e 2 (8%)	eau 1 (4%)	eau 2(8%)	ui_e 2 (8%)	eu 1(4%)	o_e 1 (4%)	er 2(8%)
ol 1 (4%)	ool 1(4%)	wo_e 1 (4%)	ea 1 (4%)	eaw 1 (4%)	ill 2(8%)	eau_e 1 (4%)	ee 1(4%)	oo 1 (4%)	u 1(4%)
ime 1 (4%)				ieu 1 (4%)	eu 1(4%)	iu 1 (4%)	uil 1(4%)	au 1 (4%)	ui 1(4%)
				iew 1 (4%)	ieuw 1(4%)	en 1 (4%)	ur 1(4%)	oi 1 (4%)	ui_e 1(4%)
				yu 1 (4%)	eum 1(4%)	ul 1 (4%)		on 1 (4%)	ew_e 1(4%)
				uw 1 (4%)	uil 1(4%)	ew 0 (0%)			ou 1(4%)
				eo 1 (4%)	ule 1(4%)	ue 0 (0%)			e 1(4%)
				ill 1 (4%)	ee 1(4%)				e_e 1(4%)
									au 1(4%)
									ol 1(4%)
									ir_e 1(4%)
									eu 0(0%)
24	24	24	24	24	24	24	24	24	24
(school) 8						(build) 9			

Normal [sku:]	Slow [spu:]	Normal [tu:d]	Slow [snu:b]	Normal [bju:]	Slow [bju:]	Normal [bju:d]	Slow [pju:d]	Normal [pɒd]	Slow [sɒd]
BC		BC		BC		BC		BC	

24 Chinese participants

BC		Mississippi		Mississippi	
Normal [dæ:z]	Slow [pæ:z]	Normal [stæ:z]	Slow [pæ:z]	Normal [stæ:m]	Slow [snæ:m]
ea 11 (46%)	a 9 (38%)	a 13 (54%)	a 13 (54%)	a 15 (63%)	a 7 (29%)
a 5 (21%)	e 5 (21%)	e 5 (21%)	a_e 2 (8%)	al 4 (17%)	ail 5 (21%)
e 4 (17%)	ai 2 (8%)	u 3 (13%)	ai 2 (8%)	e 3 (13%)	e 2 (8%)
a_e 2 (8%)	a_e 1 (4%)	a_e 1 (4%)	ai_e 2 (8%)	a_e 1 (4%)	all 2 (8%)
i 1 (4%)	ae_e 1 (4%)	ia 1 (4%)	e 1 (4%)	e_e 1 (4%)	al 2 (8%)
an 1 (4%)	ey 1 (4%)	u 1 (4%)	u 1 (4%)		ar 2 (8%)
	e_e 1 (4%)		an 1 (4%)		ai 1 (4%)
	u 1 (4%)		ar 1 (4%)		ai_e 1 (4%)
	y 1 (4%)		al 1 (4%)		elu 1 (4%)
	er 1 (4%)		aa 0 (0%)		an 1 (4%)
	air 1 (4%)				aa 0 (0%)
24	24	24	24	24	24

(death)

11

(dance)

1

Normal [dæ:z]	Slow [pæ:z]	Normal [stæ:z]	Slow [pæ:z]	Normal [stæ:m]	Slow [snæ:m]
BC		Mississippi		Mississippi	

24 Chinese participants

BC		Mississippi		Mississippi	
Normal [smɛz]	Slow [mɛz]	Normal [ʃfɛz]	Slow [stɛz]	Normal [sem]	Slow [spɛm]
a 8 (33%)	i 5 (21%)	e 8 (33%)	e 9 (38%)	il 6 (25%)	?a 7 (29%)
e	e	a	a	al	el

7 (29%)	4 (17%)	3 (13%)	3 (13%)	5 (21%)	4 (17%)
i 6 (25%)	a 3 (13%)	u 2 (8%)	e_e 3 (13%)	[?] a 4 (17%)	e 3 (13%)^a
e_e 1 (4%)	ei 3 (13%)	er 2 (8%)	ai 1 (4%)	el 4 (17%)	el 3 (13%)
i_e 1 (4%)	ai 2 (8%)	i 1 (4%)	ai_e 1 (4%)	e 1 (4%)	ea 2 (8%)
ea_e 1 (4%)	e_e 2 (8%)	e_e 1 (4%)	ea 1 (4%)	e_e 1 (4%)	ai 1 (4%)
	a_e 2 (8%)	ei 1 (4%)	ai 1 (4%)	ow 1 (4%)	ay 1 (4%)
	y 1 (4%)	iou 1 (4%)	ew 1 (4%)	aun 1 (4%)	i_e 1 (4%)
	ie_e 1 (4%)	ew_e 1 (4%)	al 1 (4%)	ail 1 (4%)	al_e 1 (4%)
	en 1 (4%)	ur 1 (4%)	ael_e 1 (4%)		eal 1 (4%)
		ir 1 (4%)	url 1 (4%)		
		eur 1 (4%)	ar_e 1 (4%)		
		∅ 1 (4%)			
24	24	24	24	24	24
Normal [smɛz]	Slow [mɛz]	Normal [ʃɛz]	Slow [stɛz]	Normal [sɛm]	Slow [spɛm]
BC		Mississippi		Mississippi	

Note. ∅ indicates that there was no vowel letter in the participant's answer.

^a Although none of the Canadian participants spelled [ɛ] in [spɛm] as <e>, I regarded <e> spelled by the Chinese participants as correct.

24 Chinese participants

BC		Mississippi		Mississippi	
[ɪ]		[ɪ]		[ɪ] ([ɪə(m)])	
Normal [dɪz]	Slow [stɪz]	Normal [spɪz]	Slow [pɪz]	Normal [pɪm]	Slow [bɪm]
i 11 (46%)	[?] ay 5 (21%)	[?] e 9 (38%)	i 7 (29%)	el 6 (25%)	el 8 (33%)
e 5 (21%)	a 3 (13%)	i 6 (25%)	ee 4 (17%)	al 5 (21%)	[?] a 7 (29%)
a 2 (8%)	ee_e 3 (13%)	a 3 (13%)	ea 3 (13%)	[?] a 4 (17%)	e 2 (8%)
ee 1 (4%)	i 2 (8%)	ea 2 (8%)	[?] e 2 (8%)	e 1 (4%)	all 2 (8%)
ea 1 (4%)	[?] e 2 (8%)	ew 1 (4%)	a 2 (8%)	ai 1 (4%)	ea 1 (4%)
a_e	i_e	ai	ii	eo	io

1 (4%)	2 (8%)	1 (4%)	1 (4%)	1 (4%)	1 (4%)
i_e 1 (4%)	ee 2 (8%)	e_e 1 (4%)	e_e 1 (4%)	il 1 (4%)	eaun 1 (4%)
ee_e 1 (4%)	a_e 2 (8%)	ur 1 (4%)	ee_e 1 (4%)	eal 1 (4%)	il 1 (4%)
ir 1 (4%)	ea 1 (4%)		eal 1 (4%)	al_e 1 (4%)	ail 1 (4%)
	eal 1 (4%)		er 1 (4%)	ell 1 (4%)	i 0 (0%)
	in_e 1 (4%)		eer 1 (4%)	ar 1 (4%)	
				ir_e 1 (4%)	
				i 0 (0%)	
24	24	24	24	24	24
Normal [dɪz]	Slow [stɪz]	Normal [spɪz]	Slow [pɪz]	Normal [pɪm]	Slow [bɪm]
BC		Mississippi		Mississippi	

24 Chinese participants

[ɑ:#]		[ɑ:#] ([a:#])		[ɑ:]		[ɑ:] ([a:])	
BC		Mississippi		BC		Mississippi	
Normal [tɑ:]	Slow [dɑ:]	Normal [sna:]	Slow [sta:]	Normal [za:d]	Slow [sta:d]	Normal [ɔ̃ɑ:d]	Slow [fɑ:d]
all 5 (21%)	ar 6 (25%)	a 10 (42%)	ar 17 (71%)	u 6 (25%)	ar 12 (50%)	a 8 (33%)	ar 10 (42%)
au 3 (13%)	ah 3 (13%)	ar 6 (25%)	a 3 (13%)	o 5 (21%)	o 4 (17%)	ar 7 (29%)	u 5 (21%)
ar 3 (13%)	oor 3 (13%)	ah 4 (17%)	ah 1 (4%)	a 4 (17%)	a 2 (8%)	a_e 4 (17%)	aa 2 (8%)
→ah 2 (8%)	oll 2 (8%)	agh 1 (4%)	au 1 (4%)	ar 4 (17%)	u 2 (8%)	u 3 (13%)	a 2 (8%)
al 2 (8%)	aw 1 (4%)	au 1 (4%)	awl 1 (4%)	aa 1 (4%)	au 1 (4%)	ou 1 (4%)	au 1 (4%)
om 2 (8%)	au 1 (4%)	u 1 (4%)	arn 1 (4%)	au 1 (4%)	a_e 1 (4%)	ar_e 1 (4%)	a_e 1 (4%)
a 1 (4%)	a 1 (4%)	us 1 (4%)		ou 1 (4%)	ao 1 (4%)	o 0 (0%)	al 1 (4%)
awn 1 (4%)	oa 1 (4%)	aw 0 (0%)		a_e 1 (4%)	or 1 (4%)	aw 0 (0%)	al_e 1 (4%)
on 1 (4%)	oo 1 (4%)			ul_e 1 (4%)	aw 0 (0%)	ah 0 (0%)	i_e 1 (4%)
oe 1 (4%)	ow 1 (4%)			aw 0 (0%)			o 0 (0%)

ow 1 (4%)	ugh 1 (4%)						ah 0 (0%)
oun 1 (4%)	onn 1 (4%)						aw 0 (0%)
orl 1 (4%)	ol 1 (4%)						
aw 0 (0%)	or 1 (4%)						
24	24	24	24	24	24	24	24
(tall) 5			(star) 17				
Normal [ta:]	Slow [da:]	Normal [sna:]	Slow [sta:]	Normal [za:d]	Slow [sta:d]	Normal [dʒa:d]	Slow [ʃa:d]
BC		Mississippi		BC		Mississippi	

24 Chinese participants

[ɔ:#] ([ɔʊ#])		[ɔ:] ([ɔʊ])		[ʌ]				[ʌ#]	
Mississippi		Mississippi		BC		Mississippi		BC	
Normal [stɔ:]	Slow [smɔ:]	Normal [smɔ:d]	Slow [stɔ:d]	Normal [fʌd]	Slow [zʌd]	Normal [mʌz]	Slow [nʌz]	Normal [bʌ]	Slow [mʌ]
ore 5 (21%)	?all 16 (67%)	o 7 (29%)	or 5 (21%)	u 11 (46%)	a 5 (21%)	u 14 (58%)	a 6 (25%)	o 5 (21%)	ar 7 (29%)
aw 4^b (17%)	aw 1^b (4%)	o_e 4 (17%)	au 3 (13%)	u_e 3 (13%)	ar 5 (21%)	a 3 (13%)	u 4 (17%)	al 3 (13%)	?a 4 (17%)
or 4 (17%)	au 1 (4%)	au 3 (13%)	aw 2 (8%)	a 3 (13%)	u 4 (17%)	ur 2 (8%)	ar 3 (13%)	au 2 (8%)	uh 2 (8%)
oe 3(13%)	ow 1 (4%)	?al 3(13%)	o 2(8%)	o 2 (8%)	e 2(8%)	o 1 (4%)	o 2(8%)	a 2 (8%)	?ah 2(8%)
ough 1 (4%)	oal 1 (4%)	a 2 (8%)	oa 2(8%)	ar 2 (8%)	au 1(4%)	au 1 (4%)	eau 1(4%)	er 2 (8%)	all 2(8%)
ow 1 (4%)	ore 1 (4%)	ou 2 (8%)	ao 2(8%)	ae 1 (4%)	u_e 1(4%)	ar 1 (4%)	eou 1(4%)	u 1 (4%)	ur 2(8%)
ao 1 (4%)	or 1 (4%)	all 2 (8%)	oh 1(4%)	a_e 1 (4%)	a_e 1(4%)	ul_e 1 (4%)	eu 1(4%)	uh 1 (4%)	ugh 1(4%)
o 1 (4%)	alloe 1 (4%)	aw 1 (4%)	oo 1(4%)	ul 1 (4%)	an 1(4%)	ee 1 (4%)	i_e 1(4%)	→ah 1 (4%)	aa 1(4%)
oo 1 (4%)	orl 1 (4%)		ao 1(4%)		in 1(4%)		oa 1(4%)	aw 1 (4%)	au 1(4%)
?all 1 (4%)			o_e 1(4%)		?un 1(4%)		ee 1(4%)	eh 1 (4%)	oh 1(4%)
ole 1 (4%)			oo_e 1(4%)		un_e 1(4%)		er 1(4%)	ung 1 (4%)	em 1(4%)
ord			al		ur		er_e	ar	?aw

1 (4%)			1(4%)		1(4%)		1(4%)	1 (4%)	0(0%)
			ol 1(4%)				ur_e 1(4%)	er 1 (4%)	
			ole 1(4%)					all 1 (4%)	
								ebe 1 (4%)	
24	24	24	24	24	24	24	24	24	24

	(small) 12								
Normal [stɔ:]	Slow [smɔ:]	Normal [smɔ:d]	Slow [stɔ:d]	Normal [fʌd]	Slow [zʌd]	Normal [mʌz]	Slow [nʌz]	Normal [bʌ]	Slow [mʌ]
Mississippi		Mississippi		BC		Mississippi		BC	

Note. ^b For Mississippi normal [stɔ:], <aw> was not the most frequently chosen one by the Canadian participants since they most frequently misperceived [ɔ:] as [ɔ:l]. However, <aw> is the default spelling in the Mississippi accent, so I gave 4 points.

24 Chinese participants

[ɔɪ#]		[ɔɪ]		[aʊ#]		[aʊ]	
BC		BC		BC		BC	
Normal [spɔɪ]	Slow [pɔɪ]	Normal [fɔɪd]	Slow [pɔɪd]	Normal [gəʊ]	Slow [fəʊ]	Normal [faʊz]	Slow [paʊz]
oy 10 (42%)	oy 10 (42%)	oi 16 (67%)	oi 16 (67%)	un 3 (13%)	→au 5 (21%)	au 6 (25%)	ou_e 7 (29%)
oil 6 (25%)	oi 3 (13%)	oe 1 (4%)	oil 2 (8%)	ao 2 (8%)	oun 3 (13%)	ou 4 (17%)	ou 3 (13%)
oi 4 (17%)	ooi 1 (4%)	io 1 (4%)	oy_e 1 (4%)	au 2 (8%)	ow 2 (8%)	ow 2 (8%)	au_e 3 (13%)
oie 1 (4%)	oe 1 (4%)	o_e 1 (4%)	ooi 1 (4%)	al 2 (8%)	[?] owl 2 (8%)	au_e 2 (8%)	oa 2 (8%)
oe 1 (4%)	o_e 1 (4%)	oin 1 (4%)	oe 1 (4%)	arl 2 (8%)	aul 2 (8%)	auo 2 (8%)	oun 2 (8%)
orn 1 (4%)	oie 1 (4%)	oal 1 (4%)	ui_e 1 (4%)	own 1 (4%)	i_e 1 (4%)	ou_e 1 (4%)	ow 1 (4%)
oob 1 (4%)	oil 1 (4%)	ol_e 1 (4%)	oil_e 1 (4%)	iew 1 (4%)	oow 1 (4%)	owl 1 (4%)	au 1 (4%)
	oill 1 (4%)	orai 1 (4%)	olie 1 (4%)	ale 1 (4%)	[?] oul 1 (4%)	a 1 (4%)	oi 1 (4%)
	oul 1 (4%)	ore 1 (4%)	oy 0 (0%)	awl 1 (4%)	oal 1 (4%)	oa 1 (4%)	ol 1 (4%)
	aule 1 (4%)			aul 1 (4%)	ail 1 (4%)	el 1 (4%)	un 1 (4%)
	oora 1 (4%)			unh 1 (4%)	awl 1 (4%)	il_e 1 (4%)	an 1 (4%)
	ory			one	un	ail_e	aun

	1 (4%)			1 (4%)	1 (4%)	1 (4%)	1 (4%)
	ore 1 (4%)			um 1 (4%)	or 1 (4%)	ar 1 (4%)	
				aun 1 (4%)	oud 1 (4%)		
				ealth 1 (4%)	aud 1 (4%)		
				ump 1 (4%)			
				ong 1 (4%)			
				ape 1 (4%)			
				ow 0 (0%)			
24	24	24	24	24	24	24	24
(<i>spoil</i>) 5							
Normal [spɔɪ]	Slow [pɔɪ]	Normal [fɔɪd]	Slow [pɔɪd]	Normal [gɑʊ]	Slow [fɑʊ]	Normal [faʊz]	Slow [paʊz]
BC		BC		BC		BC	

Note. The boxes with thick red frames are 4 points. The ones with thin red frames are 3 points. Plain boxes are 2 points. Plain boxes with an arrow are 1 point. Grey ones are 0 points. [?] indicates “acceptable” perception-related errors. “_” indicates a consonant letter.

Based on the 4-point scale, I calculated the average score of all the stimuli (the maximum score is 4 points × 71 stimuli = 284 points), that of only BC normal stimuli (the stimuli in the participants’ target dialect) (max. 4 points × 24 stimuli = 96 points), and that of the rest (i.e., BC slow, Mississippi norm, and Mississippi slow stimuli) (max. 4 points × 47 stimuli = 188 points) by the Chinese participants. I also analyzed the average number of 0-point spellings, or the spellings the Canadian participants never chose of all the stimuli (the maximum number is 71), that of only BC normal stimuli (max. 24), and that of the rest (max. 47). Then, I compared BC stimuli and the rest by using the two-tailed two-sample t-test.

Table 83 shows the summary.

Table 83. Average scores and the numbers of 0-point spellings by the Chinese participants

Overall score (Score per stimulus)	BC normal score (Score per stimulus)	BC slow & MS score (Score per stimulus)	Significance BC vs. others
Range	Range	Range	

99.3/284 (1.40/4)	32.0/96 (1.34/4)	67.3/188 (1.43/4)	N.S. p = 0.25
39 ~ 168	14 ~ 51	21 ~ 117	
# of overall 0-point spellings	# of BC normal 0-point spellings	# of BC slow & MS 0-point score	Significance BC vs. others
Range	Range	Range	
43.3/71 (61.0%)	15.0/24 (62.7%)	28.3/47 (60.3%)	N.S. p = 0.31
34% ~ 85%	42% ~ 83%	30% ~ 87%	

Note. N.S. = not significant. * = significant at the $p < 0.05$ level, ** = significant at the $p < 0.01$ level

4.4.2 Discussion

4.4.2.1 General discussion

For 36 out of the 71 stimuli, the most frequent spellings by the Chinese participants matched those by the Canadian participants. Among these 36 stimuli, only 12 were 50% or above in consistency: specifically, BC normal [spu:] (75%), BC normal [fɔɪd] (67%), BC slow [pɔɪd] (67%), MS slow [smɔ:] (67%), MS normal [stæ:m] (63%), BC slow [pju:d] (63%), MS normal [mʌz] (58%), BC slow [te'b] (58%), BC slow [sni:b] (58%), MS normal [stæ:z] (54%), MS slow [pæ:z] (54%), and BC normal [marb] (50%). Another characteristic error pattern by the Chinese participants was <|>-insertion (e.g., [spu:] spelled as <spool>), which will be discussed in §4.4.2.7.

4.4.2.2 Difficult and easy BC Normal stimuli for the Chinese participants

The K-Means Cluster Analysis divided BC normal stimuli into four clusters based on participants' scores. First, I analyzed the results from the 24 BC (the ESL participants' target dialect) normal stimuli only, as shown in Figure 47, and then analyzed the results of the whole stimuli in the next section.

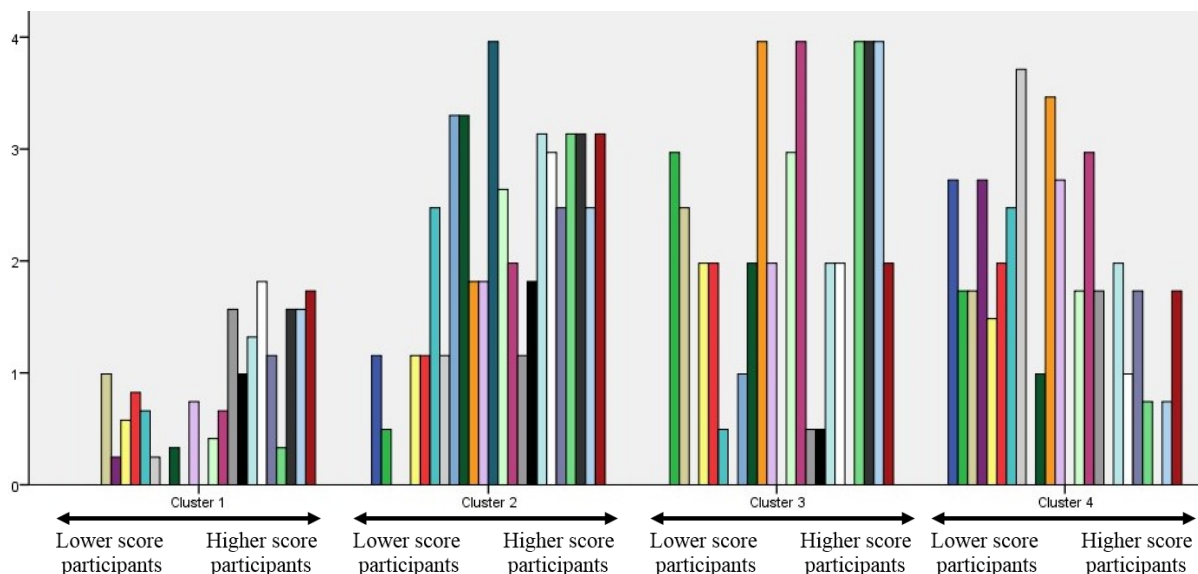


Figure 47. Clustered BC normal stimuli based on the Chinese participants' performance

Each of the four graphs in Figure 47 represents each of the four clusters. In these graphs, each bar represents each of the 24 participants' score. Each cluster consists of the 24 participants who are aligned in ascending order in their overall scores, meaning that "higher score participants" are on the right hand side and "lower score participants" are on the left hand side. The Y-axis indicates average scores (based on the 4-point scale mentioned in (based on the 4-point scale mentioned in §4.3.1) by each participant for the stimuli in each cluster: for example, if one of the bars in cluster 2 indicates 2.5, this particular participant's average score for the cluster 2 stimuli is 2.5 out of 4.

In clusters 1 and 2, there is a tendency that higher score participants simply performed better, except that cluster 1 stimuli were more challenging overall. In cluster 3, their overall scores are not clearly related to their scores of only cluster 3 stimuli. Interestingly, for cluster 4 stimuli, higher score participants had more difficulty than lower score participants. This can be interpreted in terms of the first half of U-shaped learning/development. The Japanese participants did not show such clear retrogression, except for BC normal [ε] in [smεz].

Table 84 to Table 87 show the results of the stimuli in each cluster.

Table 84. Cluster 1 (most challenging) BC stimuli for 24 Chinese participants

Stimuli	Score	# of 0-point	Stimuli	Score	# of 0-point
---------	-------	--------------	---------	-------	--------------

	(out of 4)	spellings (out of 24)		(out of 4)	spellings (out of 24)
[gəʊ]	0.00	24	[dæ:z]	0.83	19
[tɑ:]	0.25	22	[smoʊz]	0.83	19
[bʌ]	0.25	22	[pɒ]	0.83	18
[bjʊ:d]	0.42	19	[sneɪ]	1.00	17
[ke'b]	0.67	20	[sku:]	1.25	15
[zɑ:d]	0.83	19	[bjʊ:]	1.79	11

Table 85. Cluster 2 BC stimuli for 24 Chinese participants

Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)	Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)
[dɪz]	1.83	13	[tu:d]	2.13	8
[fʌd]	1.83	13	[spɔɪ]	2.17	10
[pʊd]	1.96	12	[fɔɪd]	2.67	8

Table 86. Cluster 3 BC stimuli for 24 Chinese participants

Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)	Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)
[sni:]	1.83	13	[snaɪ]	1.92	8

Table 87. Cluster 4 (retrogression) BC stimuli for 24 Chinese participants

Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)	Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)
[smɛz]	1.17	17	[faʊz]	1.96	9
[ʃi:b]	1.63	13	[marb]	2.00	12

Interestingly, [əʊ], word-final [ɑ:], and word-final [ʌ] were most difficult for the Chinese participants, just as they are for the Japanese participants. One of possible explanations is that digraphs can be more difficult to be acquired by EAL speakers; these three phonemes correspond to digraphs <ow>, <aw>, and <uh>. About <aw>, recall that the Chinese participants performed well with the <aw>-to-[o: ~ ɔ:] conversion in the reading task, but both ESL and EFL participants could not associate [ɑ:] with <aw>. This could be because the Chinese participants may have learned British-like more closed [o: ~ ɔ:] for <aw>, rather

than [ɑ:]. The problem is that even ESL learners still had not acquired the phonetic difference between the British-like [o: ~ ɔ:] and North American [ɑ:]. A difference from the Japanese participants is that [ʌ] in a closed syllable to <u> conversion and [ɪ] to <i> conversion were not in cluster 1.

As for cluster 4 stimuli, with which higher score participants performed worse, Table 88 shows all the participants' spellings aligned in ascending order in their overall scores.

Table 88. Cluster 4 BC normal stimuli and all the participants' spellings

Participants' group	Overall score	[smɛz]	[ʃi:b]	[faʊz]	[mɑrb]
ESL	39	<a>	<ea>	<ow>	<i e>
EFL	67	<i>	<i>	<au e>	<i e>
EFL	70	<ea e>	<ie e>	<ou>	<i e>
EFL	70	<e>	<e>	<au>	<i e>
EFL	71	<i>	<ea>	<ou>	<ai#>
EFL	73	<e>	<ee>	<auo>	<ye#>
EFL	74	<e>	<ea>	<au>	<i>
EFL	82	<e>	<ee>	<ou>	<i e>
ESL	85	<a>	<i>	<a>	<u>
ESL	88	<i>	<i>	<ail e>	<i e>
EFL	90	<e>	<ea>	<au>	<i e>
ESL	93	<e>	<ie>	<au>	<i e>
ESL	100	<i>	<i>	<arz>	<a>
EFL	102	<a>	<i>	<au>	<i e>
EFL	102	<e>	<ee>	<oa>	<i e>
EFL	105	<a>	<ee>	<au>	<y#>
EFL	110	<a>	<i>	<ao>	<y>
EFL	117	<a>	<ee>	<il e>	<i e>
ESL	119	<a>	<i>	<ow>	<y>
EFL	123	<i>	<i>	<ou>	<i e>
EFL	129	<e e>	<ea>	<owl>	<y#>
ESL	148	<a>	<ie>	<el e>	<igh#>
ESL	159	<i e>	<i>	<au e>	<ai#>
ESL	168	<i>	<ee>	<ou e>	<y>

Note. The participants are aligned in ascending order in their overall scores. Bold spellings are the Canadian participants' most frequent choices. Shaded boxes are ones that the Canadian participants never chose. <#> indicates word-final.

The stimulus [smɛz] by higher score participants seems to involve hyper-correction. What is interesting is that [smɛz] tended to be spelled worse by higher score participants among both

Japanese and Chinese participants. Spellings of [maɪb] by higher score participants may be accidental or careless mistakes.

4.4.2.3 Difficult and easy stimuli (the whole set) for the Chinese participants

In this section, I will discuss the details of all the stimuli, including BC normal and slow and Mississippi (MS) normal and slow stimuli, in relation to how they are spelt. Again, the K-Means Cluster Analysis divided all the stimuli into four clusters based on participants' scores, as shown in Figure 48.

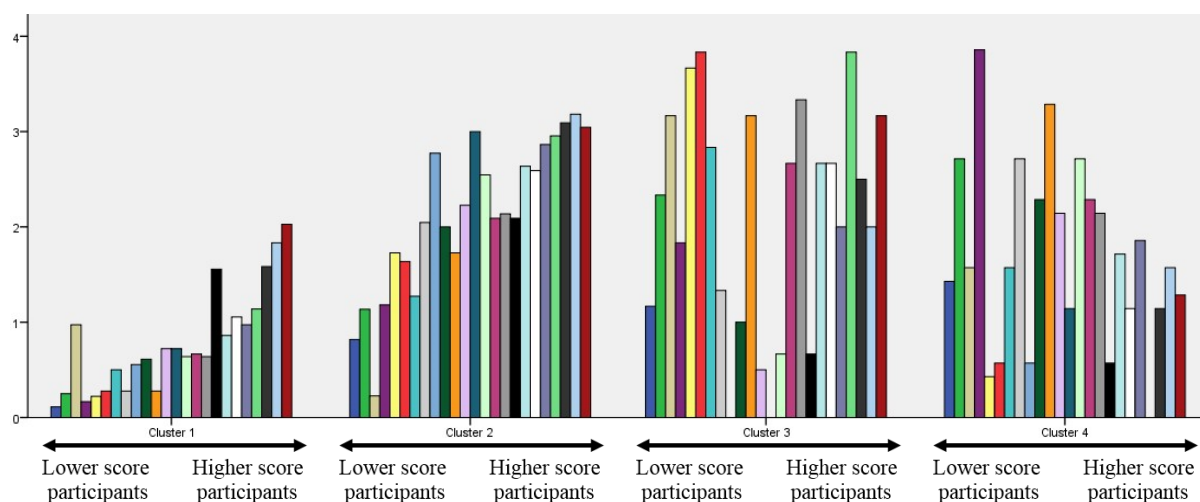


Figure 48. Clustered stimuli based on the Chinese participants' performance

In cluster 1 and 2, again, there is a tendency that higher score participants scored more in each cluster, except that cluster 1 stimuli were more challenging. In cluster 3, there is a somewhat U-shaped tendency, that is, the middle spellers tended to have difficulty. As for cluster 4 stimuli, again, higher score participants have more difficulty than lower score participants, which can be interpreted in terms of the first half of U-shaped learning/development. Again, the Japanese participants did not show such clear retrogression.

Table 89 to Table 92 show the stimuli, score, and 0-point spellings in each cluster.

Table 89. Cluster 1 (most challenging) stimuli for 24 Chinese participants

Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)	Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)
BC norm [gəʊ]	0.00	24	BC norm [dæ:z]	0.83	19

MS norm [dʒɑ:d]	0.00	24	MS norm [stɔ:]	0.83	19
MS slow [tʃɑ:d]	0.13	22	BC norm [smoʊz]	0.83	19
BC norm [ta:]	0.25	22	BC slow [sɒd]	0.83	19
BC slow [da:]	0.25	22	BC norm [pɒʊ]	0.83	18
BC norm [bʌ]	0.25	22	MS slow [stɛz]	0.83	19
MS norm [pɪm]	0.33	22	MS slow [stɔ:d]	0.96	17
BC norm [bjɜ:d]	0.42	19	BC norm [sneɪ]	1.00	17
BC slow [mɛz]	0.50	21	BC slow [mʌ]	1.04	16
MS slow [sta:]	0.63	20	BC slow [stɪz]	1.13	15
BC slow [spoʊz]	0.67	20	MS slow [snæ:m]	1.17	17
MS slow [nʌz]	0.67	20	MS slow [bɪm]	1.17	17
BC norm [keɪb]	0.67	20	BC slow [zɑɪ]	1.21	14
MS norm [sem]	0.67	19	BC slow [paʊz]	1.21	12
BC slow [zʌd]	0.75	19	BC norm [sku:]	1.25	15
BC slow [faʊ]	0.79	14	BC slow [bjɜ:]	1.25	16
BC slow [sta:d]	0.79	19	MS slow [pɪz]	1.33	15
BC norm [zɑ:d]	0.83	19	MS slow [spem]	1.67	14

Table 90. Cluster 2 stimuli for 24 Chinese participants

Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)	Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)
MS norm [tʃoʊ]	1.38	12	BC slow [skoʊ]	2.08	11
BC slow [pɔɪ]	1.58	12	MS norm [spɪz]	2.13	9
BC slow [snu:b]	1.67	12	BC norm [tu:d]	2.13	8
BC norm [dɪz]	1.83	13	MS slow [pæ:z]	2.17	11
BC norm [fʌd]	1.83	13	BC norm [spɔɪ]	2.17	10
BC slow [spi:]	1.83	13	MS norm [mʌz]	2.33	10
MS norm [sna:]	1.92	10	BC norm [fɔɪd]	2.67	8
BC norm [snaɪ]	1.92	8	BC slow [pɔɪd]	2.67	8
BC norm [pɒd]	1.96	12	MS norm [stæ:m]	2.67	8
BC slow [naɪb]	2.00	10	MS slow [smɔ:]	2.83	7
MS norm [smɔ:d]	2.00	9	BC slow [spu:]	3.00	6

Table 91. Cluster 3 (U-shaped) stimuli for 24 Chinese participants

Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)	Stimuli	Score (out of 4)	# of 0-point spellings (out of 24)
BC norm [tʃi:b]	1.63	13	BC slow [sni:b]	2.42	9
BC norm [bjɜ:]	1.79	11	BC slow [teɪb]	2.42	9
BC norm [sni:]	1.83	13	BC slow [pju:d]	2.67	8

Table 92. Cluster 4 (retrogression) stimuli for 24 Chinese participants

Stimuli	Score (out of 4)	# of 0-point spellings	Stimuli	Score (out of 4)	# of 0-point spellings
---------	------------------	------------------------	---------	------------------	------------------------

		(out of 24)			(out of 24)
BC norm [smɛz]	1.17	17	BC norm [faʊz]	1.96	9
MS norm [ʃɛz]	1.33	16	BC norm [maɪb]	2.00	12
BC slow [pæ:z]	1.50	15	MS norm [stæ:z]	2.17	11
BC slow [ske¹]	1.75	12			

To examine their retrogression patterns, I listed all the cluster 4 stimuli results in Table 93, except those for BC normal stimuli that were already shown above. In this table, all the participants' spellings are aligned in ascending order based on their overall scores.

Table 93. Cluster 4 stimuli and all the participants' spellings

Participants' group	Overall score	MS norm [ʃɛz]	BC slow [pæ:z]	BC slow [ske¹]	MS norm [stæ:z]
ESL	39	<ur>	<ai>	?<ane>	<ia>
EFL	67	<iou>	<a>	<ay>	<a>
EFL	70	<e>	<air>	<in>	<a e>
EFL	70	<e>	<a>	<ay>	<a>
EFL	71	<er>	<e>	<ein>	<ai>
EFL	73	<a>	<ai>	<a>	<u>
EFL	74	<ew e>	<a e>	<ae>	<a>
EFL	82	<er>	<a>	<an>	<a>
ESL	85	<a>	<a>	<a>	<u>
ESL	88	<e>	<a>	<ein>	<a>
EFL	90	<e>	<e e>	<ay>	<a>
ESL	93	<u>	<e>	<ay>	<u>
ESL	100	<eur>	<a>	<i>	<a>
EFL	102	<e>	<a>	<eih>	<a>
EFL	102	<e>	<er>	<ay>	<e>
EFL	105	<a>	<a>	<ay>	<a>
EFL	110	<ei>	<e>	<a>	<a>
EFL	117	<u>	<u>	<ay>	<a>
ESL	119	<e e>	<y>	<ay>	<e>
EFL	123	<e>	<ey>	?<ane>	<e>
EFL	129	<i>	<e>	<in>	<e>
ESL	148	<ir>	<a>	<an>	<a>
ESL	159	null	<ae e>	<ay>	<a>
ESL	168	<e>	<e>	?<ane>	<e>

Note. The participants are aligned in ascending order in their overall scores. Bold spellings are ones that the Canadian participants most frequently chose. ? indicate acceptable misperception errors. Shaded boxes are ones that the Canadian participants never chose. "null" indicates that there was no vowel letter in this participant's spelling.

Notice that MS norm [ʃɛz] and BC slow [pæ:z] were performed especially better by lower score participants than by higher score participants. A possible explanation is that since the [ɛ]-[æ:] contrast is known as challenging for Chinese EAL learners (e.g., Wang & Munro, 2004), higher score participants may have been too careful and hyper corrected themselves.

4.4.2.4 <r>-insertion by the Chinese participants

Just as the Japanese participants did, the Chinese participants were also tempted to spell <r> when there was no [ɹ] in the stimuli of rhotic dialects (e.g., <stard> for [sta:d]).

Table 94 shows the results in which the Chinese participants inserted <r>.

Table 94. The number of <r>-insertion for each stimulus by 24 Chinese

The Chinese participants							
Stimuli	#	Stimuli	#	Stimuli	#	Stimuli	#
MS slow [sta:]	18	BC slow [zʌd]	6	MS slow [snæ:m]	2	MS slow [pæ:z]	1
BC slow [sta:d]	13	BC slow [sʊd]	6	MS slow [pɪz]	2	BC norm [dɪz]	1
MS norm [stɔ:]	10	BC norm [tɑ:]	5	MS slow [stɛz]	2	BC norm [fəʊz]	1
MS slow [ʃɑ:d]	10	MS slow [stɔ:d]	5	BC norm [fʌd]	2	BC norm [sku:]	1
BC slow [dɑ:]	10	BC norm [zɑ:d]	4	BC norm [fɔɪd]	2	BC norm [spɔɪ]	1
BC slow [mʌ]	9	BC norm [bʌ]	4	BC norm [gəʊ]	2	MS norm [ʃo ^o]	1
MS norm [dʒɑ:d]	8	MS norm [mʌz]	3	MS norm [pɪm]	2	MS norm [spɪz]	1
MS slow [nʌz]	7	MS slow [smɔ:]	3	BC slow [pju:d]	1		
MS norm [snɑ:]	6	BC slow [pɔɪ]	3	BC slow [sko ^o]	1		
MS norm [ʃɛz]	6	BC slow [pæ:z]	2	BC slow [fəʊ]	1		

Note. The numbers are out of 24 (participants).

Note that Chinese EAL learners may have learned non-rhotic dialects in China, so I will come back to this issue in §4.5.2.2.

4.4.2.5 <h>-insertion by the Chinese participants

In this section, I will discuss <h>-insertion. Adding <h> is not necessarily errors unlike <r>-insertion. The stimuli which involved <h>-insertion are shown in Table 95.

Table 95. The number of <h>-insertion by 24 Chinese participants

Stimuli	#	Stimuli	#	Stimuli	#
BC slow [mʌ]	5	BC norm [tɑ:]	2	BC norm [sne ^h]	1
MS norm [snɑ:]	4	BC slow [spu:]	2	MS slow [sta:]	1
BC slow [dɑ:]	3	BC slow [sko ^o]	2	BC slow [ske ^h]	1
BC norm [bʌ]	3	MS slow [stɔ:d]	1		

Note. The numbers are out of 24 (participants).

4.4.2.6 Silent-E by the Chinese participants

In this section, I will discuss whether the Chinese participants had acquired the function of silent-E as an “alphabet sound” marker. There were two types of errors: missing-E errors, in which they missed <e> when they needed it (e.g., <cab> for [ke^hb], instead of <cabe>), and adding-E errors, in which they added <e> when they were not supposed to (e.g., <daze> for [dæ:z], instead of <daz>). I analyzed results of 12 stimuli that can involve missing-E errors and 20 that can involve adding-E errors. Table 96 shows the numbers of missing-E errors in each stimulus.

Table 96. The number of missing-E errors by 24 Chinese participants

Stimuli	missed <e>	Stimuli	missed <e>
BC norm [ke ^h b]	3	BC norm [mo ^o z]	10
BC slow [te ^h b]	6	BC slow [spo ^o z]	4
BC norm [ʃi:b]	1	BC norm [tu:d]	5
BC slow [sni:b]	1	BC slow [snu:b]	7
BC norm [maɪb]	5	BC norm [bju:d]	0
BC slow [naɪb]	4	BC slow [pju:d]	2

Note. The numbers are out of 24 (participants).

As for the adding-E errors for each of the 20 stimuli, the results are shown in Table 97.

Adding-E errors are much fewer and the errors occurred mostly in stimuli with [æ:] and [ɛ].

Table 97. The number of adding-E errors by 24 Chinese participants

Stimuli	added <e>	Stimuli	added <e>	Stimuli	added <e>
BC norm [dæ:z]	2	BC norm [dɪz]	1	BC norm [fʌd]	2
BC slow [pæ:z]	1	BC slow [stɪz]	1	BC slow [zʌd]	1
MS norm [stæ:z]	1	MS norm [spɪz]	0	MS norm [mʌz]	0
MS slow [pæ:z]	2	MS slow [pɪz]	0	MS slow [nʌz]	0
BC norm [smɛz]	1	BC norm [zɑ:d]	0		
BC slow [mɛz]	2	BC slow [stɑ:d]	0		
MS norm [ʃɛz]	1	MS norm [dʒɑ:d]	0		
MS slow [stɛz]	3	MS slow [ʃɑ:d]	0		

Note. The numbers are out of 24 (participants).

4.4.2.7 <l, m, n, ng>-insertion by the Chinese participants

As seen in the Japanese and even in the Canadian participants' spellings, the letters <l, m, n, ng> were incorrectly added for some stimuli. The same was observed in the Chinese participants' spellings. Table 98 shows average <l, m, n, ng>-insertion for 71 stimuli.

Table 98. Average <l, m, n, ng>-insertion by 24 Chinese participants

<l>-insertion	Nasal-letter-insertion			Nasal total
	<m>-insertion	<n>-insertion	<ng>-insertion	
8.46/71	0.50/71	2.92/71	0.29/71	3.71/71

Table 99 shows <l>-insertion for each stimulus.

Table 99. The number of <l>-insertion by 24 Chinese participants

Stimuli	L	Stimuli	L	Stimuli	L
MS slow [smɔ:]	19	MS norm [smɔ:d]	6	MS norm [ʃɔ ⁰]	2
MS norm [sem]	16	BC slow [pɔɪ]	4	BC slow [paʊz]	1
MS norm [pɪm]	16	BC slow [bjɪ:]	4	BC slow [stɪz]	1
MS slow [bɪm]	12	BC slow [pɔɪd]	4	BC slow [spu:]	1
BC norm [bjɪ:d]	10	BC norm [bʌ]	4	BC slow [sɔd]	1
BC slow [faʊ]	9	BC norm [faʊz]	4	BC slow [pju:d]	1
MS slow [snæ:m]	9	MS norm [stæ:m]	4	MS slow [pɪz]	1
BC norm [sku:]	9	BC slow [dɑ:]	3	MS slow [stɑ:]	1
BC norm [tɑ:]	8	MS slow [stɔ:d]	3	MS slow [pæ:z]	1
BC norm [gɑʊ]	8	MS slow [stɛz]	3	BC norm [zɑ:d]	1
BC slow [sko ⁰]	7	BC slow [mʌ]	2	BC norm [bjɪ:]	1
MS slow [spɛm]	6	BC norm [fɔɪd]	2	BC norm [sne ¹]	1
BC norm [spɔɪ]	6	MS slow [ʃɑ:d]	2	BC norm [fʌd]	1
BC norm [po ⁰]	6	MS norm [stɔ:]	2	MS norm [mʌz]	1

Note. The numbers are out of 24 (participants).

The cause of <l>-insertion can be the participants' misperception of "phantom" [l], but there is also a possibility that these participants added a silent-L. In real words, a silent-L occurs in the contexts of <alm> (e.g., *calm*), <alf> (e.g., *half*), <alk> (e.g., *walk*), <olk> (e.g., *folk*), <ould> (e.g., *could*), and so forth (Examples are from spellzone, n.d.). However, the contexts in which Chinese participants inserted <l> were not necessarily those in which a silent-L typically occurs: for example, <spelm> for [spɛm], <pilm> for [pɪm], <pealz> for [pɪz], <bill> for [bjɪ:], <spool> for [spu:], <poll> for [pow], <bal> for [bʌ], <garl/gealth> for [gɑʊ],

<poil> for [pɔɪ], and so forth. At this moment, I cannot judge whether these were silent-Ls or misperception of phantom [l]. Nasal letter insertion errors are shown in Table 100.

Table 100. The number of nasal letter insertion by 24 Chinese participants

Stimuli	M	N	NG	Total	Stimuli	M	N	NG	Total
BC slow [zai]	1	13	0	14	BC slow [mez]	0	1	0	1
BC norm [gaʊ]	2	7	1	10	MS slow [snæ:m]	0	1	0	1
BC slow [ske ^l]	0	9	0	9	MS slow [pæ:z]	0	1	0	1
BC slow [spi:]	0	4	2	6	MS slow [stɑ:]	0	1	0	1
BC slow [paʊz]	0	5	0	5	MS slow [stɛz]	1	0	0	1
BC norm [tɑ:]	2	3	0	5	MS slow [bɪm]	0	1	0	1
BC norm [snaɪ]	0	5	0	5	BC norm [dæ:z]	0	1	0	1
BC slow [faʊ]	0	4	0	4	BC norm [bʌ]	0	0	1	1
BC slow [zʌd]	0	4	0	4	BC norm [sni:]	0	0	1	1
BC norm [sne ^l]	1	1	1	3	BC norm [sku:]	1	0	0	1
BC norm [po ^ʊ]	3	0	0	3	BC norm [bjɜ:d]	0	1	0	1
BC slow [stɪz]	0	1	0	1	BC norm [spɔɪ]	0	1	0	1
BC slow [naɪb]	0	1	0	1	BC norm [fɔɪd]	0	1	0	1
BC slow [spu:]	0	1	0	1	MS norm [pɪm]	0	1	0	1
BC slow [bjɜ:]	1	0	0	1	MS norm [sem]	0	1	0	1
BC slow [dɑ:]	0	1	0	1	MS norm [ʃo ^ʊ]	0	0	1	1

Note. The numbers are out of 24 (participants).

Nasal letter insertion errors can also be misperception of phantom nasal consonants, but there is a possibility of adding a silent nasal letter (c.f., *autumn* or *mnemonic*).

4.4.2.8 Relationship between scores and LOR/AOA

I compared EFL learners (recruited in Shanghai, China) and ESL learners (recruited in British Columbia, Canada) in terms of their average scores and average number of 0-point spellings (or the spellings the Canadian participants never chose). Table 101 shows the summary.

Table 101. Average scores and the numbers of 0-point spellings by the Chinese EFL, ESL participants

	All the participants	ESL	EFL	Significance ESL vs. EFL
Overall score (Score per stimulus)	99.3/284 (1.40/4)	111.0/284 (1.56/4)	92.3/284 (1.30/4)	N.S. p = 0.24
Range	39 ~ 168	39 ~ 168	67 ~ 129	
BC normal score (Score per stimulus)	32.0/96 (1.34/4)	35.7/96 (1.49/4)	30.0/96 (1.25/4)	N.S. p = 0.24
Range	14 ~ 51	18 ~ 51	14 ~ 47	

BC slow & MS score (Score per stimulus)	67.3/188 (1.43/4)	75.3/188 (1.60/4)	62.5/188 (1.33/4)	N.S. p = 0.28
Range	21 ~ 117	21 ~ 117	40 ~ 95	
Significance BC vs. others	N.S. p = 0.25	N.S. p = 0.42	N.S. p = 0.44	
# of overall 0-point spellings	43.3/71 (61.0%)	40.2/71 (56.6%)	45.3/71 (63.8%)	N.S. p = 0.24
Range	34% ~ 85%	34% ~ 85%	51% ~ 73%	
# of BC normal 0-point spellings	15.0/24 (62.7%)	14.3/24 (59.6%)	15.5/24 (64.6%)	N.S. p = 0.40
Range	42% ~ 83%	42% ~ 79%	50% ~ 83%	
# of BC slow & MS 0-point score	28.3/47 (60.3%)	25.9/47 (55.1%)	29.8/47 (63.4%)	N.S. p = 0.23
Range	30% ~ 87%	30% ~ 87%	45% ~ 77%	
Significance BC vs. others	N.S. p = 0.31	N.S. p = 0.23	N.S. p = 0.74	

Note. N.S. = not significant. * = significant at the $p < 0.05$ level, ** = significant at the $p < 0.01$ level

Chinese ESL participants performed better than EFL participants. There were no statistically significant differences according to the t-test, but this may be in part because the sample size was too small. Another possible reason may be that the one who performed the best and the one who performed the worst were both in the ESL group, meaning that the ESL group showed a wider distribution (41.6 (ESL) vs. 21.5 (EFL) in the S.D. of the overall score). In fact, the Pearson's Correlation shows that there is a significant relationship between length of residence in Canada (LOR) and the score, so LOR does matter, as will be discussed below.

As for comparison between BC normal stimuli (ESL learners' target dialect) and the other stimuli, unexpectedly, even ESL participants performed slightly worse with BC normal stimuli than with the rest of the stimuli, but the difference was not significant. This could be interpreted that dialectal differences between BC and Mississippi as well as speech rate differences were marginal for the Chinese participants (as well as for the Japanese participants).

I also examined a relationship between the overall scores and LOR/AOA (age of acquisition) with the Linear Regression by assigning the score of the spelling task to the dependent variable, and LOR and AOA to the independent variables. Note that their LOR was not evenly distributed since 15 participants were EFL students (c.f., LOR = 0), while their AOA was more evenly distributed (ranging from five to 13 years old (mean = 10)). The results show that LOR alone has a significant moderate correlation with the overall score ($r = 0.45$, $p < 0.05$ by Pearson's Correlation). AOA does not play a significant role for the score. Recall that in the reading task, LOR does not have a relationship with the score by the Chinese participants, but in the spelling task, it does.

As for <r>-insertion errors (e.g., [tɑ:] spelled as <tar>), the Linear Regression shows no significant relationship between the number of <r> insertion with LOR and/or AOA. This means that the ESL participants who were exposed in a rhotic dialect did not necessarily acquire spelling rules of rhotic dialects. Specifically, seven out of nine ESL participants used <r> (max. = 16, min. = 2) in the spelling. About the silent-E-related errors (e.g., [ke'b] spelled as <cab> or [dæ:z] spelled as <daze>), again, there was no significant relationship between the number of silent-E-related errors and LOR and/or AOA.

However, when it comes to the number <l>-insertion errors (e.g., [spu:] spelled as <spool>), interestingly, the Linear Regression shows that it has a significant correlation with LOR and AOA ($p < 0.005$). Table 102 shows standardized coefficients of <l>-insertion and the two factors.

Table 102. Standardized coefficients of <l>-insertion and the two factors of the Chinese participants

Dependent Variable: <l> insertion by the Chinese participants		
Independent variables	Beta	Significance
Length of residence in Canada (LOR)	-0.013	N.S. $p = 0.940$
Age of acquisition (AOA)	-0.692	** $p < 0.005$

Note. N.S. = not significant

Although if both LOR and AOA are combined, LOR does not have a significant role, but the Pearson Correlation shows that LOR alone has a marginally significant relationship with the number of <l>-insertion errors ($r = -0.303$, $p = 0.75$). All this indicates that early age of acquisition seems to help Chinese learners not to misperceive phantom [l], and so does longer length of residence to a much lesser extent. In contrast, there was no relationship between the number of nasal letter insertion errors (e.g., [spi:] spelled as <speen>) with LOR and/or AOA.

4.4.2.9 The Chinese participants' learning patterns

Based on the K-Means Cluster Analysis, the Japanese participants generally have more trouble with more difficult stimuli and less trouble with less difficult stimuli. However, two Chinese participants showed a different pattern. The results of the Cluster Analysis is shown in Figure 49.

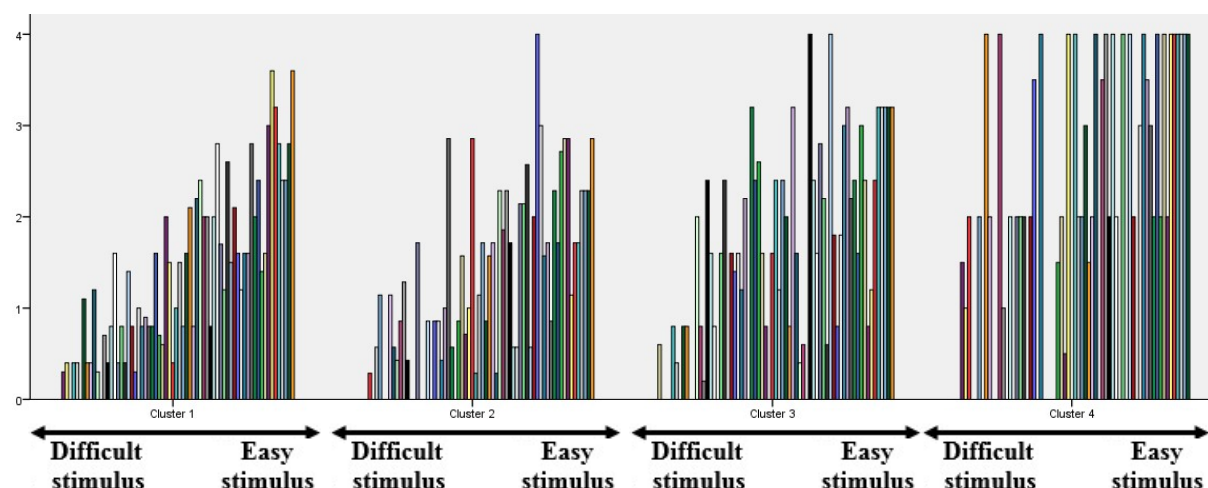


Figure 49. Clustered Chinese participants based on difficulty of all the stimuli

In these graphs, each bar represents each of the 71 stimuli's score. On the X-axis, each cluster consists of the stimuli which are aligned in ascending order in terms of the Chinese participants' average scores, meaning that "easy stimuli" are on the right hand side and "difficult stimuli" are on the left hand side. The Y-axis indicates average scores (based on the 4-point scale) for each stimulus by the Chinese participants.

As can be seen, cluster 4, to which two participants belong, showed that these participants performed well for both easy and difficult stimuli. (Since cluster 1 to 3 do not

show unusual characteristics, I will not discuss these.) One of these participants is a 22-old female in the ESL group (from Shanghai, LOR 1.5 years, AOA 10 years old) and the other one is a 20-year-old female in the EFL group (from Shanghai, AOA 7 years old). In terms of the overall score, among all the 24 Chinese participants, they were in the 3rd (148 points) and the 4th (129 points) places respectively, and among all the 69 EAL participants including the Japanese participants, they were in the 6th and the 12th places. Their interesting characteristic is that although they were not in 1st place, they did well with difficult stimuli which other participants did not do well.

4.5 Comparison between the Japanese and Chinese participants

4.5.1 Overall results

Table 103 shows the first (most frequent) and second (second most frequent) choices by the Canadian, Japanese, and Chinese participants, so that all the three groups can be compared. In the Japanese and Chinese participants' answers, I put red frames for spellings that match the Canadian participants' first choice. Note that the percentages are of 45 Japanese participants, 24 participants, and 14 Canadian participants for normal stimuli and 10 for slow stimuli. Notice that the number of the Canadian participants for slow stimuli is small, so 10% indicates only one participant.

Table 103. First (most frequent) and second (second most frequent) choices by the Canadian, Japanese, and Chinese participants in the spelling task

Target vowel	Dialect	Speed	Stimulus	Canadian		Japanese		Chinese	
				1st	2nd	1st	2nd	1st	2nd
[e ^l #]	BC	Norm	[sne ^l]	ay 93%	ae 7%	ay 18%	e 13%	ay 21%	a
		Slow	[ske ^l]	ay 90%	?ane 10%	ay 22%	?ane 18%	ay 38%	?ane 13%
[e ^l]	BC	Norm	[ke ^l b]	a e	*ay#	e	a e	i	a e

				93%	7%	60%	22%	58%	17%
		Slow	[te'b]	a_e 100%		a_e 49%	ei 11%	a_e 58%	a 25%
[i:#]	BC	Norm	[sni:]	ee 93%	*e 7%	ee 44%	ie 13%	ee 46%	i 25%
		Slow	[spi:]	ee 100%		ee 56%	een 13%	ee 46%	e, in 8%
[i:]	BC	Norm	[fɪ:b]	ee 71%	ea 14%	i 42%	ee 13%	i 38%	ee 25%
		Slow	[sni:b]	ee 80%	e_e 10%	ee 38%	ee_e 16%	ee 58%	i 25%
[aɪ#]	BC	Norm	[snaɪ]	y, ye, igh 21%		y ine 18%		y 25%	igh ai, →i ine 13%
		Slow	[zaɪ]	ye 30%	igh 20%	ain 22%	ai 16%	ai 29%	ine, ign 17%
[aɪ]	BC	Norm	[maɪb]	i_e 86%	?y# 14%	i_e 38%	ai 18%	i_e 50%	y 21%
		Slow	[naɪb]	i_e 90%	→ai 10%	i_e 51%	→ai 20%	i_e 46%	i, igh 13%
[o ^o #]	BC	Norm	[po ^o]	oe 57%	oh 21%	ow 22%	oe 9%	ou 21%	o 17%
		Slow	[sko ^o]	oh 40%	o 30%	ow 26%	ou 13%	o 38% ^a	oal 13%
	MS	Norm	[fo ^o]	o 57%	oe 29%	→ou 38%	ow 20%	o ow 21%	
[o ^o]		Norm	[mo ^o z]	o_e 100%		o_e 33%	ou 24%	o 42%	o_e 21%
		Slow	[spo ^o z]	o_e 90%	*ound 10%	o_e 29%	ou_e ou 24%	o_e o 17%	
[u:#]	BC	Norm	[sku:]	oo 79%	→ew 7%	ue 24%	oon 13%	ool 33%	oo 29%
		Slow	[spu:]	oo 90%	ou 10%	oo 56%	oon 9%	oo 75%	ooh 8%
[u:]	BC	Norm	[tu:d]	oo 71%	u_e 21%	u_e 38%	oo 22%	u_e 54%	u 21%
		Slow	[snu:b]	oo 90%	u_e 10%	oo 38%	oo_e 18%	oo 33%	u 29%

[labial C + ju:#]	BC	Norm	[bju:]	ew 57%	eu, ue 14%	iew 36%	ew 26%	ew 21%	ue, iu 17%
		Slow	[bju:]	ew 50%	ue 20%	iew 33%	ew 16%	ew 25%	u, iu 13%
[labial C + ju:]	BC	Norm	[bju:d]	ew 50%	ue 14%	iew 31%	u_e 18%	uil 38%	u_e 17%
		Slow	[pju:d]	u_e 40%	ew 40%	u_e 62%	eu 13%	u_e 63%	u, uu 8%
[ʊ]	BC	Norm	[pʊd]	u 64%	oo 21%	u 73%	o 18%	u 46%	o 17%
		Slow	[sʊd]	oo 50%	u 30%	u 36% ^a	oo 7%	oo 17%	u_e, ir 13%
[æ:]	BC	Norm	[dæ:z]	a 100%		a 42%	an_e 13%	ea 46%	a 21%
		Slow	[pæ:z]	a 90%	→aa 10%	a 44%	a_e 11%	a 38%	e 21%
	MS	Norm	[stæ:z]	a 93%	→ah 7%	a 60%	ar 13%	a 54%	e 21%
		Slow	[pæ:z]	a 50%	aa 50%	a, ar 24%		a 54%	a_e, ai ai_e 8%
[æ:] [æə(m)]	MS	Norm	[stæ:m]	a 100%		a 73%	ar 13%	a 63%	al 17%
		Slow	[snæ:m]	a 80%	aa 20%	a 33%	ea 13%	a 29%	ail 21%
[ɛ]	BC	Norm	[smɛz]	ɜ 100%		e 64%	i 18%	a 33%	e 29%
		Slow	[mɛz]	e 100%		e 73%	e_e 9%	i 21%	e 17%
	MS	Norm	[ʃɛz]	e 100%		e 62%	a 16%	e 33%	a 13%
		Slow	[stɛz]	e 100%		e 24%	a ea 16%	e 38%	a e_e 13%
[ɛ] [ɛə(m)]	MS	Norm	[sem]	e 50%	[?] a 36%	[?] a 20%	ea 16%	il 25%	al 21%
		Slow	[spɛm]	a 100%		a 40%	ea 16%	a 29%	el 17%
[ɪ]	BC	Norm	[dɪz]	i 100%		e 44%	i 20%	i 46%	e 21%
		Slow	[strɪz]	i, [?] ay 40%		a_e 20%	e 13%	[?] ay 21%	a, ee_e 13%

	MS	Norm	[spɪz]	i 86%	[?] e 14%	[?] e 42%	ee 20%	[?] e 38%	i 25%
		Slow	[pɪz]	i 80%	[?] e, [?] eh 10%	[?] e 24%	ee 20%	i 29%	ee 17%
[ɪ] [ɪə(m)]	MS	Norm	[pɪm]	[?] a 71%	[?] ou 14%	[?] a ea 16%		eɪ 25%	aɪ 21%
		Slow	[bɪm]	[?] a 90%	[?] ayu 10%	ea 22%	[?] a 16%	eɪ 33%	[?] a 29%
[ɑ:#]	BC	Norm	[tɑ:]	aw 64%	ah 36%	oe 18%	ah ou 9%	all 21%	au ar 13%
		Slow	[dɑ:]	aw 60%	a, awe auh 10%	a au 9%		ar 25%	ah oor 13%
	MS	Norm	[sɑ:]	ah 36%	a, aw 29%	ah 38%	a 16%	a 42%	ar 25%
		Slow	[stɑ:]	a 40%	ah 30%	ar 49%	a 13%	ar 71%	a 13%
[ɑ:]	BC	Norm	[zɑ:d]	o 79%	aw 14%	a 42%	o 38%	u 25%	o 21%
		Slow	[stɑ:d]	o 50%	aw, au ah au_e 10%	a ar 29%		ar 50%	o 17%
	MS	Norm	[dʒɑ:d]	o 43%	aw 21%	a 49%	ar 13%	a 33%	ar 29%
		Slow	[ʃɑ:d]	o 40%	ah, aw awe au_e →aa 7%	a 33%	ar 20%	ar 42%	u 21%
[ɔ:#]	MS	Norm	[stɔ:]	[?] all 71%	a, aw [?] ahl [?] ol 7%	ow ool 13%		ore 21%	aw or 17% ^b
		Slow	[smɔ:]	[?] all 80%	[?] aow, → [?] al 10%	[?] all 24%	oll 9%	[?] all 67%	aw au ow etc. 4% ^b
[ɔ:]	MS	Norm	[smɔ:d]	au 36%	o 29%	ou 24%	o 18%	o 29%	o_e 17%
		Slow	[stɔ:d]	aw 30%	o, au 20%	au 16%	oo 11%	or 21%	au 13%
[ʌ#]	BC	Norm	[bʌ]	uh	→ah	a	o	o	al

				86%	7%	44%	9%	21%	13%
		Slow	[mʌ]	[?] aw 30%	[?] a, [?] ah 20%	[?] a 24%	[?] ah 20%	ar 29%	[?] a 17%
[ʌ]	BC	Norm	[fʌd]	u 100%		a 80%	u 13%	u 46%	u_e, a 13%
		Slow	[zʌd]	u 80%	[?] un [?] uhn 10%	a 62%	u 11%	a, ar 21%	
	MS	Norm	[mʌz]	u 86%	*au, *o_e 7%	a 56%	u 16%	u 58%	a 13%
		Slow	[nʌz]	u 80%	[?] aw 10%	a 24%	ar 16%	a 25%	u 17%
[ɔɪ#]	BC	Norm	[spɔɪ]	oy 57%	oi 43%	oi 36%	oy 29%	oy 42%	oil 25%
		Slow	[pɔɪ]	oi 80%	oy 20%	oi 38%	oy 26%	oy 42%	oi 13%
[ɔɪ]	BC	Norm	[fɔɪd]	oi 100%		oi 88%	oy 4%	oi 67%	oe, io, o_e, etc. 4%
		Slow	[pɔɪd]	oi 80%	oy 20%	oi 88%	oy, oie 4%	oi 67%	oil 8%
[aʊ#]	BC	Norm	[gʌʊ]	ow 79%	→aoo 7%	aw 24%	awn 13%	un 13%	ao, au, al, arl 8%
		Slow	[fʌʊ]	ow 80%	[?] owl, [?] oul 10%	aw 36%	→au, ao 16%	→au 21%	oun 13%
[aʊ]	BC	Norm	[fʌʊz]	ow 36%	ou_e 21%	au_e 38%	au 29%	au 25%	ou 17%
		Slow	[pʌʊz]	ow 60%	ou 20%	au 33%	au_e 29%	ou_e 29%	ou, au_e 13%

Note. Bolded numbers indicate over 70% consistency. [?] indicates an acceptable misperception error. → indicates that the sound-to-spelling conversion is fine but the other direction is not. In the Canadian participants' columns, * indicates an error. In EAL participants' columns, the boxes with red frames are spellings that the Canadian participants chose most frequently. The shaded boxes are spellings that the Canadian participants never chosen.

^a For BC slow [sko^u] and [sɔd], 10 Canadian participants, who listened to the synthetically lengthened stimuli, most frequently spelled <skoh> and <sood> respectively, but including the spellings from the other four, who listened to the original stimuli, the most frequent spellings were <sko> and <sud>. For this reason, I regarded both <oh> and <o> for [sko^u] and <oo> and <u> for [sɔd] as the most frequent spellings.

^b For Mississippi [smɔ:] and [stɔ:], <aw> was not the most frequently chosen spelling by the Canadian participants, but since this is the default spelling in the Mississippi accent, <aw> by EAL participants is marked with the red frame.

4.5.2 Discussion

4.5.2.1 Score difference between the Japanese and Chinese participants

Table 104 shows the comparison between Chinese (top) and Japanese (bottom) participants in terms of scores and 0-point spellings.

Table 104. Comparison between the Japanese and Chinese participants in performance

	Average score	# of 0-point spellings
Japanese participants	99.2/284 (1.40/4 points per stimulus)	42.6/71 (60%)
Chinese participants	99.3/284 (1.40/4 points per stimulus)	43.0/71 (61.0%)
Significance (J vs. C)	N.S. p = 0.99	N.S. p = 0.73

Note. N.S. = not significant

The Chinese and Japanese participants' scores are surprisingly similar. This means that *apparent* spelling native-likeness may not be different between these two L1 groups.

4.5.2.2 <r>-insertion by the Japanese and Chinese participants

The Chinese participants tended to add more <r>s than the Japanese participants did, but the two-sample t-test showed no significant difference, as shown in Table 105.

Table 105. The average number of <r>-insertion errors in all the 71 stimuli from each participant in both Chinese and Japanese groups

	<r>-insertion error
Japanese participants	4.96 (out of 71 stimuli)
Chinese participants	6.75 (out of 71 stimuli)
Significance (J vs. C)	N.S. p = 0.20

Note. N.S. = not significant

One thing to note is that the reason of <r>-insertion by the Chinese participants can be derived from China's English education which traditionally focused more on Received Pronunciation (a non-rhotic dialect) (c.f., Yong & Campbell, 1995)). If the Chinese participants followed a non-rhotic dialect GPC rules, some of their <r>-insertions must be

regarded as correct. Therefore, I regarded the following spellings for nine stimuli as correct (judged by a 50-year-old native British English-speaking ESL teacher from Hampshire):

<ar> for BC [ɑ:]: normal [ta:], slow [da:], slow [sta:d]

<ar> for Mississippi [ɑ:] ([a:]): normal [sna:], slow [sta:], normal [dʒɑ:d], slow [ʃɑ:d]

<ur, er> for BC slow [mʌ] and Mississippi slow [nʌz], which sound like British [ɜ:]

Note that <ar> for BC normal [za:d] was not acceptable according to the British English-speaking ESL teacher, presumably because the tongue position of BC [ɑ:] is not front enough to be perceived as British [a:] ([a:]) as in *car*. Likewise, <ur, er> for BC normal [fʌd], slow [zʌd], and Mississippi normal [mʌz] were not acceptable, so <ur, er> is accepted only for BC slow [mʌ] and Mississippi slow [nʌz]. This means that only when North American [ʌ]s were sufficiently (synthetically) lengthened, these sounded like British [ɜ:] as in *bird*. Table 106 shows the revised versions of <r>-insertion errors.

Table 106. Revised <r>-insertion errors with possible British spellings excluded

	Revised <r>-insertion error
Japanese participants	3.58 (out of 71 stimuli)
Chinese participants	4 (out of 71 stimuli)
Significance (J vs. C)	N.S. p = 0.67

Note. N.S. = not significant

The numbers of <r>-insertion errors decreased in both L1 groups, but the Chinese participants still made slightly more <r>-insertion errors although the difference between the groups became smaller. This suggests that Chinese EAL learners still need to improve regarding the spelling of <r>.

4.5.2.3 <h>-insertion by the Japanese and Chinese participants

The Chinese participants use <h> less frequently in spellings than the Japanese participants, and two-sample t-test showed a marginally significant difference in the number of <h>-insertion, as shown in Table 107. The tendency of the Japanese participants'

preference of <h> may be an influence of one of the varieties of regular rōmaji (see §2.4.3 for more details).

Table 107. <h>-insertion in all the 71 stimuli by the Japanese and Chinese participants

	Revised <r>-insertion error
Japanese participants	2.13 (out of 71 stimuli)
Chinese participants	1.04 (out of 71 stimuli)
Significance (J vs. C)	p = 0.064

4.5.2.4 Silent-E by the Japanese and Chinese participants

Table 108 shows comparison between Chinese and the Japanese participants' silent-E-related errors.

Table 108. Silent-E-related errors by the Japanese and Chinese participants

	# of missing-E error per participant	# of missing-E error per participant	# of both errors per participant
Japanese	0.89 (out of 12 stimuli)	0.76 (out of 20 stimuli)	1.64 (out of 32 stimuli)
Chinese	2 (out of 12 stimuli)	0.75 (out of 20 stimuli)	2.75 (out of 32 stimuli)
J vs. C	** p < 0.005	N.S. p = 0.98	** p < 0.01

Note. N.S. = not significant

The Chinese participants significantly made more missing-E errors than the Japanese participants (calculated by the two-sample t-test). The reason that the Japanese participants performed better may partially be because the Japanese participants positively transferred loanword rōmaji (e.g., in loanword rōmaji, *S'capade* as Japa/esukapeido/, *Filtrike* as Japa/φirutoraiku/, *Fozztone* as Japa/φodzuto:N/, and *Kiramune* as Japa/kiramju:N/ (examples from Nogita, 2016c)); also see §2.5.7.

4.5.2.5 <l, m, n, ng>-insertion by the Japanese and Chinese participants

Table 109 shows average <l, m, n, ng>-insertion for 71 stimuli by the Japanese and Chinese participants.

Table 109. Average <l, m, n, ng> insertion by the Japanese and Chinese participants

	<l>-insertion	Nasal-letter-insertion			Nasal total
		<m>-insertion	<n>-insertion	<ng>-insertion	
Japanese	2.07/71	1/71	3.49/71	0.07/71	4.60/71
Chinese	8.46/71	0.50/71	2.92/71	0.29/71	3.71/71

J vs. C	** p < 0.001	N.S. p = 0.11	N.S. p = 0.34	N.S. p = 0.11	N.S. p = 0.28
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Note. N.S. = not significant

The Chinese participants were much more tempted to insert <l> than the Japanese participants, and the difference is significant according to the two-sample t-test. Chinese speakers' <l>-insertion can be one of the major factors that lowered their overall spelling scores regardless of whether their <l>-insertion was due to misperception of phantom [l] or adding a silent-L.

As for nasal letters, the Japanese participants were more tempted to insert nasal letters, but there was no significant difference from the Chinese participants. Note that there can be several types of nasal insertion errors. Acceptable errors are ones in which the vowel sound does not change even if a nasal letter is added, while unacceptable errors involve a vowel sound change. Here are examples:

- Acceptable: <pome> for [po^o], <sign> for [zai], <fund> for [fʌd]
- Unacceptable type 1: <sping> for [spi:], <pom> for [po^o], <zain> for [zai]
- Unacceptable type 2: <fawm> for [fau], <stenz> for [stɪz], <sken> for [skeⁱ]
- Unacceptable type 3: <spoong> for [spu:]
- Unacceptable type 4: <ton> for [ta:]

An examples of acceptable errors are <o_e> in <pome> for [po^o], which still corresponds to [o^o]. Unacceptable type 1 spellings are that nasal letter addition changes the vowel sound: for example <po> → <pom> changes [po^o] to [pa:m]. Unacceptable type 2 spellings are that regardless of nasal letter, the spellings are not native-like: for example, <aw> in either <fawm> or <faw> would not represent [aʊ] in [fau]. Unacceptable type 3 spellings involve phonotactically unusual sounds: for example, in <spoong> for [spu:], <oo> correctly represents [u:], but *[u:ŋ] is phonotactically disallowed as an English rhyme (according to Hammond, 1999). Unacceptable type 4 spellings are correct based on the default spelling rules but happen to be irregularly spelled existing words: for example, in <ton> for [ta:],

although the default phoneme of <o> is [ɑ:], there is the irregularly spelled real word *ton* [tʌn] (but not *[tɑ:n]). Table 110 shows revised nasal-letter-insertion errors with acceptable errors excluded.

Table 110. Average numbers of unacceptable nasal-letter-insertion errors by the Japanese and Chinese participants (out of 71 stimuli)

	Revised total nasal insertion
Japanese participants	2.53/71
Chinese participants	2.33/71
Significance (J vs. C)	N.S. p = 0.72

Note. N.S. = not significant

The difference is still not significant between these two groups.

I also revised the aforementioned 0-point spellings (or spellings that the Canadian participants never chose). First, the acceptable nasal-letter-insertion spellings were excluded. Second, the aforementioned acceptable <r>-insertion spellings were excluded. As shown in Table 111, the revised numbers of 0-point errors are surprisingly similar between these two L1 groups.

Table 111. Both original and revised numbers of 0-point spellings that exclude British English-like <r>-insertion and acceptable nasal-letter-insertion

	Original # of 0-point spellings	Revised # of 0-point spellings
Japanese participants	42.6/71 (60.0%)	38.6/71 (54.4%)
Chinese participants	43.3/71 (61.1%)	37.9/71 (53.4%)
Significance (J vs. C)	N.S. p = 0.73	N.S. p = 0.73

Note. N.S. = not significant

However, while these two groups are apparently similar in terms of the numbers, the error types were different. Specifically, the Chinese participants made more presumably perception-based <l>-insertion errors. When <l>-insertion errors are excluded, the Japanese participants significantly made more 0-point spelling errors, as shown in Table 112. This means that the Japanese participants made more “pure” vowel GPC errors.

Table 112. Revised number of 0-point spellings excluding <l>-insertion errors

	Revised # of 0-point spellings - <l>-insertion errors
Chinese participants	33.7/71 (47.5%)
Japanese participants	37.3/71 (52.5%)

4.5.2.6 Other differences and similarities

One of the differences between the Japanese and Chinese participants is that the Chinese participants showed U-shaped learning/development or retrogression patterns for some stimuli, while the Japanese participants did not show clear retrogression patterns, except for BC normal [smɛz]. Another difference is that the Chinese participants added the letter <l> more often than the Japanese participants. As well, the Chinese participants made more missing-E errors (e.g., <cab> for [ke'b]) than the Japanese participants. In these areas, the Japanese participants performed better. On the other hand, while the Japanese participants tended to miss silent-E in normal stimuli than in slow stimuli, Chinese speakers did not show the same tendency. This implies that the Japanese participants may have used silent-E to transcribe (non-phonemic) phonetic length, while the Chinese participants did not. In terms of vowel graphemes, the Japanese participants had severe difficulties in [ʌ] in a closed syllable to <u> conversion and [ɪ] to <i> conversion, but the Chinese participants did not as much as the Japanese participants. In contrast, while the Japanese participants performed fairly well with the stimuli with [ɛ]-to-<e> conversion in general, the Chinese participants did not perform as well.

As for similarities, the number of the most frequent spellings by the Chinese participants that matched those by the Canadian participants was 36, while the number of the most frequent spellings by the Japanese participants that matched those by the Canadian participants was 33. The Chinese participants were better, but not by much. Among these 36 and 33 stimuli, the number of those with over 50% consistency was 12 by both Japanese and Chinese participants. In this sense, the Chinese and Japanese participants tied. Among these 12 stimuli, six of them were the same: BC normal [spu:], BC slow [pju:d], MS normal [stæ:m], MS normal [stæ:z], BC normal [fɔɪd], and BC slow [pɔɪd]. In other words, these six

stimuli were relatively easy for both Chinese and Japanese participants. On the other hand, very few Japanese and Chinese participants spelled word-final [aʊ] as <ow>. This means that the [aʊ]-to-<ow> conversion was very challenging for both groups. As to nasal letter insertion errors, both Japanese and Chinese participants most frequently inserted <n> (e.g. <speen> for [spi:]). Interestingly, although Mandarin has both word-final <n> and <ng> (but not <m>), <ng>-insertion was even less frequent than <m>-insertion by the Chinese speakers.

4.6 Relationship between the reading and spelling tasks

4.6.1 Correlation between the reading task and the spelling task

In this section, I will discuss whether there is a correlation between scores of the reading task and those of the spelling task by both Japanese and Chinese participants. Table 113 shows the correlation calculated by the Pearson's R Correlation test.

Table 113. Correlation between the reading task and the spelling task

	Correlation	Significance
Japanese participants	$r = 0.59$	** $p < 0.001$
Chinese participants	$r = 0.48$	* $p < 0.05$

In both groups, there is a significant moderate, but not strong, correlation. This means that although these two skills are correlated, these could be two separate skills.

4.6.2 Relationship between grapheme-to-phoneme and phoneme-to-grapheme conversions by the Japanese participants

Some GPC patterns in the Japanese participants' interlanguages were easy or difficult in both grapheme-to-phoneme and phoneme-to-grapheme conversion, while other GPC patterns were easy in one direction but not in the other. In this section, I will discuss these two patterns.

4.6.2.1 Easy/difficult correspondences in both directions

The <e>-[ɛ] correspondence and the <oi, oy>-[ɔɪ] correspondence were easy for the Japanese participants in both directions. The silent-E as an alphabet sound marker was also moderately easy in both reading and spelling in many cases.

In contrast, firstly, the <aw, au>-to-[ɑ:] conversion and the [ɑ:]-to-<aw, au> conversion were severely problematic in both directions. The Japanese participants were strongly tempted to read <aw, au> as [aʊ] (and [oʊ] to a lesser extent), so when they heard [ɑ:], they could not associate the graphemes <aw, au>. Likewise, when they heard [aʊ], they were tempted to spell <aw, au>, instead of <ow, au>. The <o>-[ɑ:] correspondence was also problematic in both directions. The Japanese participants were tempted to read <o> as [o:] or [õ], so when they heard [ɑ:], they could not associate <o>. The <ow, ou>-[aʊ] correspondence was also very challenging in both directions. Since the Japanese participants were tempted to read <ow, ou> as [oʊ], when they heard [aʊ], they could not associate <ow, ou>. Likewise, when they heard [oʊ], they were tempted to spell <ow, ou>, instead of <o>. The problem of both <aw, au> and <ow, ou> is that the Japanese participants have a false concept that <w> and <u> in these graphemes stand for the [ʊ~w] off-glide. This false concept may be rooted in the difference between a mora language (L1) and a syllable language (L2); the Japanese participants perceived diphthongs as two units.

4.6.2.2 Easy correspondences only in one direction

The <ee>-to-[i:] conversion was very solid by the Japanese participants. On the other hand, the [i:]-to-<ee> conversion was relatively poor if the stimulus was at the normal speed in a closed syllable. The problem is that they assumed that <ee> corresponded to Eng[i:] with long duration, or probably two morae (two timing units), like Japa/i:/. Therefore, when they heard Eng[i:] with relatively short duration and could not feel two morae, they could not associate <ee>. Rather, they were tempted to spell <i>. Likewise, the <a_e>-to-[e']

conversion was very solid by the Japanese participants. On the other hand, the [e^l]-to-<a_e> conversion was relatively poor if the stimulus was at the normal speed. Again, when they heard [e^l] with a relatively short duration or with a relatively unclear [j] off-glide, or in other words they could not feel the second mora, they could not associate <a_e>. Rather, they were tempted to spell the monograph <e>. The cause of these problems is that the Japanese participants were too sensitive to non-contrastive phonetic differences, particularly duration. Or I could also argue that they overly depend on morae.

Another interesting observation is that in terms of scores, the Japanese participants' <u>-to-[ʌ] conversion was relatively poor, but in reality, it seems close to achievement; many of them intended to pronounce [ʌ], but their articulation problem or hyper-correction made their productions off the target. On the other hand, when they heard [ʌ], they were strongly tempted to spell <a>, rather than <u>. Interestingly, my loanword rōmaji data in Nogita (2016c) reflect this asymmetrical pattern; the letter <u> is almost evenly read as Japa/a/ and /u/, or /a/ is slightly more frequent (see §2.5.7). On the other hand, the phoneme Japa/a/ is predominantly spelled as <a> (see §2.5.7). In other words, the <u>-to-[ʌ] conversion was relatively easy while the [ʌ]-to-<u> conversion was very challenging.

Another interesting asymmetry is that the Japanese participants' [æ:]<-to-<a> (including [æ:, æə, εə]-to-<a>) conversion was not very problematic. On the other hand, their <a>-to-[æ:] conversion was relatively poor, and they were tempted to pronounced [a:] or [ã]. One might argue that articulation of [æ:] is challenging for the Japanese participants. However, as Nogita and Lin (2016) mentioned, Japanese EAL learners can substitute Japa/ea/ for Eng[æ:], so this is not necessarily an articulation issue. My interpretation is that among many Japanese EAL learners, it seems well-known that the IPA symbol <æ> represents the first sound of the word *apple*, and the visual image of the ligature <æ> enables Japanese EAL learners to associate the combination of Japa/a/ and Japa/e/, as mentioned above. Thanks to

this well-known IPA symbol, when Japanese EAL learners hear sounds like [æ:, æə, εə], they can associate the IPA symbol <æ>, which in turn allows them to associate the word *apple*. Therefore, the letter <a> can be activated in their mind. In contrast, the letter <a> cannot immediately activate the IPA symbol <æ>, but rather activates Japa/a/ due to both regular/loanword rōmaji. Figure 50 shows the asymmetrical [æ:, æə, εə]-to-<a> conversion and <a>-to-[a] conversion by Japanese EAL learners.

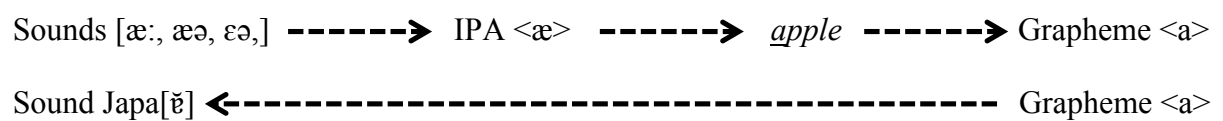


Figure 50. Asymmetrical [æ:, æə, εə]-to-<a> and <a>-to-[a] conversions

4.6.3 Relationship between grapheme-to-phoneme and phoneme-to-grapheme conversions by the Chinese participants

The Chinese participants' <aw>-to-[o:, ɔ:] conversion was fairly solid, while the [ɑ:]-to-<aw> conversion was as problematic as that of the Japanese participants. Apparently, these two L1 groups share the same problem, but I believe that it involves two different issues. The Chinese participants' difficulty in the [ɑ:]-to-<aw> conversion may be because they may have been familiar with the closed and rounded Received Pronunciation THOUGHT vowel (like [ɔ:]), so when they heard the more open and unrounded North American THOUGHT vowel ([ɑ:]), they could not associate <aw>.

4.7 Overall patterns about GPC by EAL learners

Overall, the Japanese participants performed significantly worse in the reading task than the Chinese participants. In addition, the Japanese participants pronounced non-English phones, such as non-existing diphthongs like [εʊ], [ɔɑ:], and [jε], much more frequently than

the Chinese participants. These differences between two L1 groups are probably due to a difference in their explicit knowledge of the English phoneme inventory.

As for the spelling task, in terms of scores, the Japanese and Chinese participants were not significantly different. However, their patterns were different. Specifically, the Chinese participants' errors were quite systematic. For example, one problem with them was adding <l> in their spelling when there was no [l] in the sound stimulus (e.g., [pɔɪ] spelled as <poil>), presumably due to misperception at least in many cases. Another common error by the Chinese participants was missing silent-E when representing alphabet sounds (e.g., <moz> for [mo^uz], instead of <moze>), presumably due to a lack of knowledge of its alphabet sound marking function. Since these patterns were quite systematic, it may not be difficult to correct their errors.

In comparison, while the Japanese participants made fewer <l>-insertion and missing silent-E errors than the Chinese participants, overall, many of the Japanese participants' errors were L1 interference and showed somewhat more complex patterns than the Chinese participants'. For instance, for some correspondences, the Japanese participants used both L1 and L2 modes: one of the examples is that they spelled [æə, ɛə] as <a> by using their L2 knowledge, and at the same time, they also spelled phonetically very different [ʌ] as <a> by using their L1 regular rōmaji knowledge. This suggests that both L1 and L2 GPC patterns coexist in the Japanese participants' interlanguage. In consideration of this, before learning the English GPC patterns, they would first need to recognize that L1 regular rōmaji and L2 English spelling are different entities. So their errors may be more difficult to correct than the Chinese participants'.

Chapter 5 Implications and conclusion

5.1 Practical application in teaching and the direction of future research

5.1.1 Teaching method that I suggest

The results of this study can potentially be of great help to ESL teaching. In this section I will make some tentative suggestions about how the results of this study can be applied in teaching practice. It may be helpful to refer to languages such as Japanese and Mandarin which have complex orthographies. As I mentioned in §2.5, Japanese kanji logographs and what I call loanword rōmaji possibly have even more inconsistent letter-sound-correspondence (LSC) patterns than English spelling does. One might question how learners of Japanese handle such inconsistent LSC. The answer is that L2 Japanese speakers simply go through the following three steps:

1. Master the sound inventory and corresponding phonographic letters.
2. Put the phonographic letters alongside corresponding logographic letters as pronunciation guides.
3. Gradually memorize a sound of each logographic letters as well as rules if any.

First, L2 Japanese speakers learn all the phonographic hiragana/katakana letters, and at the same time, learn the sound inventory. This is the crucial step to build the foundation of the target language. Second, L2 Japanese speakers read texts in which phonographic hiragana/katakana letters are alongside corresponding logographic kanji characters as pronunciation guides. Such texts can be readable not only for beginner L2 Japanese speakers, but also native Japanese speakers. I will present the example given in §2.5.3 again: the Japanese manga texts in which small hiragana/katakana put on the right side of

kanji/loanword rōmaji to indicate pronunciation, shown in Figure 51 (from *Toriko* in the Japanese manga magazine Weekly Shōnen Jump no. 41, 2015, p. 306).

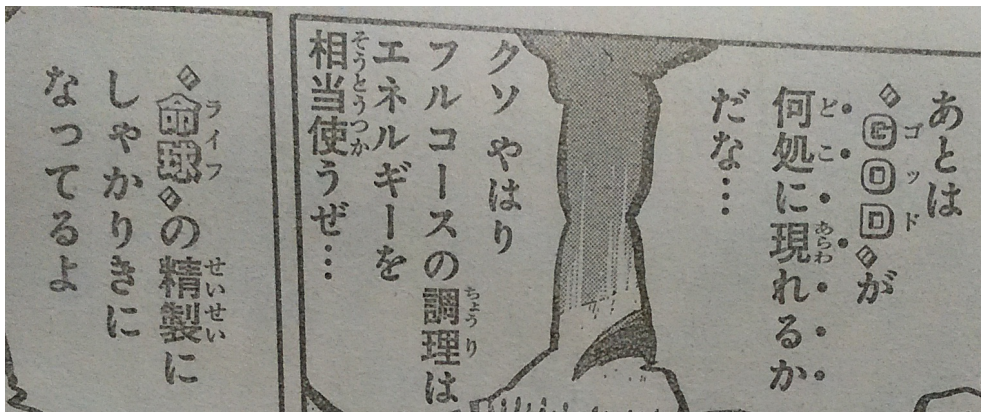


Figure 51. Hiragana/katakana put on the right side of kanji and loanword rōmaji in the Japanese magazine *Shōnen Jump*

Then, L2 Japanese learners gradually learn sounds of each word written with kanji/loanword rōmaji over a long period of time. After readers have memorized a sufficient number, they no longer need hiragana/katakana pronunciation guides, and therefore, texts for advanced readers generally do not have pronunciation guides, except for unusual/infrequent words. Native Japanese speakers follow the same process except that they learn the spoken language before learning the written language, so they already have the knowledge of the Japanese sound system to some extent before learning the Japanese phonographic characters and already know sound forms of a number of lexical items before learning written forms.

The same is true in Mandarin, which is another language with logographic characters. First, L2 Mandarin speakers learn phonographic pinyin, and at the same time, learn the sound inventory of Mandarin. This is the crucial step to build the foundation. Second, L2 Mandarin speakers read texts in which phonographic pinyin is alongside corresponding logographic hanzi as pronunciation guides. In Mandarin texts for beginner readers (including both L1 and L2 Mandarin speakers), all the hanzi characters are along with roman pinyin letters in every sentence. Figure 52 shows roman alphabet pinyin put above hanzi logographs in the children's book *dizigui* (2014, 13).

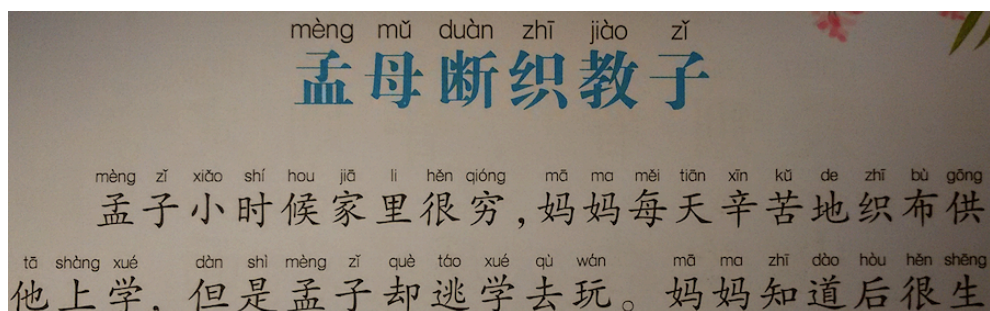


Figure 52. Pinyin put above hanzi in the children's book *dizigui*

Finally, L2 Mandarin speakers gradually memorize the sound of each hanzi, and eventually they can read Chinese texts without pinyin pronunciation guides, just as L2 Japanese speakers do when learning kanji and loanword rōmaji.

I suggest exactly the same method in the EAL setting. Japanese EAL learners first memorize the English sound inventory. Note that Teshima (2011) mentions that it is an English teachers' duty to teach all the English phonemes to students, although this very important step is neglected in the English education in Japan. Table 114 shows all the 13 vowel phonemes in North American English dialects at issue written with the default spellings as discussed in §2.3.1.2, along with perceptually similar Japanese vowel counterparts as a reference based on the results of Nogita and Lin's (2016) perception study discussed in §2.2.3.2.

Table 114. 13 stressed vowel sounds represented in The American Heritage Dictionary of the English Language along with perceptually similar Japanese vowel counterparts

Alphabet vowels	ā	ē	ī	ō	ōō ^a
Sound	えい	いー	あい	おう	うー
Words	<i>hate</i>	<i>Pete</i>	<i>bite</i>	<i>hope</i>	<i>food</i>
Relative vowels	ǎ	ě	ĩ	õ	ũ
Sound	えあ	えー	え	あー	あ
Words	<i>hat</i>	<i>pet</i>	<i>bit</i>	<i>hop</i>	<i>cut</i>
Digraphs	oi	ou	õõ		
Sound	おい	あお	う		
Words	<i>boil</i>	<i>count</i>	<i>book</i>		

Note. ^a Since “alphabet U” [ju:] includes the consonant [j], I replaced it with “Long OO” (<ōō>) as in *goose*.

Incidentally, Table 115 shows the 24 consonant inventory in the English dialect at issue.

Since I focus on vowels in this present study, I omit complex onsets/codas and other details.

Table 115. English consonant inventory

Voiced	b	d	v	g		j	l	m	n	r	z	w	y	zh	<i>th</i>	ng
Voiceless	p	t	f	k	h	ch					s			sh	th	

Note. <zh> represents /z/ as in *vision*, and the italicized <th> represents /ð/ as in *this* in accordance with Scholastic Pocket Dictionary (2005).

Such a simply organized vowel inventory chart seems extremely helpful for Japanese EAL learners, although it is still at a pilot stage, just as L2 Mandarin learners learn pinyin at the same time as the Mandarin sound inventory, and L2 Korean learners learn *Hangul* at the same time as the Korean sound inventory.

Once they have memorized all the GPC patterns in these 13 vowels and 24 consonants, just as Japanese learners memorize all the hiragana letters and sounds and Mandarin learners memorize all the pinyin graphemes and sounds, as the second stage, learners read English texts with pronunciation guides in exactly the same way as L2 Mandarin learners do. 9) shows sentences from *The Wind and the Sun* (from

<http://www.umass.edu/aesop/content.php?n=31&i=1>):

- 9) The Wind and the Sun were disputing which was the stronger.
thū wīnd ānd thū sūn wur dīs-pyōō-tīng wīch wūz thū strōng-gur.

Suddenly they saw a traveller coming down the road.
sū-dūn-lē thā sō ũ trāv-lur cū-mīng down thū rōd

Note that <ur> indicates [ɹ] as in *turn*. By using this method, even the beginner EFL learners in their 60's and 70's seem to be able to read aloud these sentences even if they do not necessarily understand the meaning, according to my pilot study. What is more impressive is that by using this method, their pronunciation does not seem to be influenced by loanwords.

Specifically, as the first stage, learners focus on accuracy of each syllable, and read sentences in the syllable-timed rhythm. After they are taught stress, they can read in the stress-timed rhythm. (I will not discuss stress and other issues any further.) As the second stage, they gradually memorize a few basic spelling rules, such as aforementioned silent E as an “alphabet sound” marker, “When two vowels go walking, the first one does the talking”, <aw> and <au> as “relative O”, and so forth. Then, they do nonsense word-reading drills and nonsense word-spelling drills, just in the experiments above: for example, *skay*, *skeap*, *mibe*, *staw*, *koun*, *snad*, *tib*, and so forth. Particularly, according to the results of the experiments above, correspondences like <ow, ou>-[aʊ], <au, aw>-[ɑ:], <o>-[ɑ:], <a>-[æ:], <i>-[ɪ], <u>-[ʌ], <oe, oa, o_e, o#>-[o⁰], and so on, need to be focused.

There is a difference between the method that I introduce here and the traditional phonics method. In English education in Japan, phonics is gradually becoming familiar to Japanese EAL learners. In fact, some teachers attempt to teach phonics to Japanese EAL learners. I was also teaching Japanese EAL learners (high school students or older) about phonics in a similar way to those teachers’ for four to five years. More specifically, I was teaching the silent E rule, the first-one-does-the-talking rule, and did nonsense word drills. However, that was not successful. Firstly, most students could not memorize even these basic spelling rules. Secondly, a few good students memorized these rules and could read and spell one-syllable nonsense words accurately and fluently. However, they could not handle words with two or more syllables, not to mention sentences. In actual conversation, their overall pronunciation still sounded completely in the loanword way (or so-called katakana pronunciation) as if they were different individuals when reading one-syllable words alone.

This failure originates from two problems. Firstly, phonics is not effective for those who do not know the English sound system, as mentioned in §2.3.2.2. This problem can be easily solved by teaching the English sound inventory shown in Table 114 and Table 115.

Secondly, loanword influence is so stubbornly rooted that it cannot be easily removed because most Japanese EAL learners do not know the proper phonological forms of English lexical items. However, impressively, this problem can also be solve by adopting pronunciation guides along with sentences as shown in 9) above, although it is still at a pilot stage. To make it short, my (and probably other phonics teachers’) failure was that I skipped step 1 and step 2 mentioned above.

Another question to ask would be what the difference from IPA symbols is. Indeed, IPA symbols can be a substitute for the pronunciation respelling that I adopted here. However, the first problem of IPA is that as discussed in §2.1.6, an unfamiliar script requires considerably higher cognitive demands. The second problem is that while transition from pronunciation respelling to regular spelling is easy since pronunciation respelling is mostly based on default spellings, while transition from IPA to regular spelling requires learning of another GPC rules. The third problem, which may be specific to Japan, is that as some Japanese linguists and teachers of English point out, there are fundamental problems in IPA symbols used in Japan. Makino (unpublished) even claims that IPA used in Japan must be called defect transcription, although I do not discuss this issue in this paper. At least in Japan, IPA itself should be improved if one wants to adopt IPA in the English education. Due to these reasons, I adopted pronunciation respelling with diacritics.

5.1.2 Loanword rōmaji and English education

English teachers’ concern may be that loanword rōmaji spoils Japanese EAL learners’ English pronunciation and spelling. However, I suggest a very simple solution by using pronunciation respelling. Compare Japanese learners of Mandarin who regard kanji as the Japanese orthography but they take advantage of it in learning Mandarin. For example, the word 大学 shares the same meaning ‘university’ and the same written form <大学> between Japanese and Mandarin but only its pronunciation (Japa[děigěkū] vs. Mand[tac̥y̥ɛ]) (Lin,

2001), so learners are required to only memorize the sound form of this Mandarin word by relying on pinyin <dà xué>. What is important is that Japanese learners of Mandarin typically regard this shared orthography as an advantage, rather than a disadvantage. The same strategy should be adopted to the English education. Japanese EAL learners should regard loanword rōmaji as the Japanese orthography, but take advantage of its similarities with English orthography. For example, the word *street* (as shown in Figure 31) shares the same meaning and the same written form between Japanese (loanword rōmaji) and English but only its pronunciation is different (Japa[st̚ɔ̃ri:t̚ɕ] vs. Eng[sti:t]), so learners only need to memorize the sound form of this English word by relying on pronunciation respelling <strēt>. I argue that there is much to learn from the Mandarin education for Japanese speakers in order to improve the English education.

5.1.3 Future research and challenges for practical application

In order to put this method into practice and improve Japanese EAL learners' GPC skills, a larger scale experimental lesson is needed. I only recently started this method, and I have taught only a relatively small group of students at once (up to five students in one group) as pilot lessons. If I attempt to adopt this method in classroom teaching, I need to conduct an experimental lesson with a bigger group, like 20 or 30 students at once, and examine its effectiveness. Nevertheless, this method has been widely adopted in the Mandarin education, so effectiveness and possible problems can be predictable to some extent.

A bigger challenge is that many Japanese teachers of English would not immediately accept this method. This is because they would not be comfortable teaching the English default GPC patterns, English phoneme inventory, and particularly pronunciation respelling which is hardly used in Japan. It is understandable that they would not want to teach what they cannot do. In fact, there is a similar problem in Japanese-as-an-additional-language

teaching. According to Minematsu (2015) and Yamane (2015 in personal communication), even native Japanese speaking teachers are not comfortable identifying Japanese phonemic pitch accent (see §3.5.1), and therefore, they are reluctant to teach Japanese pitch accent. However, there seems to be a solution. Minematsu (2015) is creating online lessons in order to build a foundation of teaching Japanese pitch accent. This method can reduce the burden on teachers who are not comfortable teaching pitch accent by themselves. Likewise, in order to build a foundation of teaching the English GPC method in Japan, a similar strategy, such as creating teaching materials like video lectures, application software, and so forth, could minimize the burden on Japanese teachers of English. Incidentally, at an English education conference in Kumamoto in 2015, I received advice from Hatae and Nagakura (2015 in personal communication) that an ideal situation would be that teachers and students together learn the English phoneme inventory, pronunciation respelling, and basic GPC by using such teaching materials in class. Their suggestion seems to be worth a try.

There is also a question to ask, which is whether my method is effective only to Japanese EAL learners or to any L1 speaking EAL learners. At a pilot stage, I have taught this method to a few Korean and Indonesian EFL learners, and it seems effective. This is not surprising because in the Mandarin-as-a-second/foreign-language teaching, the same method is used regardless of the learners' L1 backgrounds. Still, if I attempt this method with other EAL learners of different L1 backgrounds, further experimental lessons will be needed.

5.2 Limitation

As for the experiments discussed in Chapter 3 and 4, the major limitation is that the Japanese participants' English proficiency and backgrounds were not controlled. I originally planned to collect the same number of both EFL learners (who have never lived in an English-speaking country) from a university famous for its high-level English education and

ESL learners (who live in an English-speaking country) from the University of Victoria. However, due to various constraints, I had no choice but almost randomly recruited as many Japanese ESL learners as possible. If their English proficiency is more controlled, more interesting data could be collected and results might have been more revealing. Still, I calculated the correlation between their performance in both reading and spelling tasks and their self-evaluation of their overall English proficiency, so this can be a compensation of this limitation. There was also an unexpected issue, which is that although the stimuli for the spelling task were all nonsense words, a few stimuli were misperceived as real words by some EAL participants: for example, [bjʊ:] as *view* and [dɪz] as *death* due to the Japanese participants' misperception of non-L1 consonant contrasts /b/-/v/ and /z(s)/-/θ/ (and misidentification of /ɪ/ and /ɛ/). In these cases, participants spelled the words logographically rather than phonographically, which impeded examination of their pure GPC knowledge. However, such cases were infrequent, so the overall results do not seem to be skewed. As well, another limitation is that although synthetically manipulated durational differences affected Japanese participants' spelling patterns in some cases, what exact durational point changes their spelling patterns have not been examined. This is left for future research.

5.3 Conclusion

In this dissertation, I examined Japanese EAL learners' English graphophonic skills in vowels. In the nonsense word-reading task, the Japanese EAL participants read vowel letters differently from the Canadian participants 40.1% of the time. As well, in the nonsense word-spelling task, the Japanese EAL participants spelled out vowel sounds differently from the Canadian participants 60.0% of the time. These results suggest that the Japanese EAL participants' English vowel grapheme-phoneme mapping patterns were quite different from those of the native English-speaking participants. In consideration of these results, it would

not be surprising if many mispronunciations of English vowels by Japanese EAL learners' in fact come from their misinterpretation of English graphemes, rather than their inability to produce particular sounds, although further research will be needed.

In more details, some correspondences were performed very well in both grapheme-to-phoneme and phoneme-to-grapheme directions: specifically, <e>-[ɛ] and <oi, oy>-[ɔɪ]. In contrast, some were performed very poorly in both directions: specifically, <aw, au>-[ɑ:], <ow, ou>-[aʊ], <uh#>-[ʌ#] (# = word-final), <i>-[ɪ], and to a lesser extent <o>-[ɑ:], and <o#, oe#, oh#>-[o^u]. In addition, some were performed very well only in the grapheme-to-phoneme direction but not in the other direction: specifically, word-medial <ee>-to-[i:] and <a_e>-to-[e^l]. To a lesser extent, the <u>-to-[ʌ] conversion was also much less problematic than the [ʌ]-to-<u> conversion, although the <u>-[ʌ] correspondence was performed relatively poorly overall. On the other hand, none of the correspondences were performed very well only in the phoneme-to-grapheme direction but not in the other direction, but there were correspondences that showed this tendency. For example, the [æ: (æə)]-to-<a> conversion was much less problematic than the <a>-to-[æ: (æə)] conversion.

There were also many cases that what I call loanword rōmaji seemed to influence on the participants' performance in both tasks. On one hand, some loanword rōmaji LSC patterns seemed positively transferred to Japanese EAL learners' English. Specifically, particularly in the reading task, the Japanese participants performed well with the conversions <a_e>-to-Eng/eɪ/, <i_e>-to-Eng/aɪ/, <ee>-to-Eng[i:], <ie>-to-Eng[i:] (but not [aɪ]), <oo>-to-Eng[u:], and so forth; compare the common loanword rōmaji correspondences in Nogita's (2016c) loanword rōmaji data, <a_e>-Japa/eɪ/, <i_e>-Japa/aɪ/, <ee>-Japa/i:/, <ie>-Japa/i:/, <oo>-Japa/u:/, and so forth, as discussed in §2.5.7. There were also loanword rōmaji LSC patterns that seemed somewhat positively transferred particularly in the reading task but only by some participants, such as to the conversions <ew>-to-Eng[(j)u:], <ay>-to-Eng[e^l], <u>-

to-Eng[ʌ], and so forth; compare the common loanword rōmaji correspondences <ew>-Japa[u:], <ay>-Japa[ei], <u>-Japa/a/([ẽ]), and so forth. On the other hand, some loanword rōmaji LSC patterns seemed negatively transferred. Specifically, they had difficulty in English correspondences like <ow, ou>-Eng[aʊ], <i>-Eng[i], <o>-Eng[ɑ:] in both grapheme-to-phoneme and phoneme-to-grapheme conversions, as well as the Eng[o^u]-to-<o#> conversion, the <a>-to-Eng[æ:] conversion, and so forth; compare the common loanword rōmaji correspondences <ow>-Japa/o:/, <ou>-Japa/o:, u, o/, <i>-Japa/i/([ĩ]), <o>-Japa/o/([õ]), <a>-Japa/a/([ẽ]), and so forth. Notice that these negatively transferred loanword rōmaji patterns are almost the same as the regular rōmaji (i.e., Hebon-shiki, kunrei-shiki, etc.) patterns. However, as opposed to these negatively influenced correspondences, the <ai>-to-Eng[ei] conversion and, to a lesser extent, the Eng[æə] (diphthongized /æ/) -to-<a> conversion were performed better than expected even though these patterns were not frequently or never observed in the loanword rōmaji data I collected; compare the common loanword rōmaji correspondences <ai>-Japa/ai/ and <a>-Japa/a/([ẽ]). So there are cases that loanword LSC patterns do not match the results of the experiments. Although I found these patterns, the relationship between loanword rōmaji LSC patterns and the results of the experiments is not conclusive yet, so further research will be needed.

As for participants' background factors, in both reading and spelling tasks, length of residence played a role, but self-evaluation of their overall English proficiency better predicted their performance in the reading and spelling tasks.

In comparison with the Chinese participants, in the reading task, the Chinese participants performed significantly better than the Japanese participants, although the Chinese participants still read vowel letters differently from the Canadian participants 30.9% of the time (c.f., 40.1% by the Japanese participants). Moreover, the Japanese participants tended to pronounce non-English phones, such as non-existing diphthongs like [ɛʊ], [ɔɑ:],

and [jɛ] (in the stimuli *bew*, *poad*, and *kie* respectively), non-existing coda consonants like [h#] and [x#] (# = word-final) (in *kah*), phonotactically disallowed word-final vowels like [ɛ#] (in *zobe*), phonologically irrelevant contrasts like [o^u]-[o:]-[ɔ̃] (in *koun*, *poad*, and *zo* respectively) and [i:]-[ĩ] (in *pede* and *tib* respectively), and so forth. In contrast, the Chinese participants produced such non-English phones much less frequently. This implies that the Chinese participants had a much better understanding of the English sound inventory. Furthermore, there was a difference in hyper rhotacization; the Japanese participants pronounced [ɹ] or [ɹ]-like sounds when they were not supposed to in 37 tokens out of 1452 (33 stimuli × 44 participants) (2.5%), whereas the Chinese participants' hyper rhotacization occurred only in three tokens out of 792 (33 stimuli × 24 participants) (0.4%). These patterns also imply that the Chinese participants had a better understanding of the English sound system.

As for the spelling task, there was no significant difference between the Chinese and Japanese participants in terms of the average scores. However, it would be too hasty to conclude that both Chinese and Japanese participants performed equally poorly in terms of vowel phoneme-to-grapheme conversion. Briefly, the major factor that lowered the Chinese participants' average score was that the Chinese participants significantly more frequently spelled <l> when they were not supposed to (e.g., [bjɹu:] spelled as <bill> and [pɔɹi] spelled as <poil>) than the Japanese participants (8.64 out of 71 stimuli vs. 2.07 out of 71 stimuli on average per person). Presumably, many of their <l>-insertion errors were due to misperception, rather than their English GPC knowledge. If <l> insertion errors were excluded, the Chinese participants performed significantly better than the Japanese participants. This suggests that the Japanese participants made more “pure” vowel GPC errors.

Finally, these results seem to suggest that Japanese EAL learners can benefit from being taught English default GPC patterns in order for them to improve on their graphophonic skills.

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Appendix 1 The reading task

Instruction (English) along with the sound narration:

Thank you very much for participating in this experiment today. In this “reading task,” I would like you to read aloud some English words. Although these are made-up nonsense words, please pretend that they are actual English words. You may come up with a few different sounds, but please choose one that you think is the best. If you change your mind, you can pronounce the same word again with a different sound. For example, if the word is spelled as “beb”, a possible way to pronounce it would be [beb]. Please read aloud each word as clearly as possible with your best English pronunciation.

Instruction (Japanese) along with the sound narration:

今日は、実験にご参加いただき、ありがとうございます。まず、「単語読みタスク」では、英単語を読み上げていただきます。

これらは、実際には存在しない意味の無い単語ですが、実際の英単語だと思って読んで下さい。

何通りか読み方が思い浮かぶものもあるかもしれませんが、一番良いと思う読み方で読んで下さい。途中で、やはり他の読み方に変えたいと思った場合は、言い直していただいて結構です。

例えば、もしつづりが“beb”だったら、可能な読み方としては[beb]があります。できるだけ明確に、あなたのベストな英語の発音で読み上げて下さい。

Instruction (Mandarin) along with the sound narration:

非常感谢您参与本次实验。

在“朗读任务”中，我希望您大声地朗读一些英语单词。这些英语单词是无意义的人造词，但是希望您能将像正常英语单词那样朗读出来。

您看到这些人造词，可能会觉得不止一个读音，请选择一个您认为最适合的读音。如果您改变主意了，您可以再次朗读。比如，如果这个单词是“beb”，您可能会读作 [beb]。

请尽可能大声清晰地用您最好的英语发音读出这个音。

Stimuli

1. yee
2. staw
3. thas
4. cass
5. bew
6. skay
7. stoe
8. meethe
9. noy
10. pede
11. poad
12. psyme
13. snad
14. skeap
15. spug

26. cib
27. sta
28. stoh
29. pude
30. sith
31. koun
32. plin
33. spoo
34. tib
35. tob
36. paip
37. mibe
38. teb
39. fow
40. smy

16. zo
17. poid
18. woon
19. ree
20. vock
21. kie
22. nupe
23. faud
24. zobe
25. pook

41. tuh
42. rass
43. cuth
44. kah
45. lipe
46. hooz
47. shiff
48. zhoo
49. tate
50 peest

Appendix 2 The spelling task

Instruction (English) along with the sound narration:

Now we are moving on to the “spelling task.”

In this task, I would like you to listen to each English word and write down the spelling of what you hear on the answer sheet. You can hear each word by clicking on each speaker icon.

Again, these words are made-up nonsense words, but please pretend that they are actual English words and spell them in the English way.

You may come up with a few different ways of spelling, but please choose one that you think is the best as English. You may listen to the words as many times as you want. For example, if the word is [beb], a possible way to spell it would be “beb”.

There are two things to note. First, you may notice that there are two different speakers’ voices, depending on the words. One speaker is from Canada and the other speaker is from the US. Second, some words are pronounced in natural speed while others are pronounced slowly. Enjoy!

Instruction (Japanese) along with the sound narration:

次は「綴りタスク」です。「綴りタスク」では、英単語を聞いて、そのつづりを回答紙に書いていただきます。

スピーカーのアイコンを押すと、音声を聞く事ができます。先ほどと同様、これらの英単語は、実際には存在しない意味の無い単語ですが、実際の英単語だと思って、英語式につづって下さい。

何通りか綴り方が思い浮かぶものもあるかもしれませんが、一番英語として良いと思うつづりを書いて下さい。例えば、もし音声が [beb] だったら、可能な綴り方としては、“beb” があります。

ここで、注意が2つあります。1つ目は、単語によって、声が違うということです。1人はカナダ人で、もう1人はアメリカ人です。2つ目は、単語によって、普通の速さで読んでいるものと、ゆっくり読んでいるものがあるということです。では、楽しんで下さい！

Instruction (Mandarin) along with the sound narration:

第二个是“拼写任务”。

在这个任务中，您先听英语单词（点击扩音器图标），然后在答题纸上拼写下您听到的英语单词。这些英语单词和上个任务一样，还是无意义的人造词，请当做他们是有意义的英语单词，并用英语的形式拼写出来。

您可能会认为有多种拼写方式，请选择您认为最适合的一种。您可以根据需要，反复聆听读音。比如您听到的单词是[bɛb]，那么它可能的拼写方式是“beb”。

有两点需要注意的是，您可能会注意到单词不同，发音人也不同。我们有两个发音人，一位来自加拿大，一位来自美国。第二点需要注意的是，有一些单词是以正常语速，有一些单词是较慢的语速。

现在我们开始实验吧。