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Pronunciation of French vowels by Japanese speakers learning French as a foreign language: back and front rounded vowels /u y ø/

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Abstract. This article deals with the application of experimental (acoustic and perceptual) phonetics to the teaching of pronunciation. The issue is illustrated by Japanese speakers' difficulties in learning French vowels in general. Experiments were specifically conducted on the vowels /u y ø/. The objective is to elucidate the case of individual phones depending on whether or not their phonemic status and their phonetic realization differ in the two languages under study.

The French /u/ differs phonetically from its phonemic counterpart, the Japanese /u/. The present study confirms that the French /u/, which is phonemically identical (to the Japanese /u/), turns out to be more difficult than the “new” vowel /y/, which has no phonemic or phonetic counterpart in Japanese. The production of /ø/, which is phonemically “new” but acoustically close to the Japanese /u/, seems to present still less difficulty.

The study also brings a reflection on the teaching of pronunciation. The analysis of general French textbooks published in Japan suggests that learners and teachers are seldom aware of the difference in the difficulties caused by the three vowels /u y ø/. Also, some methods of pronunciation teaching (some traditional, others new) are presented in terms of how they foster learners' awareness of these difficulties.

The goal of this study is to help shed light on the learning processes of the pronunciation of foreign languages, and to improve its learning and teaching.

Keywords: pronunciation learning, French as a foreign language, vowels, perception and production, phonetic and phonemic levels, Japanese-speaking learners, pronunciation teaching

0. Introduction

The objective of the present study lies in the application of experimental phonetics to the pronunciation teaching of foreign languages. The production and perception of foreign and second languages are influenced by the learner's linguistic experience in his/her native language (L1) and other language(s) he/she has acquired or learned, and by the phonemic system and its phonetic realization of the target languages (L2, L3, ...).

Our goal is to examine the production and perception of French vowels, in particular the high and high-mid rounded vowels /u y ø/ in isolation and to link perception and production during the course of the acquisition of the phonetics and phonology of French by native speakers of Japanese learning French as a foreign language. The learners studied in this research work included beginners (3 month of learning experience) and intermediate learners (3 to 4 years of learning experience).

1. Background

This section presents various questions concerning the teaching and learning of pronunciation, the phonemic system of French and Japanese, previous studies, and the research questions.

First, a brief description is made of the situation of the teaching of French as a foreign language (FFL) in Japan: it is generally taught as a third language (L3), after (mostly North American) English as a first foreign language (L2).

Second, various issues concerning the pronunciation teaching and learning of foreign languages are discussed: why teach pronunciation, how to teach it, whether or not to set the goal to attain intelligibility, or perfection, etc.

Third, some models of production and perception of second and foreign languages are presented.

Fourth, major characteristics of the phonemic system and its phonetic realization of Tokyo Japanese (learners' first language: L1), Parisian French (L3), and American English (L2) are described. They can be summarized as follows:

1) The number of vowel phonemes and their precise vowel qualities differing from a regional variety to another in France (Martinet 1969), the reference chosen here is Parisian French. This variety presents 3 phonemically nasal vowels and 10 oral vowels with 4 degrees of aperture (Vaissière 2007, among others). Tokyo Japanese has 5 vowels /i e a o u/ (Sugitô 1995, among others). American English (General American: GA) has 15 vowels (Wells 1982, among others). Parisian French is characterized, unlike the 2 other languages, by a series of front rounded and of nasal vowels.

2) The phonetic realizations of the high back rounded vowel (transcribed /u:/ or /u/ for English) are considerably different in the three languages (Figure 1). The Japanese /u/ is realized with less rounding, some tongue fronting, and a less narrow constriction than the French /u/ (Uemura 1990 for Japanese, Bothorel *et al.* 1986 for French) and so the symbol [u] is generally used in broad phonetic transcription. The articulatory difference between the French and Japanese /u/ gives rise to the following acoustic differences: the French /u/ in isolation is characterized by the first two formants closely located (it is an acoustically focal vowel) below 1000 Hz (CALLIOPE 1989 for the [pV] and [pVɤ] contexts; Gendrot and Adda-Decker 2004 for data from running speech). The second formant (F2) of /u/ in Tokyo Japanese is superior to 1000 Hz (Sugitô 1995, Mokhtari and Tanaka 2000 for 22 different words for each vowel) and not grouped with the first formant (F1). The American English /u/ is characterized by a slight diphthongization (Wells 1982, among others), and by a higher F2 than that of the French /u/ (Hillenbrand *et al.* 1995, among others): the first two formants are not grouped, as in Japanese.

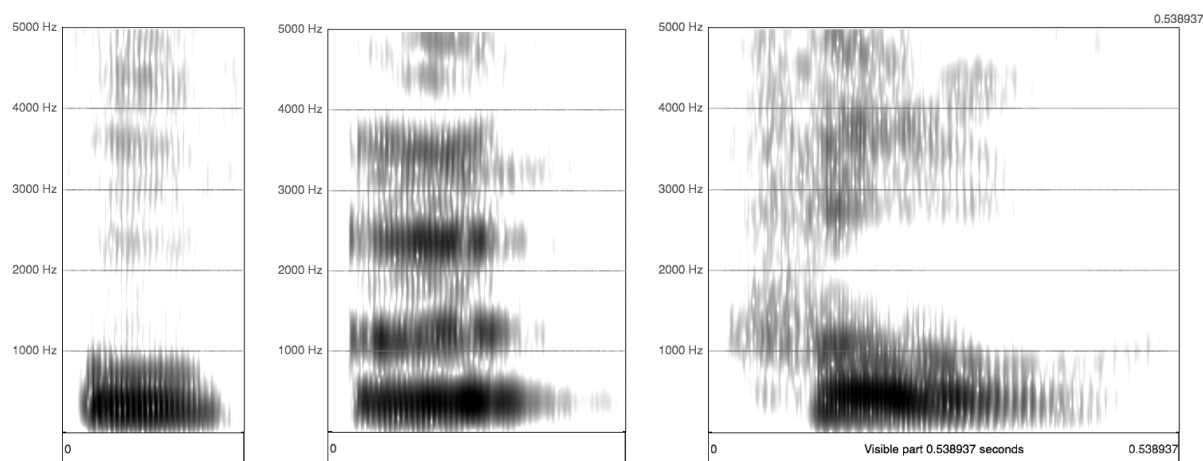


Figure 1: Wide-band spectrogram (on Praat¹; window length: 5 milliseconds) of the French /u/ in isolation pronounced by a male French native speaker (left), of the Japanese /u/ in isolation pronounced by a male native speaker of Tokyo Japanese (middle), of the American English /u/ pronounced by a male speaker in the word “who” /hu:/, taken from the CD-ROM of Jones *et al.* 2006 (right).

3) Among the 3 front rounded vowels in Parisian French, /y/ can be distinguished from the others by a grouping of the second and third formants (F3), while the energy is evenly distributed in /ø/ and /œ/ (“acoustically central” vowels: Vaissière 2006: 73), with their F2 around 1500 Hz. Tokyo Japanese and American English (GA) do not have a phoneme

corresponding to /y/ (unlike languages such as Swedish, German, Dutch, Finnish, Cantonese, *etc.*).

The acoustic characteristics of /u/, /y/ and /ø/ are considerably distinct in French. The vowels /u/ and /y/ are focal, with a concentration of energy in a very low frequency zone in /u/ and around 1900-2100 Hz in /y/. By contrast, /ø/ is an acoustically central vowel. The Japanese /u/ [ɯ], which does not show any grouping of formants, could then be considered acoustically close to the French /ø/. The three vowels /u/, /y/ and /ø/ are thus phonemically and/or phonetically (acoustically) new to Japanese-speaking learners.

The learning experience of L2 English does not favor the acquisition of these 3 vowels: English lacks the front rounded series, and the English /u:/ resembles the Japanese /u/ [ɯ] in the sense that it is not as far back and rounded as the French /u/ (Ostiguy *et al.* 1996, among others). Note also that the English /u:/ is often diphthongized unlike the Japanese /u/ [ɯ].

Flege (1987) examined the production of the French /u/ and /y/ by native speakers of American English, and showed that even well-experienced speakers (adults living in Paris for 11.7 years in average and using French as a primary language) did not produce the French /u/ as French native speakers did (*i.e.* with a low F2, according to Flege), while they did not have difficulties in producing /y/ as native speakers did (with close F2 and F3). The author thus suggested that it is more difficult to learn to produce “similar” L2 phones (*i.e.* /u/) than “new” L2 phones (*i.e.* /y/) in a native-like manner.

These observations and findings lead us to the following research questions: do Japanese-speaking learners of French show a tendency similar to that of the English-speaking learners in Flege’s study, since the phonetic realization of the Japanese /u/ –phonemic equivalent of the French /u/– is considerably distant from that of the French /u/, while the French /y/ does not have a corresponding phoneme in Japanese? What about the French /ø/, which could be considered phonemically new, but acoustically similar to the Japanese /u/? A series of experiments are presented in the sections 2 and 3 to answer these questions.

2. Preliminary experiments: the 10 oral vowels of French in isolation learned by Japanese-speaking learners²

The goal of this series of experiments is to grasp the general tendency of difficulties encountered by Japanese-speaking learners in the perception and production of French oral vowels.

2.1. Vowels in Tokyo Japanese

Four native speakers of Tokyo Japanese (2 males and 2 females) pronounced the 5 Japanese vowels 6 times in the carrier sentence “*sorewa /V/ to iimasu*” /sorewa ... to iRmasu/. The values of the first four formants of these vowels present tendencies similar to those found in the literature (Mokhtari and Tanaka 2000, among others).

2.2. Vowels in Parisian French

Four native speakers of French (2 males and 2 females from the northern half of France) pronounced the 10 oral vowels and the 3 nasal vowels of French 3 times in the carrier sentence “*je dis /V/ comme dans ...*” [I say /V/ as in ...]. The measures of the first four formants (Figure 2) present tendencies similar to those found in the literature (CALLIOPE 1989, among others).

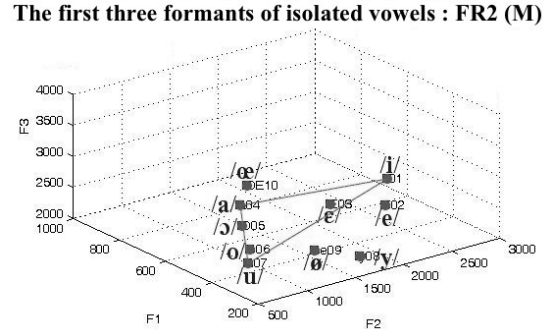
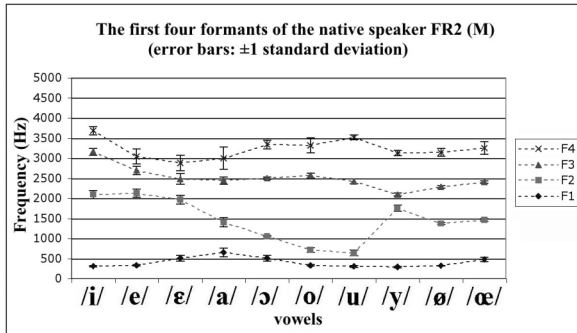


Figure 2: The formant values of a male native speaker of French. The first 4 formants (right), and the first 3 formants represented in a vowel triangle (right). Note the grouping of F3 and F4 for /i/: /i/ and /e/ have similar F1 and F2 values, but are distinguished by F3 and F4.

2.3. Perception of French vowels by Japanese-speaking learners

Five Japanese-speaking learners of French participated in an auditory identification test of the 13 French vowels (including the 3 nasals) in isolation, extracted from the carrier sentences mentioned above, pronounced by 4 native speakers of French (2 males and 2 females).

The results (see Tables 1-2) show a high confusion rate (41% of all responses *vs.* 17% in the same test conducted with 5 native listeners of French). Among other types of confusions, the following 3 tendencies stand out:

- 1) stimuli of nasal vowels (33% of all confusions);
- 2) between high-mid and low-mid vowels (28% of all confusions);
- 3) between /u/, /y/ and /ø/ (17% of the confusions), even though /y/ and /u/ were rarely confused (only 1% of confusions: Table 3).

Note that the native speakers of many languages without a phonemic contrast between front and back rounded vowels tend to confuse /u/ (generally rounded in their native language) and /y/ (Lauret 2007), unlike Japanese-speaking learners.

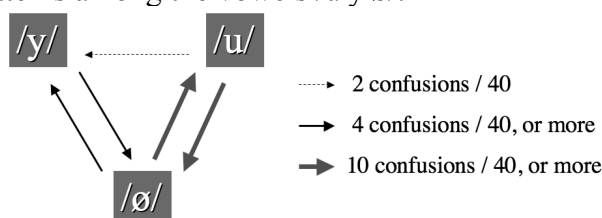
Table 1: Results of the auditory identification of vowels in isolation, represented in the number of identification responses and in percentage between parentheses. 40 responses per vowel: 8 stimuli per vowel (2 males and 2 females x 2 repetitions) x 5 listeners (Japanese-speaking learners). The stimuli are presented in rows, responses, in columns.

stimuli/responses	i	e	ɛ	a	ɔ	o	u	y	ø	œ	ẽ	ā	õ	total_stimuli
i	39 (98)	1 (3)												40 (100)
e	5 (13)	16 (40)	16 (40)						1 (3)	1 (3)	1 (3)			40 (100)
ɛ		15 (38)	24 (60)							1 (3)				40 (100)
a				34 (85)					1 (3)	2 (5)		3 (8)		40 (100)
ɔ				1 (3)	24 (60)	6 (15)			2 (5)	3 (8)	1 (3)	3 (8)		40 (100)
o					6 (15)	23 (58)	8 (20)		3 (8)					40 (100)
u							22 (55)	2 (5)	12 (30)				4 (10)	40 (100)
y								33 (83)	6 (15)	1 (3)				40 (100)
ø							12 (30)	5 (13)	17 (43)	6 (15)				40 (100)
œ							1 (3)	1 (3)	11 (28)	24 (60)	1 (3)	2 (5)		40 (100)
ẽ				5 (13)						2 (5)	21 (53)	12 (30)		40 (100)
ā					8 (20)	2 (5)					3 (8)	14 (35)	13 (33)	40 (100)
õ					3 (8)	5 (13)			3 (8)	1 (3)	5 (13)	8 (20)	15 (38)	40 (100)
total_responses	44 (110)	32 (80)	40 (100)	40 (100)	41 (103)	36 (90)	43 (108)	41 (103)	56 (140)	41 (103)	32 (80)	42 (105)	32 (80)	

Table 2: Results of the auditory identification task. The stimuli and responses of high-mid and low-mid vowels are merged into one category (80 responses for the merged categories of mid vowels, 40 for the others).

stimuli/responses	i	e/ɛ	a	ɔ/o	u	y	ø/œ	ẽ	ã	õ	total_stimuli
i	39 (98)	1 (3)									40 (100)
e/ɛ	5 (6)	71 (89)					3 (4)	1 (1)			80 (100)
a			34 (85)				3 (8)		3 (8)		40 (100)
ɔ/o			1 (1)	59 (74)	8 (10)		8 (10)	1 (1)	3 (4)		80 (100)
u					22 (55)	2 (5)	12 (30)			4 (10)	40 (100)
y						33 (83)	7 (18)				40 (100)
ø/œ					13 (16)	6 (8)	58 (73)	1 (1)	2 (3)		80 (100)
ẽ			5 (13)				2 (5)	21 (53)	12 (30)		40 (100)
ã				10 (25)				3 (8)	14 (35)	13 (33)	40 (100)
õ				8 (20)			4 (10)	5 (13)	8 (20)	15 (38)	40 (100)
total_responses	44	72	40	77	43	41	97	32	42	32	

Table 3: Confusion patterns among the vowels /u y ø/.



2.4. Production of French vowels by Japanese-speaking learners

The first four formants of the 10 French oral vowels in isolation pronounced by 3 Japanese-speaking learners in tasks of reading and immediate repetition were measured and compared with those of the 4 native speakers measured in the same manner and presented in 2) (Figure 3).

The most remarkable differences from the native speakers' data include the following;

1) The F2 of /u/ is higher (1000-1300 Hz with 2 male learners, 1300-1400 with the other female learner), which results in a vowel acoustically close to /ø/.

2) Two of the learners produced /y/ with close F2 and F3, but with a high F2 (> 2000 Hz, which would be quite high for French male speakers), while the other learner pronounced a diphthong (F2 lowers during the vowel) close to the sequence /ju/ [ju] in Japanese.

3) As expected from the 5-vowel system of Japanese with only 3 degrees of aperture, the high-mid and low-mid vowels are not as well distinguished as in the native speakers' data.

This experiment illustrates inter-learner differences in the realization of the French /y/.

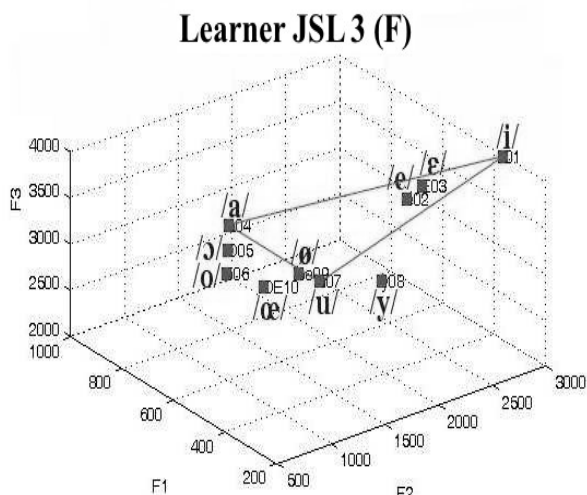
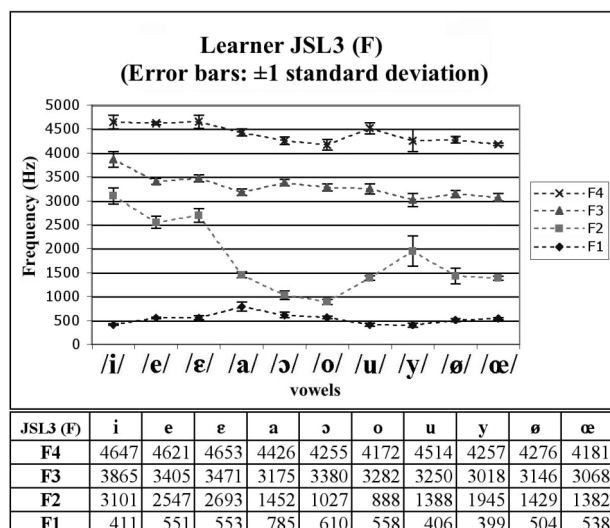


Figure 3: The first 4 formants (left) and the first 3 formants (in a 3D vowel triangle: right) of the ten oral vowels of French pronounced by a female Japanese-speaking learner (JSL). Mean of 5 measures $\times$ 2 repetitions. Note the high standard deviation of the F2 of /y/, which is due to the diphthongization (as in Japanese /ju/).

2.5. French native listeners' perception of French vowels produced by Japanese-speaking learners

The 10 French oral vowels pronounced by the 3 Japanese-speaking learners were identified and rated by 26 native speakers of French. The vowel /u/ pronounced by the 3 learners in the reading task was recognized as /u/ in only 43% of the cases (39% as /ø/, 13% as /y/), while /y/ was recognized as such in 69% of the cases (14% as /u/, 7% as /ø/).

This series of perception and production experiments highlights 3 groups of vowels that cause difficulties for Japanese-speaking learners: i) the high rounded vowels /u/, /y/ and the high-mid front rounded /ø/; ii) high-mid and low-mid vowels; iii) nasal vowels. These results correspond to the phonemic and phonetic differences lying between French and Japanese vowel systems.

3. Perception and production of the vowels /u/, /y/ and /ø/ in isolation³

The goal of the experiments presented in this section is to examine thoroughly the auditory discrimination and the production of the vowels /u/, /y/ and /ø/ in isolation by Japanese-speaking learners. These 3 vowels were chosen because they are among the 7 vowels (/i E a O u y œ/. /ø/ is part of the archiphoneme /œ/; /œ/ never appears in isolation)⁴ which, according to Lebel (1990), need to be distinguished to guarantee even a minimally reduced form of communication in French.

3.1. Auditory perception by Japanese-speaking learners: AXB discrimination

In order to study the perception of these 3 vowels by Japanese-speaking learners, an AXB discrimination test was administered with 14 native listeners of Japanese learning French. The pairs chosen for this experiment include /u/-/y/, /y/-/ø/, /u/-/ø/, as well as /i/-/e/, /u/-/o/ and /ɛ/-/a/. The results (Figure 4) reveal that the performance of discrimination was significantly poorer (Student's t-test) for the pair /u/-/ø/ (85%) than for /u/-/y/ (95%) and /ɛ/-/a/ (99%, not significantly inferior to 100%). The pair /u/-/ø/ is indeed more difficult to distinguish than /u/-/y/.

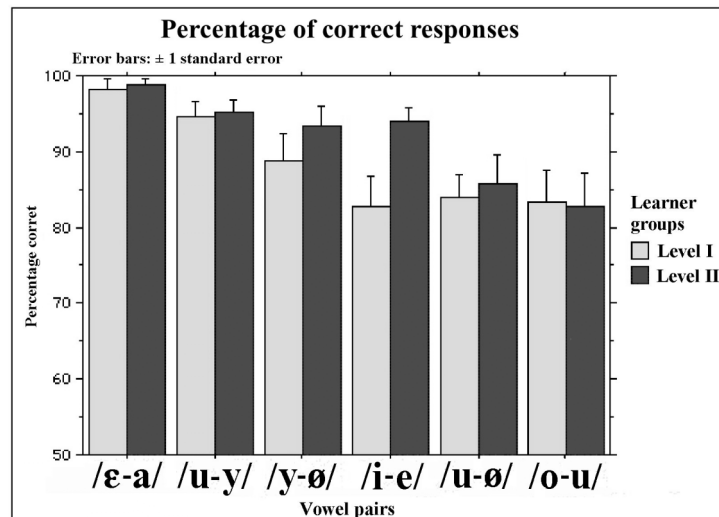


Figure 4: The results of the AXB discrimination task. Auditory perception of French vowels by Japanese learners. Mean score of each of the two groups (7 listeners in “level 1” and 7 in “level 2” groups), 2 repetitions of 72 triplets. Error bars represent 1 standard error.

3.2. Production of /u y ø/ by 47 Japanese-speaking learners

The acoustic study presented in Section 2 was complemented by an extensive study conducted with 47 Japanese-speaking learners at 3 different levels (beginners in their first year, intermediate, upper-intermediate), using a reading task with the same carrier sentence. The result indicates that only 4 learners pronounced /u/ with an F2 below 1000 Hz, while 20 of them produced /y/ with close F2/F3 at least once, and 31 of them produced /ø/ at least once with evenly distributed formants and with F2 around 1500 Hz. These data corroborate those presented in Section 2, in the sense that more learners (at all levels) pronounced /y/ with close F2/F3 than /u/ with close F1/F2 below 1000 Hz.

3.3. /u y ø/ produced by Japanese-speaking learners and perceived by native listeners of French

Tokens of /u/, /y/ and /ø/ produced by the learners in the previous experiments were presented to native listeners of French in an auditory perception test. The task of the participants (16 listeners) was to identify and rate 18 tokens each of /u/, /y/ and /ø/ pronounced by 5 Japanese-speaking learners. The stimuli were repeated 4 times. The tokens of /u/ with an F2 between 700 Hz and 800 Hz obtained a good rating score (more than 4 out of 5 in average), while those of the same vowel /u/ with an F2 between 1000 Hz and 1100 Hz (a male learner’s tokens) were perceived as /u/ and /ø/ almost equally often, with a much poorer rating score for /u/ (1.0 out of 5 in average). The other tokens of /u/, with an even higher F2 (between 1100 Hz and 1600 Hz) obtained rating scores ranging between 2.0 and 4.5 in average for /ø/, while the average score for /u/ was below 1.0. These results suggest that the tokens of /u/ produced by a great majority of Japanese-speaking learners in the previous experiments, with an F2 above 1000 Hz (16 stimuli out of 18), are indeed not perceived as good exemplars of /u/ but as /ø/. They thus confirm the difficulty encountered by Japanese-speaking learners in pronouncing this vowel. The tokens of /y/ and /ø/ pronounced by the learners were identified more correctly (12 tokens of /y/, 14 of /ø/ out of 18) by the native listeners of French.

3.4. Perception of synthesized stimuli

In order to study further the relation between the production, acoustics and perception of the vowels /u/, /y/ and /ø/, the following 2 series of stimuli synthesized by articulatory synthesis and formant synthesis were generated, and then used in an identification and rating task.

1) Articulatory synthesis (VTCalc: Maeda 1982): three series of continua were generated: A. between a (simulated) French [u] and [ø]; B. a French [u] with the tongue body moving gradually forward; C. a French [u] with the lips gradually less rounded and protruded.

2) Formant synthesis (Klatt's synthesizer: Klatt 1980): two series of continua were generated: A. F1 constantly at 300 Hz and F2 ranging from 600 Hz and 2200 Hz; B. F1 ranging from 300 Hz and 460 Hz, F2 from 600 Hz to 2200 Hz. F3 and F4 were set to 2350 Hz and 3600 Hz in both series.

These 2 types of stimuli were identified and rated as one of the French vowels by 16 native listeners of French. The results (Figure 5: left) show the following: i) both labialization and (back) tongue position play an important role in the F2 frequency and the perception of the French /u/; ii) vocoids simulating high back unrounded vowels are perceived mainly as /œ/; iii) the stimuli with an F2 above 1000 Hz are not perceived as good exemplars of the French /u/.

By contrast, 16 native listeners of Japanese (not learning French) who identified the same stimuli as one of the 5 Japanese vowels generally perceived the Japanese /u/ in zones where the French listeners recognized /u/ and /ø/ (Figure 5: right). This tendency suggests that Japanese listeners perceive the Japanese /u/ [u] in a larger acoustic zone than French listeners perceive their /u/, as far as F2 is concerned.

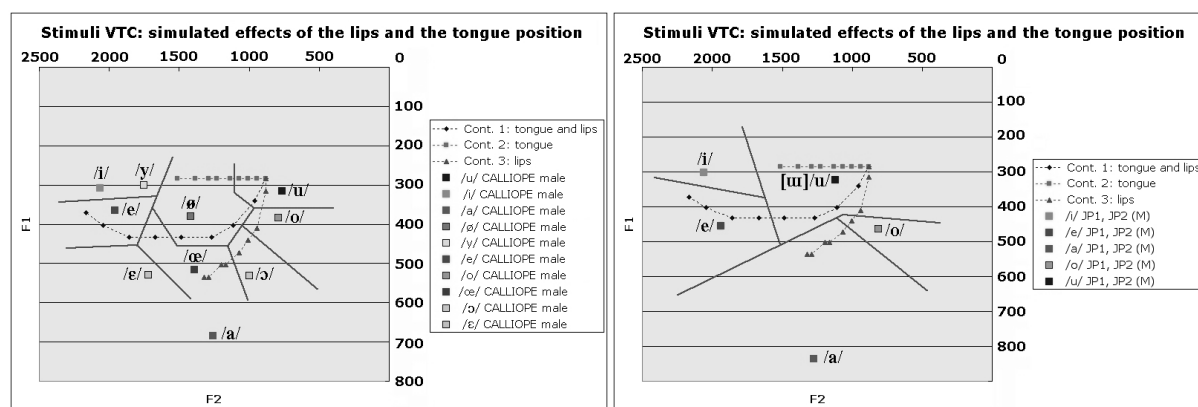


Figure 5: Division of the F1-F2 acoustic space according to the modal response of the stimuli; 1) (left) French-speaking listeners (64 responses per stimulus: 16 listeners x 4 responses), in comparison to the formant values of CALLIOPE (1989: measured in the syllable [pV_R] for [i ɛ a ɔ œ], [pV] for the other vowels, pronounced by 10 male speakers); 2) (right) Japanese-speaking listeners (64 responses per stimulus: 16 listeners x 4 responses), in comparison to the formant values of Kamiyama (2009: pronounced in the carrier sentence "sore-wa /V/ to iimasu [we call that /V/] by 2 male speakers x 6 repetitions).

3.5. Discussion

The results of these 4 experiments indicate and suggest the following points:

a) The high F2 of /u/ observed in the learners' productions is responsible for the high percentage of /ø/ answers (modal response for all 16 stimuli with an F2 above 1000 Hz) given by the native listeners of French, while tokens of /y/ with close F2/F3 were perceived more often as /y/ (modal response for 12 stimuli out of 18), as intended by the learners.

b) Japanese speakers perceive /u/ in the articulatory and acoustic zones where French speakers hear /u/ and /ø/, which explains the difficulty encountered by Japanese-speaking learners in distinguishing these two phonemes.

c) The French /u/ can be considered phonemically identical, in the sense that it occupies the same place (high non-front) in the L1 (Japanese) phonemic inventory, but differs phonetically from the corresponding phoneme in L1 (the Japanese /u/ [u]). This vowel is more difficult to learn to pronounce than the “new” vowel /y/, which does not have an L1 counterpart either phonemically or phonetically. These findings corroborate Flege’s (1987) results. However, the production of the French /ø/, another phonemically new vowel, causes even less difficulty. This tendency may be explained by the phonetic (acoustic) similarities between the French /ø/ and the Japanese /u/ [u]. The vowel /ø/ can thus be considered phonemically new, but phonetically similar. These cases are summarized in Table 4 below.

	Difficulty in production →			
	/a/	/ø/	/y/	/u/
Phonemically equivalent (same bundle of features)	+	-	-	+
Phonetically (acoustically) similar	+	+	-	-

Table 4: Difficulty of acquisition of production; in terms of phonemic equivalence and phonetic similarity.

The factors involved in the difficulty of /u/ are multiple: 1) articulatory difficulty: backing of the tongue, as well as lip rounding and protrusion is difficult to master for those who are not used to these articulatory gestures; 2) difficulty in explaining and understanding the tongue position explicitly and concretely because of the invisibility of the tongue body; 3) perceptual difficulty with phones which would be classified in the same phonemic category in the L1 vowel system (Kuhl *et al.* 1992: “Perceptual Magnet Effect”; Best 1995: “Perceptual Assimilation Model”); 4) lack of awareness of the difficulty of /u/; 5) the fact that the Japanese /o/ is realized with a lower F2 than that of the Japanese /u/.

4. Reflection on the teaching of pronunciation

The goal of this section is to bring a reflection on pronunciation teaching, taking into account the results obtained in the preceding sections.

4.1. Analysis of textbooks published in Japan

Seventy-one textbooks in French as a foreign language published in Japan were analyzed as an indication of how the vowels /u/, /y/ and /ø/ are typically treated in French classes taught in Japan. Most of them were conceived as course books to be used in elementary French classes in Japanese universities.

The results show the following: i) the differences between the French /u/ and the Japanese /u/ [u], and the difficulty in the production of the French /u/ are often neglected, even though the labialization of /u/ is more often mentioned than its tongue position; ii) the small acoustic distance between the French /ø/ and the Japanese /u/ is almost never treated. These findings suggest that both learners and (especially, Japanese-speaking) teachers are

rarely aware of these difficulties in the course of the teaching-learning processes of French as a foreign language in Japan.

4.2. Illustration of some teaching methods of pronunciation

Some methods of pronunciation teaching (some traditional, others relatively new) are presented in terms of how they foster learners' awareness of these difficulties, with some concrete examples of the case of the French /u/ learned by Japanese-speaking learners.

1) The Verbo-Tonal Method already in use: the idea of combining the auditory impression of “deepness” of /u/ due to a concentration of energy in the low frequency zone, with a low fundamental frequency (F0); back articulation of /u/ with velar and uvular consonants.

2) Use of a continuum of cardinal vowels: articulating [a] first, and then gradually moving toward [ɔ] and [o] to reach the French [u].

3) Acoustic images, combined with gestures and colors: *e.g.* “deep” acoustic image of the French [u] (due to a concentration of energy in the low frequency zone) with a dark color.

4) Articulatory synthesis (VTCalc, TractSyn: Birkholz 2006).

5) Spectral representation.

6) Real-time spectrogram (WaveSurfer: Sjölander and Beskow 2000), especially useful in learning focal vowels (Figure 6).

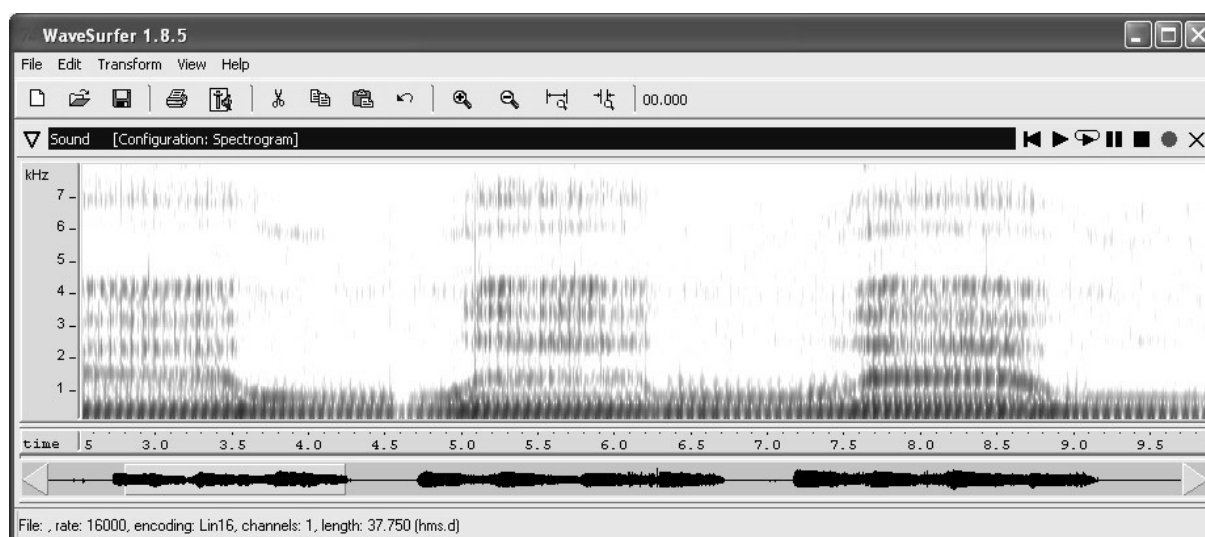


Figure 6: An example of real-time spectrogram display (WaveSurfer): alternation between a Japanese [u] (/u/) and a French [u].

5. Conclusion

The present research work is expected to contribute, in theoretical terms, to elucidating the learning and teaching processes of the pronunciation of foreign languages, and, in practical terms, to improving the teaching and learning of French pronunciation to/by Japanese-speaking learners. In particular, it illustrates the cases of phones which are new or not phonemically and/or phonetically.

This study examined oral vowels in isolation. The acoustic image of a phoneme depends on the position in the syllable structure, in the word, and in relation to the lexical accent, to surrounding phonemes and to the prosodic context. The phonetic realization of the French /u/ is variable in real context (see the results of Gendrot and Adda-Decker 2004). It is important to work on the same phonemes in various syllabic and prosodic contexts in pronunciation activities in language classes, as illustrated by Wioland (1991), Lauret (2007),

or in pronunciation textbooks such as Abry and Chalaron's (1994) and Charliac *et al.*'s (2003). Patterns of coarticulation between phonemes depend on the language in question.

It is also essential nowadays to make use of digital tools that could facilitate pronunciation learning and teaching. Visual representation of various phonetic characteristics, such as formants and their grouping (for the French /u/ and /y/, for instance), F0 curve, *etc.* might help learners raise awareness.

Notes

* The present article summarizes the doctoral dissertation “*Apprentissage phonétique des voyelles orales du français langue étrangère chez des apprenants japonophones*” (Kamiyama 2009) presented to the University of Paris 3 – Sorbonne Nouvelle – and publicly defended in 28 November 2009 after examination by a committee composed of Dr. Jean-Yves Dommergues, Dr. Pierre Hallé, Dr. Shinji Maeda, Dr. Rudolph Sock, Dr. Jacqueline Vaissière, and Dr. François Wioland. The author would like to express his gratitude to his research advisor Dr. Jacqueline Vaissière, all members of the defense committee, and all those who contributed directly and/or indirectly to the completion of the dissertation.

¹ Boersma (2001).

² The results of some of the experiments (2.2., 2.3. and 2.4.) were published in Kamiyama (2006).

³ The results of some of the experiments were published in Kamiyama and Vaissière (2009: experiments in 3.1., 3.2. and 3.3.), Kamiyama (2010: part of the experiment in 3.4.).

⁴ In Parisian French, high-mid and low-mid vowels are in a limited distribution, the opposition between the two series being neutralized in some contexts. “Archiphonemes”, term proposed by some French phonologists and phoneticians, refer in this case to the “merged” categories of mid-vowels.

References

- Abry, Dominique, and Marie-Laure Chalaron. 1994. *350 exercices de phonétique*. Paris: Hachette.
- Best, Catherine T. 1995. A direct realist view of cross-language speech perception. *Speech perception and linguistic experience: Issues in cross-language research*, ed. by Winifred Strange, 171-204. Baltimore: York Press.
- Birkholz, Peter, Dietmar Jackel, and Bernd J. Kröger. 2006. Construction and control of a three-dimensional vocal tract model. *Proceedings of the International Conference on Acoustics, Speech, and Signal Processing 2006*, vol. I. 873-876.
- Boersma, Paul. 2001. Praat, a system for doing phonetics by computer. *Glott International* 5:9/10. 341-345.
- Bothorel, André, Péla Simon, François Wioland, and Jean-Pierre Zerling. 1986. *Cinéradiographie des voyelles et consonnes du français*. Strasbourg: Publications de l'Institut de Phonétique de Strasbourg.
- CALLIOPE. 1989. *La parole et son traitement automatique*. Paris, Milano, Barcelona, Mexico: Masson.
- Charliac, Lucile, Anne-Claude Motron, Jean-Thierry Le Bougnec, and Bernard Loreil. 2003. *Phonétique progressive du français (niveau débutant)*. Paris: CLE International.
- Flege, James-Emil. 1987. The production of “new” and “similar” phones in a foreign language: evidence for the effect of equivalence classification. *Journal of Phonetics* 15. 47-65.
- Gendrot, Cédric and Martine Adda-Decker. 2004. Analyses formantiques automatiques de voyelles orales: évidence de la réduction vocalique en langues française et allemande. *Proceedings of the Workshop MIDL (Modélisation et IDentification des Langues) 2004*. 7-12.
- Hillenbrand, James, Laura A. Getty, Michael J. Clark, and Kimberlee Wheeler. 1995. Acoustic characteristics of American English vowels. *Journal of the Acoustical Society of America* 97 (5). 3099-3111.
- Jones, Daniel, Peter Roach, James Hartman, Jane Setter (eds.) 2006. *Cambridge English pronouncing dictionary* (17th edition). Cambridge: Cambridge University Press.
- Kamiyama, Takeki. 2006. La production et la perception des voyelles orales françaises par les apprenants japonophones. *Proceedings of the XXVIèmes Journées d'étude sur la Parole*. 49-52.

- Kamiyama, Takeki. 2009. *Apprentissage phonétique des voyelles du français langue étrangère chez des apprenants japonophones*. Doctoral dissertation in phonetics. Paris: Université Paris 3 – Sorbonne Nouvelle dissertation.
- Kamiyama, Takeki. 2010. Perception de vocoïdes postérieurs fermés synthétisés: l'effet de la configuration labiale et de la position de la langue sur les auditeurs francophones et japonophones. *Proceedings of the XXVIIIèmes Journées d'étude sur la Parole*. 297-300.
- Kamiyama, Takeki and Jacqueline Vaissière. 2009. Perception and production of French close and close-mid rounded vowels by Japanese-speaking learners. *Revue AILE... LIA* 2, ed. by Jean-Yves Dommergues, 9-41.
- Klatt, Denis H. 1980. Software for a cascade/parallel formant synthesizer. *Journal of the Acoustical Society of America* 67(3). 971-95.
- Kuhl, Patricia, Karen A. Williams, Francisco Lacerda, Kenneth N. Stevens and Bjorn Lindblom. 1992. Linguistic experience alters phonetic perception in infants by 6 months of age. *Science* 255. 606-608.
- Lauret, Bertrand. 2007. *Enseigner la prononciation du français: questions et outils*. Paris: Hachette.
- Lebel, Jean-Guy. 1990. *Traité de correction phonétique ponctuelle*. Québec, QC: Centre international de Recherche en aménagement linguistique.
- Maeda, Shinji. 1982. A digital simulation method of the vocal tract system. *Speech Communication* 1(3-4). 199-229.
- Martinet, André. 1969. *Le français sans fard*. Paris: Presses Universitaires de France.
- Mokhtari, Parham, and Kazuyo Tanaka. 2000. A corpus of Japanese vowel formant patterns. *Bulletin of Electrotechnical Laboratory* 64 (special issue). 57-66.
- Ostiguy, Luc, Robert Sarrasin, and Glenwood Irons. 1996. *Introduction à la phonétique comparée: les sons: le français et l'anglais nord-américains*. Sainte-Foy, QC: Les Presses de l'Université Laval.
- Sjölander, Kåre, and Jonas Beskow. 2000. Wavesurfer - an open source speech tool. *Proceeding of the Sixth International Conference on Spoken Language Processing*, vol. 4. 464-467.
- Sugitô, Miyoko 1995 CD-ROM [CD-ROM
Accent Dictionary of Spoken Osaka and Tokyo Japanese: explanatory booklet]
- Uemura, Yukio 1990 [Vowels, consonants and syllables in Japanese: an experimental phonetic study on articulatory gestures]
- Vaissière, Jacqueline. 2006. *La phonétique*. Paris: Presses Universitaires de France.
- Vaissière, Jacqueline. 2007. Area functions and articulatory modeling as a tool for investigating the articulatory, acoustic and perceptual properties of sounds across languages. *Experimental Approaches to Phonology*, ed. by Maria-Josep Solé, Patrice Speeter Beddor, Manjari Ohala, 54-71. Oxford: Oxford University Press.
- Wells, John. 1982. *Accents of English*. Cambridge: Cambridge University Press.
- Wioland, François. 1991. *Prononcer les mots du français: des sons et des rythmes*. Paris: Hachette.