

A Cluster Analysis of the German Vowel System¹⁾

Takeshi Yamamoto²⁾

1. Introduction

Few objections seem to exist against the view that German stressable monophthongs have long-short oppositions. It is clearly due to the fact that “long vowels” are clearly monophthongal in this language, which can be contrasted to American English, where high “long vowels” /i:, u:/ are sometimes diphthongized and mid “diphthongs” /eɪ, oʊ/ are sometimes monophthongized. In Dutch, another West Germanic language, “long” mid vowels /e:, ø:, o:/ are diphthongized (Booij (1995: 5), Gussenhoven (1999: 76)). It must be said that vowels in these cases are classified as long vowels or diphthongs rather arbitrarily.

With regard to American English mentioned in the preceding paragraph, Yamamoto (2006) proposes an analysis in which all the bimoraic vowels are represented as two-member clusters of five short vowels. Some of his analyses are given in (1).

(1) Yamamoto's (2006) cluster analysis of some American English vowels

| | Wells's (2000) phonemic transcription | Typical phonetic values in IPA | Analysis |
|---------------------------------|---|--------------------------------------|----------|
| "Short vowels" | | | |
| K <u>I</u> T | /ɪ/ | [ɪ] | //ɪ// |
| D <u>R</u> ESS | /e/ | [ɛ] | //ɛ// |
| TR <u>A</u> P/B <u>A</u> TH | /æ/ | [æ: ~ ɛɔ] | //ɛΛ// |
| STR <u>U</u> T | /ʌ/ | [ɜ ~ ʌ] | //Λ// |
| FO <u>O</u> T | /ʊ/ | [ʊ] | //ʊ// |
| "Long vowels" and "diphthongs" | | | |
| F <u>L</u> EECE | /i:/ | [i: ~ i̠] | //i// |
| F <u>A</u> CE | /eɪ/ | [eɪ] | //eɪ// |
| PR <u>I</u> CE | /aɪ/ | [ɸɪ ~ qɪ ~ aɪ] | //aɪ// |
| CH <u>O</u> ICE | /ɔɪ/ | [ɔɪ] | //ɔɪ// |
| GO <u>O</u> SE | /u:/ | [u: ~ u̠] | //ʊʊ// |
| GO <u>A</u> T | /oʊ/ | [oʊ] | //ɔʊ// |
| M <u>O</u> UTH | /aʊ/ | [æʊ ~ ɸʊ ~ qʊ ~ aʊ] | //ʌʊ// |
| B <u>O</u> MB/B <u>A</u> LM | /ɑ:/ | [ɸɑ: ~ qɑ:] | //ΛΛ// |
| CLO <u>T</u> H/TH <u>O</u> UGHT | /ɔ:/ | [ɔ: ~ ɔ:] | //ɔΛ// |

The purpose of the present paper is to explore the possibility of applying a cluster analysis of a similar kind to German vowels and to consider what kind of merit can be obtained.

2. Basic analysis

Below are the vowels of German we are going to deal with.

(2) German vowels

| Phonemic transcription | Typical phonetic value ³⁾ | Example word | Gloss |
|------------------------|--------------------------------------|-----------------------------|------------|
| Short vowels | | | |
| 1. /ɪ/ | [ɪ] | <i>b<u>ī</u>tt<u>er</u></i> | ‘bitter’ |
| 2. /ʏ/ | [ʏ] | <i>M<u>ü</u>tt<u>er</u></i> | ‘mothers’ |
| 3. /ʊ/ | [ʊ] | <i>M<u>u</u>tt<u>er</u></i> | ‘mother’ |
| 4. /ɛ/ | [ɛ] | <i>b<u>e</u>tt<u>er</u></i> | ‘better’ |
| 5. /œ/ | [œ] | <i>G<u>ö</u>tt<u>er</u></i> | ‘gods’ |
| 6. /ɔ/ | [ɔ] | <i>G<u>o</u>tt</i> | ‘god’ |
| 7. /a/ | [A] ⁴⁾ | <i><u>a</u>lt</i> | ‘old’ |
| Long vowels | | | |
| 8. /i:/ | [i:] | <i>K<u>ni</u>e</i> | ‘knee’ |
| 9. /y:/ | [y:] | <i>Br<u>ü</u>d<u>e</u>r</i> | ‘brothers’ |
| 10. /u:/ | [u:] | <i>Br<u>u</u>d<u>e</u>r</i> | ‘brother’ |
| 11. /e:/ | [e:] | <i>z<u>e</u>hn</i> | ‘ten’ |
| 12. /ø:/ | [ø:] | <i>Ö<u>l</u></i> | ‘oil’ |
| 13. /o:/ | [o:] | <i>r<u>o</u>t</i> | ‘red’ |
| 14. /ɛ:/ ⁵⁾ | [ɛ:] | <i>V<u>ä</u>t<u>e</u>r</i> | ‘fathers’ |
| 15. /a:/ | [A:] | <i>V<u>a</u>t<u>e</u>r</i> | ‘father’ |
| Diphthongs | | | |
| 16. /ɔʏ/ | [ɔʏ ~ ɔɪ] | <i>E<u>u</u>l<u>e</u></i> | ‘owl’ |
| 17. /aɪ/ | [Aɪ] | <i>r<u>e</u>ich</i> | ‘rich’ |

18. /au/ [ʌʊ] Auge ‘eye’

Unstressable vowel

19. /ə/ [ə] beginnen ‘begin’

Four nasalized vowels occurring only in loans are not taken into account, which Mangold (2005: 35) includes among the vowel phonemes as /õ:, ê:, œ:, â:/. Unstressable [ə] as in *Wasser* ‘water’ and centering diphthongs such as [i:ɐ] as in *Bier* ‘beer’ are excluded because they are regarded as /ər/ and long vowels followed by /r/, respectively, just as they are treated by Mangold (2005: 35).

Among the vowel phonemes in (2), long and short vowels are widely assumed to be paired as in (3).⁶⁾

(3) German long-short vowel pairs

| Phonemic transcription | Typical phonetic value | Example word | Gloss |
|------------------------|------------------------|----------------------|------------|
| /i:/ | [i:] | <i><u>K</u>nie</i> | ‘knee’ |
| /ɪ/ | [ɪ] | <i><u>b</u>itter</i> | ‘bitter’ |
| /y:/ | [y:] | <i><u>B</u>rüder</i> | ‘brothers’ |
| /ʏ/ | [ʏ] | <i><u>M</u>ütter</i> | ‘mothers’ |
| /u:/ | [u:] | <i><u>B</u>ruder</i> | ‘brother’ |
| /ʊ/ | [ʊ] | <i><u>M</u>utter</i> | ‘mother’ |
| /e:/ | [e:] | <i><u>z</u>ehn</i> | ‘ten’ |
| /ɛ/ | [ɛ] | <i><u>b</u>esser</i> | ‘better’ |
| /ø:/ | [ø:] | <i><u>Ö</u>l</i> | ‘oil’ |

This difference between “tenseness” and “laxness” found in Germanic languages is, however, questioned on phonetic grounds by some researchers including Ladefoged and Maddieson (1996: 302–06), who deny that this distinction is the same as the ATR distinction of West African languages such as Igbo and Akan and conclude that the advancement of the tongue root found in Germanic languages is simply one of the concomitants of vowel height.

What concerns us here in this paper is to pursue an analysis without such a phonological feature, in which “tenseness” is derived from other natures of vowels. This will enable us to explain why only /a:/ and /ɛ:/ are “lax” long vowels. However, it seems to be too hasty to assume that “tenseness” is simply a concomitant of height as Ladefoged and Maddieson indicate, because, in that case, we will have to distinguish four heights in the German vowel system, leading to an unwelcome complexity for phonological analysis.

Considering the issues mentioned above, analyzing long vowels into clusters of two short vowels will be a solution, thereby attributing the “tense” or higher nature of long vowels to clustering, and avoiding the increase of height features.

However, an analysis in which long vowels are represented merely as double short ones, e.g., /o:/ as //ɔɔ//,⁸⁾ would be of no use for two reasons. First, such an analysis is no different from the one under which long vowels are regarded as lengthened versions as short ones, e.g., /o:/ as //ɔ:/, in that the “tense” or higher nature of /o:/ compared with the “lax” counterpart /ɔ/ cannot be derived. Second, representing /o:/ as //ɔɔ//, and consequently /e:/ as //ɛɛ//, will imply the existence of unattested diphthongs such as //æɛ// and //ɛɔ//, which means that such a system will overgenerate vowels.

To prevent the second problem mentioned above, we propose that

German long vowels be underlyingly falling diphthongs. Considering that the three diphthongs /ɔʏ, aɪ, aʊ/ in (2), as well as many diphthongs in other languages, are falling ones ending in high vowels and can be analyzed as two consecutive short vowels as in (5), the long high and mid vowels can also be regarded as clusters of the same kind as in (6).

(5) German diphthongs

| Phonemic transcription | Typical phonetic value | Analysis |
|------------------------|------------------------|--------------------------------|
| /ɔʏ/ | [ɔ̟̞ ~ ɔ̟̞̞] | //ɔʏ// or //ɔɪ// ⁹⁾ |
| /aɪ/ | [aɪ̟] | //aɪ// |
| /aʊ/ | [aʊ̟] | //aʊ// |

(6) German long high and mid vowels

| Phonemic transcription | Typical phonetic value | Analysis |
|------------------------|------------------------|----------|
| /i:/ | [i:] | //ɪɪ// |
| /y:/ | [y:] | //ʏʏ// |
| /u:/ | [u:] | //ʊʊ// |
| /e:/ | [e:] | //ɛɪ// |
| /ø:/ | [ø:] | //œʏ// |
| /o:/ | [o:] | //ɔʊ// |

What this analysis shows is that these long vowels are underlyingly falling diphthongs with a high vowel as their second element, whose first and second elements coalesce and appear as monophthongs in the surface. Their “tense” or higher nature compared with the “lax” counterparts can be attributed to their high second element.

Admitting that long high and mid vowels are underlyingly falling diphthongs ending in high vowels, the long low vowel cannot be assumed as one of the same kind. Taking into account that centering diphthongs

ending in schwa are also common among languages,¹⁰⁾ the long low vowel will be analyzed in the following way.

(7) Long low vowel

| Phonemic transcription | Typical phonetic value | Analysis |
|------------------------|------------------------|----------|
| /a:/ | [A:] | //Aə// |

Note that, unlike high second elements, //ə// does not raise nor lower the preceding element but functions merely as length.¹¹⁾ This inert nature of schwa is found in the process of syllabic sonorant formation as in (8).

(8) *Luxemburg* ‘Luxembourg’ /əɪm/ → [ɪɪ]

sitzen ‘sit’ /əɪn/ → [ɪɪ]

doppel ‘double’ /əɪl/ → [ɪɪ]

Wasser ‘water’ /əɪr/ → [ɪɪ]¹²⁾

Now that //ə// is admitted as a vocalic element functioning merely as length, the long but “lax” mid vowel can be represented in the following way.¹³⁾

(9) Long lax mid vowel

| Phonemic transcription | Typical phonetic value | Analysis |
|------------------------|------------------------|----------|
| /ɛ:/ | [ɛ:] | //ɛə// |

Thus, German long vowels are analyzed as diphthongs having a homorganic second element //ɪ, ʏ, ʊ, ə//, i.e., an element agreeing in [front], [back] and [round] with the first element. The high second elements //ɪ, ʏ, ʊ// result in “tenseness” of long front or back vowels, and

//ə// keeps the long central vowel “lax.” The exception is the front but “lax” long vowel /ɛ:/ analyzed as //ɛə//, whose exceptionality can probably be attributed to the fact that this vowel is umlauted from /a:/ analyzed as //Aə// and to the fact that //ə// is transparent to the umlauting process.¹⁴⁾

3. Further analysis

To summarize our analysis conducted so far, it is convenient to give the following diagrams, in which bimoraic vowels, i.e., long vowels and diphthongs, are classified according to the ending elements.

(10) Monomoraic

| | | |
|---|---|---|
| I | Y | U |
| ɛ | œ | ɔ |
| | A | |

Bimoraic

| a. //ɪ// | b. //ɥ// | c. //u// | d. //ə// |
|-----------|-----------|----------|----------|
| II — — | — YY — | — — UU | — — — |
| ɛI — (ɔI) | — œY (ɔY) | — — ɔU | ɛə — — |
| AI | — | AU | Aə |

What remains to be determined is the analysis of /ɔY/, which is allophonically realized as [ɔɥ ~ ɔɪ]. The naturalness of analysis will not help in this case in that the assumed process seems sufficiently natural whether it is assumed that the second element of //ɔɪ// is rounded by the preceding rounded element, or that the second element of //ɔY// is unrounded because of the markedness of a diphthong terminating with

//y//.

However, from a viewpoint of the vowel system as a whole, this diphthong seems to be //ɔɪ//. Taking into account the existence of the marginal diphthong [ɔɪ] found in the interjections *hwi* ‘whoosh’ and *pfwi* ‘ugh’,¹⁵⁾ it seems that //ɪ// can follow all the non-umlauted vowels, whereas //y// can follow both the umlauted vowels, i.e., //ɤ, œ//. In addition, //ʊ// can follow all the non-front vowels, and //ə// can follow unrounded vowels. Furthermore, the fact that //ə// cannot follow //ɪ// can also be explained by presuming that the first element has to be more sonorous than, or as sonorous as, the second element in the following sonority hierarchy, which is solely determined by height.

- (11) More sonorous ← → Less sonorous
 //A// > //ɛ// = //œ// = //ɔ// > //ə// > //ɪ// = //y// = //ʊ//

As for the two vowels terminating with //y//, we might be able to advance our analysis one step further. Vowels terminating with //y// are considered marked, as pointed out above, and the two vowels are in complementary distribution either with the vowels terminating in //ɤ// or with those terminating in //ʊ//. This situation can be schematized as below.

- (12) a. //ɪ// b. //ɤ// c. //ʊ// d. //ə//

| | | | | | | | | | | |
|---|------|----|---|---|---|------|----|----|----|---|
| ɪ | (yɪ) | — | — | — | — | (yʊ) | ʊʊ | — | — | — |
| ɛ | (œɪ) | ɔɪ | — | — | — | (œʊ) | ɔʊ | ɛə | — | — |
| | ʌɪ | | — | | | ʌʊ | | | ʌə | |

It is not easy to decide whether /y:/ and /ø:/ are //yɪ// and //œɪ//, respectively, or //yʊ// and //œʊ//.

A phonological phenomenon that will determine the analyses of /y:/ and /ø:/ is the distribution of the allophones of the voiceless dorsal fricative. This phoneme, often represented as /x/, but sometimes as /ç/,¹⁶ is realized as [χ ~ x]¹⁷ (*ach-Laut*) before back or central vowels /u:, ʊ, o:, ɔ, a:, a, au/ (excluding /ə/¹⁸) and as [ç] (*ich-Laut*) elsewhere as seen in the following examples.

- | | | |
|------|-------------------|--|
| (13) | [u:χ]/[y:ç] | <i>B<u>u</u>ch</i> ‘book’/ <i>B<u>ü</u>cher</i> ‘books’ |
| | [ʊχ]/[yç] | <i>Fr<u>u</u>cht</i> ‘fruit’/ <i>Fr<u>ü</u>chte</i> ‘fruits’ |
| | [o:χ]/[ø:ç] | <i>h<u>o</u>ch</i> ‘high’/ <i>h<u>ö</u>chst</i> ‘highest’ |
| | [ɔχ]/[œç] | <i>T<u>o</u>chter</i> ‘daughter’/ <i>T<u>ö</u>chter</i> ‘daughters’ |
| | [A:χ]/[ɛ:ç] | <i>spr<u>a</u>ch</i> ‘spoke’ (1st/3rd sg. past)/ <i>spr<u>ä</u>che</i> ‘spoke’ (1st/3rd sg. conjunctive II) |
| | [Aχ]/[ɛç] | <i>N<u>a</u>cht</i> ‘night’/ <i>N<u>ä</u>chte</i> ‘nights’ |
| | [Aʊχ]/[ɔʏç ~ ɔɪç] | <i>rau<u>ch</u>en</i> ‘smoke’ (vi)/ <i>r<u>ä</u>uch<u>e</u>rn</i> ‘smoke (meat or fish)’ (vt) |

Because the place of articulation of this consonant phoneme is determined by the immediately preceding element, /y:/ and /ø:/ have to terminate with a front vowel, i.e., //yɪ// and //œɪ//, respectively, instead of //yʊ// and //œʊ//, where the second back element //ʊ// would induce [χ ~ x]. As for /a:/ and /ɛ:/ analyzed as //Aə// and //ɛə//, respectively, the place of articulation of the consonant is determined by the first elements //A// and //ɛ// because of the transparency of the placeless //ə//. Thus, the indeterminacies in (12) have been resolved as in (14).

- (14) a. //ɪ// b. //ɣ// c. //ʊ// d. //ə//

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|----|----|---|
| ɪ | ɣ | — | — | — | — | — | ʊ | — | — | — |
| ɛ | œ | ɔ | — | — | — | — | ɔ | ɛə | — | — |
| | ʌ | | — | | | | ʌ | | ʌə | |

An analysis of German vowels should also correspond with the umlauting facts. The umlauting processes play a considerable part in German morphology as the following examples show.

- (15) /ʊ/ → /ɣ/
- Muter*
- ‘mother’/
- Mütter*
- ‘mothers’

/ɔ/ → /œ/ *Gott* ‘god’/*Götter* ‘gods’/a/ → /ɛ/ *Hand* ‘hand’/*Hände* ‘hands’/u:/ → /y:/ *Bruder* ‘brother’/*Brüder* ‘brothers’/o:/ → /ø:/ *hoch* ‘high’/*höchst* ‘highest’/a:/ → /ɛ:/ *Vater* ‘father’/*Väter* ‘fathers’/ʌʊ/ → /ɔɣ/ *Maus* ‘mouse’/*Mäuse* ‘mice’

German umlauting is basically a process where non-front, i.e., central and back, vowels except schwa turns into front ones, with the height and roundness unchanged. Exceptions are the low vowels, /a, ʌ:/, and the diphthong /ʌʊ/; the former lose their lowness, and the latter turns into /ɔɣ/ instead of the expected */ɛɣ/ or */ʌɣ/.¹⁹⁾ These facts, except for the diphthong case, can be confirmed by the following feature matrix, which is extracted and adapted from Wiese shown above as (4).

(16) Extracted from Wiese (1996: 20, 152), boxes added

| | ʊ | ʏ | ɔ | œ | a | ɛ | ui | y: | oi | ø: | a: | ɛ: |
|-------------|---|---|---|---|---|---|----|----|----|----|----|----|
| consonantal | - | - | - | - | - | - | - | - | - | - | - | - |
| high | + | + | - | - | - | - | + | + | - | - | - | - |
| low | - | - | - | - | + | - | - | - | - | - | + | - |
| front | - | + | - | + | - | + | - | + | - | + | - | + |
| back | + | - | + | - | - | - | + | - | + | - | - | - |
| round | + | + | + | + | - | - | + | + | + | + | - | - |
| ATR | - | - | - | - | - | - | + | + | + | + | - | - |
| long | - | - | - | - | - | - | + | + | + | + | + | + |

Our cluster analysis of the umlauting processes in (15) will give the following.

- (17) //ʊ// → //ʏ// *Mutter* ‘mother’/*Mütter* ‘mothers’
//ɔ// → //œ// *Gott* ‘god’/*Götter* ‘gods’
//ʌ// → //ɛ// *Hand* ‘hand’/*Hände* ‘hands’
- //ʊʊ// → //ʏʏ// *Bruder* ‘brother’/*Brüder* ‘brothers’
 //ɔʊ// → //œʏ// *hoch* ‘high’/*höchst* ‘highest’
 //ʌə// → //ɛə// *Vater* ‘father’/*Väter* ‘fathers’
 //ʌʊ// → //ɔʏ// *Maus* ‘mouse’/*Mäuse* ‘mice’

In our analysis, umlauting of bimoraic vowels can be regarded as affecting the first and second morae individually: the first mora is umlauted just as monomoraic vowels, and, as for the second mora, //ʊ// turns into //ʏ// instead of the expected //ʏ// to avoid its markedness, whereas //ə// does not participate in the process just as individual schwa does not. As regards diphthongs, //ʌʊ// behaves exceptionally also in our analysis.²⁰⁾ Incidentally, //ʌʏ// does not take part in umlauting in spite of its

umlautable first element, probably because its second front element blocks the process.

4. Conclusion

The following table recapitulates our cluster analysis of the German vowel system.

(18) German vowels

| Phonemic transcription | Typical phonetic value | Example word | Gloss | Our cluster analysis |
|------------------------|------------------------|---------------|------------|----------------------|
| Short vowels | | | | |
| 1. /ɪ/ | [ɪ] | <i>bitter</i> | 'bitter' | //ɪ// |
| 2. /ʏ/ | [ʏ] | <i>Mütter</i> | 'mothers' | //ʏ// |
| 3. /ʊ/ | [ʊ] | <i>Mutter</i> | 'mother' | //ʊ// |
| 4. /ɛ/ | [ɛ] | <i>besser</i> | 'better' | //ɛ// |
| 5. /œ/ | [œ] | <i>Götter</i> | 'gods' | //œ// |
| 6. /ɔ/ | [ɔ] | <i>Gott</i> | 'god' | //ɔ// |
| 7. /a/ | [a] | <i>alt</i> | 'old' | //a// |
| Long vowels | | | | |
| 8. /i:/ | [i:] | <i>Knie</i> | 'knee' | //i:// |
| 9. /y:/ | [y:] | <i>Brüder</i> | 'brothers' | //y:// |
| 10. /u:/ | [u:] | <i>Bruder</i> | 'brother' | //u:// |
| 11. /e:/ | [e:] | <i>zehn</i> | 'ten' | //e:// |
| 12. /ø:/ | [ø:] | <i>Öl</i> | 'oil' | //ø:// |
| 13. /o:/ | [o:] | <i>rot</i> | 'red' | //o:// |
| 14. /ɛ:/ | [ɛ:] | <i>Väter</i> | 'fathers' | //ɛ:// |

15. /a: / [A:] Vater ‘father’ //Aə//

Diphthongs

16. /ɔʏ / [ɔɪ̯ ~ ɔ̯ɪ] Eule ‘owl’ //ɔɪ//

17. /aɪ / [Aɪ̯] reich ‘rich’ //Aɪ//

18. /aʊ / [Aʊ̯] Auge ‘eye’ //Aʊ//

Unstressable vowel

19. /ə / [ə] beginnen ‘begin’ //ə//

It is concluded from (18) and, conveniently, (14) above that the German vowel system has the following natures, where the sonority hierarchy is given in (11) above.

- (19) a. //ə// is not allowed in the first mora of stressable vowels.
 b. Only //ɪ, ʊ, ə// are allowed in the second mora.
 c. The first mora is more sonorous than, or as sonorous as, the second mora.
 d. //ɪ// in the second mora follows all the vowels (as far as the condition (a) is met) if marginal [ʊɪ] is included.
 e. //ʊ// in the second mora follows all the [- front] vowels (as far as the condition (a) is met).
 f. //ə// in the second mora follows all the [- round] vowels (as far as the conditions (a) and (c) are met).
 g. All the [- low] vowels in the first mora and //ɪ, ʊ// in the second mora coalesce into bimoraic “tense” monophthongs, their “tenseness” caused by the [+ high] feature of the //ɪ, ʊ//.
 h. Vowels in the first mora and //ə// in the second mora coalesce into bimoraic “lax” monophthongs, their “laxness” inherited

from the original first mora.

Note also that the conditions (e) and (f) can be paraphrased as constraints that prohibit the co-occurrence of [+ front] vowels and //ʊ// and that of [+ round] vowels and //ə//, respectively. The former constraint will also account for the marginality of [ʊ_I] mentioned in condition (d).

The most important recapitulation is our success in representing the German vowel system without recourse to the problematical feature [tense] or [ATR], and this new system can treat such phonological processes as voiceless dorsal fricative assimilation and umlauting.

Many works on German phonetics and phonology, e.g., Mangold (2005: 21, 36), mention that /ɛ:/ tends to be replaced by /e:/. In our framework, this fact is represented in the following way.

(20) //ɛə// → //ɛɪ//

The sequence of //ɛə//, i.e., [+ front, – back] plus [– front, – back], is marked and likely to change into //ɛɪ//, i.e., two [+ front, – back] segments, by assimilation.

Notes

- 1) This study is partly supported by Hiroshima Jogakuin Daigaku Gakujutsu Kenkyu Josei [Hiroshima Jogakuin University Grant-in-Aid for Scientific Research] 2007, “Ryushi On’inron no Kakucho ni-yoru Boin Taikei no Kenkyu [Studies on Vowel Systems by Extension of Particle Phonology].”
- 2) The author can be contacted at <Takeshi.Yamamoto@ma6.seikyuu.ne.jp>.
- 3) The phonetic values are based on Kohler’s (1999: 87) vowel diagram, represented in the IPA by the present author.
- 4) Here and hereafter, [A] represents a fully low central unrounded vowel, [ɶ] (Cf. Pullum and Ladusaw (1996: 14)).

- 5) The current status of this phoneme will be mentioned in the conclusion.
- 6) Lass (1976: 44–49) compares the vowel systems of Mangalore Kannaḍa, Swedish, and modern Standard North German. He argues for long-short vowel pairing in the former two languages on phonetic and morphophonemic grounds, respectively, but argues against such pairing in German. However, it seems that the possible replacement of unstressed [ɪ, ʏ, ʊ] with [i:, y:, u:], respectively, before /r/ in word-final or pre-consonantal position in standard speech (*Saphir* ‘sapphire’, *Zephyr* ‘zephyr’, *Femurs* ‘of femur’ (*gen.*)) (Mangold (2005: 43)) and that of [i, y, u, e, ø, o] (< /i:, y:, u:, e:, ø:, o:/) with [ɪ, ʏ, ʊ, ε, œ, ɔ], respectively, in non-word-final and pre-consonantal position in a conversational variety (*Methylen* ‘methylene’, *Politologie* ‘political science’, *voluminös* ‘voluminous’) (Mangold (2005: 65)) support such pairing.
- 7) Wiese (1996) also gives a radically underspecified feature matrix of German vowels and a contrastively underspecified one (pp. 153 and 163, respectively).
- 8) Here and hereafter, analytic forms are enclosed in double slashes as in (1).
- 9) To be discussed later.
- 10) It is well known that British English has [ɪə, ʊə, eə].
- 11) The three British English diphthongs mentioned in the previous note are also realized as [ɪ:, ʊ:, e:] (Cruttenden (2001: 143–46)), which means that schwa clearly functions as mere length.
- 12) [ɐ] is the vocalized version of /r/ in this language (Cf. *Bier* ‘beer’ /bi:r/ [bi:rɐ]).
- 13) As indicated in the IPA in (2) and (3), Kohler (1999: 87) shows that /ɛ:/ is even lower than /ε/ despite its bimoraicity, which could be attributed to the //ə// part.
- 14) The hypothesis discussed in Wiese (1996: 198–99) that /ə/ is derived from underlying /ε/ will also account for why //ə// follows front //ɛ//.
- 15) Wiese (1996: 160) mentions that *ruhig* ‘quiet’ is also pronounced with this diphthong by many speakers.
- 16) See the discussion in Wiese (1996: 209–18).
- 17) For details, see, for example, Kohler (1999: 88) and Wiese (1996: 209–18). The phonetic representations of this phoneme in (13) below have been simplified to [χ].
- 18) It seems that the voiceless dorsal fricative never follows /ə/ in this language, which may or may not concern us here.

- 19) The asterisks here denote that these diphthongs do not exist in this language.
- 20) Wiese (1996: 159–62) considers that /ɔʏ/ is a surface form of the underlying /aʏ/, the first element rounded by an assimilation rule. Yamamoto (2002) proposes an account for this exceptional behavior using monovalent features.

Works Cited

- Booij, Geert. (1995). *The Phonology of Dutch*. Oxford: Oxford University Press.
- Cruttenden, Alan. (2001). *Gimson's Pronunciation of English*. 6th ed. London: Arnold.
- Gussenhoven, Carlos. (1999). "Dutch." *International Phonetic Association (1999)*, 74–77.
- International Phonetic Association, ed. (1999). *Handbook of the International Phonetic Association: A Guide to the Use of the International Phonetic Alphabet*. Cambridge: Cambridge University Press.
- Kohler, Klaus. (1999). "German." *International Phonetic Association (1999)*, 86–89.
- Ladefoged, Peter and Ian Maddieson. (1996). *The Sounds of the World's Languages*. Oxford: Blackwell.
- Lass, Roger. (1976). *English Phonology and Phonological Theory: Synchronic and Diachronic Studies*. Cambridge: Cambridge University Press.
- Mangold, Max. (2005). *Das Aussprachewörterbuch*. [Duden Band 6.] 6., überarbeitete und aktualisierte Auflage. Mannheim: Dudenverlag.
- Pullum, Geoffrey K. and William A. Ladusaw. (1996). *Phonetic Symbol Guide*. 2nd ed. Chicago: The University of Chicago Press.
- Wells, J. C. (2000). *Longman Pronunciation Dictionary*. New ed. Harlow: Pearson.
- Wiese, Richard. (1996). *The Phonology of German*. Oxford: Oxford University Press.
- Yamamoto, Takeshi. (2002). "An Extended Particle Analysis of Two English Vowel Systems." Unpublished doctoral dissertation. Kyoto: Kyoto University.
- _____. (2006). "How Many Vowels Are There in English?: A Cluster Analysis of General American." *Journal of Language and Culture* [Hiroshima: The Graduate School of Language and Culture, Hiroshima Jogakuin University] 9, 249–68.