Effects of word familiarity in contexts on speaker's vowel articulation

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Abstract

This study is conducted to provide support for the prediction that familiarity of words in contexts affects the degree of hyper/hypo-articulation of vowels in these words. Results from the present analysis show that the repetition of words in a story causes hypoarticulation of vowels in these words. Among the eight types of vowels whose F1 and F2 values are measured, two types of vowels in words that come for the second time in a context show hypoarticulation to a much higher degree than those in words that come for the first time. One type of vowel in the words that come for the second time shows more partial hypoarticulation than that in the words that come for the first time. Three types of vowels show almost the same F1 and F2 values in both cases. A vowel space with four corner vowels in the words that come for the second time is smaller than that in words that come for the first time, which also indicates a tendency toward hypoarticulation for vowels in words repeated after their first introduction.

Keywords: formant, hypoarticulation, repetition, space, vowel

1 Introduction

Stories are told by a master of narratives beautifully and fascinatingly. They are also told by persons in our daily life in their own original way. In both cases, story tellers may intentionally or unintentionally prolong or shorten certain words to make the stories sound interesting. They may utter words with high or low pitch and with or without stress to make the stories sound lively. As is illustrated in Wennerstrom (2001, 200), intensified prosody can bring particular story events to the foreground. Certain key words, for example, may be uttered with a higher-than-usual pitch; vowels may be lengthened; pauses may be used strategically to provoke tension; volume may be increased at crucial points for a crescendo

effect.

Stories are constructed with words of new and old information. The words introduced for the first time in a context carry new information and those that are repeated in it carry old information. Whether the words carry new information or old information is decided not only by their occurrences in contexts of stories but also by their common occurrences in a daily life.

How overall temporal variables of a passage affect acoustic characteristics of words are closely examined (Moon and Lindblom, 1994). There is, however, still a lack of studies on factors found in contexts that cause changes in the acoustic characteristics of words. This study aims to examine the effects of familiarity of words in contexts on hyper/hypo-articulation.

2 Vowel articulation

Factors that affect the acoustic characteristics of vowels, whose changes are called phonological or phonetic vowel reductions, are often discussed in the field of phonetic sciences. The effects of changes in stress and rate of speech are examined to show the magnitude of phonetic vowel reduction caused by faster tempo and less stress, relative to the slow-stressed condition (Fourakis, 1991). Differences in kinematic parameters in different speaking conditions including normal, fast, clear and slow are the focus of the study by Perkell (2002a, 2002b). The results show that clear speech is produced with greater articulatory effort, that is, higher peak speeds, longer movement durations and greater distances, than normal speech. Longer durations are not accompanied by proportionally larger distances in slow condition.

Vowels are described with reference to their formant structure. With the first formant (F1), the auditory quality of height, and the second formant (F2), the auditory impression of the front/back dimension, plotted on axes with directional and scaling characteristics, we can get a vowel map and vowel spaces.

Vowels are also described in terms of their length. There has been an ongoing debate in the literature with regard to length difference versus quality difference of vowels (Brown, 2000; Jennifer, 2002). Although length of vowels is intricately intertwined with quality of vowels, there is a general characteristic increase in length with vowel openness as is noted in Cox (2006).

3 Repetition of words

Content words are usually replaced by pronouns in a sentence. Pronouns are used repeatedly in a paragraph as long as their anaphoric references are easy to be traced back. In a long passage, however, content words are repeated again even after they have been replaced by pronouns. Repetition, or reiteration is a form of lexical cohesion (Halliday and Hassan, 1976: 278). Repetition of the main characters in narratives is a special type of lexical cohesion and they are frequently to be the topic referent in discourse (Huang, 2000).

It is estimated that repeated words which are discussed at length in contexts become given. Chafe (1974: 112) proposes that words of given and new information are treated differently by speakers.

> The speaker must make assumptions as to what the addressee is conscious of, and transmit his own material accordingly. Virtually every sentence a speaker utter is a mixture of given material, which the speaker assumes is already in the addressee's consciousness, and new material, which he assumes is not. As he converts this mixture into sound, the speaker does not treat the given and new material in the same way: typically, he will attenuate the given material in one way or another, e.g. by pronouncing the items that convey such material with lower pitch and weaker stress, or by the attenuated specification or pronominalization of such items.

Besides a lower pitch and weaker stress, words of given information would be pronounced with shorter length.

Acoustic characteristics of repeated words are examined to show that they are shortened in spontaneous speech even when the rate of speaking is not increased (Fowler, et al., 1987, 1988). It is estimated that vowels of shortened repeated words are also hypoarticulated as length and hyper/hypo-articulation must be related. This study designs an experiment to examine whether or not the words produced for the first time in a story, that is, new words, would be hyperarticulated much more than the words produced for the second time, that is, old words.

4 Experiment

4.1 Objective

The main prediction of the experiment is that familiarity of words in context would affect the degree of hyper/hypo-articulation in production of vowels. Words of high familiarity or old word would show a greater degree of hypoarticulation than words of low familiarity or new words. Words of low familiarity are predicted to have vowels that are at the more dispersed end of the hyperarticulation and hypoarticulation continuum than words of high familiarity. Decreased dispersion is characterized by an expanded vowel space.

4.2 Method

4.2.1 Materials

Tokens in the study are all content words drawn from a recorded audiobook (Doyle 2003). The last content word in a sentence, which holds prosodically strong position, is selected.[1] It is decided that whether words are used for the first time or the second time in a chapter determines a level of familiarity of these words in a context. The words are chosen to provide a balanced segmental context for the vowel[2] and three tokens for each type of vowels are selected. Primary accented vowels are extracted from each word with three tokens for each vowel, /iː/, /ɪ/, /e/, /æ/, /ɑː/, /ɔː/, /ʊ/, /uː/. Overall, there are 24 words spoken by 1 male speaker.[3] Sample sentences are presented in Appendix A. The full set of words is listed in Appendix B.

4.2.2　Measurement

Formant frequency measures are obtained interactively using a combined LPC and spectrographic analysis of Praat.[4] The first and second formants (F1 and F2) of each vowel are measured at the point of maximal displacement on all 24 tokens. The point of maximal displacement occurs when F1 and F2 are the most characteristic for that particular vowel. For example, for the vowel /iː/, this is the point where F1 is lowest and F2 is highest, and for /ɑː/, this is the point where F1 is highest and F2 is lowest. Where F1 and F2 are not in agreement, F1 is taken as the point of reference and F2 is measured at that point.

4.3　　Results

4.3.1 Vowel space area

Overall, the main prediction is borne out: there is an effect of lexical category（'high familiarity in contexts' versus 'low familiarity in contexts'）on formant values. Table 1 shows the means of F1 and F2 values of each vowel for words of low and high familiarity.

Table 1　Means of F1 and F2 values of each vowel in words of low familiarity and high familiarity [Hz]

vowel	low familiarity		high familiarity	
	F1	F2	F1	F2
i:	319	2,294	357	1,510
ɪ	478	1,642	441	1,879
e	537	1,893	611	1,735
æ	783	1,741	798	1,684
ɑ:	746	1,190	740	1,151
ɔ:	456	809	483	787
ʊ	576	1,340	459	1,186
u:	368	1,347	519	1,557

　　Differences in F1 and F2 for each vowel in words of high and low familiarity are contrasted with arrows in Figure 1. There is general tendency toward the centralization for vowels in words of high familiarity than the words of low familiarity. Vowels, /i:/ and /u:/ in words of high familiarity are centralized more than those in the words of low familiarity. Vowels /æ/, /ɑ:/ and /ɔ:/ show the similar values in words of both levels of familiarity. Vowels /ʊ/ and /ɪ/ in words of high familiarity are more peripheralized than the ones in words of low familiarity.

Table 2 Vowel space of words of high and low familiarity (Hz^2)

low familiarity	high familiarity
313,199	74,401

4.3.2 Vowel length

The average length of eight types of vowels analyzed in this study is listed in Table 3. Among eight types of vowels, three vowels in words of high familiarity are shorter than those in words of low familiarity. Means of length of all types of vowels show that the length of vowels in words of high familiarity is slightly longer than that in words of low familiarity. As far as the data collected in this study is concerned, a proportional relation between long/short length and hyper/hypo-articulation is not observed.

Table 3 Means of length of each vowel in words of low familiarity and high familiarity [msec]

vowel	low familiarity	high familiarity
i:	154	135
ɪ	48	62
e	94	97
æ	143	97
ɑ:	168	194
ɔ:	200	182
ʊ	115	123
u:	119	163
Means	130	132

4.4 Discussion

Results from the present analysis provide support for the main prediction of this study that familiarity in contexts would affect the degree of hyper/hypo-articulation of vowels. Among the eight types of vowels whose F1 and F2 values are measured, two types of vowels in words of high familiarity show centralization to a much higher degree than those in words of low familiarity. One vowel in the former shows more partial centralization than that in the latter. Three vowels show almost the same F1 and F2 values in words of both levels of familiarity
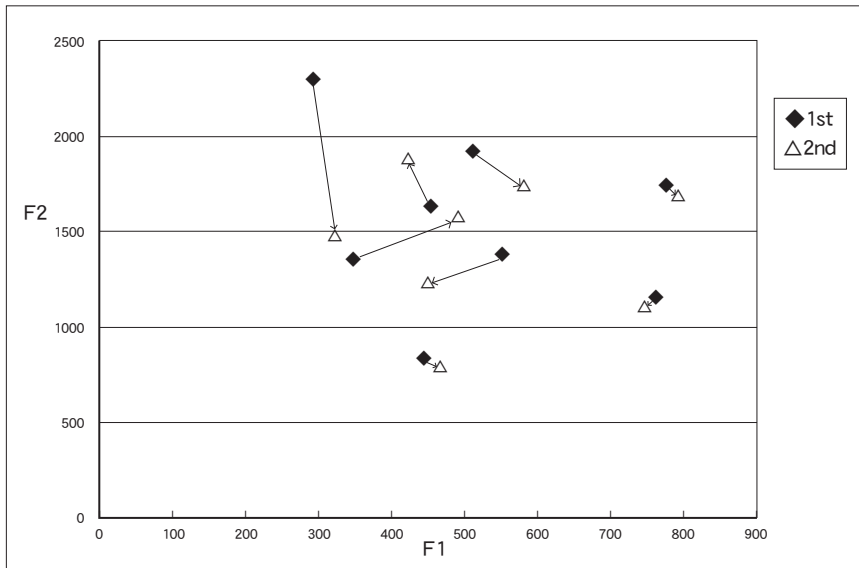
Figure 1 Means of F1 and F2 of vowels in words of high/low familiarity [Hz]

For a vowel space,[5] F1 and F2 values of corner vowels, /i:/, /æ/, /ɑ:/, /u:/ in the words of high familiarity and low familiarity are selected as is shown in Figure 2.
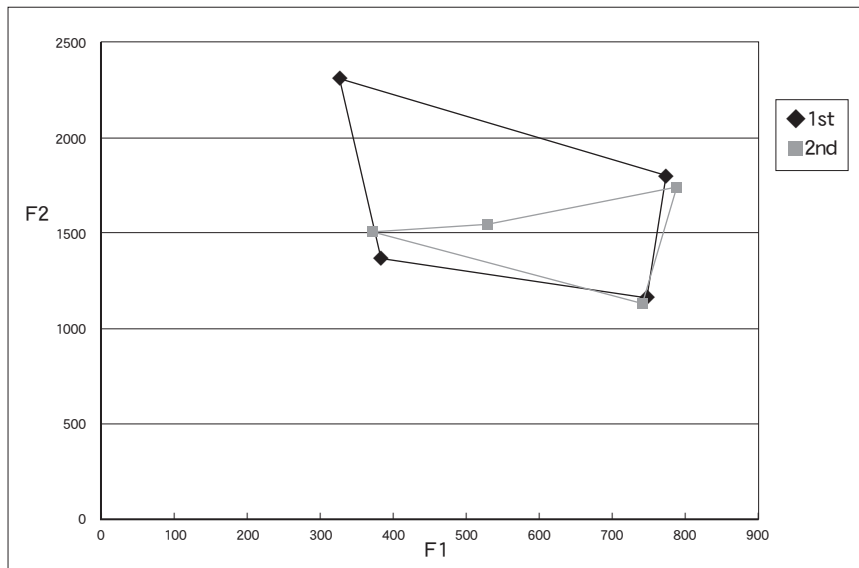
Figure 2 Vowel space with corner vowels in words with high/low familiarity [Hz]

A vowel quadrilateral constructed to calculate the area (Hz^2) within it is presented in Table 2. Differences were observed between the vowel spaces with the vowels in the words of low familiarity and high familiarity. The latter is smaller than the former.

and two vowels in the former show more peripheralization than those in the latter.

A vowel space with four corner vowels in words of high familiarity is smaller than that in words of low familiarity. The difference in the vowel space of these two levels of familiarity of words is large. This indicates a tendency toward more centralization for vowels in words of high familiarity than the words of low familiarity.

5 Conclusion

The finding of the present study is that repetition of words in a story causes hypoarticulation of vowels in these words. This could add more data which support the prediction that contextual predictability of words affects hyper/hypo-articulation of these words, which is also examined in Tomita (2006) that focuses on the effects of word frequency values on speaker's vowel articulation. Although this study has not analyzed materials of oral readings large enough to present statistical data, the tendency toward centralization for vowels in words of high familiarity in contexts than the words of low familiarity in contexts is observed.

The most important outcome of this study is that besides factors in overall temporal variables, lexical factors cause hyperarticulation or hypoarticulation. First or second occurrences of words in a story, that has an association with new or old information of words, has effects on hyperarticulation or hypoarticulation. This may correspond with the general phenomena in our daily life. Very common words are changed into curtailed words. Nicknames are usually shorter than full names. Lawful variability should be observed in spoken language.

Notes

1 There is a general tendency to put an element that is important in the sense of being new information at the end.

2 Vowels were selected while referring to *Pronunciation Dictionary*, Longman, First edition, 1990.

3 The narrator who read the story of this audiobook has appeared in London's West End in *The Hired Man* and in Shakespeare's *Coriolanus* and *The Winter's Tale*, and has toured nationally and internationally with the English Shakespeare Company.

4 Praat is a program for speech analysis and synthesis written by Paul Boersma and David

Weenink at the Department of Phonetics of the University of Amesterdam.

5 A formula used for calculating a vowel space is as follows: 0.5[{i: F2　æ F1 ＋ æ F2 α: F1 ＋α: F2 u: F1 ＋ u: F2 i: F1} － {i: F1 æ F2 ＋ æ F1 α: F2 ＋ α: F1 u: F2 ＋ u: F1 i: F2}]

References

Works consulted

Brown, C. 2000. The interrelation between speech perception and phonological acquisition from infant to adult. In John Archibald (ed.), *Second Language Acquisition and Linguistic Theory*, 4-63. MA: Blackwell.

Chafe, W. 1974. Language and consciousness. *Language*, 50:1, 111-133.

Cox, F. M. 2006. The acoustic characteristics of / hVd / vowels in the speech of some Australian teenagers. *Australian Journal of Linguistics*, 26:2, 147-179.

Fourakis, M. 1991. Tempo, stress, and vowel reduction in American English. *Journal of Acoustic Society of America*, 90:4, 1816-1827.

Fowler, C. et al. 1987. Talkers' signaling of "new" and "old" words in speech and listeners' perception and use of the distinction. *Journal of Memory and Language*, 26, 489-504.

Fowler, C. et al. 1988. Differential shortening of repeated content words produced in various communicative contexts. *Language and speech*, 31:4, 307-319.

Halliday, M. et al. 1976. *Cohesion in English*. London: Longman.

Huang, Y. 2000. Discourse anaphora: Four theoretical models. *Journal of Pragmatics*, 32, 151-176.

Jennifer, M. and Archibald, J. 2003. Acquisition of L2 length contrasts. *Proceedings of the 6th Generative Approaches to Second Language Acquisition Conference*, 208-212.

Moon, S.-J., and Lindblom, B. 1994. Interaction between duration, context, and speaking style in English stressed vowels. *The Journal of the Acoustic Society of America*, 96, 40-55.

Perkell, J. et al. 2002a. Economy of effort in different speaking conditions. I. A preliminary study of intersubject differences and modeling issues. *Journal of Acoustic Society of America*, 112:4, 1627-1641.

Perkell, J. et al. 2002b. Economy of effort in different speaking conditions. II. A preliminary study of intersubject differences and modeling issues. *Journal of Acoustic Society of America*, 112:4, 1642-1651.

Tomita, K. 2006. Effects of word frequency values on speakers' vowel articulation. *Bulletin of*

Yamagata University (Humanities), 16:2, 65-76.

Wennerstrom, A. 2001. *The Music of Everyday Speech*. Oxford: Oxford Univ. Press.

A text and an audiobook examined

Paolini, C. 2007. *Eragon*. New York: Random House, Inc.

Doyle, G. 2003. *Eragon on 14 CDs*. Virginia: Random House, Inc.

Appendix

A. Sample sentences (words selected for analyses are italicized)

For vowel /i:/ The shade howled in rage and stalked forward, flinging his sword at a *tree*. (p.4)

He confirmed that the stone was gone, then retrieved his horse from its hiding place among the *trees*. (p.5)

For vowel /ɪ/ A hunting knife with a bone handle was sheathed at his belt, and a buckskin tube protected his yew bow from the *mist*. (p.6)

Eragon watched for danger for several long minutes, but the only thing that moved was the *mist*. (p.7)

For vowel /e/ He shot nine bolts of energy from his palm — which killed the Urgals instantly — then ripped his sword free and strode to the *elf*. (p.4)

Disgust curled his lip before he turned back to the unconscious *elf*. (p.4)

For vowel /æ/ He remained unnaturally quiet, a long pale sword in his *hand*. (p.1)

Black Urgal blood dripped from her sword, staining the pouch in her *hand*. (p.4)

For vowel /ɑ:/ A light tingling ran up his *arm*. (p.39)

He smiled as the small creature looked around with interest from the safety of his *arms*. (p.41)

For vowel /ɔ:/ And it came to pass at the height of their power that a boy, Galbatorix by name, was born in the province of Inzilbeth, which is no *more*. (p.32)

The elves, too, fought bitterly against Galbatorix, but they were over thrown and forced to flee to their secret places, from whence they come no *more*. (p.34)

For vowel /ʊ/ Eragon's temper flared at the exorbitant price, and he started to complain hotly, but Brom silenced him with a quick *look*. (p.116)

When Saphira landed, he asked, How do the plains *look?* (p.122)

For vowel /u:/ His voice reverberated through the *room*. (p. 14)

Glowering venomously, Sloan slipped into the back *room*. (p.14)

B.   Words used in study (vowels selected are italicized)

vowel	words
i:	tr*ee*
	m*ea*t
	sl*ee*p
ɪ	m*i*st
	b*ui*lding
	w*i*nter
e	*e*lf
	h*ea*d
	*e*lse
æ	h*a*nd
	*a*rrow
	p*a*ck
ɑ:	*a*rm
	f*a*rm
	*a*sk
ɔ:	m*o*re
	fl*oo*r
	d*oo*r

	l*oo*k
ʊ	g*oo*d
	g*oo*d
	r*oo*m
u:	d*o*
	sm*oo*thly

単語の文脈内親密に基づく母音の音響特徴分析

冨田　かおる

物語に繰り返し現れる語の音響特徴には一定の傾向が見られる。語が文脈内で初めて使われる場合と、その後，繰り返し使われる場合では、語の持つ新旧情報が異なると思われるが，この異なりが発話にも影響を与え、そのフォルマント値に反映される。母音８つの第１フォルマントと第２フォルマントを測定した結果、２度目に使われた語の音は最初のものよりも曖昧な音となり，口内の発音空間の中心に近い位置で発せられる傾向が見られた。また、母音４つの第１・第２フォルマントで示された母音空間も、２度目に使われた語の音によるものの方が狭くなった。