ISCA

International Speech Communication Association

Proceedings of the second ISCA Tutorial and Research Workshop on

Experimental Linguistics

ExLing 2010

25-27 August 2010, Athens, Greece

Edited by Antonis Botinis

University of Athens

Dialect and generational differences in vowel space areas

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Abstract

We address methodological issues in calculating the size of the working vowel space area. Although corner vowels are most commonly used in determining its size, we show that this approach may severely underestimate the actual working space. The vowel spaces determined using the large vowels set provided insight into subtle differences between dialects and among age groups. Three approaches were tested which were based on the number of vowels used, formant measurement location and the way boundary lines were drawn.

Key words: vowel, vowel space, formants, dialect.

Introduction

Different dialects of the same language vary in terms both the location and formant movement of vowels in the acoustic (and articulatory) vowel space (e.g., Fox & Jacewicz 2009). A logical question is whether this variation also leads to a significant difference in the size of the acoustic vowel space between speakers of different dialects. The area of a vowel's working space arises from the articulatory configuration of the tongue and jaw that produced vowels. The coordinated tongue and jaw movements are reflected in the formant pattern, which is the basis for measurement of the vowel space area (VSA). Systematic variation in the VSA was found as a function of speaking styles (Bradlow et al. 1996), speech disorders (Turner et al. 1995; Liu et al. 2005) and child development patterns (Vorperian & Kent 2007). The general finding from these studies is that a reduced VSA in production leads to lower intelligibility scores in perception.

However, there are several methodological issues that have not been fully addressed in determining the size of the VSA. For example, should one use a designated subset of the vowels such as the so-called "corner vowels" ([i æ ɑ u]), only the monophthongs (ignoring the diphthongs with their significant formant changes) or all vowels? Second, should the VSA boundaries be drawn on the basis of a single measurement point from each vowel or from more than one point? Finally, which approach should be taken in drawing the boundaries: liberal or conservative? Our current research addresses these issues, and this paper presents an overview of our approach.

Methodology and results

The study examines the variation in VSA as a function of dialect in a larger corpus produced by 260 English speakers of two distinct dialects in the United States: Wisconsin (upper Midwestern dialect) and North Carolina (Southern dialect). More details about these dialect regions can be found in Jacewicz et al. (2009). Data presented here come from 114 female speakers who fall into four age groups (in years): girls (8-12), young (35-50), older (51-65) and oldest (66-91) women. The acoustic measurements used in the calculation of the VSA were taken from 13 vowels produced in citation from "words" in the hVd context: *heed, hid, heyd, head, had, hod, hawed, hoed, who'd, hood, hoyd, hide, howed.*

The boundaries of the VSA were determined on the basis of (1) either the four corner vowels [i æ ɑ u] or all 13 vowels, (2) the F1 and F2 values at the midpoints (50%) or at the 20-35-50-65-80% points and (3) drawing the boundary lines of the VSA using a liberal or a conservative approach. The liberal approach connects the most disparate points with a straight line, ignoring the fact that this may include a portion of the speaker's VSA in which vowels are never produced. The conservative approach determines boundaries on the basis of where vowels are actually found in the VSA as produced by that particular speaker. These differences are illustrated in Figures 1 and 2 which display three of the vowel spaces calculated for an individual North Carolina female speaker. Mean group areas are provided in Table 1.

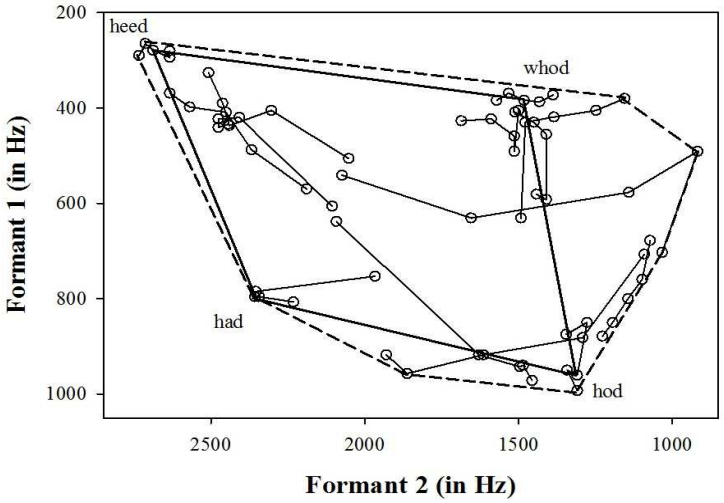

Figure 1. Vowel space areas encompassing the four corner vowels measured at the midpoint (bold solid line) and all vowels measured at all five temporal points using a liberal approach (broken line).

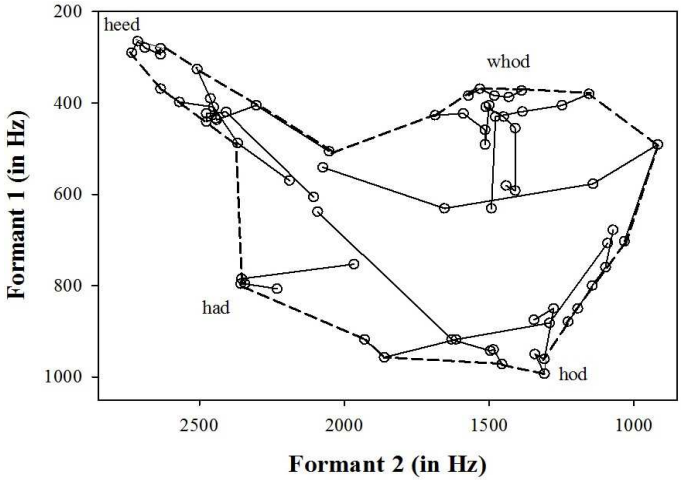

Figure 2. Vowel space area encompassing all vowels and all five measurement points using a conservative approach (broken line).

Table 1. Mean liberal and conservative vowel space areas for measurements at the midpoint and at all 5 temporal points for four groups of females.

Dialect	Age	Corner Vowels		All 13 vowels	
		Midpoint	All	Midpoint	All
Liberal Vowel Space Boundaries (kHz^2)					
Wisconsin	8-12	0.887	1.042	1.039	1.240
	35-50	0.650	0.765	0.733	0.874
	51-65	0.657	0.822	0.761	0.923
	66-91	0.696	0.810	0.804	0.923
North Carolina	8-12	0.601	0.791	0.773	1.112
	35-50	0.392	0.522	0.662	0.860
	51-65	0.384	0.525	0.673	0.869
	66-91	0.362	0.543	0.676	0.867
Conservative Vowel Space Boundaries (kHz^2)					
Wisconsin	8-12	0.887	1.003	0.739	0.967
	35-50	0.650	0.728	0.524	0.664
	51-65	0.657	0.780	0.567	0.672
	66-91	0.696	0.765	0.563	0.699
North Carolina	8-12	0.601	0.688	0.675	0.882
	35-50	0.392	0.480	0.591	0.708
	51-65	0.384	0.475	0.623	0.697
	66-91	0.362	0.477	0.624	0.663

Conclusions

A review of the data in Table 1 underscores the challenges and pitfalls in making generalizations and theoretical claims regarding differences in VSA between individual speakers, age groups (children versus adults) and dialects. For example, the VSA for North Carolina (NC) speakers determined on the basis of the midpoints of the corner vowels (probably the most common approach used in calculation of VSA) is much smaller than that of the Wisconsin (WI) speakers. This is primarily because the NC /u/ is much more fronted than the WI /u/. However, the positions and movements of the back vowels (especially /ɔ/) and the onglide of the /oɪ/ for NC vowels makes the difference in VSA between the NC and WI speakers much smaller (a difference which is actually reversed in the conservative approach) when VSA is calculated using all vowels and all measurement points. Our overall conclusion is that when making comparative evaluations of VSA, a rationale and motivation should be provided for the measurement selection criteria (in terms of both vowels and measurement points) in determining the boundaries of the VSA.

Acknowledgements

This work was supported by NIH/NIDCD research grant R01DC006871.

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