

How acoustically consistent and perceptually distinguishable non-cardinal IPA vowels are?

Danila Gomulkin, TUSUR

Problem The IPA Phonetic alphabet contains 28 letters for labeling vowel sounds, each may be further modified with additional diacritics. The 28 letters refer to 28 positions of imaginary articulatory space described in proprioceptive dimensions of frontness, height and labialization. It is seducing to assume that these 28 proprioceptive descriptions refer to 28 acoustically consistent and perceptually distinguishable vocal qualities suitable for use beyond phonetics e.g. for discrimination and labeling of synthetic timbres in computer music. Bearing in mind the later application, I undertook this preliminary research.

History IPA vowels have never been as frequent an object of articulatory, acoustic, or perceptual studies as vowels of real languages, however you can find sample sets (e.g. Daniel Jones, 1956), formant plots (e.g. Peter Ladefoged, 1967), confusion matrices (e.g. Patricia D. S. Ashby, 2003) and even synthetic emulation (e. g. Delattre et al. 1952) predominantly for the first 16-18 (cardinal) IPA vowels showing that these are pretty evenly distributed in formant space and fairly distinguishable. However IPA vowels beyond these cardinal ones have rarely been addressed.

Methods There still exist quite a few 28-piece vowel sets available for illustrative or education purposes, oftentimes commercially distributed. We have found and obtained 15 sets in total, of which 10 sets were selected based on the quality of sound and/or the speaker's authority. Quantitative measurement included formant measurement of recorded vowel samples in Praat, where satisfactory precision was assured through measuring averaged spectra. Qualitative evaluation was done through auditory categorization of the samples within 10 Russian vowel allophones. The result was processed, visualized and annotated in F1/F2 charts, and statistically analyzed with R programming language.

Results While the first 18 (cardinal) IPA vowels do not overlap in the formant space of individual speakers, introduction of non-cardinal vowels (as if to fill in the empty space in the middle of articulatory trapezoid) cramps the middle part of the formant space with a cluster homogenous sounds (both acoustically and perceptually), the location and quality of such clusters strongly varying from speaker to speaker.

Qualitative evaluation of non-cardinal IPA vowels indicated their significant speaker-intrinsic similarity and speaker-extrinsic discrepancy. In other words, the non-cardinal vowels fit relatively narrow quality range within each individual speaker, this range (read: vowel quality) significantly differing from speaker to speaker.

It may be that non-cardinal vowels could permit for distinguishing subtler shades within the wider classes that we attributed them to, but their occurrence in these classes shows inconsistency and individual variation.

Conclusion The available expanded (28-piece) sets of IPA vowels do not seem to provide a reliable quantitative and qualitative tool for finer evaluation of vocal timbers.

Sample charts Please see next page.

