

R Three Ways: Capturing the dynamics of Scottish word-final /r/, using DCT and GAMMs

Sounds can be represented in terms of ‘static’ acoustic measures, e.g. from a single timepoint, or a summary mean, or through ‘dynamic’ trajectories taken across the course of a segment. Sósokuthy¹ outlines an effective continuum from static, through less dynamic methods, such as Discrete Cosine Transformation (DCT), which forces trajectories to fixed reference shapes and whose coefficients can be hard to interpret, to the more intuitive outputs of Generalized Additive Mixed Models (GAMMs) whose flexible reference points permit closer approximation and visualization of trajectories. As we might expect, dynamic analyses reveal further insights over static measures into social-phonological contrasts (e.g. vowels, sibilants^{2,3}) though the inherently dynamic nature of rhotics means that dynamic analysis of /r/ has been used to characterise these sounds for a long time.⁴ However, comparison of different different dynamic techniques for interpreting the same feature is less usual.⁵

This paper considers the relative contribution of static, less and more dynamic acoustic representations, specifically mean, DCT and GAMM, in specifying the role of linguistic, social and regional factors for Scottish word-final /r/ over the 20th century. Largely auditory analyses of Scottish /r/ report changes from apical trills/taps to postalveolar, retroflex and now bunched approximants favoured by middle-class females; long-term coda /r/ weakening has also been observed for urban Central Belt vernaculars.⁶ The acoustic signature of a lowered third formant is found for approximant /r/; taps, trills, and weakened /r/ show high and/or rising F3.⁷

21-point F3 formant tracks (>49ms) were taken from all instances of pre-segmented Scottish word-final /r/, extracted from 711 speakers covering geographical, social and ethnic diversity across an apparent-/real-time span of 100+ years; likely erroneous measures were removed against existing hand-measures (36,845 tokens, 275 words). The first three DCT coefficients, capturing the trajectories’ mean, slope and curvature, were modelled for following context and lexical stress, and gender, dialect, ethnicity and decade of birth, using LME in R, controlling for speech rate, (log)/r/ duration, (log)lexical frequency, and speaker/word. GAMMs were fitted separately to male and female speaker subsets, with smooths by (log)duration, stress, following context, and dialect, ethnicity, and decade of birth, and random smooths for speaker/word.

All measures show that Scottish word-final /r/ is influenced by linguistic, regional, ethnic and social factors. DCT analysis provides robust identification of key differences and interactions for the whole dataset; GAMMs permit more refined examination of contrasts of interest. For example, DCT shows how gender interacts with decade of birth: those born most recently show lowered F3 trajectories, especially female speakers, likely reflecting a gendered shift from taps to (more bunched) approximants. GAMMs show a similar pattern, but enable better inspection of differences between groups in trajectory shapes and variability over time.

References

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