

The variable diphthongisation of vowels in English is a widely attested form of synchronic variation, such as the monothongisation of GOAT and PRICE in the dialects of Northern England [6, 2], as well as diphthongisation of tense monophthongs, such as FLEECE and GOOSE [5, 7]. Dynamic variation also underlies many diachronic sound changes, such as the development of high vowels into diphthongs during the English Great Vowel Shift [3], which appears to involve splitting a single vowel into a two-target diphthong. While these descriptive facts of vowel variation are well-documented, it remains challenging to provide a convincing account that explains the wide range of gradient synchronic variation in dialects and the apparently categorical shifts of long-term sound change. In this paper, we develop a theoretical and computational model of vowel variation and change, showing how it captures multifaceted aspects of English vowels in a unified sociophonetic and sociophonological framework.

We advance a model grounded in the principles of Articulatory Phonology [1] and implement a task dynamic computational model that allows us to specify the number and nature of vowel targets and generate simulated articulatory trajectories based on this [4]. This gives us a precise quantitative prediction that can be compared with empirical data. A key assumption of our model is that both tense monophthongs and diphthongs are composed of two discrete targets: a nucleus and an offglide. A monophthong has two targets with identical parameters, but gradient variation in the nucleus target generates varying degrees of diphthongisation. In this model, long monophthongs and diphthongs are structurally identical, but emerge as phonetically distinctive as a result of quantitative variation in gestural parameters.

We test our model using data from two British English dialects (SSBE; West Yorkshire), which are well-known to vary in the production of diphthongs and tense monophthongs [2]. We collected data from 16 speakers of SSBE and West Yorkshire English (WYE), who read words containing a full set of English vowels in hVd and sVd contexts, while their articulatory movements were tracked using electromagnetic articulography (EMA). Our analysis examines the motion of a sensor attached to the tongue dorsum and finds a wide range of variation between the two dialects; specifically, SSBE has more vowels that appear to have two distinct targets (CHOICE, PRICE, FACE, MOUTH, GOAT), whereas WYE only has two vowels that show this pattern (CHOICE, PRICE), although FLEECE is also more diphthongal in WYE. We then test whether our model can generate this range of variation using the two-target model for tense monophthongs and diphthongs. We find that it can adequately reproduce our findings, and it successfully captures observed historical sound changes. In doing so, we identify a mechanism that facilitates both gradient and categorical variation and change between tense monophthongs and diphthongs. Methodologically speaking, these results also provide a theoretical grounding for the use of two measurement points when analysing formants in any tense monophthongs or diphthongs.

References [1] C. P. Browman and L. Goldstein. “Articulatory phonology: an overview”. In: *Phonetica* 49.3-4 (1992). [2] A. Hughes, P. Trudgill, and D. Watt, eds. *English Accents and Dialects: An Introduction to Social and Regional Varieties of English in the British Isles*. Fifth. London: Hodder, 2012. [3] O. Jespersen. *A Modern English Grammar on Historical Principles*. London: George Allen & Unwin Ltd, 1909. [4] E. Saltzman and K. G. Munhall. “A dynamical approach to gestural patterning in speech production”. In: *Ecological Psychology* 1.4 (1989). [5] P. Strycharczuk et al. “General Northern English: Exploring regional variation in the north of England with machine learning”. In: *Frontiers in Artificial Intelligence* 3.48 (2020). [6] D. Watt and L. Milroy. “Patterns of variation and change in three Newcastle vowels: is this dialect levelling?” In: *Urban Voices: Accent Studies in the British Isles*. Ed. by P. Foulkes and G. J. Docherty. London: Arnold, 1999. [7] J. C. Wells. *Accents of English: Volumes 1–3*. Cambridge: Cambridge University Press, 1982.