NOT JUST /ɪ/ AND /ə/: SPELLING PREDICTS UNSTRESSED VOWEL QUALITY IN ENGLISH

Sarah Tasker
University of York
st657@york.ac.uk

ABSTRACT

Most British English varieties are reported to have two possible vowels in unstressed syllables: /ɪ/ and /ə/. Such descriptions assume that variation in unstressed vowels is categorical, that is, speakers always aim for /ɪ/ or /ə/. This paper reports on a study of unstressed vowels using a corpus of data from Derby, UK. It investigates whether unstressed vowels vary categorically between /ɪ/ and /ə/, or whether intermediate variants exist. Through the comparison of unstressed vowels represented by the spellings <i>, <e> and <a>, I assess whether unstressed vowels categorically reduce to either /ɪ/ or /ə/. It was found that there was a significant three way difference in F2 across these three spellings. Whilst there was considerable variation in the patterning of the three spellings across speakers, the results suggest that for some speakers unstressed vowels do not vary categorically between /ɪ/ and /ə/.

Keywords: acoustics, unstressed vowels, categoricity, spelling

1. INTRODUCTION

Unstressed vowels are a complex and under researched groups of sounds. There is a particular inconsistency in the way that schwa is defined. Some researchers use schwa in a phonetic sense [21], i.e. to refer to a vowel of mid central quality, whether or not that vowel is stressed. Others define schwa phonologically [6, 10], describing a vowel that can only be found in unstressed positions and is the outcome of the neutralisation of other vowel contrasts. The quality of this vowel itself can be highly variable [2, 6, 12, 14], and in word medial position it is in fact rarely realised with the mid central phonetic position implied by the symbol /ə/.

Standard descriptions of English tend to describe unstressed vowels as having one of three possible qualities: /ɪ/, /ə/ and /ʊ/ [9, 18], with all other differences said to be neutralised [7]. As /ʊ/ is less common and more restricted in its occurrence [18] the focus here is on the opposition between /ɪ/ and /ə/.

The vowels /ɪ/ and /ə/ are reported to contrast in certain words e.g. *Lennon* and *Lenin* [21]. However there has been very little empirical investigation into the actual realisation of these vowel qualities. In addition, in standard descriptions there is an assumption that unstressed vowels vary categorically between two distinct qualities, and that no other variants are possible.

This study thus investigates vowel quality distinctions in unstressed syllables, examining the extent to which there is a consistent and categorical difference between /ɪ/ and /ə/. This is done through comparison of unstressed vowels represented with different spellings.

1.1 Why spelling?

As the varying definitions of schwa (in 1) do not map neatly onto one another, defining schwa is problematic. It is important to note though that vowel quality in unstressed syllables is partly related to their pre-reduced historical pronunciations. Although by no means a perfect relationship, there is a link here between the historical pronunciation of an unstressed vowel and its orthographic representation [13]. Today, spellings are also observed to represent different unstressed vowel qualities; it is generally implied that <i> generally represents /ɪ/, <a>, <u> and <o> represent /ə/, and <e> is variable between /ɪ/ and /ə/ [11, 18, 22]. These spelling correspondences can be observed most clearly where an unstressed vowel has an equivalent unreduced full vowel in a cognate word e.g. *atom* (/ˈatəm/) vs *atomic* (/əˈtɒmɪk/).

Therefore I take an alternative approach to examining unstressed vowel quality differences, by looking at differences between spellings. By taking this approach, we distance ourselves from the problem of how exactly to define schwa. Additionally, as well as simply investigating the extent of a distinction between /ɪ/ and /ə/, I also examine differences between groups of vowels that were historically different forms.

1.2 Unstressed vowels in Derby

The variety in focus is that spoken in Derby, a city in the linguistic north of England. Like most British dialects we would expect there to be a /ɪ/ and /ə/ distinction available in Derby. There is little known about unstressed vowels in Derby specifically. Docherty and Foulkes [4] transcribe the vowel in their keyword HORSES with /ə/, rather than the more commonly used variant in such suffixes in British

English: /ɪ/. This was an auditory impression rather than based on an empirical investigation. It does, however, suggest that backer variants may be used where other varieties would use /ɪ/.

2. METHOD

2.1 Speakers

Data was taken from a sample of 26 speakers from a corpus recorded in Derby [15]. All of the data used is from spontaneous conversational speech.

2.2 Data measurements

Vowel midpoint measurements of F1 and F2 were collected automatically [8], and vowel boundaries and formants were corrected manually [3, 19].

Measurements are reported as raw Hz values respect of statistical models and in visualisations for individual speaker data. Where the overall data is visualised, normalised values are given following [5].

2.3 Token selection

The initial data sample included all lexically unstressed vowels, excluding stem final vowels e.g. *comm<u>a</u>s*, *happ<u>y</u>* and vowels in suffixes e.g. *box<u>e</u>s* This was because (a) unstressed vowels are known to behave differently in stem final contexts [7], and (b) <e> spellings would be vastly overrepresented in suffixes, and I wanted to balance token numbers.

It was important to include only unambiguous cases of reduced vowels, in order to ensure that the target vowel was indeed a reduced vowel. The sample of vowels was therefore restricted to cases where the vowel was unambiguously reduced. This meant that cases where a full vowel was also possible e.g. .g. *<u>a</u>dvice* (in Derby, /ədˈvaɪs/ or /adˈvaɪs/). Such tokens were excluded from the study. The decision to exclude a word was made if any of the following criteria were true:

1. The author had heard alternative pronunciations with a vowel other than /ɪ/ or /ə/ e.g. /a/ in *advice*, /i/ in *<u>e</u>lectronic*
2. An alternative full vowel was given in the Longman pronunciation dictionary [22]. e.g. /ɛ/ in *orch<u>e</u>stra*
3. The vowel was clearly pronounced with a full vowel on at least one occasion within the corpus, e.g. /ɛ/ in *<u>e</u>xam*.

The final data set included vowels represented by <a> (n=792), <e> (n=805) and <i> (n=584).

2.4 Modelling of data

To test the effect of spelling on F1 and F2 linear mixed effects analysis was used [1, 16]. Spelling, preceding consonantal environment, and following consonantal environment were modelled as fixed effects, and speaker and word were modelled as random effects (with by-speaker random slopes for all fixed effects). The significance of effects was obtained by a likelihood ratio test, where the model was compared with and without the effect in question, with separate models for each spelling pair.

2.5 Predictions

The central question asked is whether unstressed vowels vary categorically between only /ɪ/ and /ə/. If this is the case it was predicted that there should be a clear two way difference across the three tested spellings. Based on the perceived link between spelling and pronunciation noted in 1.1, a clear and consistent difference between <i> and <a> would be expected. If no consistent differences are observed across the spelling groups this would indicate that there are no vowel quality differences in unstressed syllables in this variety. If there is a three way difference across the spellings this would indicate that there are additional differences and that unstressed vowels do not vary categorically between only /ɪ/ and /ə/.

3. ANALYSIS

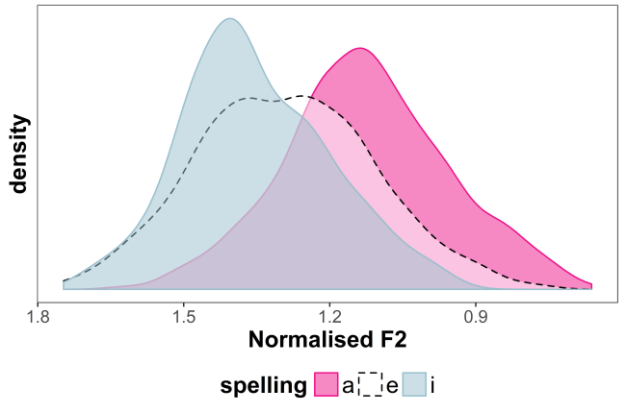
The main focus of this paper is F2. This is because the spellings largely overlap in F1 and do not have clearly distinct distributions; average F1 for each spelling is very similar (<a>=463 Hz, <e>=415 Hz, <i>=434 Hz). Although <a> has a slightly higher F1 than <e> and <i>, this is only apparent when an interaction between spelling and duration is also considered in a mixed effects model ($p<0.0001$). This is a positive interaction, meaning that <a> spellings have somewhat higher F1 values but only in vowels of relatively long duration. This F1 difference is consistent with what is predicted if /ɪ/ and /ə/ are distinct. That it is only apparent in interaction with duration indicates that the short durations of unstressed vowels may be causing a lack of variation in phonetic height. This is likely due to tongue body raising caused by adjacent consonants. This means that overall there was a lack of observable variation in vowel height within these unstressed vowels. The vast majority were realised as phonetically high. Therefore, the rest of this section focuses on F2 as that was where the majority of the variation lay.

We first present data from the whole data set, followed by data for individual speakers.

3.1 Overall data

Figure 1 shows the density distribution for F2 over the whole data set. The <i> spellings have a higher F2 than <a>, as predicted if they are generally representative of the two different vowel qualities /ɪ/ and /ə/. Although there is a reasonable degree of overlap between the two distributions, they appear clearly separate, with distinct peaks in the density distributions. The spread of the data is also similar for both spellings, as evidenced both in the density distributions and the standard deviation for both groups (<a>=0.168, <i>=0.152)

Figure 1: Normalised F2 density distributions by spelling



This difference between <i> and <a> is significant ($p<0.0001$). These results show that, as was predicted if /ɪ/ and /ə/ are distinct, <i> is indeed fronter than <a>.

<e> is intermediate in F2 between <a> and <i>, suggesting that unstressed vowels may not pattern exclusively with either /ə/ or /ɪ/. <e> is significantly lower in F2 than <i> ($p<0.01$) and significantly higher in F2 than <a> ($p<0.0001$). This is what would be expected given that <e> is suggested to be variable in unstressed vowel quality. However this does not tell us whether this intermediate distribution derives from a mixture of tokens that pattern with <a> and <i>, or whether <e> is genuinely intermediate between <a> and <i>. However, the distribution of <e> does not show strong bimodality, and the spread of data (normalised SD=0.181) is comparable to <a> and <i>. These results certainly suggest the possibility that there may not be a categorical two-way difference between two vowel qualities in unstressed syllables [20].

3.2 Data from individual speakers

Figure 2 shows that the F2 differences between <a> and <i> found over the whole data set are also found for the individual speakers. All but one of the 26 speakers (speaker 15) have a clear difference in the F2 distribution of <a> and <i>. The size of this difference is variable but only speaker 15 has distributions which are largely overlapping.

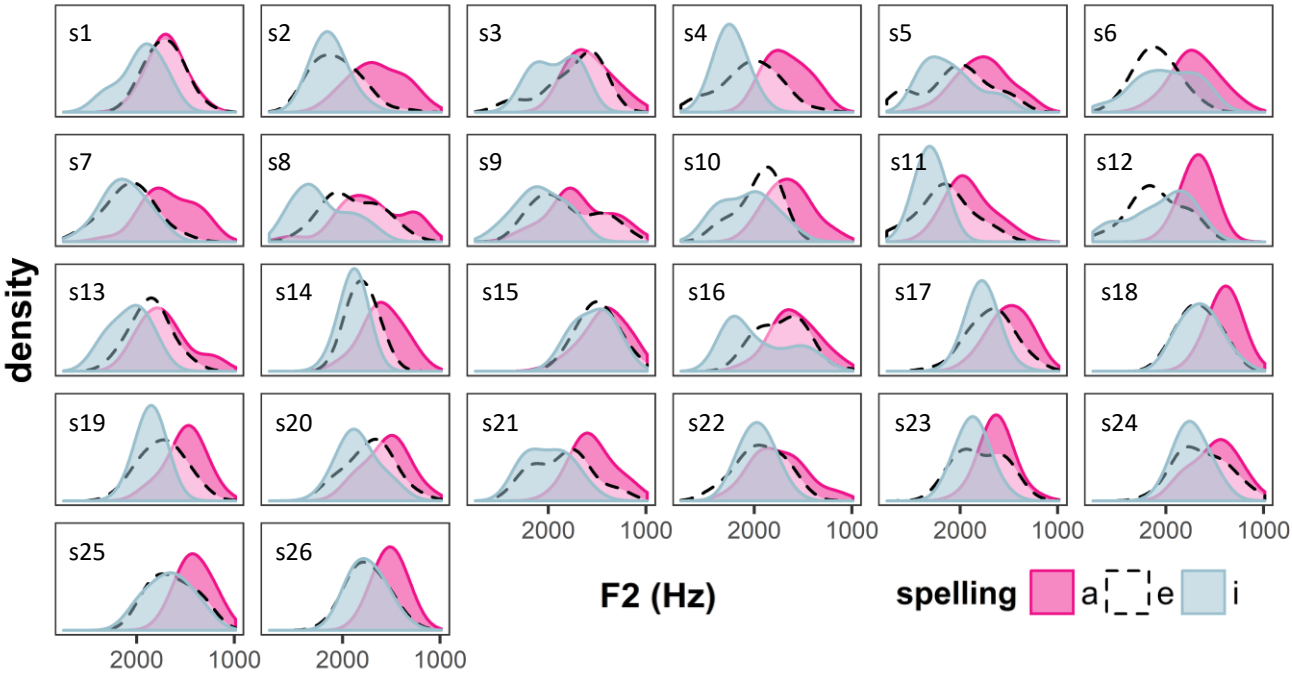
Compared to the uniformity across speakers in the relationship between <a> and <i>, there is much more variation in terms of the relative position of <e>. Some speakers' <e> tokens pattern with <a> (e.g. speaker 1) and for some they pattern with <i> (e.g. speaker 25). There are also many speakers for whom <e> tokens do not pattern neatly with either group (e.g. speaker 13). Instead, for these speakers <e> appears intermediate between <i> and <a>. Importantly, for these speakers it is not necessarily the case that these <e> spellings are a clear mixture of two separate categories. For some speakers these tokens look genuinely intermediate, as evidenced in unimodal distributions and a similarly size spread of data to <i> and <a>. We cannot definitively say that these speakers have an intermediate variant between /ɪ/ and /ə/. However, the variable and often intermediate status of the <e> tokens suggests that the relationship between /ɪ/ and /ə/ is not straightforward, and we have not been able to find evidence that all unstressed vowel tokens are categorically /ɪ/ or /ə/ across all speakers.

4. DISCUSSION

The fact that there are differences between spellings provides empirical support for the fact that there are distinct vowel qualities in unstressed syllables. The backer vowel quality for <a> compared to <i> evidenced in F2 values is as was predicted, given the general observation that <a> tends to represent /ə/ and <i> represent /ɪ/. The fact that we find a consistent difference between these spellings for all but one speaker suggests that the distinction between /ɪ/ and /ə/ is present in the variety of English spoken in Derby. The positive interaction between F1 and duration for <a> spellings is also consistent with speakers aiming for different vowel heights for the two spellings.

By contrast, the great variability between speakers for <e> suggests that the situation may not be as simple as all vowels categorically varying between two vowel qualities. It suggests that, although often overlooked, unstressed vowels can be an interesting source of speaker variation. Furthermore, the fact that some speakers have a three way difference between spelling, with <e> falling intermediately of <a> and

Figure 2: F2 (Hz) density distributions by spelling for individual speakers



<i> suggests that there may be additional variation other than a simple distinction between /ɪ/ and /ə/. It is likely that for some speakers unstressed vowels do not vary categorically between only /ɪ/ and /ə/. Note that the F2 values here correspond to what the order of F2 would be for the expected full vowels, i.e. /ɪ/ for <i>, /ɛ/ for <e>, and /a / for <a>.

4.1 Why the intermediate position of <e>?

There are three possible reasons for this pattern.

1) Influence of orthography

Some speaker's pronunciations could be influenced by the orthography of the unstressed vowel [17]. However, this explanation seems somewhat unlikely, given that the data was from spontaneous speech. In addition, if speakers were influenced by what would be the full vowel, it would be expected that the given vowels would be sometimes realised as full vowels (e.g. vowels spelt with <a> realised with /a/), However this cannot have been the case as only unambiguously reduced tokens were included, where no full vowel pronunciations were possible.

2) Phonetic analogy with related cognates

It is possible that when producing a reduced vowel speakers make connections with other related words e.g. *prefer*, *preference*. This would mean that through their association with the related word, and the general relationship between spelling and vowel quality, spelling might have an indirect effect on their pronunciation. Unfortunately in the data here, it was not possible to test this particular hypothesis, as only 125 out of 2181 tokens had such a cognate word where the equivalent vowel was stressed. However, this in itself shows that this explanation in itself is unable to account for all of the data.

3) Incomplete neutralisation of full forms

For the reasons given above, this is the most likely explanation. This would mean that although reduction has taken place, the neutralisation of the differences between historical different full vowel qualities has not been completed. Therefore the spelling differences found may be an indirect effect of the fact that historically these spellings would have represented different vowels. Although it is not an exact relationship we can assume that the spelling of reduced vowels is a general indicator of their historical pronunciation [l3]. In this sense, any possible relationship between current reduced vowel quality and historical full vowel quality may actually be stronger than what is indicated purely by looking at spelling.

5. CONCLUSION

We have provided empirical evidence for a distinction between /ɪ/ and /ə/ and shown that this mainly manifests itself in F2, and for vowels of longer duration, in F1 also. However the idea that in unstressed vowels only /ɪ/ or /ə/ is possible may be an oversimplification. In reality the situation is more complex and there is much interspeaker variation in the way that unstressed vowel qualities pattern. The data also suggests that, for at least some speakers, unstressed vowel quality does not just vary categorically between /ɪ/ and /ə/, and that there are further differences which are suggestive of incomplete neutralisation of historical full vowel qualities.

6. REFERENCES

[1] Bates, D., Maechler, M., Bolker, B. 2011. lme4: Linear mixed-effects models using S4 classes. R package version 1.1-7.

[2] Bates, S.A.R (1995). *Towards a Definition of Schwa: An Acoustic Investigation of Vowel Reduction in English.* Ph.D. dissertation. Edinburgh University: United Kingdom.

[3] Boersma, P., Weenink, D. 2014. Praat: doing phonetics by computer (Version 5.4.04)

[4] Docherty, G., Foulkes, P. (1999). Derby and Newcastle: instrumental phonetics and variationist studies. In Foulkes, P., Docherty, G. (eds.) *Urban voices: Accent studies in the British Isles*. Abingdon: Routledge.

[5] Fabricius, A., Watt, D., Johnson, D.E. (2009). A Comparison of Three Speaker- Intrinsic Vowel Formant Frequency Normalization Algorithms for Sociophonetics. *Language Variation and Change*, 21, 413-435.

[6] Flemming, E. (2009). The phonetics of the schwa vowel. In Minkova, E. (Ed.). *Phonological Weakness in English: From old to present-day English* (Pp 78-95). Palgrave MacMillan.

[7] Flemming, E., Johnson, S. (2007). Rosa's roses: Reduced vowels in American English. *Journal of the International Phonetic Association*, 11, 83-96.

[8] Fromont, R., Hay, J. (2012). LaBB-CAT: An annotation store. In *Proceedings of the Australasian Language Technology Association Workshop 2012*, 113-117.

[9] Gimson, A.C. (1962). *An Introduction to the Pronunciation of English*. London: Edward Arnold.

[10] Heselwood, B. (2007). Schwa and the phonotactics of RP English. *Transactions of the Philological Society*, *105* (2), 148-87.

[11] Jones, D. (1956). *The Pronunciation of English, 4th Edition.* London: J.M. Dent.7

[12] Kondo, Y. (1994). Targetless Schwa: Is that how we get the impression of stress timing in English? *Proceedings of the Edinburgh Linguistics Department Conference*, 63-76.

[13] Ladefoged, P., Johnson, K. (2014). *A Course in Phonetics* (*7th edition)*. Stamford: Cengage learning.

[14] Lilley, J. (2012). *The characterization of variation American English schwa using hidden Markov Models*. Ph.D. dissertation. University of Delaware, USA.

[15] Milroy, L., Milroy, J., Docherty, G.J. (1997) *Phonological Variation and Change in Contemporary Spoken British English*. ESRC End of Award Report, R000234892.

[16] R CoreTeam, 2013. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria.

[17] Racine, I., Burke, A., & Spinelli, E. (2014). The implication of spelling and frequency in the recognition of phonological variants: evidence from pre-readers and readers. *Language, Cognition and Neuroscience*, *29*(7), 893-898.

[18] Roach, P. (1983). *English Phonetics and Phonology.* Cambridge: Cambridge University Press.

[19] Sóskuthy, M. (2014). Formant Editor: Software for editing dynamic formant measurements (version 0.8.1)

[20] Tasker, S., Sóskuthy, M., Foulkes, P. (2018). How many reduced vowels are there in English? A Bayesian process-based approach. Poster, *Laboratory Phonology 18*, Lisbon, Portugal.

[21] Wells, J. C. (1982). *Accents of English* (Vol. 1). Cambridge University Press.

[22] Wells, J.C. (1990). *Longman Pronunciation Dictionary*. Harlow: Longman.