An acoustic study of the RP English LOT and THOUGHT vowels

Jussi Wikström
University of Cambridge
jussiwikstrom@hotmail.com

While there is variation among existing impressionistic accounts where the description of the RP English LOT and THOUGHT vowels is concerned (compare Wells 1982 (vol. I), Collins & Mees 2003, Roach 2004, Cruttenden 2008), not much attention has been paid to this issue in acoustic studies of RP (e.g. Wells 1962, Deterding 1990, Hawkins & Midgley 2005). In the present study, seven female native speakers of RP or near-RP born between 1985 and 1993 (i.e. speakers aged between 18 and 25 years at the time of the study) were recorded saying English words containing monophthongal vowels. In addition, data consisting of read speech from 18 male native speakers of RP or near-RP born between 1983 and 1991 (i.e. speakers aged between 18 and 25 years at the time they were recorded) contained in the DyViS database (Nolan et al. 2009) were analysed. The data were analysed acoustically by measuring F1 and F2 and normalising the measurements according to Lobanov's (1971) formula along with the mean F1 and F2 frequencies reported in Wells (1962), Deterding (1990) and Hawkins & Midgley (2005). Statistical analysis revealed statistically significant differences between the F1 formant measurements of the seven female speakers and the 18 male speakers versus Hawkins & Midgley's speakers born between 1946 and 1951; mean F1 was higher for the speakers born between 1946 and 1951. As for the THOUGHT vowel, the F1 measurements overlapped with the means relating to all different age groups in Hawkins & Midgley's (2005) data. It is suggested that RP LOT is undergoing raising whereas there is no strong evidence of any shift of the THOUGHT vowel.

1 Introduction

While the Received Pronunciation (RP) English accent, which is defined as being the accent associated with the upper end of the social scale rather than any particular region within England (e.g. Wells 1982, vol. I), has been studied extensively (Fabricius 2007), not much has been said about the quality of the LOT and THOUGHT vowels and any change in vowel quality where these vowels are concerned in previous acoustic work on the variety (e.g. Wells 1962, Deterding 1990, Hawkins & Midgley 2005). It is, however, well established through acoustic analysis that many of the monophthongal vowels in RP have shifted, with the TRAP vowel becoming more open in the early twentieth century and the FOOT and GOOSE vowels fronting in the late twentieth century (e.g. Wells 1997, Hawkins & Midgley 2005, Fabricius 2007). This paper will show that while Hawkins & Midgley (2005) do not consider the seemingly age-related differences between RP speakers' LOT vowels in their data or those

Journal of the International Phonetic Association (2013) 43/1
doi:10.1017/S0025100312000345

of previous studies to be significant, the acoustic evidence in Hawkins & Midgley (2005) can nevertheless be taken to suggest that the RP LOT vowel is shifting. Finally, this paper will argue that there is little acoustic evidence to imply that the quality of the THOUGHT vowel has changed substantially over the past five decades, in spite of the fact that a shift from a more open to a closer quality for this vowel is identified in the literature on RP. As noted in Hawkins & Midgley (2005), up-to-date information about RP vowels is of interest to language teachers and speech therapists and it is therefore relevant to conduct an in-depth descriptive analysis of the RP LOT and THOUGHT vowels. Expanding current datasets by collecting further data from young RP speakers is important, considering that any findings based on a small dataset such as five speakers born between 1976 and 1981 in Hawkins & Midgley's (2005) study must be regarded as preliminary and the trends identified on the basis of that dataset alone must therefore be treated with some caution. For this reason, the present investigation will include analysis of new data from female RP or near-RP speakers born between 1985 and 1993 as well male speakers born between 1983 and 1991 (i.e. speakers aged between 18 and 25 years at the time of the recordings). It should be noted that while the Hawkins & Midgley (2005) data are older than the present data, it is useful and appropriate to draw on all datasets in considering whether general trends that can be seen in the Hawkins & Midgley (2005) data are supported by more recent data.

2 Background

This section looks at previous literature on the RP LOT and THOUGHT vowels. With regard to previous descriptive work on the RP LOT and THOUGHT vowels, Wells (1982, vol. I: 130) and Roach (2004) refer to RP LOT as a raised Cardinal 13. Wells (1982, vol. II: 356) points out that this vowel tends to be more open in northern English than in RP, which by definition excludes a fully open realisation of this sound from RP. Cruttenden (2008: 120), by contrast, refers to RP LOT as a fully open (i.e. Cardinal-13-like) vowel, which is in line with Jones's (1917: 40) account and Gimson's (1962) edition of Jones's work. Jones (1977) and Collins & Mees (2003) seem to permit a range of realisations including fully open, while Wells (2008) appears to exclude a fully open variant and points to possible closer variants instead.

The average F1 and F2 measurements of the LOT and THOUGHT vowels in Wells's (1962), Deterding's (1990) and Hawkins & Midgley's (2005) studies are given in Table 1. The findings reported in the acoustic studies suggest that there is some variability in the realisation of the LOT vowel. Based on the lower F1 values for younger speakers in Hawkins & Midgley's (2005) data in comparison with older speakers in their data and Wells's (1962) and Deterding's (1990) datasets, it appears that such speakers use a closer quality than older speakers. The mean F1 measurement for Hawkins & Midgley's (2005) youngest speakers born between 1976 and 1981 (i.e. speakers aged between 20 and 25 years at the time of the study) seems to be intermediate between the most open realisations of the LOT and THOUGHT vowels, suggesting that the vowel may be close to Cardinal 6 in quality for young male speakers. Hawkins & Midgley (2005: 187) point out that the differences between their measurements and those of the previous studies may be due to hyperarticulation being more prominent in the previous work, particularly Wells (1962). However, there is a systematic difference between older and younger speakers even within Hawkins & Midgley's (2005) dataset. This systematic variation between age groups within the same study can be taken to suggest that the LOT vowel is indeed shifting. However, given that the study in question only includes data from five speakers, this observation must be treated with some caution. This issue is therefore explored in detail in the present study through the analysis of further data. With regard to rounding, Wells (1982, vol. I: 130) describes LOT as weakly rounded, as do Jones (1917) and Cruttenden (2008: 120).

https://doi.org/10.1017/S0025100312000345 Published online by Cambridge University Press

Table 1 Average formant values of the RP LOT and THOUGHT vowels taken from Wells's (1962), Deterding's (1990) and Hawkins & Midgley's (2005) studies.

Dataset Study, speakers' birth years and ages at the time of the study	Vowel	Average F1 frequency (Hz)	Average F2 frequency (Hz)
Wells 1962	LOT	599	891
Deterding 1990	LOT	593	866
Hawkins & Midgley 2005 1976–1981 (aged 20–25)	LOT	484	865
Hawkins & Midgley 2005 1961–1966 (aged 35–40)	LOT	496	833
Hawkins & Midgley 2005 1946–1951 (aged 50–55)	LOT	522	865
Hawkins & Midgley 2005 In or before 1936 (aged 65+)	LOT	518	875
Wells 1962	THOUGHT	449	737
Deterding 1990	THOUGHT	453	642
Hawkins & Midgley 2005 1976–1981 (aged 20–25)	THOUGHT	392	630
Hawkins & Midgley 2005 1961–1966 (aged 35–40)	THOUGHT	382	626
Hawkins & Midgley 2005 1946–1951 (aged 50–55)	THOUGHT	360	604
Hawkins & Midgley 2005 In or before 1936 (aged 65+)	THOUGHT	391	619

Beside pure scientific interest, there are also practical reasons for investigating the RP LOT vowel. Looking at the RP LOT vowel is of particular educational interest, considering that the quality of this vowel is generally identified as more open than is the case for back rounded vowels in many other languages (e.g. Cruttenden 2008). If this vowel is indeed undergoing raising, it may be necessary to take this into account in language teaching involving speakers of a substantial number of other languages (see Cruttenden 2008: 121). According to some approaches to L2 speech learning, such as Jenkins (2000, 2007), it is not regarded as necessary for L2 learners to closely imitate a native speaker accent. While this may be true for some speakers, information relating to L1 vowel quality is nevertheless relevant as some learners will seek to approach a native speaker target relatively closely and distinguishing between certain vowel qualities may be deemed to be particularly important (see Cruttenden 2008). Moreover, there will be L2 learners or non-RP English native speakers with a strong interest in acquiring a particular accent for temporary purposes, such as actors (see Hawkins & Midgley 2005: 184).

Turning now to impressionistic accounts of the RP THOUGHT vowel, Wells (1982, vol. I: 145) describes it as being somewhere between Cardinal Vowel 6 and 7 and notes that this sound is more open in old-fashioned RP. Cruttenden's (2008: 122) description is in line with this, and such a description of the quality of this vowel is also to be found in Gimson's (1962) edition of Jones's work. In Jones's (1917) account RP THOUGHT is described as more open, i.e. intermediate between Cardinal Vowels 13 and 6. Comparison between Jones's more recent (1977) vowel chart with that of Roach (2004) reveals that the quality of this vowel has been associated both with a more open, Cardinal-6-like quality in Jones (1977), and a closer, Cardinal-7-like quality in Roach (2004). Wells's (2008) chart indicates that the quality varies, but excludes very open (i.e. Cardinal-6-like) realisations. The fact that a more open variant of the THOUGHT vowel is associated with old-fashioned RP is reported in the literature

https://doi.org/10.1017/S0025100312000345 Published online by Cambridge University Press

(e.g. Wells 1982, vol. I), but it is interesting to note that Collins & Mees's (2003) relatively recent vowel chart positions this vowel close to Cardinal 6. Considering what acoustic data reveal about the RP THOUGHT vowel is paramount and this is examined in the following paragraph.

On the basis of higher average F1 values in their datasets, the participants in Wells (1962) and Deterding (1990) appear to be using slightly more open qualities than the participants in Hawkins & Midgley's (2005) study. This may be due to more hyperarticulation in those studies, particularly in Wells (1962), as Hawkins & Midgley (2005) point out, not least considering the fact that older and younger male speakers' F1 varies little within the Hawkins & Midgley (2005) data, which include data from speakers born as early as 1928 and as late as 1981. Cruttenden (2008: 122) notes that this vowel is produced with medium lip-rounding and is accordingly slightly more rounded than LOT.

In the light of the issues identified above, this paper seeks to answer the following research questions:

- How do young native RP or near-RP (see Wells 1982, vol. I) speakers' productions of the RP LOT and THOUGHT vowels correspond to those of RP or near-RP speakers from the same and other generations as reported in previous studies?
- What is the quality of the RP LOT and THOUGHT vowels in RP as currently spoken by speakers born between 1983 and 1993?

3 Participants and method

It was decided that speakers of near-RP as well as RP could be included in this study. Near-RP in this context refers to accents which are close to RP but which may incorporate some potentially localisable features which do not deviate too markedly from the RP norm, e.g. some features of London English, such as vocalisation of dark /l/ (see e.g. Cruttenden 2008: 82). From a sociolinguistic point of view, speakers of near-RP as defined here would not usually be instantly localisable other than possibly in broad terms, e.g. 'southern'. The fact that near-RP speakers were included was regarded as unproblematic considering that the LOT and THOUGHT vowels are considered to vary little in terms of vowel quality within England (Cruttenden 2008: 120, 123). Moreover, it should be noted that there are no undisputed criteria for establishing exactly what constitutes an RP speaker. Furthermore, it is also evident that participants in previous acoustic studies of RP vowels also exhibited a certain degree of variation; for example Cruttenden (2008: 98) points out that some minor influence of London English can be seen in Deterding's (1990) RP vowel data. However, this is unlikely to have a substantial influence on any general trends identified in this or previous studies as any slight regional influence in a particular speaker is likely to be cancelled out by a lack of the same influence in other participants. This is inevitable in practice when investigating accents as they are rarely, if ever, homogeneous. For this reason, and because it would be very difficult and subjective to decide which participants should be included on the basis of the presence or absence of particular phonetic cues, few detailed phonetic criteria were used in selecting participants. Instead, the main criterion was to ask the participants whether their accents were generally localisable by other people and participants who reported that people could not generally tell what part of England or Britain they were from were recruited to the study. As such, the criterion for defining 'RP' is in line with that of Wells (1982, vol. I: 117), according to which RP must be defined as the English accent which cannot be attributed to any particular part of England or Britain. In the same vein, it was not regarded as relevant where the participants were brought up or what their schooling background was, as it is clear that there are RP speakers in all parts of England and RP speakers can be found in state schools as well as private schools. However, the participants' recordings were impressionistically analysed

https://doi.org/10.1017/S0025100312000345 Published online by Cambridge University Press

by the author to see whether a feature which is obviously not RP was included, in particular, a TRAP vowel for BATH words. In terms of age, since the research includes a focus on possible language change emerging in young speakers, it was decided that participants should be between 18 and 25 years old and thus born between 1983 and 1993. Only participants who reported normal hearing were included in the study. Seven female participants who met the above criteria, identified by a specially-designed questionnaire, were recruited to the study by approaching students of three UK higher education institutions: the University of Leeds, the University of York, and the University of Reading, via e-mail.

Data from 18 male speakers contained in the Dynamic Variability in Speech: A Forensic Phonetic Study of British English (DyViS) database (Nolan et al. 2009) were also analysed as part of the present study. This was in order to extend the sample size and thus ensure more reliable conclusions to be drawn regarding the realisation of the RP or near-RP LOT and THOUGHT vowels. The participants in the DyViS project are described as speakers of 'Standard Southern British English' (SSBE). Nolan et al. (2009: 38) observe that speakers of this accent are most accessible at the University of Cambridge. They state that while the accent in question might be regarded as RP, they decided not to use this term due to its association with more old-fashioned pronunciation and because the variety at issue is localisable as it is associated with south-east England, something which also appears to be true of RP historically (Nolan et al. 2009: 38). Nolan et al. (2009: 38) acknowledge that SSBE as defined in their paper is spoken by a small number of native speakers from other parts of the UK. They concede that SSBE cannot be defined in terms of a set number of accent characteristics so that participant selection depended on a number of criteria, some of which were applied more stringently than others (Nolan et al. 2009: 38). Thus a number of different characteristics were referred to including whether a potential participant had a TRAP vowel for BATH words, a characteristic which would lead to a person being excluded from the sample (see Nolan et al. 2009: 39 for further details). It was determined that the accent referred to as SSBE in Nolan et al. (2009) was synonymous with RP or near-RP as defined in this paper and which the female speakers recruited to the present study spoke.

The remainder of the present section deals first with the elicitation methods used to obtain data from the seven speakers recruited to this study and then with the elicitation techniques used in the DyViS project (Nolan et al. 2009).

A Microsoft PowerPoint presentation was used as a prompt for the production test. It contained 14 English words and each word was repeated three times in randomised order. The words were presented in standard British English orthography alongside an International Phonetic Alphabet (IPA 1999) phonemic transcription of RP. The test words and the corresponding phonemic transcriptions, shown in brackets, were *heed* /hiːd/, *Keith* /kiːθ/, *head* /hɛd/, *Etty* /ˈɛti/, *had* /hæd/, *cat* /kæt/, *hard* /hɑːd/, *cart* /kɑːt/, *cot* /kɒt/, *odd* /ɒd/, *caught* /kɔːt/, *awed* /ɔːd/, *who'd* /huːd/ and *coot* /kuːt/. The purpose of providing the IPA transcription was to aid those participants who might feel uncertain about the pronunciation of a particular word to potentially help them with its pronunciation. The participants were linguistics students who had been taught IPA transcription. It was thought that uncertainty about a pronunciation might lead to increased anxiety and lack of interest in completing the testing session. However, it should be made clear that the words were also presented in standard orthography, which most participants relied on in practice. In any event, there is no strong reason to suspect that the fact that the IPA transcription was presented alongside normal orthographic notation would affect the participants' pronunciation beyond a participant possibly using the right phonemes in place of a mispronunciation; but this is irrelevant in the context of the present study, which looks at phonetic realisation rather than the participants' ability to use RP phoneme categories correctly. The words *odd* and *awed* were included as they are part of a minimal pair featuring the RP LOT and THOUGHT vowels under investigation. It was necessary to include the other English words featuring vowels from across the English vowel space in order to reduce the possibility that participants might guess the aim of the investigation which, if known to the participants, could affect their pronunciation. The inclusion of these vowels also made it

https://doi.org/10.1017/S0025100312000345 Published online by Cambridge University Press

possible to normalise vowel data for comparison with previous acoustic data collected from male speakers using the Lobanov (1971) normalisation method, as discussed below.

Each session began with informed consent being obtained from the participant. This was followed by the production test in which the participant said the words in the PowerPoint presentation while being recorded using a Marantz PMD 671 recorder and a Shure SM48 dynamic microphone. The data were recorded at a sampling rate of 44.1 kHz and 16-bit amplitude resolution. The PowerPoint presentation was run with the participant instructed to pronounce the word shown on the screen then move to the next slide and pronounce the word shown on screen.

The DyViS database consists of data from four tasks: a simulated police interview, a simulated telephone call, passage reading and sentence reading (see Nolan et al. 2009). The passage-reading data were used in the present study (see Nolan et al. 2009: 50–51). The DyViS recordings were made in a sound-treated room at the University of Cambridge (Nolan et al. 2009: 40). They were made using a Marantz PMD670 recorder and a Sennheiser ME64-K6 cardioid condenser microphone (Nolan et al. 2009: 40). The strong monophthongal vowels in stressed syllables in the following words were analysed: *Deacon*, *Beetle*, *teacher*, *Detman*, *headlights*, *Dexter*, *Pat*, *Hatfield*, *Baxter's*, *part*, *Harper*, *Parkville*, *opposite*, *Scott*, *Hobbs*, *hoards*, *Court*, *sports*, *poodles*, *Coot* and *Hooper's*.

Turning now to data analysis, the production data, including those from the DyViS database were analysed acoustically using Praat speech analysis software (Boersma & Weenink 2011). The vocalic segments in the relevant words were located by inspecting waveforms and spectrograms in Praat. F1 and F2 measurements were then taken at the temporal midpoint of each vocalic segment with the programme's LPC algorithm being used to track the formants. The default settings, with the cut-off at 5500 Hz, were appropriate for tracking all female speakers' formants accurately and was thus used for analysing the data from those speakers. However, the cut-off was lowered to 5000 Hz for the analysis of the recordings from male speakers. Because male and female formant frequencies are not comparable, due to the fact that there are sex-related differences in vocal tract size and shape, it was necessary to employ a vowel normalisation procedure in order to allow reliable comparison between male and female speakers' vowels (see e.g. Thomas & Kendall 2007a). The Lobanov (1971) normalisation method has been found to be particularly good in reducing anatomical variation while retaining variation of sociophonetic interest and was therefore used for this purpose (see e.g. Adank, Smits & van Hout 2004). It can thus be used to enable comparison between male and female speakers' vowels. The normalisation formula is given in (1).

$$(1)\quad \mathrm{F}^{\mathrm{N}}_{n[V]} = (\mathrm{F}_{n[V]} - \mathrm{MEAN}_{\mathrm{n}})/\mathrm{S}_{\mathrm{n}}$$

Here $\mathrm{F}^{N}_{n[V]}$ stands for the normalised value for $\mathrm{F}_{n[V]}$ for formant *n* of vowel *V*, $\mathrm{MEAN}_{\mathrm{n}}$ is the mean value for formant *n* for the speaker in question and S_{n} is the standard deviation for the speaker's formant *n* (Thomas & Kendall 2007b). Lobanov normalisation does not deal with possible issues, such as females using more peripheral vowels than males for reasons of clarity, or that they may use more peripheral vowel qualities to make up for under-sampling of the spectrum because of their higher fundamental frequency (Diehl et al. 1996). Despite these drawbacks, Lobanov normalisation is nevertheless typically regarded as an appropriate method for comparing male and female speakers in sociophonetic studies (see e.g. Thomas & Kendall 2007a). Crucially, Figure 1 shows that the female speakers' normalised vowel formants from this study overlap well with those of the male speakers from previous studies suggesting that these issues are not particularly relevant to the RP vowel surveyed in this paper. As already mentioned above, this method requires input from the speakers' entire vowel system in order to produce reliable results (Thomas & Kendall 2007b). For this reason, the participants' raw formant values relating to vowels from across the RP vowel space, and the average raw formant values of the same vowels reported in the literature, i.e. Wells (1962), Deterding (1990) and Hawkins & Midgley (2005), were normalised according to Lobanov's

(1971) vowel normalisation method, as adapted by Thomas & Kendall (2007b) using NORM vowel normalisation software (Thomas & Kendall 2007c). Mean formant values from previous accounts relating to RP phoneme categories were used as input. The Mann-Whitney U test was used to test whether identified differences between groups with regard to Lobanov-normalised formant values were statistically significant using PASW Statistics (IBM 2010). The Bonferroni correction was used to adjust the *p*-values as the Mann-Whitney U test was used repeatedly.

4 Results

The F1 and F2 frequencies for the FLEECE, DRESS, TRAP, START, LOT, THOUGHT and GOOSE vowels of the female participants in this study and the 18 male speakers in the DyViS database are available as supplementary materials accompanying the online version of the present paper (via http://journals.cambridge.org/IPA). Figure 1 shows the Lobanov normalised mean F1 and F2 frequencies for the FLEECE, DRESS, TRAP, START, LOT, THOUGHT and GOOSE vowels in the data contained in Hawkins & Midgley (2005) as well as for the present datasets from male and female speakers.

As Figure 1 shows, the highest mean F1 values for the LOT vowel are associated with Hawkins & Midgley's youngest age group, born between 1976 and 1981, the data from female participants born between 1985 and 1993 and the data from male speakers born between 1983 and 1991. Their mean F1 values are all clearly higher than those of Hawkins & Midgley's speakers born in or before 1951. The F1 and F2 values for the THOUGHT vowel seem to be relatively similar for all age groups with no systematic difference between data relating to different age groups in Hawkins & Midgley (2005) and the present data. As far as F2 for the LOT vowel is concerned, the figure indicates that this does not vary greatly between the different groups, although F2 is slightly further forward for the younger age groups in the Hawkins & Midgley (2005) data and for the present data from both male and female speakers. It should be noted that F2 is also generally lower for the THOUGHT vowel than for the LOT vowel, which can be taken to suggest that higher F2 is characteristic of the most open vowel qualities for back rounded vowels in the RP system. Since it is F1 that seems to vary most between the different groups for the LOT vowel and considering that this formant correlates most strongly with vowel openness, and taking account of the fact that the existing accounts of RP vowels differ in their descriptions of vowel openness where both the LOT and THOUGHT vowels are concerned, we will now look at F1 in more detail.

The Mann-Whitney U test can be used to examine whether the differences between the Lobanov-normalised F1 values are statistically significant between the speakers in the female data (born between 1985 and 1993), male data (born between 1983 and 1991) and the youngest speakers in Hawkins & Midgley's data (born between 1976 and 1981) as well as the participants born between 1961 and 1966 or 1946 and 1951 included in Hawkins & Midgley (2005). Since the Mann-Whitney U test was used nine times, the Bonferroni correction was applied so that a $p < .0056$ was statistically significant at the .05 level and $p < .0011$ was statistically significant at the .01 level. Comparison between the F1 measurements relating to the LOT vowel from the data from the female and male speakers of this study using the Mann-Whitney U test does not give a statistically significant result ($U = 361$, $z = –2.431$, exact two-tailed $p = .014$). Equally, statistical comparison of Lobanov-normalised F1 relating to the LOT vowel between the female participants in the present study and those of Hawkins & Midgley's youngest participants using the Mann-Whitney U test does not yield a statistically significant finding ($U = 119$, $z = –1.25$, exact two-tailed $p = .223$). Conversely, when the same test is employed to compare the F1 measurements of the male participants in this study and the youngest participants in Hawkins & Midgley's study, the result is statistically highly significant ($U = 181$, $z = –3.259$, exact two-tailed $p = .001$). Comparing the equivalent data

https://doi.org/10.1017/S0025100312000345 Published online by Cambridge University Press

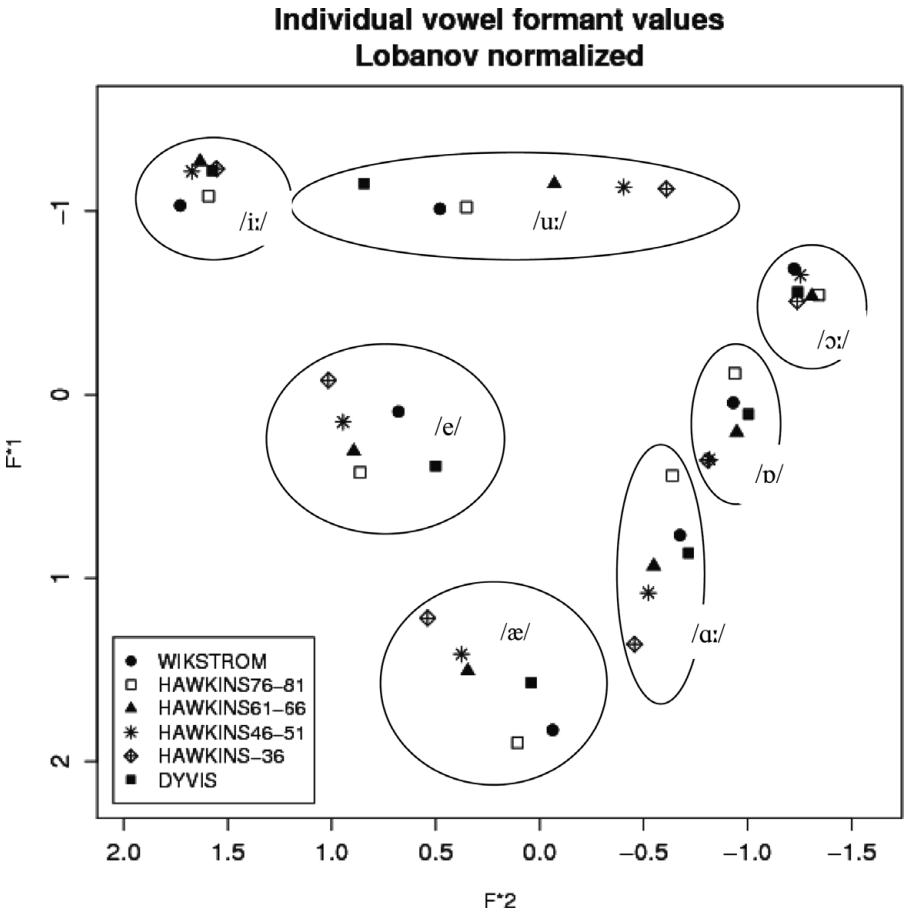

Figure 1 The Lobanov normalised mean F1 and F2 measurements relating to the FLEECE, DRESS, TRAP, START, LOT, THOUGHT and GOOSE vowels in Hawkins & Midgley (2005) and the present data.

between the female participants in the present study and the participants born between 1961 and 1966 using the Mann-Whitney U test, a statistically significant result is found ($U = 67$, $z = –2.905$, exact two-tailed $p = .003$). By contrast, comparison between the male data from the present study and Hawkins & Midgley's male data relating to those born between 1961 and 1966 using the Mann-Whitney U test does not result in a finding of statistical significance ($U = 350$, $z = –0.807$, exact two-tailed $p = .425$).

Considering the above, it is necessary to look into how the formant measurements of younger speakers compare to those of older speakers born between 1946 and 1951 as reported in Hawkins & Midgley (2005). In that regard, the Mann-Whitney U test performed to compare the female participants in this study with the male speakers born between 1946 and 1951 where F1 is concerned for the LOT vowel shows that the difference between the groups is statistically highly significant ($U = 31$, $z = –4.060$, exact two-tailed $p < .001$). Similarly, F1 comparison between the male speakers born between 1976 and 1981 and those born between 1961 and 1966 using the same statistical procedure reveals a statistically highly significant difference between the groups ($U = 12$, $z = –4.171$, exact two-tailed $p = < .001$). When the F1 data from male speakers born between 1983 and 1991 from the present study are compared with the F1 data of Hawkins & Midgley's (2005) speakers born between 1946 and

https://doi.org/10.1017/S0025100312000345 Published online by Cambridge University Press

1951 the Mann-Whitney U test result is statistically significant ($U = 198.5$, $z = –3.004$, exact two-tailed $p = .002$). However, similar comparison between the F1 data relating to Hawkins & Midgley's participants born between 1961 and 1966 and those born between 1946 and 1951 does not give a statistically significant result ($U = 71$, $z = –1.723$, exact two-tailed $p = .089$). The statistical analysis thus supports the conclusion reached by inspecting Figure 1 that higher F1 values are associated with the older male speakers in Hawkins & Midgley (2005) born in or before 1951 (i.e. speakers aged 50 years or above at the time of the study) than with the younger speakers in the present study or the younger male speakers in Hawkins & Midgley (2005) born between 1976 and 1981 (i.e. speakers aged between 20 and 25 years at the time of the study).

5 Discussion and implications

In light of the research questions formulated in Section 2 above, this section discusses the relationship between the findings from this and previous studies and what this reveals about the quality of the RP LOT and THOUGHT vowels in RP or near-RP speakers born between 1983 and 1993. As is shown in the Section 4 above, comparison of normalised F1 values from the subjects in this study and those from previous studies reveals a stronger tendency for lower F1 values to occur for the LOT vowel in the present data from male speakers born between 1983 and 1991 and female speakers born between 1985 and 1993 than is the case for the participants born in 1951 or earlier in Hawkins & Midgley's (2005) study. This was supported by statistical analysis which confirmed that the difference between Lobanov-normalised F1 for those born between 1946 and 1951 in Hawkins & Midgley (2005) and the male speakers born between 1983 and 1991 was statistically significant, as was the difference between the speakers born between 1946 and 1951 and the female speakers born between 1985 and 1993. Furthermore, it is clear that F2 is slightly lower for the data relating to younger speakers with lower F2 seemingly characteristic of closer back vowels. It therefore appears appropriate to interpret the present data as providing further confirmation for the hypothesis expressed in Section 1 above on the basis of Hawkins & Midgley's (2005) study that the RP LOT vowel is undergoing raising. It should be recalled that this conclusion is reinforced by the fact that the data agree with the trend that could be identified on the basis of Hawkins & Midgley's (2005) data. It seems to be the case that younger RP or near-RP speakers typically use a closer quality, possibly approaching Cardinal 6 considering that the quality appears to be roughly intermediate between that used by older speakers for the LOT vowel and that used for the THOUGHT vowel, while older speakers use a more open quality, between Cardinal Vowels 13 and 6. As mentioned in Section 1, it is widely reported that RP vowels have shifted across the vowel space, with the TRAP vowel becoming more open and FOOT and GOOSE vowels fronting (see e.g. Gimson 1980, Wells 1997, Hawkins & Midgley 2005, Fabricius 2007, Cruttenden 2008). For this reason, it appears that RP vowels tend to be shifting in an anticlockwise direction. As the RP LOT vowel is also raising, it can be seen as taking part in a systematic anticlockwise shift of RP vowels.

It is clear that the change in vowel quality associated with the LOT vowel has pedagogical implications. Cruttenden (2008: 121) notes that the back rounded vowels found in other languages tend to be closer in quality than the back rounded vowels used in many other languages (according to Cruttenden, the LOT vowel is fully open). As Wells (1997) points out, it is still necessary for teachers of English as a foreign language working in a British-English–oriented environment to use RP as the pronunciation model for L2 learners, but that model needs to be updated in the light of changes occurring within the accent. Since this research reveals that the shifting RP LOT vowel is becoming closer, approaching Cardinal 6, Cruttenden's (2008: 120) statement regarding the openness of this vowel in L2 learning may be in need of some revision. L2 learners and others aiming at a modern RP accent should

https://doi.org/10.1017/S0025100312000345 Published online by Cambridge University Press

now be encouraged to use a quality somewhat closer than fully open where appropriate, particularly if a suitable vowel occurs in the learner's L1. This finding is particularly relevant because vowels of this type are more likely to occur in the learner's L1 than fully open ones (see Cruttenden 2008) and requires teachers of L2 English to be alert to the fine distinctions between different types of back rounded vowel and knowledge of each individual learner's L1 vowel system and that of the changing RP system. Equally, this finding is relevant to those teaching young RP or near-RP speakers another language or to those who teach them another accent of English in contexts such as accent coaching for actors. They may need to take the changing nature of the RP LOT vowel into account in assessing the particular problems that are likely or unlikely to occur for this group of learners.

Let us now turn to the THOUGHT vowel. Interestingly, comparison between the present data and the data in previous accounts, such as Wells (1962) and Hawkins & Midgley (2005), reveals that the RP THOUGHT vowel does not seem to be shifting. In general, the present data support the descriptions of Roach (2004) and Cruttenden (2008) suggesting that the RP THOUGHT vowel is generally closer to Cardinal 7 than to Cardinal 6. This may also account for the degree of generational variation found for the LOT vowel involving both more open and considerably closer qualities, as well as the variation between the averages for the LOT and THOUGHT vowels with more open qualities for LOT and for THOUGHT, even for the youngest speakers. Collins & Mees's (2003: 96) vowel chart, which suggests that the RP THOUGHT vowel is closer to Cardinal 6 than to Cardinal 7, does not therefore position it correctly in the light of the present data. Taking account of the present findings regarding the LOT vowel, it would seem important to ensure that L2 learners aiming at a high level of competency in RP-type pronunciation avoid pronunciations of the RP THOUGHT vowel close to Cardinal 6 as such realisations could potentially be confused with the LOT vowel.

Acknowledgements

An earlier version of this paper was presented at the British Association of Academic Phoneticians' Colloquium 2012. I would like to thank Barry Heselwood for his comments on previous versions of this paper. My gratitude is due to the speakers who took part in the study. I am grateful to Francis Nolan, Kirsty McDougall and Toby Hudson for helping me access the DyViS database. I also wish to thank the three anonymous *JIPA* reviewers and the editor for their comments.

References

Adank, Patti, Roel Smits & Roeland van Hout. 2004. A comparison of vowel normalization procedures for language variation research. *Journal of the Acoustical Society of America* 116, 3099–3107.

Boersma, Paul & David Weenink 2011. Praat: Doing phonetics by computer (version 5.0.11). http://www.praat.org/ (accessed 28 February 2011).

Collins, Beverley & Inger M. Mees. 2003. *Practical phonetics and phonology: A resource book for students*. London & New York: Routledge.

Cruttenden Alan (ed.). 2008. *Gimson's pronunciation of English*, 7th edn. London: Hodder Education.

Deterding, David. 1990. *Speaker normalisation for automatic speech recognition*. Ph.D. dissertation, University of Cambridge.

Diehl, Randy, Björn Lindblom, Kathryn Hoemeke & Richard Fahey. 1996. On explaining certain male–female differences in the phonetic realization of vowel categories. *Journal of Phonetics* 24, 187–208.

Fabricius, Anne H. 2007. Variation and change in the TRAP and STRUT vowels of RP: A real time comparison of five acoustic data sets. *Journal of the International Phonetic Association* 37, 293–320.

Gimson, Alfred C. 1962. *An introduction to the pronunciation of English*. London: Edward Arnold.

Gimson, Alfred C. 1980. *An introduction to the pronunciation of English*, 3rd edn. London: Edward Arnold.

Hawkins, Sarah & Jonathan Midgley. 2005. Formant frequencies of RP monophthongs in four age groups of speakers. *Journal of the International Phonetic Association* 35, 183–199.
IBM. 2010. PASW statistics (Version 18.0.2).
IPA [International Phonetic Association]. 1999. *Handbook of the International Phonetic Association: A guide to the use of the International Phonetic Alphabet*. Cambridge: Cambridge University Press.
Jenkins, Jennifer. 2000. *The phonology of English as an international language*. Oxford: Oxford University Press.
Jenkins, Jennifer. 2007. *English as a lingua franca: Attitude and identity*. Oxford: Oxford University Press.
Jones, Daniel. 1917. *An English pronouncing dictionary*. London: J. M. Dent.
Jones, Daniel. 1977. *Everyman's English pronouncing dictionary*. Revised and edited by A. C. Gimson. London: Dent.
Lobanov, Boris. M. 1971. Classification of Russian vowels spoken by different speakers. *Journal of the Acoustical Society of America* 49, 606–608.
Nolan, Francis, Kirsty McDougall, Gea de Jong & Toby Hudson. 2009. The DyViS database: Style-controlled recordings of 100 homogenous speakers for forensic phonetic research. *Journal of Speech, Language and the Law* 16, 31–57.
Roach, Peter. 2000. *English phonetics and phonology*. 3rd edn. Cambridge: Cambridge University Press.
Roach, Peter. 2004. British English: Received Pronunciation. *Journal of the International Phonetic Association* 34, 239–245.
Thomas, Erik R. & Tyler Kendall. 2007a. About vowel normalization. http://ncslaap.lib.ncsu.edu/tools/norm/about_normalization.php (accessed 1 February 2011).
Thomas, Erik R. & Tyler Kendall. 2007b. NORMs vowel normalization methods. http://ncslaap.lib.ncsu.edu/tools/norm/norm_methods.php (accessed 1 February 2011).
Thomas, Erik R. & Tyler Kendall. 2007c. NORM: The vowel normalization and plotting suite. http://ncslaap.lib.ncsu.edu/tools/norm/ (accessed 30 June 2011).
Wells, John C. 1962. *A study of the formants of pure vowels of British English*. M.A. Dissertation, University College London. http://www.phon.ucl.ac.uk/home/wells/formants/index.htm (accessed 1 November 2010).
Wells, John C. 1982. *Accents of English*, 3 vols. Cambridge: Cambridge University Press.
Wells, John C. 1997. Whatever happened to Received Pronunciation? In Carmelo Medina Casado & Concepción Soto Palomo (eds.), *II Jornadas de Estudios Ingleses* 19–28. Jaén: Universidad de Jaén.
Wells, John C. 2008. *Longman pronunciation dictionary*, 3rd edn. Harlow: Pearson.