Evidence for a relationship between synchronic variability and diachronic change in the Queen's annual Christmas broadcasts

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Abstract

The present study was designed to test whether phonetic sound change can take place within an individual beyond the critical age and, if so, whether it is gradual. An acoustic analysis was made of /u/-fronting and /æ/-lowering which are both sound changes that have occurred in the standard accent of England in the last fifty years. The speech data were taken from the messages that have been broadcast annually by Queen Elizabeth II since 1952. Measurements were made of the first two formant frequencies at the vowel onset and at the vowel target of /u/ and /æ/ over various time periods between 1952 and 2002. An analysis of F2 showed that /u/ has fronted in the Christmas broadcasts and that the fronting is associated with a greater coarticulatory influence of the preceding consonant. Based on F1 and the rate of change of F1, it is shown that /æ/ has lowered and that the change is associated with increased vowel hyperarticulation in later years. Both changes are shown to be gradual. Since neither the effects of increasing age nor of a change in speaking style are able to explain these vowel shifts, it is concluded that these are phonetically gradual sound changes that have taken place over a fifty year period within the same speaker.

1. Introduction

In the last three to four decades, much research in sociolinguistics and dialectology has established links between sound change and factors such as age or social class (Labov 1994; Labov 2001). Many of these studies are based on the idea firstly that the pronunciation characteristics of a speaker have stabilised after the critical age or in young adulthood; and secondly that sound change comes about when certain groups in the community, such as the young or those of a certain social class, introduce innovations that are then copied or possibly even exaggerated by subsequent generations or by other speaker groups. In Labov's (2001) linear model of sound

change, incremental changes to a sound take place within young speakers, but only up to the critical age; the next generation continues with the incremental change, and so on through subsequent generations so that the entire trajectory of what may turn out to be a major change in phonetic quality is formed from progressive changes by different speakers of different generations.

This idea that there is no, or very limited, participation in sound change beyond the critical age is the foundation for so-called apparent-time studies in sociolinguistics (Weinreich, Labov, and Herzog 1968) in which the extent and direction of sound-change are assessed experimentally by comparing young and old members of the same speaking community: the differences between 20 and 60 year old speakers in 2005 should be indicative of sound change that has taken place in the community since 1965, but only on the assumption that pronunciation has stabilised beyond the age of the youngest group.

We know very little about the extent to which adults adapt to pronunciation changes taking place in the community, partly because there are so few longitudinal studies in which the same speakers are reanalysed over long time periods. Brink and Lund (1975) examined recordings of several Danish speakers over many decades and found all speakers' phonologies to be extremely stable. Labov and Auger's (1998) analysis of middle-aged Philadelphia speakers in a trend study showed no changes in their vowel systems over a 17-year time span and only limited real-time change is found in Sankoff, Blondeau, and Charity (2002). On the other hand, Cedergen (1987) and Trudgill (1988) have provided some evidence that speakers participate to a certain extent in community changes and most recently, Sankoff (in press) has carried out a longitudinal study of the speech of two of the participants of a BBC documentary series who were recorded at seven-yearly intervals from the age of seven. Her analysis showed that both speakers made some significant phonetic, and possibly phonemic, alterations to their speech after adolescence and in her review of the literature, she comments that "phonology, even though stable in most of its features across individual life spans, is nonetheless available to some speakers for some amount of modification".

A related issue that is explored in this paper is the extent to which phonetic sound change is gradual. According to the Neogrammarian theory (Paul 1880), regular sound change is phonetically gradual, perhaps advancing by imperceptible increments, and affects all words simultaneously. Labov's (1994, 456) analysis of the American Northern Cities vowel shift

shows evidence of incrementation, and not of discrete jumps. Similarly, a study by Kerswill (2002) of the formants of /u/ in speakers of the South East of English also show gradual change across different speaker groups of age, gender, and class. However, gradual change *within* individual speakers, is according to Kerswill (2002), less likely because "the spread of a change is always a matter of dialect contact: old and new variants will therefore be 'salient' (Trudgill 1986) and consequently most likely discrete". In Ohala's (1993) model of sound change, in which the catalyst for sound change is a misparsing by the listener of the speech signal, sound change is lexically and phonologically abrupt: that is, the listener (erroneously) reconstructs a sound that is qualitatively different from the one intended by the speaker. For Ohala (1993), gradual sound change does not arise within the same speaker, but only across different words (if these change at gradually different rates) or across different speakers (if different speaker groups change at different rates). Milroy (1994) takes a strong stand on gradual change within the individual: "…linguistic change cannot be demonstrated in the speech of one speaker during a short period of time, especially in laboratory conditions, even if it is actually taking place: this is because *change takes place in the speech community, not in the speech of one person* [emphasis mine] " (Milroy 1994, 121).

One of the main aims of the present paper is to explore further the adult's adaptation to sound change through an analysis of the Christmas broadcasts that have been delivered annually since 1952 (with the exception of 1969) by Queen Elizabeth II. The motivation for analysing these data has already been dealt with in previous publications (Harrington, Palethorpe, and Watson 2000a, b; 2005; Harrington in press) and so will only be summarised briefly here. These materials are perhaps the only acoustically high-quality annual recordings of speech data from the same person over a fifty year period. (The Queen's Christmas messages have been televised since 1954 and are typically of between 5-10 minutes in duration). Moreover, since the communicative intent of these annual messages is more or less the same (a message to the British Empire in earlier years and then to the Commonwealth), the broadcasts are much less likely to be affected by non-phonetic changes such as those due to changes in speaking style. There is also extensive evidence that the accent spoken by the Queen – a variety of Received Pronunciation (RP), the standard accent of England – has undergone numerous phonetic changes over the last fifty years that can often be linked to the collapsing class structure in England in the second half of the 20th Century. Since some of these changes to RP have

been carefully documented (e.g., Gimson 1980; Roach, and Hartman 1997; Wells 1982; 1994), we can establish whether any sound changes that are found in the Christmas broadcasts over time are in the same direction as those of the RP-speaking community.

In Harrington, Palethorpe, and Watson (2000a, b, 2005), we compared the formants in the Christmas broadcasts in three time periods (the 1950s, late 1960s/early 1970s, 1980s) with those from five newsreaders recorded in the 1980s. Their accent was mainstream RP, a variety of RP that is spoken by the majority of the RP speaking community (Wells 1982). Our results showed changes between the earlier and later broadcasts that were in the direction of the 1980s vowel positions of these mainstream RP speakers. We argued that this was evidence for phonetic adaptation in the Christmas broadcasts towards a more modern, less aristocratic form of RP.

Harrington (in press) analysed over 1300 schwa vowels from the 1950s and the 1990s Christmas broadcast vowels with the aim of establishing whether there were any long-term acoustic changes that might be the result of maturational changes to the Queen's vocal tract with increasing age. The motivation for analysing schwa was that any observed formant changes in schwa would be unlikely to be phonetic (both because so much phonetic information to vowel quality is neutralised in schwa; and because there is no evidence that schwa has undergone a phonetic change in RP). The findings that will be relevant for the present investigation from Harrington (in press) included significant decreases in the Christmas broadcasts from the 1950s to the 1990s in F1 and in F2 of schwa by an average of 123 Hz and 72 Hz respectively. These results provide evidence that the Christmas broadcast vowels are also diachronically influenced by long-term *non-phonetic* vocal tract changes.

The present study was designed as an extension of the earlier analyses in Harrington, Palethorpe and Watson (2000a, b, 2005) from various perspectives. Firstly, it seeks to provide an answer to the incrementation issue: is there any evidence for a gradual phonetic adaptation in the same individual over a number of years? This issue was addressed by comparing the extent of phonetic shift in two vowels in the Christmas broadcasts over various time intervals between 1952 and 2002. Secondly, the present study seeks to relate phonetic sound change more directly to synchronic variability. It is well established that speech varies synchronically along a continuum from hypo- to hyperarticulation (H&H) (Lindblom 1990), and there is evidence that synchronic H&H variability is the basis of many types of sound change (Lindblom et al. 1995). For example, the diachronic ten-

dency for high and mid long vowels to break into rising diphthongs in Germanic languages was related synchronically to an articulatory manoeuvre for tongue dorsum hyperarticulation (Harrington, Fletcher, and Beckman 2000); and sound changes that are related synchronically to hypoarticulation and increased coarticulatory overlap between segments are well documented (Bybee 2001; Ohala 1993). If synchronic H&H variability is one of the mechanisms by which sound change takes place and if – as I will argue later in this Chapter – the mechanisms for sound change operate *within* and not just between speakers of the same community, then there should be some evidence for hypo- and hyperarticulation induced sound changes within the same speaker. This second issue will then be central to the third issue that is considered at various points in this paper: whether the observed changes really are phonetic or perhaps instead the result of a change in speaking-style that might come about because the Queen has adopted a more 'relaxed' mode of delivery in later broadcasts.

The analysis in this paper is of changes to /u/ (*who'd*) and to /æ/ (*had*). These vowels were chosen partly because the direction of formant change is opposite to the formant-lowering due to vocal tract maturation discussed above that was found in schwa: there is evidence that in the last 50 years /u/ has fronted (Gimson 1966; Henton 1983; Roach and Hartman 1997) involving a raising of F2 (Bauer 1985; Henton 1983) and that /æ/ has lowered (Gimson 1966; Wells 1982; Wells 1994). Some evidence for /u/-fronting and clearer evidence for /æ/-lowering in the Christmas broadcasts between the 1950s and late 1960s was found in Harrington, Palethorpe, and Watson (2000a, b). These changes will be reconsidered in order to assess whether there is any incrementation in these changes over five decades. Another reason for choosing these two vowels is because the effect of context seems to be quite different in these cases. As far as /u/ is concerned, there seems to be coarticulatory pressure on it to front given that, in RP at least, /u/ occurs so often following /j/ and alveolars that have a high F2-locus. More specifically, an analysis of the CELEX database (Baayen, Dijkstra, and Schreuder 1997) shows that 46.4% of /u/ occur in the context of a tautosyllabic /j/ (e.g., *argue*, *cute*, *duty*, *few*) and a further 21.3% of /u/ occur after alveolars (e.g., *lose*, *noon*, *soon*). Given that over 70% of /u/ occurs in words following a consonant with a high F2-locus, and since English does not contrast front/back high rounded vowels, /u/ can shift into a more central position without encroaching on the space occupied by another vowel. There does not seem to be any context-conditioned effect for RP /æ/-lowering, neither from earlier auditory analy-

ses, nor from a consideration of the frequency of occurrence of consonant types that can precede or follow this vowel. Instead, and as shown in Harrington, Palethorpe and Watson (2000a, b), the quite considerable lowering of /æ/ (raising of F1) in the Christmas broadcasts produces a vertical expansion of the vowel space in the 1960s relative to the 1980s and shifts /æ/ further away from the front mid vowel /E/ (*head*).

2. /u/-fronting and F2-raising

2.1. Method

Segmentation and labelling of the vowels reported in this paper were carried out in the Institute of Phonetics and Digital Speech Processing, University of Kiel by two trained transcribers using the same procedures as in Harrington, Palethorpe, and Watson (2000a,b). In order to be able to assess more clearly the effects of context, /u/ was divided into those vowels that followed /j/ (e.g., *argue*, *cute*, *duty*, *few*, *use*, *you*; henceforth /ju/) and all other /u/ vowels (e.g., *brew*, *lose*, *move*, *noon*, *soon*; henceforth /u/). All vowels were taken from syllables with primary lexical stress in prosodically accented words and none were taken before a syllable-final /l/ (e.g., *cool*, *mule*) given that the vowel target is likely to be very strongly influenced by the low F2 of the velarised realisation of /l/ in this context. For /ju/, no segmentation boundary was placed between /j/ and /u/ i.e., the 'vowel' in /ju/ extended from the onset of /j/ to the offset of /u/. 433 vowels were analysed in this study, including 254 /ju/ and 179 /u/. These vowels were taken from the Christmas broadcasts that were available and that had been labelled at the time of writing: these included all those from 1952-1972, except 1953, 1959, 1961, 1969; broadcasts from 1983, 1985, 1988; and from all years from 1995 to 2002. These Christmas broadcasts were divided into roughly early, middle and late time periods as follows: 1952-1965 (henceforth 50s); 1966-1988 (henceforth 70s); and 1995-2002 (henceforth 90s). The distribution of /ju/ and /u/ across these three year groups is shown in Table 1.

Table1. The number of /ju/ (= /u/ with a preceding /j/) and /u/ (=/u/ without a preceding /j/) tokens in three groups of Christmas broadcasts years (left columns) that were analysed in this study.

Years	Group name	/ju/	/u/	n
1952-1965	50	96	70	166
1966-1988	70	81	44	125
1995-2002	90	77	65	142
Total		254	179	433

The speech data was digitized at 16 kHz and filtered at 8 kHz. Formant frequencies were calculated within the EMU system (Cassidy and Harrington 2001) with parameters LPC-order of 10, a pre-emphasis of 0.95, and a 30 ms Blackman window with a frame shift of 5 ms. For every vowel that was analysed, the formants were assessed for any tracking errors and corrections were made if these were considered necessary. The tracked formant frequencies from EMU were compared with those obtained from another formant tracker that forms part of the Praat system in order to provide a further check on formant centre frequencies in difficult cases. Formants were also sometimes inspected using a narrowband (50 Hz) as well as wideband displays, especially when F1 and F2 were very close together. F2 values were extracted from the acoustic onset of /u/ and /ju/ and from the vowel target which was defined as the minimum F2 value within the middle section (between the 20% and 80% time points) of /u/ and /ju/. All the formant frequencies in Hz were converted to Bark using the formulae in Zwicker (1961).

Two types of measurements were made across the year-groups: the value of the F2-minimum to establish the extent to which /u/ and /ju/ have fronted; and $F2_o - F2_t$, the difference between the F2-onset (in Bark) and the F2-target (in Bark) which is a measure of the extent to which the vowel is influenced by the preceding consonant. That is, since $F2_o$ is strongly related to the consonant's place of articulation locus, then smaller values of $F2_o - F2_t$ (for the same consonant-vowel type) generally indicate greater vowel target undershoot and/or a greater approximation between the preceding consonant's place of articulation at the F2-onset and the vowel target at the F2-minimum (Hewlett and Shockey 1992; Lindblom and Lindgren 1985).

2.2. Results

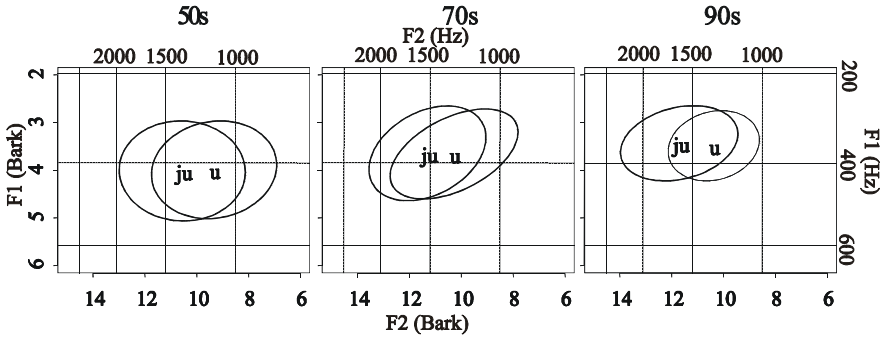

Figure 1. Two standard-deviation ellipses for /ju/ (= /u/ with a preceding /j/) and /u/ (=/u/ without a preceding /j/) in the Bark-scaled F1 x F2 plane for the three Christmas broadcast year groups shown in Table 1.

Fig. 1 shows 2 standard deviation ellipses at the vowel target (F2-minimum) in the Bark-scaled F1 x F2 plane from the three year groups. The data show a progressive raising of F2 from earlier to later years with F2-means (at the centre of the ellipses in Fig. 1) for /u/ of 1135 Hz (50s), 1307 Hz (70s), 1328 Hz (90s); and for /ju/ of 1364 Hz (50s), 1522 Hz (70s), and 1619 Hz (90s). (The data also show F1-lowering of the vowels from earlier to later years, which, as discussed earlier, is likely to be the result of long-term maturational changes to the vocal tract and will not be discussed further here). The progressive F2-increase across these three time periods is reflected not just in the means but in the distributions. For example, the /u/ ellipses extend rightwards along the F2-axis to about 750 Hz in the 50s, to 900 Hz in the 70s, and to just over 1000 Hz in the 90s; similarly, the /ju/ ellipses extend leftwards along the F2-axis to just under 2000 Hz in the 50s, to just over 2100 Hz in the 70s, and to around 2250 Hz in the 90s. The results of an ANOVA with factors year (50s, 70s, 90s) and vowel-type (/ju/, /u/) showed significant differences in the F2-target by year ($F = 31.2$, $p < 0.0001$, $df = 2, 427$) but not by vowel-type.

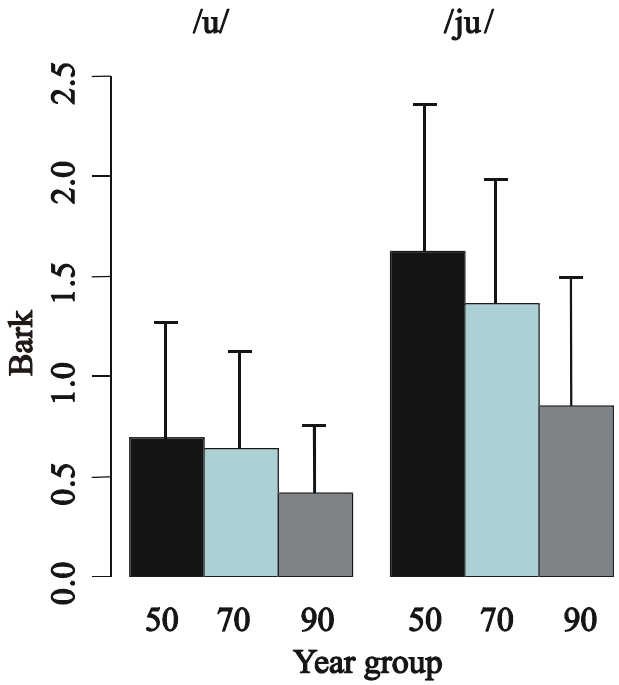

Figure 2. The average value of F2o – F2t (the difference between F2 at vowel onset and the F2 minimum at the vowel target) separately by year and by vowel type (/u/, /ju/). The error bars are one standard deviation.

Fig. 2 shows the average values for the F2 onset-target difference ($F2_o$ – $F2_t$) separately by year and by vowel type, obtained by subtracting the F2-target (in Bark) from the F2 at vowel onset (in Bark). Here again a clear progression is apparent: for /u/ and /ju/, the onset-target difference is greatest in the 50s, intermediate in the 70s, and least in the 90s (and predictably, the onset-target difference is greater in /ju/ than in /u/). The results of a two-factor ANOVA with independent variables year (50s, 70s, or 90s) and vowel-type (/u/ or /ju/) showed significant differences on $F2_o$ – $F2_t$ for year ($F = 36.5$, $p < 0.0001$, $df = 2, 427$) and (predictably) for vowel type ($F = 139.7$, $p < 0.0001$, $df = 1, 427$).

2.3. Discussion

These data show evidence for /u/-fronting in the Christmas broadcasts in the 90s relative to the 50s with intermediate F2-positions in the 70s. The progressive decrease in the difference between F2-target and F2-onset from the earlier to the later year groups is indicative of increased coarticulation between the preceding consonant and the vowel. As Hewlett and Schockey (1992) have observed in their F2 analysis of citation-form and read speech: "coarticulation is a process which makes two adjacent sounds more similar to each other, so if it can be shown that there is a shallower transition between consonant and vowel in one condition than in another, then that condition can be thought of as more coarticulated." Compatibly, the shallower F2 transitions in /ju/ and /u/ in later years can be interpreted as the result of a hypoarticulation-induced sound change that comes about because of the progressively greater influence of the prevocalic consonant on /u/ in later years.

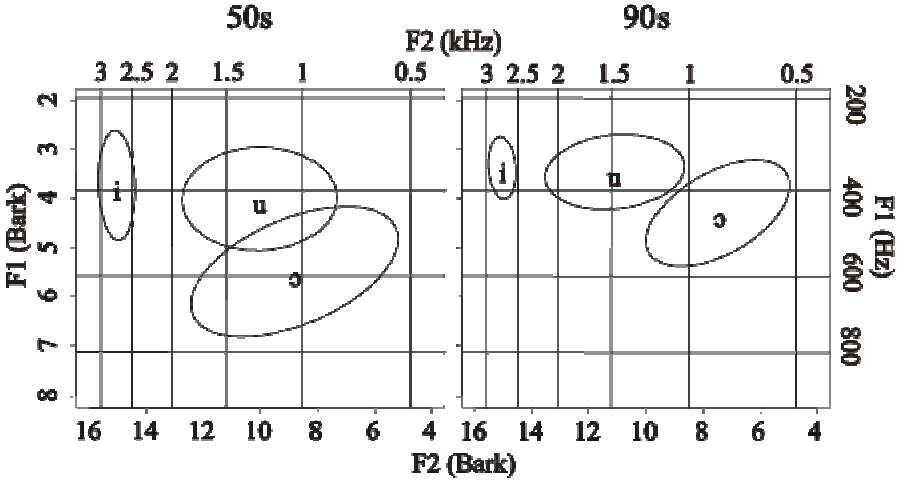

Figure 3. Two standard deviation ellipse plots for Christmas broadcast vowels in the Bark-scaled F1 x F2 plane. All vowels are from primary stressed syllables in accented words. The formant values for /i/ and /ɔ/ were extracted from the vowel midpoint. /u/ vowels were collapsed across /j/ and non-/j/ contexts and the formants were extracted at the time of the F2-minimum. Left: vowels from 1952-1965: n = 114, 49, 166 for /i/, /ɔ/, /u/ respectively. Right: vowels from 1995-2002 and, additionally for /ɔ/, from 1983, 1985, 1988. n = 165, 83, 142 for /i/, /ɔ/, /u/ respectively.

It could be argued that the change to /u/ is not a *phonetic* change, but one that is due to speaking style. That is, the Queen becomes more relaxed in delivering the Christmas messages in later years and the speaking style is less formal resulting in increased undershoot and hypoarticulation (Lindblom 1990), of which this type of context-induced /u/-fronting is an example. If later broadcasts are generally produced in a more hypoarticulated/relaxed speaking style, then the vowel space should become smaller, given the relationship between contraction of the vowel space and hypoarticulation (e.g., de Jong 1995). Fig. 3 shows ellipse plots in the F1 x F2 Bark plane for three vowels that vary in RP along the front-back dimension: these are /i/ (*heed*), /u/ from this study collapsed across the two contexts, and /ɔ/ (*hoard*, *saw*). The vowels on the left in Fig. 3 are from 1952-1965; those on the right are from 1995-2002 and, for /ɔ/ only, also from 1983, 1985, 1988 (1980s data is included for /ɔ/ because at the time of writing, there were too few analysed tokens in 1995-2002). A comparison of these plots shows no evidence of any F2-compression: the /i/ and /ɔ/ spaces are at least the same distance from each other in both year groups and /ɔ/ is perhaps even further away from /i/ on F2 in the 1995-2002 broadcasts (although for the reasons stated earlier, the F2-decrease may be an artefact of vocal tract maturation). What stands out in Fig. 3 is that there is a rearrangement of /u/ in relation to the other two vowels, such that /u/ is higher on F2 (acoustically closer to /i/) in the 1995-2002 broadcasts with /ɔ/ partly taking up the space left by /u/, possibly in a drag-chain movement.

The evidence, therefore, does not support a shift in speaking-style and corroborates the experimental findings that the change in /u/ from earlier to later broadcasts is phonetic.

3. /æ/-lowering and F1-raising

3.1. Method

586 /æ/ vowels and their associated formants were extracted from the corpus and divided into five year groups as shown in Table 2. The methodology for calculating the formants was the same as for /u/ described in 2.1.

Table 2. The number of /æ/ tokens on five groups of Christmas broadcasts years (left columns) that were analysed in this study.

Years	Group name	*N*
1952-1959	5	187
1960-1964	6	79
1965-1972	7	169
1983, 85, 88	8	79
1995-2002	9	72
Total		586

F1 was extracted at the time at which F1 reached a maximum within the middle section (between the 20% and 80% time points) of /æ/. Two other parameters were obtained: the F1-change defined as $F1_t - F1_o$, where $F1_t$ is the F1-maximum in /æ/ and where $F1_o$ is the F1-value at the vowel onset; and the linear rate of F1-change defined as $(F1_t - F1_o)/d$, where *d* is the duration between the vowel onset and the vowel target. The motivation for these two parameters is the following. When open vowels are hyperarticulated, they tend to be produced with a larger and often faster vocal tract opening (Edwards, Beckman, and Fletcher 1991; Beckman, Edwards, and Fletcher 1992; Harrington, Fletcher, and Beckman 2000). As Summers (1987) has shown, this articulatory reorganisation in open vowels is often reflected acoustically in larger and faster F1-onset to F1-target values, commensurate with the relationship between increased vocal tract opening and F1-raising (Lindblom and Sundberg 1971).

3.2. Results

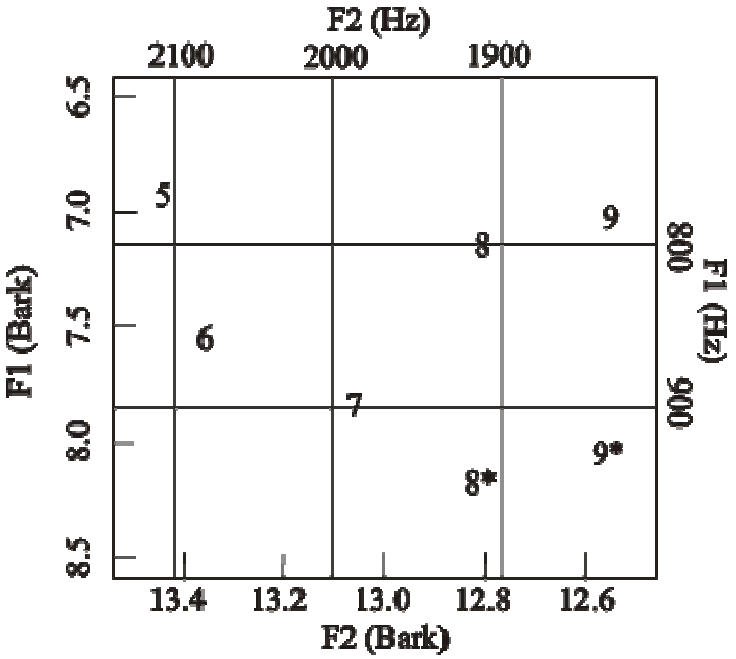

Figure 4. Average positions in the Bark-scaled F1 x F2 Bark of /æ/ at the time of the F1-maximum separately for the year groups 5, 6, 7, 8, 9 shown in Table 2. 8* and 9* are the average positions of the year groups 8 and 9 shifted by 1 Bark on the F1-axis to take into account the likely effects of vocal tract maturation due to ageing.

Figure 4 shows the average positions in the F1 x F2 plane of /æ/ for the five year groups. At first sight, there doesn't seem to be any clear continuity as far as increasing vowel openness is concerned from the earliest to the latest years: there is a clear progression of F1-raising from the 50s to the 60s to the 70s, but then for the 80s and 90s, F1 decreases. However, as the schwa-data discussed in the introduction show, there is also an age-related (non-phonetic) effect such that F1 in the 90s is around 1 Bark lower in the later than in the 50s broadcasts. As a result, F1 for /æ/ in Fig. 4 is likely to be roughly 1 Bark lower in later years than /æ/ in earlier broadcasts because of this age-induced, F1-lowering. When a correction is made for this age-effect by adding roughly 1 Bark to the mean values for the 80s and 90s as in Fig. 4, then a fairly clear trend from earlier to later years of F1-raising emerges. (There is also a clear trend across the year groups for F2 to de-

crease as F1 increases which may be an age-related effect or which might come about because of greater centralisation as /æ/ lowers).

If /æ/ is produced with a more extensive and faster vocal tract opening in later years, then, as discussed earlier, there should be a greater difference between the F1-onset and F1-target values as well as a greater rate of F1-change. As Fig. 5 shows, there is a tendency for $F1_t - F1_o$ to increase in later years and an even clearer trend for the linear rate of F1-change between the onset and the target to increase progressively through the 50s, 60s, 70s, 80s, and 90s.

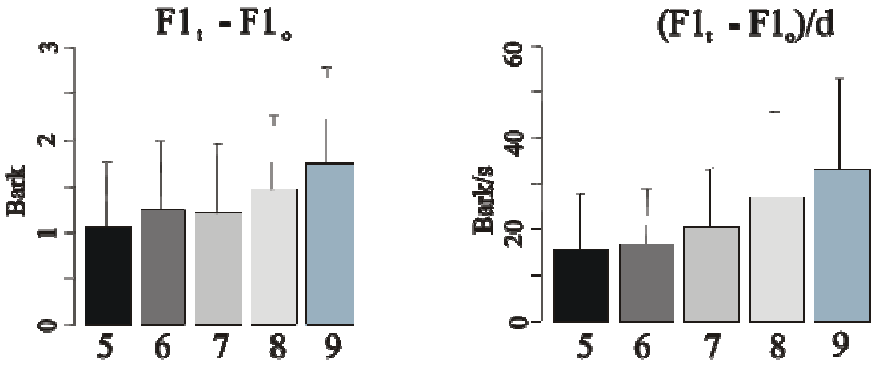

Figure 5. The average value of F1t – F1o (the difference between the F1-maximum and F1-onset) (left) and of (F1t – F1o)/d (the linear rate of change in F1-onset to F1-target) (right), separately for the year groups shown in Table 2. The error bars are one standard deviation.

All these results are compatible with the view firstly that there is a phonetic change from earlier to later broadcasts in which /æ/ becomes progressively more open and secondly that this openness is accompanied by progressively greater /æ/ hyperarticulation, where hyperarticulation means that /æ/ is produced with a bigger and faster vocal tract opening in later years.

4. General discussion

The analysis in this study has provided acoustic evidence for two phonetic vowel changes in RP that are consistent with various auditory and acoustic analyses discussed earlier: between the 1950s and the present day, RP /u/ has fronted and RP /æ/ has lowered. The prevalence of consonants preceding /u/ with a high F2-locus, coupled with the absence of a /u/ - /y/ con-

trast are the likely sources of /u/-fronting. /æ/-lowering may instead come about to decrease the crowding of the vowels in the front part of the vowel space (Harrington, Palethorpe, and Watson 2000b, 2005). There is no evidence from any preliminary analyses that /æ/-lowering can be related to an effect of context, in the same way that this has been possible for /u/.

The changes to these vowels do not come about because of the physiological maturation of the vocal tract, given that these physiological age-related changes in the Queen produce an overall decrease in F1 and F2 (Harrington, in press), whereas these changes are associated with formant *increases* in F2 (/u/-fronting) and in F1 (/æ/-lowering). Neither are these changes compatible with a change towards a more relaxed speaking style because there is no evidence from these data that the overall vowel space in the Christmas broadcasts has contracted. The conclusion is that /u/-fronting and /æ/-lowering in the Christmas broadcasts are long-term *phonetic* changes which, as the earlier study by Harrington, Palethorpe and Watson (2000a, b) showed, are in the direction of a more modern and less aristocratic form of RP.

The study provides some support for the view that phonetic changes occur within the same individual well beyond the critical age and that the change continues into late adulthood. The overall size of the vowel shifts between the 1950s and 1990s found here is quite considerable and certainly perceptible': in /æ/, there is an F1-increase of about 250 Hz from the 1950s to the 1980s and in /u/ there is an F2-increase of almost 300 Hz (see Fig. 3) from early to later broadcasts. The extent of these formant changes is comparable, and perhaps even larger, than some formant frequency changes that have been observed in comparing older with younger speakers in 'apparent-time' studies (e.g., Labov's 2001 analysis of /u/-fronting in the North American Atlas project which shows young speakers' F2 in /u/ to be 175 Hz higher than that of speakers of the same community who were fifty years older). Moreover, these changes have occurred in a speaker who, as the very personification of the 'Queen's English', is perhaps more likely than most to resist pronunciation change, to the extent that this is possible. Sound change is therefore not just a function of differences between different speaker groups: instead sound change and the mechanisms of sound change (hyperarticulation, hypoarticulation, and perhaps even drag-chain effects) take place over a long period of time within the same individual.

The data from these vowel shifts in the Christmas broadcasts are compatible with the Neogrammarian view that sound change is gradual. By contrast, phonetic gradualness of this kind is rejected in those models that

place greater emphasis on the speaker or listener as initiating sound change. For example, Ohala (1993) comments that sound change must be phonetically abrupt in order for the shift from one pronunciation to another to be detected. Similarly, since in Milroy (1994) all sound change is socially conditioned and since it is speakers who change language (rather than language changing itself), it "does not make sense to say that sound change is phonetically gradual". The data presented here are not consistent with this strong position. The evidence for gradual sound change is especially apparent in the data for /æ/: although the change is most rapid between the 1950s and 1960s, there is nevertheless incrementation in the same direction of increasing vowel openness in the following three decades. Similarly, the intermediate positions of /u/-fronting in the 1970s between the positions of the 1950s and 1990s seem to point to a gradual, incremental change.

It is interesting to speculate whether these changes are perceptible during the long time period over which they take place. As already discussed, there are certainly clear auditory differences in comparing Christmas broadcast /u/ or /æ/ in the 1950s with their 1990s productions. If the change is more or less linear in time, then the average shift per annum for a 300 Hz F2 change in /u/ is 6 Hz, i.e., 60 Hz per decade. It does not seem likely that a shift of this magnitude would be perceptible from year to year. One possibility is that /u/-fronting is lexically abrupt (Wang 1977), i.e. that it takes place in some words before others: in this case, the finding that the formants change slowly from year to year would be an artefact that arises because of a confound between words in which the sound change advances at different rates. However, there is no evidence so far from the Christmas broadcast data that sound change advances at different rates in different words, but then there are too few tokens of the same words to say anything very conclusive on this issue at the time of writing. Alternatively, perhaps the change is not linear: that is, there might be an abrupt jump in any one year between the 1950s and 1970s and then another one between the 1970s and the present day. Although abrupt changes of this kind in the Christmas broadcasts cannot be ruled out, the data from /æ/, showing a gradual progression in the magnitude and rate of F1-change (Fig. 5), and an almost curvilinear relationship in the absolute F1 positions (Fig. 4) as a function of successive decades (once age-effects are factored out), seem to be strongly suggestive of gradual, incremental change.

Moreover, a theory that adheres to sound change as abrupt would have to account for why there are two discrete jumps in /u/-fronting (one be-

tween the 1950s and 1970s; and another between the 1970s and 1990s). To argue that there are two abrupt jumps would also be to suggest that /u/-fronting is made up of two discrete sound changes. The more plausible alternative is that this is a single, gradual, sound change that has taken place within the same speaker over a half a decade.

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Notes

1. The sound files illustrating /u/-fronting and /æ/-lowering in the Christmas broadcasts are available from the author.

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