

A corpus-based account of variation in the realisation of 'released' /t/ in English

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ABSTRACT: In this paper we describe the main patterns of realisation which we have observed in non-glottaled/ised stops in pre-pausal position in British English. We present quantitative results which suggest that the patterns cannot be entirely accounted for in terms of free variation or articulatory economy, and we outline some ideas about how this data might be interpreted. The principal points which emerge are (a) that work on phonological variation and change can be enhanced by making use of a more detailed phonetic analysis than is usually the case; and (b) aspects of phonological variation which can only be observed from a corpus of naturalistic speech bring into sharp focus issues related to the nature of phonological theory and its relationship to speech performance.

INTRODUCTION

Previous work on Newcastle English (Docherty et al, 1995, to appear) has shown that whilst glottal variants of stops are on the whole more widespread than in many other varieties of British English, in pre-pausal position stops seem to be categorically non-glottaled/ised. We have referred to these variants in our work up to this point as 'released', because this is the auditory impression which we receive. Our fieldwork with a different variety, that of Derby, has shown that in the same context, there are a significant number of stops which are 'released', although the pattern here is not categorical.

'Release' has essentially meant 'non-glottal' for our purposes, but since the aim of our study is to identify structured variation in consonant realisation in British English varieties, we decided that we should unpack this descriptor a little in order to identify any sub-patterns of articulation which it embraced.

FIELDWORK

The fieldwork we refer to consists of recordings representing a sample of speech from two English urban communities: Newcastle and Derby. Thirty-two speakers were sampled from two social groups (working class (WC); middle class (MC)) and two age groups (16-25 and 45-65), equally divided between males and females and with four speakers per cell. Subjects were recorded in a dyadic conversational exchange for around 50 minutes, and also reading a word-list designed to elicit tokens of voiceless stops in syllable-final, pre-pausal position (e.g. *sheet, gate, put, boot, out*).

ACOUSTIC PROFILE

An acoustic profile was constructed to analyse what is constituted by 'released', via investigation of 12 /t/-final items from the word-list: *sheet, gate, bet, hat, cart, pot, boat, put, boot, bite, out, pit*. The 12 items were investigated by visual inspection of spectrograms.

Conventional textbook descriptions indicate that two principal acoustic features characterise voiceless stops (see Fig. 1):

- *silent stop gap* - a period of nil energy in the spectrographic trace, reflecting the fact that there is a complete closure in the vocal tract behind which pressure is being increased
- *release burst* - abrupt onset of energy across a wide frequency range, reflecting the sudden release of the oral constriction; this may be followed by a distinct period of voiceless friction noise, created by the rapid outflow of air

In our data, such 'canonical' tokens were rare. In addition to those acoustic features listed above, the following were found to be common in our data:

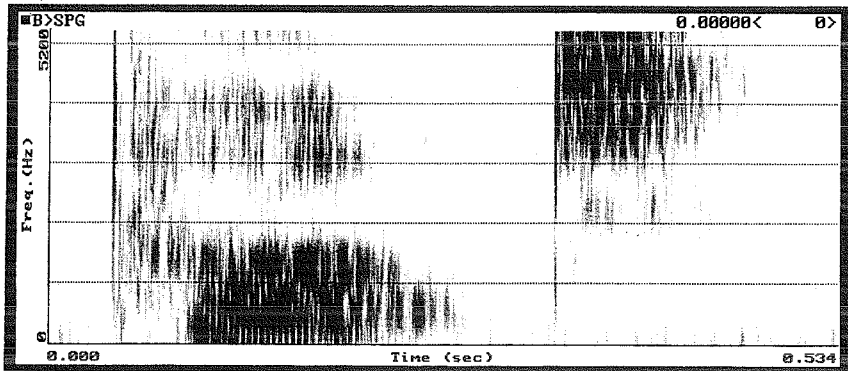


Fig. 1. Spectrogram of *put* (young MC female, Derby)

- *continued formant structure* - continuation of formant structure through the majority of the stop 'slot', often to the release burst itself; duration, intensity and number of formants varies - Fig. 2
- *continued voicing* - perseverance of voicing through the majority of the stop 'slot', and even into the post-burst frication - see Fig. 2
- *extended frication* - distinct periods of fricative energy before the plosion phase of the stop; two main patterns are found:
 - (i) '*Quotes*' - see Fig. 3 - a patch of high frequency energy at the end of the vowel, yielding a visual pattern of quotation marks around the stop 'slot'; the first patch is usually shorter, narrower in frequency range, and less intense than the second; diffuse energy in the higher frequencies may link the two patches
 - (ii) '*Archway*' - see Fig. 4 - a single, uninterrupted period of fricative energy, consistent in intensity but varying in frequency; this may appear similar to the 'quotes' pattern, but the two patches are linked with well-defined energy, giving the appearance of an archway

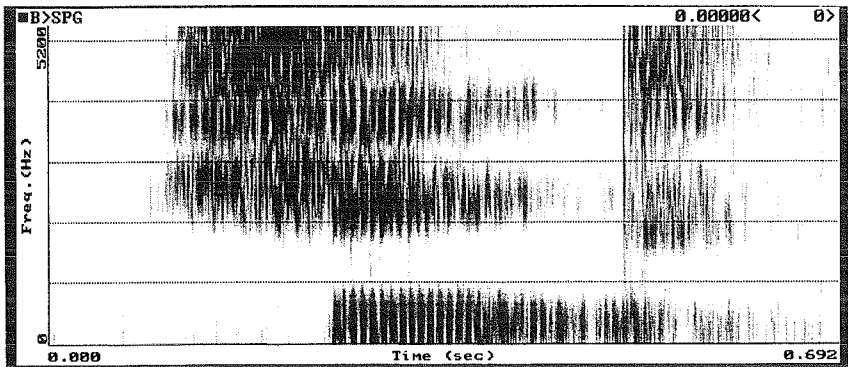


Fig. 2. Spectrogram of *sheet* (older MC male, Derby)

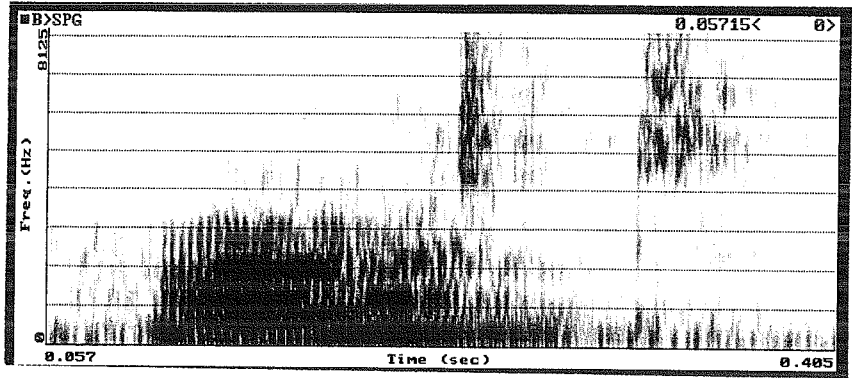


Fig. 3. Spectrogram of *hat* (young MC female, Newcastle)

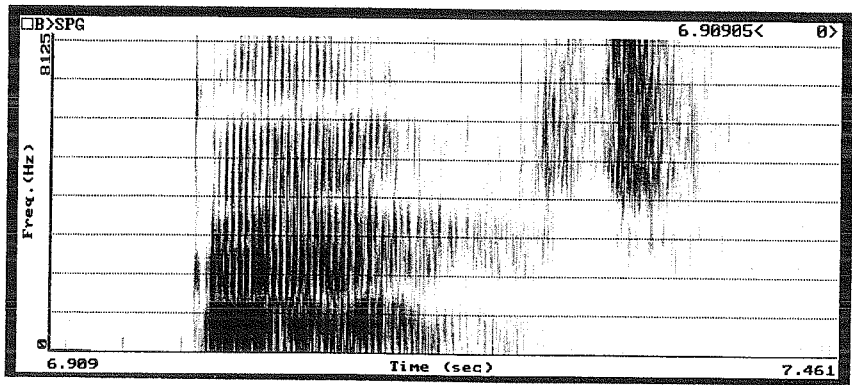


Fig. 4. Spectrogram of *bet* (younger MC female, Newcastle)

One interesting aspect of these findings is whether the diverse patterns can be shown to 'fall-out' from a single process of weakening of the laryngeal and supra-laryngeal gestures associated with the syllable rhyme - with different acoustic manifestations resulting from different degrees of weakening. This is an area which is currently being investigated. For the purposes of this paper, however, we want to focus on another aspect of these findings, namely the high degree of inter-speaker variability which was found in our sample.

Specifically, the question arose of whether what we are observing is essentially free variation. That is, since these stops are in pre-pausal position they presumably have little information-bearing content, and the articulatory system may therefore be permitted a good deal of variability in the realisation of these stops (and in Lindblom's (1990) terms, they are being produced at the hypo- end of the hyper-hypo continuum).

To test this we performed a quantitative analysis of the occurrence of the salient acoustic features produced by our speakers. If the patterns of performance had essentially been a result of economy at the stage of articulatory execution we would not expect to find any significant difference across the different varieties investigated nor across the different groups of speakers within each variety. Results however, suggest that at least some of the features appear to be significantly associated with particular speaker groups. None of these associations are categorical, but the chi-square results are quite persuasive.

RESULTS

Chi-square tests have been carried out on the data (1). Table 1 (Newcastle) and Table 2 (Derby) illustrate the proportional occurrence of acoustic features for each speaker group. Overwhelming statistical significance (in each case $p < 0.001$) is indicated by two asterisks (**). Strong significance ($p < 0.05$) is indicated by a single asterisk (*).

group	contin. formants	contin. voicing	silent gap	extended frication	release burst	N
MC	79.7	37.9 *	27.5	36.3	75.3	182
WC	80.4	49.2 *	21.8	29.1	74.3	179
males	94.1 **	57.3 **	9.2 **	18.9 **	68.6 *	185
females	65.3 **	29.0 **	40.9 **	47.2 **	81.3 *	176
older	76.6	43.4	30.3 *	12.0 **	89.7 **	175
younger	83.3	43.5	19.4 *	52.2 **	60.8 **	186
ALL	80.1	43.5	24.7	32.7	74.8	361

Table 1. Newcastle: main social effects - proportional (%) occurrence of acoustic features

Principal findings - Newcastle:

- clear formant structure perseveres through all or most of the stop 'slot' in 80% of tokens
- voicing continues through all or most of the stop 'slot' in over 40% of all tokens
- silent stop gaps, however short in duration, are rare - less than 25% of tokens overall
- extended frication occurs in over 30% of tokens
- release bursts for most speakers tend to be clear
- numerous statistically significant socially-correlated differences emerge:
 - * clear formant structure perseveres almost categorically in the male tokens
 - * voicing continues in over half of the tokens produced by males
 - * silent stop gaps are found in less than 10% of male tokens and are more frequent in the speech of older informants
 - * extended frication occurs in around half the tokens by younger speakers and females
 - * release bursts are more typical of older and female speakers - thus, younger speakers and males have a greater tendency to produce fully spirantised variants

group	contin. formants	contin. voicing	silent gap	extended friction	release burst	N
MC	69.9	7.5	57.0	0.0	93.0	186
WC	79.0	8.0	54.9	3.1	88.9	162
males	81.8 *	8.2	48.8 *	0.6	89.4	170
females	66.9 *	7.3	62.9 *	2.2	92.7	178
older	75.1	10.8 *	49.2 **	2.2	90.3	185
younger	73.0	4.3 *	63.8 **	0.6	92.0	163
ALL	74.1	7.8	56.0	1.4	91.1	348

Table 2. Derby: main social effects - proportional (%) occurrence of acoustic features

Principal findings - Derby

- continuation of formants found in nearly 75% of tokens
- continuation of voicing is rare
- silent stop gaps are found in over 50% of tokens
- extended friction is virtually absent (occurring in the speech of only 2 informants)
- release bursts are produced almost categorically
- several socially-correlated differences emerge:
 - * clear formant structure perseveres more regularly in male tokens
 - * continuation of voicing is more common in older speech
 - * silent stop gaps are more frequent in the speech of female and younger informants

SUMMARY OF FINDINGS AND DISCUSSION

(a) voiceless stops in the corpus are rarely match 'canonical' descriptions presented in the literature; Newcastle tokens manifest several unexpected features, i.e. lack of appreciable silent gap, regular continuation of formant structure and voicing, and substantial occurrence of extended friction; Derby tokens approximate more closely to 'canonical' descriptions, but continuation of formants is frequent and only around half the tokens in the sample contain silent stop gaps.

(b) salient acoustic features are found to correlate with non-linguistic factors such as age, and particularly sex, of speakers.

(c) certain socio-phonetic correlations are found equally in both Newcastle and Derby: continuation of formants is a male trait; presence of silent stop gap is characteristic of females.

(d) certain socio-phonetic correlations are found with different distributions: continuation of voicing is a male and WC trait in Newcastle, but is typical of older speakers in Derby; presence of a silent stop gap is characteristic of older Newcastle informants, but younger speakers in Derby.

These findings raise two main issues. The first relates to a source of tension between the insights of instrumental phonetic investigation and conventional practice within phonology and sociolinguistics. Work in the latter disciplines has been (and still is) largely carried out on the basis of auditory analysis of segmental categories. However, one outcome which is emerging very clearly from recent work looking at the relationship between phonetics and phonology is that there has been a significant discrediting of segmental representation, because of the concern that this may have more to do with the analytic categories of the investigator than with the activities of the speaker-listener. There is therefore a significant question mark concerning the nature of the data which is relevant to studies of variation and change. We would promote the view that instrumentation can have a vital part to play, and that phonetic studies can yield legitimate information which can be used to refine and assess descriptions and theoretical models. Indeed the figures in Tables 1 and 2, illustrating structured variation in the subtle acoustic features of released stops, are entirely analogous to those which

emerge from analyses of auditorily-transcribed data relating to other variants (e.g. glottal stops, vowel variables) and which are used as the basis for arguments relating to change in progress and the discrete/gradient change debate. The only difference is that our data was obtained from acoustic analysis, which allowed us to make observations which we suspect (although we have not yet tested in a controlled fashion) would be very hard to pick up robustly using even well-trained ears. This is not a new position to take - Kerswill & Wright (1990) and Nolan (1992) pursue exactly this line, but the attractions of work of this sort seem to us as strong as ever.

Our second point relates to how we might account for our findings. It seems every time an investigation focuses on fine-grained cross-language or cross-accent variation in speech production it can be found in abundance. This would seem to constitute evidence for a learned set of phonetic implementation conventions which form a significant part of what it is that makes a native speaker a native speaker, or which mark off a speaker as being a member of a particular speech community. Understanding the nature of this knowledge is a real challenge, especially in relation to systematic patterns of performance such as those illustrated in Tables 1 and 2, which are not categorical but variable, and which can only be identified on observation of a sizeable corpus of data.

Since our work suggests that what we hear as 'released' /t/ may in fact be some form of weakened articulation, we are currently pursuing this work by looking at the phonetic characteristics of 'weakened' /t/ in Australian English. Tollfree (1996) suggests that this is a very salient form which may well function as a social/age marker, and that underlying the term 'weakened' there may be a range of phonetic realisations. However, to the best of our knowledge there have been no instrumental phonetic studies of this variant in Australian English. We are interested in exploring the question of whether the phonetic characteristics of Australian 'weakened' /t/ are similar to those found in other varieties of English (suggesting that a similar weakening process is taking place) and whether similar patterns of variation are observed. Initial results will be presented at SST-96.

NOTE

(1) Figures for extended frication combine 'quotes' and 'archway' patterns. The difference between the two forms is largely dependent on whether there is a release burst: of the 99 'quotes' tokens in the Newcastle data, 73 also have a clear release burst; only 19 tokens of the 'archway' pattern were recorded, and all but one of these lacked a burst. Group figures do not always total 48 due to omissions, misreadings, excessive background noise, etc. One young WC male in Derby produced categorical glottal stop in word-list readings and as a result his scores are not included in Table 2.

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