SOCIOPHONETIC VARIATION IN 'GLOTTALS' IN NEWCASTLE ENGLISH

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ABSTRACT

At ICPhS XIII we presented a preliminary acoustic study of glottal and glottalised variants of /t/ as spoken in Newcastle upon Tyne [3]. In this paper we present our full acoustic analysis of glottal variants from 22 speakers. Tokens perceived as glottal stops were typically found to be fully voiced with an interval of laryngealisation. In "glottalised" tokens different speaker groups differed in respect of their acoustic features. Most tokens were characterised by creaky voicing and formant movement. However, 26% also contained an acoustic transient, suggesting either that the oral gesture lags behind the laryngeal gesture. These tokens were significantly more common in the productions of older males. Our findings suggest that very fine phonetic differences of this sort merit further attention in determining the way in which the vocal tract is harnessed for sociolinguistic purposes.

1. INTRODUCTION

The phonetics literature does not paint a clear picture with regard to the phonetic basis of glottal consonants. Some investigators suggest that a glottal stop differs from other stops largely by virtue of its place of articulation; e.g. Catford [1] takes the view that a "glottal stop requires total tight closure of the glottis maintained for an appreciable time" (:109); Laver [12] echoes this pointing out that "the maintenance of a glottal closure is called a glottal stop" (:188). Other investigators identify different articulatory characteristics. Nolan [13] points out that "The term "glottal stop" probably covers a range of realizations all of which may be associated with perturbed phonation, from brief creaky voice alone, through actual full-glottal closure, to glottal closure reinforced by closure of other structures above the true vocal folds." (:366) Esling [7] argues that it is necessary to describe the articulation of glottal and pharyngeal sounds in terms of the action of a laryngeal sphincter mechanism as opposed to simply referring to narrowing in one of the areas which are but a single component of this "articulator" (e.g. occlusion of the true vocal folds, as typically conceived of in conventional descriptions of the glottal stop). Ladefoged & Maddieson [11] suggest that different types of glottal stop can be observed across languages (:74ff). They suggest that "true stops" only occur reliably in cases of gemination, and that more typically, glottal "stops" do not have complete glottal occlusion, especially in intervocalic position, and are realised as an interval of creaky voice or "stiff phonation". Ladefoged & Maddieson point out further that glottal stop and creaky or laryngealised voice quality share the property of having a high degree of constriction in the glottis, and they place them as close neighbours on a continuum of laryngeal articulation which ranges from glottal abduction to glottal stop "in which the vocal folds are even more tightly together than in creaky voice" (:49).

Nearly all of the accounts diverging from the view that glottal stops are simply the same as other stops but with a different place of articulation are based on instrumental evidence of some sort. This suggests that this is an area where there may be a complex relationship between auditory impression and articulatory and acoustic characteristics. Nonetheless, most of what can be found in the literature is based either on auditory judgement, the instrumental representation of a small number of tokens from individual speakers, or is simply a view expressed without any supporting evidence.

British English (BrE) provides a good source of material for further investigation of this question. Glottal variants have increased in frequency in BrE throughout this century. Most writers (e.g. [14, 2, 9, 15]) agree that there are two types of glottal variant in BrE; full replacement (sometimes referred to as glottaling), where a glottal stop is substituted for the oral stop /t/; reinforcement of /p/, /t/, or /k/. In most accents, reinforcement is achieved by pre-glottalisation with the reinforcing glottal gesture being established just prior to the supralaryngeal gesture and being removed before the latter's release.

In line with the situation applying more generally, the literature on BrE also provides different views of the phonetic basis of these glottal variants. For example, Gimson [9], echoing early accounts by Jones, points out that in [ʔ] "the obstruction to the airstream is formed by the closure of the vocal folds, thereby interrupting the passage of air into the supra-glottal organs. The air pressure below the glottis is released by the sudden separation of the vocal folds. The compression stage of the articulation consists of silence, its presence being perceived auditorily by the sudden cessation of the preceding sound or by the sudden onset (often with an accompanying strong breath effort) of the following sound."(:167) On the other hand, investigators working on the transcription and labeling of corpora of British English (e.g. [10]) have noted that the percept of a glottal variant can sometimes correlate with an interval of creaky voice but without the presence of any of the features which would normally be associate with a voiceless stop.

Tyneside English (spoken in the urban conurbation straddling the River Tyne in the North-East of England) is a particularly rich environment in which to study the phonetic characteristics of glottal consonants. Whilst the contexts giving rise to glottal variants are different in many ways to those which apply in other varieties (e.g. glottals occur only rarely in pre-pausal position, but glottalised variants of /p t k/ are common in intervocalic contexts – see [4,5,6] for full details), glottal variants occur with very high frequency. Furthermore, Tyneside English seems to have a particular type of glottal reinforcement not seen elsewhere in the UK described [17] as "glottal masking of the oral plosive burst" (:374); i.e. unlike other varieties of British English, the glottal occlusion is sustained until after the release of the supralaryngeal occlusion, thus rendering the latter's release inaudible.

2. METHOD

2.1. Speech sample. In each of two Tyneside neighbourhoods a judgment sample of 16 speakers (n=32) was drawn to include equal numbers of men and women. Half of the speakers were aged between 16 and 25, and half between 45 and 60. The neighbourhoods were differentiated on broad socio-economic grounds (for convenience we refer to these neighbourhood groups as working class "WC" and middle class "MC"). This design allowed us to consider the effects of age, gender and "class" on patterns of linguistic variation and change (see [4,5,6] for a more detailed account of the larger sociophonetic investigation within which this study is embedded).

The data presented below was elicited from a 150-item word-list recorded by each speaker, designed to elicit the production of a significant number of glottal variants. Observations of our subjects' performance in conversational samples suggest that the findings from our word-list task are a good reflection of speakers' natural performance. Recordings were made using a portable Sony TCD-D10 Pro II DAT recorder.

2.2. Acoustic Analysis. In view of the almost complete lack of assistance in the acoustic phonetic literature in respect of what the important acoustic parameters might be for a study of this sort we proceeded to construct a detailed acoustic profile of glottaled/ised realisations of /p t k/ in which we mapped the presence of some key features

Each potential /p t k/ glottaling site was assessed auditorily as being one of (a) released, (b) glottal/glottalised, or (c) other. A number of tokens were not analysed either due to mispronunciations or interference on the recording, etc. In the small number of cases where the auditory judgement was difficult to make with any confidence, a conservative path was taken and these were assigned to the non-glottal category. No attempt was made to auditorily differentiate between glottaled and glottalised variants. All subsequent analysis was carried out on tokens assigned to the glottal variant category (b).

For all speakers, wide-band spectrographic analysis (using a Kay Elemetrics CSL system) was carried out of /p t k/ word-list items auditorily judged to be produced with a glottal variant. This gave a total of 549 tokens (98 of which were variants of underlying /p k/, the rest being variants of /t/). The vast majority of these tokens consisted of /t/ in within-word and across-word ['V_ (#) V] environments (e.g. *daught̲er, beat̲ it*). In Tyneside English these represent the key environments in which glottal variants are found; as already pointed out, in pre-pausal position voiceless stops are never glottalised, being clearly released instead. The sample of data did, however, include a small number of tokens in other environments, including [`V_ syllabic l] (e.g. *bot̲t̲le, brit̲t̲le*), and [`V _ nasal V] (e.g. *jump̲er, hunt̲er*). In all cases, however, the criterial stops were located between two voiced segments, either vowels, approximants or nasals, and were in a *s_w* prosodic environment. Table 1 shows how the sample of glottal variants identified auditorily was distributed across the different groups making up the sample of speakers. 10/32 subjects failed to produce a single glottal token (4 x OMC-F, 2 x OMC-M, 3 x YMC-F, 1 x OWC-F), and a further 8 produced < 10 – so, only 14/32 reached double figures.

	y. WC	**o. WC**	**y. MC**	**o. MC**	***total***
Male	176	143	79	20	***418***
Female	111	15	5	0	***131***

Table 1. Distribution of glottaled/-ised plosives across the sample of speakers (y. - young, o.=old, WC = "working class", MC = "middle class").

Our acoustic profile of the key characteristics of the glottal/ised variants was based on the visual identification of three principal acoustic parameters:

(a) each token was categorised as being fully voiced, partially voiced or completely voiceless. Full voicing was assigned when there was no break in voicing corresponding to the plosive. "Voiceless" was assigned when there was a period of voicelessness coterminous with the end of the preceding V and the onset of the following V -- for this purpose we ignored any small incursion of c. 20ms into an otherwise totally voiceless stop slot). Partial voicing was assigned to tokens where there was an interruption in voicing during the production of the stop but not of sufficient duration for the stop to be labelled as fully voiceless.

(b) each token was inspected for evidence of a release burst corresponding to the release of an oral stop constriction. In the case of glottaled variants no such burst would be expected. For glottalised variants the spectral characteristics of the burst would vary according to the place of articulation of the stop [16] (:461). Note, however, Wells' claim mentioned above that in Tyneside English glottalised variants have been claimed to have the oral release masked by the glottal articulation; if true, this

would mean that no oral release burst should be observable in any of the glottal variants.

(c) each token was classified as glottal or glottalised on the basis of the presence or absence of F2 transitions into or out of the stop "slot" which were characteristic of the appropriate supralaryngeal gesture. A glottal stop produced in intervocalic position without any simultaneous oral articulation should not exert any particular influence on F2 of an adjacent vowel.

For examples of some of the typical patterns observed in our analysis, as well as some more detailed description of these, see [3, 4, 5, 6]. [image0166.tif] provides an example of a case where the perception of a glottalised variant correlates with a very short interval of laryngealisation during what is otherwise an interval of continuous voicing (the word being produced is *total* by a young male speaker).

3. RESULTS

Table 2 gives a description of the overall frequency of acoustic patterns which we tracked (N=549). Each of the three acoustic parameters is now considered in turn.

			Voicing		
		Fully Voiced	**Partially Voiced**	**Voiceless**	**Total**
F2 activity	**Y**	284	139	13	**436**
	N	100	10	3	**113**
		384	**149**	**16**	**549**
Release Burst	**N**	286	108	13	**407**
	Y	98	41	3	**142**
		384	**149**	**16**	**549**

Table 2. Frequency of different patterns of voicing, F2 activity in glottal variants, and release burst activity: aggregates across all subjects. "N" applied to F2 activity and release burst signifies that these were not observed; "Y" signifies that they were present.

3.1. Voicing. 70% of all glottal variants were fully voiced. Only 3% of the glottal tokens were produced with an interval looking like a canonical voiceless stop occlusion. The intervals of voicing in the fully- and partially-voiced tokens were usually characterised by some degree of laryngealisation. In some cases the only acoustic correlate of the audible production of a glottal variant was the misalignment of two or three vertical striations bounded by the two adjacent vowels. It seems that remarkably little laryngealisation indeed may be sufficient to cue the percept of a glottal variants for this variety of English.

3.2. Oral articulation. In 79% of the tokens F2 transitions into and/or out of the stop were indicative of the presence of an oral gesture. The exceptions to this (i.e. [ʔ]) were almost all found in /t/ occurring before a syllabic /l/.

3.3. Release burst. The co-occurrence of release burst and oral occlusion is shown in Table 3. A release burst was observed in 32% (141/435) of the glottalised tokens analysed. This could be considered rather a high figure given the claims (referred to above) that in the Tyneside variety of English, the glottal gesture masks the oral release.

		F2 activity		
		glottalised	**glottaled**	
Release	**absent**	294	113	**407**
	present	142	0	**142**
		436	**113**	**TOTALS**

Table 3. Frequency of different patterns of F2 activity in glottal variants, and release burst activity: aggregates across all subjects.

3.4. Inter-speaker variability. Variation is expected in any detailed investigation of large amounts of data. Close examination of the acoustic data shows that glottalised tokens with a release burst do not occur with a random distribution across the corpus, but are in fact significantly correlated with particular speaker groups. Fig. 1 shows the proportion of glottalised tokens produced with an oral release by each speaker group.

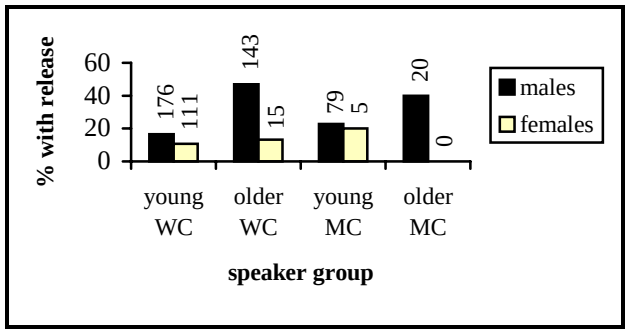

Figure 1. Sociolinguistic distribution of glottalised tokens produced with an oral release (number above each bar = N tokens analysed)

Despite diversity in the number of tokens analysed, clear patterns emerge from Fig. 1. Most notably, released tokens account for a far higher proportion of the older males' productions than any other group, and there is a very large difference between the older WC males and the corresponding females (47% versus 13%). By contrast, younger speakers from both social classes produce proportionately fewer released tokens, and there is virtually no difference in the scores for males and females. The disparity in the number of tokens analysed and the number of informants per cell means that statistical comparisons are hard to make (further investigation of such patterns from a much larger speaker sample is necessary to

confirm these results). However, there is a clear suggestion of skewing in the distribution of released tokens, with age (and possibly gender) appearing to be a factor in their occurrence; older males appear to be producing glottalised tokens with a different pattern of articulatory co-ordination than some other members of the speech community: they have a greater tendency to time the oral gesture such that it lags behind the accompanying glottal articulation, thereby making the release audible.

4. DISCUSSION

A striking feature of the results is the virtual absence of "canonical" glottal stop or glottalised stop articulations in any of the data. Whilst we cannot comment directly on the actual articulatory gestures produced by our speakers, the vast majority of our tokens are produced with full or partial voicing. The irregularity observed in the pattern of vertical striations suggests that speakers are producing laryngealised voice quality which in turn suggests that there is a degree of constriction of the vocal folds (compared to that found in modal voice), but no sustained occlusion. Indeed, in some cases, clear glottal percepts arise merely from the presence of very slight and short-term perturbations in the vertical striations (and hence vocal fold vibration) in the middle of what appears to be a smooth transition from the voiced segment preceding the underlying stop to the following vowel segment. Note that similar findings have emerged from a parallel study which we have carried out of the Derby variety of English suggesting that this is not a feature that is peculiar to Tyneside English. The majority of the tokens also bear a strong resemblance to the examples of [ʔ] in Lebanese Arabic and [*] in Gimi given in [11] (:75ff). Thus, our findings are consistent with the reports of other investigators that glottal variants of BrE (and other languages) are commonly produced without a glottal stop articulation and that the most typical laryngeal characteristic associated with these sounds is an interval of laryngealised voice quality.

Our results also support the claims in the literature that there are two types of glottal variant in this variety; with and without an accompanying supralaryngeal gesture, the latter occurring most commonly in the environment of a following syllabic lateral. In their production of glottalised variants, most Tyneside speakers typically delay the glottal reinforcing gesture such that the stop release is masked (as suggested for this variety by Wells [17]). It is interesting, however, that others (particularly older males) produce a significant quantity of glottalised variants with an audible oral release (i.e. with the laryngeal-supralaryngeal timing adjusted such that there is no masking of the oral release); i.e. in producing these complex double articulations, different speakers make use of subtly different patterns of interarticulator timing.

This latter finding supports the outcome of previous work [5] which showed that there may be a socio-phonetic dimension to fine-grained aspects of consonant production. This contrasts with most existing work on socially-sensitive variation in consonants which has been based almost exclusively on a rather coarse-grained segmental auditory analysis. It seems likely that instrumental phonetic analysis such as that carried out in this study may also be informative about the extent to which the vocal tract can be harnessed for sociolinguistic purposes. If speakers are indeed systematically modulating fine-grained aspects of performance as part of their social identity, this will require a more sophisticated account of the dimensions along which variation is taking place [6], and of how it comes to be acquired by children within the same community as part of their acquisition of phonology [8].

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