Word-Initial Glottal Stop Insertion, Hiatus Resolution and Linking in British English

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Abstract

Glottal stop insertion at word boundaries is usually not included in descriptions of the phonology of Southern Standard British English (BrE), and little is known about the factors that determine it. This paper investigates the insertion of glottal stops before vowels at word boundaries (e.g. <town is> pronounced as [taunʔɪz]) in the spontaneous and read speech of 10 speakers of BrE.

Results show that glottal stops are inserted in certain contexts in up to 50% of all cases before vowel-initial words at word boundaries. Glottal stop insertion is least frequent after obstruents (11.8%), followed by sonorants (19.0%) and vowels (29.0%). Preceding high vowels and following low vowels also make glottal stop insertion more likely. In addition, glottal stop insertion is slightly more frequent in read than in spontaneous speech, which suggests that it is a feature of the standard rather than a colloquial feature of BrE.

Index Terms: British English, Standard Southern British English, glottal stops, word-initial glottal stops, glottal stop insertion, glottal stop, prothesis, hiatus resolution, linking, liaison

1. Introduction

Many aspects of the sound system of Standard Southern British English (BrE) have, based on empirical and acoustic evidence, been extensively described in the literature, including its vowels [1–5], consonants [6–8], intonation [9–12] and speech rhythm [13, 14]. Although glottal stops are usually not included in a description of the consonant inventory of BrE, they may occur in two contexts. The first is replacement of /t/ with a glottal stop in intervocalic or postvocalic position, which is a well-documented non-standard feature that has started to become more accepted in the standard in recent years [15, 16].

This paper is concerned with the second context in which glottal stops may occur, which is at the beginning of a word starting in a vowel. For example, the two words <town is> may be pronounced without a glottal stop [taunɪz] or with a glottal stop before the initial vowel of the second word [taunʔɪz].

Standard descriptions of the phonology of BrE do not mention this insertion of glottal stops at word boundaries [17–19]. Instead, the final sound of the preceding word is said to be “linked” to the following word, a process also described as “liaison”. Depending on the preceding context, two cases can be distinguished: The last phoneme of the preceding word is either a consonant (C#V), or a vowel (V#V). In the second case, /h/ (intrusive r) or /l/, i.e. the glottal stop insertion that is usually said to be absent from BrE.

However, the use of glottal stops for hiatus resolution (V#IV) has been documented for other varieties of English. [20–22] found this strategy for hiatus resolution in the London Bangladeshi community and in Multicultural London English. Moreover, glottal stops have also been found to occur exceptionally after consonants, where no hiatus occurs (C#V) [23]. The insertion of glottal stops before words starting in a vowel has also been documented for Singapore, Hong Kong and Indian English, contributing to their more syllable-timed speech rhythm [24–29].

Early small-scale empirical studies of American English (AmE) found that the presence of stress and accent on the following vowel increases the likelihood of glottal stop insertion [30, 31]. Based on a corpus of AmE (read) newscaster speech, [32] reported insertion of glottal stops in vowel-initial words in c. 10% to 25% (depending on speaker) of all words that did not occur at the beginning of intonation phrases, and c. 19% to 70% (depending on speaker) of all phrase-initial words. In addition, glottal stop insertion was more frequent before stressed accented than before stressed unaccented syllables, where it was in turn more frequent than before unstressed syllables. In non-phrase-initial contexts, it was also more likely after vowels than after approximants, and in turn less likely after obstruents.

[33] found glottal stop insertion in AmE at word boundaries between vowel-final and vowel-initial words to be more frequent at a slower speech rate, and more frequent if the second vowel was stressed than if it was unstressed. They also found that the occurrence of different acoustic realisations of glottal stop insertion, such as different degrees of creak and full glottal stops, were all governed by these factors. Another contextual variable that might influence the rate of glottal stop insertion in English is vowel height, since research on Polish and German indicated that in these languages glottal stops at word boundaries are more frequent, if the following vowel is low than if it is high or mid [34].

While a certain number of studies have looked at glottal stop insertion in AmE, there are hardly any studies on BrE. The exception is [35], who reported, in spite of the widespread belief that words beginning in a vowel are always "linked" to the preceding word in BrE (i.e. no glottal stop is inserted), the insertion of glottal stops in 5.7 %, and the use of creaky voice in another 25.5 % of all cases in a corpus of BBC newscasts. A hiatus between the two vowels occurs, and the hiatus may be resolved with different strategies such as the insertion of /ʊj/ /w/, /V#IV/ refers to glottal stop insertion at the beginning of vowel-initial words that are preceded by a vowel.

2The hash symbol (#) denotes a word boundary. Consequently, /V#IV/ refers to glottal stop insertion at the beginning of vowel-initial words that are preceded by a vowel.

1This is an example occurring in the data presented in this paper (speaker GB11). The phrase reads "This part of town is known for ..."
in contexts where linking-ᵣ or intrusive-ᵣ can potentially occur. However, it is not known whether glottal stops can also occur after consonants in BrE or outside of the environments that trigger linking-ᵣ and intrusive-ᵣ, and whether glottal stop insertion is, like in AmE, more likely before stressed syllables. Another open question is whether the occurrence of glottal stops at word boundaries is restricted to formal or read speech or occurs also in spontaneous speech. Finally, the influence of the height and backness of vowels at word boundaries needs to be elucidated.

2. Aims

Previous research has thus left unresolved several questions on the frequency and function of word-initial glottal stop insertion in BrE. It is the aim of this paper to answer the following questions for BrE:

- Does glottal stop insertion occur only as hiatus breaker (i.e. in the V#IV context) or also after consonants (C#IV)?
- How style-dependent is glottal stop insertion? Does it occur more frequently in spontaneous speech than in scripted/read speech?
- Is glottal stop insertion more frequent before stressed syllables?
- Is glottal stop insertion more frequent after or before particular sounds?

3. Data and Methods

3.1. Data and Elicitation Methods

Read and spontaneous speech of 10 male speakers of Standard Southern BrE from the Dynamic Variability in Speech (DyViS) database was used [36]. The speakers were between 18 and 25 years old at the time of recording (2005-2009) in a sound-treated studio. The spontaneous speech task consisted of a simulated police interview during which speakers played the role of a suspect in a drug trafficking case.

3.2. Analysis

Approximately two thirds of the reading task (392 words) and at least five minutes of spontaneous speech were segmented. This was achieved in a semi-automatic process. First, the interviewers’ questions were replaced with silence. Then, phonemic forced alignment with HTK [37] was used for the automatic part of the annotation process. The Penn Phonetics Forced Aligner (P2FA) [38] served as a front-end, and made the results of the forced alignment process available in the form of a Praat TextGrid [39]. Finally, the annotation was manually corrected where necessary.

Subsequently, a Praat script identified all word boundaries that were followed by a vowel, were not preceded by a pause (i.e. not utterance-initial), and were not preceded by /t/ (to avoid glottal stops due to t-glottaling, see introduction). All relevant tokens were then classified according to preceding context, i.e. either preceded by a vowel (V#IV context) or by a consonant (C#IV).

Glottal stops were identified and annotated based on auditory and visual cues in the spectrogram and the waveform. Where short periods (not extending over a major part of the vowel) of creaky voice occurred, these were classified as glottal stops if the durations of individual periods were highly irregular.

Fig. 1 shows an example of a realisation of the phrase ‘<Causeway is>’, pronounced (with a glottal stop at the word boundary) as [kʌzweɪʔɪz]. In this example, the preceding word ends in a vowel, the following word starts in a vowel (V#IV context), and there is a glottal stop inserted at the word boundary. In the subsequent analyses, only the manually corrected parts of the transcriptions were used.

In total, speakers produced between 419 and 531 (median 474) syllables in read speech, and between 199 and 542 (median 262) syllables in spontaneous speech. The number of words matching the variable context (beginning in a vowel, not preceded by /t/, not utterance-initial) amounted to between 60 and 88 per speaker (median 75.5) in read speech, and between 41 and 131 (median 56.5) in spontaneous speech, or 1,382 in total.

Next, mixed effects regression models were run in R with lme4 [40, 41]. The presence of a glottal stop was used as a dependent variable. In a general model comprising all contexts, SPEAKING STYLE (read/spontaneous), STRESS on the following syllable (stressed/unstressed), FOLLOWING VOWEL HEIGHT (high/medium/low), FOLLOWING VOWEL BACKNESS (front, central, back) and PRECEDING PHONOLOGICAL CONTEXT (obstruent, sonorant, vowel) were used as independent variables. Next, in a model comprising only tokens occurring after words ending in a vowel (i.e. V#V), PRECEDING VOWEL HEIGHT and PRECEDING VOWEL BACKNESS were used as independent variables instead of PRECEDING PHONOLOGICAL CONTEXT. SPEAKER, FOLLOWING WORD and PRECEDING WORD were initially entered as random variables. Model selection was conducted by minimising BIC (Bayesian Information Criterion, [42]). For the first regression analysis, candidate models did not converge, so that one random variable (PRECEDING WORD) had to be removed.

4. Results

4.1. All contexts

SPEAKING STYLE, PRECEDING PHONOLOGICAL CONTEXT and FOLLOWING VOWEL HEIGHT were selected as variables
in the regression model, without any interactions. Glottal stop insertion was slightly more likely in read (18.5%) than in spontaneous speech (14.0%; see Fig. 2a). A post-hoc Tukey test revealed this difference to be highly significant (z=-5.1, p<0.0001). Regarding preceding phonological context (see Fig. 2b), more glottal stops were inserted after words ending in a vowel (29.0%, e.g. <Causeway is> pronounced as [kÆsweɪti]) syllables after sonorants (19.0%), where it was in turn more likely than after obstruents (11.8%; vowels vs. obstruents z=6.1, p<0.001; vowels vs. sonorants z=2.7, p<0.05; obstruents vs. sonorants z=3.2, p<0.001).

Following vowel height was another influential factor (see Fig. 2c), with glottal stops occurring significantly more frequently before low (21.3%) than before mid vowels (9.2%; z=3.8, p<0.001), and significantly more frequently before high (19.3%) than before mid vowels (z=2.4, p<0.05). The difference between low and high vowels was not significant (z=0.4, p=0.93). Glottal stops were also more likely to occur before stressed (21.5%) than before unstressed syllables (14.6%). However, this factor turned out to be not consistently influential enough to be included in the model (and, if included, is not significant: z=1.1, p=0.26).

4.2. After vowel-final words

Backness of the preceding vowel and vowel height of the following vowel were selected as influential factors. Glottal stops were significantly more likely to occur after preceding central vowels (55.6%, see Fig. 3a) than after back vowels (19.2%; z=3.2, p<0.01). After front vowels, glottal stops were inserted in 29.0% of all cases, and the difference with preceding central vowels is relatively close to significance (z=2.1, p=0.097), but not significant compared to preceding back vowels (z=1.9, p=0.15). Glottal stop insertion was also significantly more likely before low vowels (37.5%, see Fig. 3b) than before mid vowels (18.8%; z=2.6, p<0.05).

Glottal stops were somewhat more often inserted after high vowels (25.5%) than after mid vowels (z=0.8, p=0.67), and more often after low than after high vowels (z=1.5, p=0.31), but none of these differences were significant. Glottal stops were also more likely to occur before stressed (33.7%) than before unstressed syllables (26.3%). However, this factor turned out to be not consistently influential enough to be included in the model (and, if included, is not significant: z=0.5, p=0.61).

5. Discussion

This study set out to determine how often BrE speakers insert glottal stops at word boundaries before vowel-initial words, and what factors influence the likelihood of this phonological process. Glottal stop insertion was shown to be

- slightly more likely in read than in spontaneous speech,
- more likely after vowels than after sonorants, where it was in turn more likely than after obstruents,5
- more likely before low vowels than before mid vowels.
- At word boundaries preceded and followed by a vowel (V#V), where glottal stop insertion is a means of hiatus resolution, preceding central vowels were more likely to trigger glottal stop insertion than preceding back vowels.

These results show that glottal stop insertion at word boundaries before vowels occurs in BrE across a variety of phonological contexts, and not just in the contexts investigated previously (i.e. those contexts where linking-r and intrusive-r can occur [35]). At word boundaries between two vowels, glottal stop insertion occurred in 29% of all cases (which is comparable to previous results for AmE at fast speech rates [33]). This shows that glottal stop insertion is an important means of hiatus resolution in BrE, and that liaison/linking, glide insertion and intrusive-r are not the only ways a hiatus can be resolved in BrE, in spite of what the standard literature claims [17–19].

Since glottal stop insertion was not shown to be more frequent in spontaneous than in read speech, it appears to be a feature that is not characteristic of colloquial speech only.6 At the same time, glottal stop insertion occurred not only after vowels but also after consonants, which suggests that a description of this

5A reviewer mentioned that the low frequency of glottal stops after obstruents might be due to the difficulty of verifying their occurrence in the vicinity of plosives. However, this is only true for glottal stops occurring before plosives, a context that was not considered in the present study.

6A reviewer suggested that differences in speech rate or the frequency of phrase boundaries might explain the higher frequency of glottal stops in read speech. However, the speakers articulated faster and with fewer phrase boundaries in read speech, both of which suggest (all else being the same) a lower likelihood of glottal stop insertion. A stylistic difference between read and spontaneous speech therefore seems to be the most likely explanation.
process as hiatus resolution strategy does not account for its full range of functions. Since previous analyses of postcolonial varieties of English assumed that BrE does not have glottal stop insertion at word boundaries [24–27], a reanalysis of their results might show that these postcolonial varieties make more frequent use of glottal stop insertion than BrE, or perhaps even to a similar degree.

The results furthermore suggested that glottal stop insertion occurs more frequently before stressed than unstressed syllables in BrE, although this difference was not significant. Compared to previous results for AmE, the stress-induced difference was rather small, which suggests that stress on the following syllable might be a less important factor for BrE than for AmE [33]. Alternatively, the presence of a pitch accent (rather than word stress) might be a triggering factor in BrE.

The result that glottal stop insertion occurs more frequently after preceding vowels than after sonorants, and is least likely after obstruents, confirms previous results for AmE and puts them on a broader empirical basis [32]. Since vowels are more sonorant than sonorants, and these in turn more sonorant than obstruents, this suggests that glottal stop insertion might be a strategy to increase the difference in sonority between syllable onset and syllable nucleus [43, 44].

The analysis also included several factors that were not considered in previous research on BrE and AmE. Specifically, vowel height and backness of the vowels preceding and following the word boundaries were investigated. It emerged that glottal stop insertion was more frequent after central vowels (in contexts with a preceding vowel), where it occurred in more than 50% of all tokens, than after front and back vowels, and that it was more frequent before low vowels than before mid vowels (with ambiguous results for high vowels). The role of vowel backness in the preceding vowel might be explained with the availability of alternative strategies of hiatus resolution, which are only available for front and back vowels (j-insertion and w-insertion, respectively). The influence of vowel height in following vowels has also been found for Polish and German, which showed that low vowels trigger glottal stop insertion more frequently than high and mid vowels. The reason is likely that the articulatory gestures for low values are more favourable to glottal stop insertion than mid or high vowels [34, 45].

6. Conclusion

This paper investigated glottal stop insertion (after vowels and consonants) in BrE, which standard descriptions of the phonology of BrE do not consider. Results showed that word-initial vowels are often preceded by a glottal stop, particularly after central vowels and before low vowels. While the presence of stress on the following syllable did not show a significant effect in the present study, it is conceivable that acoustic measurements of stress correlates (intensity, duration, f0, spectral balance) might show a stronger effect in future work.

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8. References
