I CAN BE BOTH? (PRE-)ASPIRATION AND (PRE-)GLOTTALISATION DO NOT HAVE TO BE MUTUALLY EXCLUSIVE

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ABSTRACT

This paper explores the relationship between pre-aspiration and pre-glottalisation, which have traditionally been seen as mutually exclusive when occurring in the same language and/or language family. Acoustic analysis of Welsh English fortis plosives and fricatives produced by 45 speakers reveals that glottalisation is less frequent (17%; *n* = 545) than pre-aspiration (56%; *n* =1846). 181 of 3306 tokens show both pre-aspiration and pre-glottalisation (5%). This co-occurrence takes the following forms: 1. the two happen simultaneously, in various forms of whispery/breathy/lax creak; 2. the two happen successively; 3. a combination of 1. and 2. is found. Where the two happen successively, (whispery/breathy/lax) creak typically precedes local breathiness and/or voiceless pre-aspiration. Option 1 is the most frequent in the data, with variable degrees of aspiration and glottalisation present. Whispery/breathy/lax creak emerge(s) as (a) phonatory setting(s) which can be meaningful for our understanding of subsegmental phonatory phenomena, and not only paralinguistic phenomena.

Keywords: pre-aspiration, pre-glottalisation, whispery creak, breathy creak, lax creak, breathiness.

1. INTRODUCTION

This paper focuses on the relationship between pre-aspiration and pre-glottalisation. The former is defined here as a period of primarily glottal friction which occurs in the sequences of sonorants and phonetically voiceless obstruents, prior to the release of the obstruent, as in Welsh English *mat* [ma^{h}t^{s}] and *mass* [ma^{h}s]. The latter is defined here as aperiodic glottal pulsing and/or as a sudden drop in f_0 in the contexts of sonorants and phonetically voiceless obstruents, as in Welsh English *mat* [ma^{ʔ}t^{s}]. The two phenomena are typically investigated separately (e.g., [4, 15, 17-18, 24], but they can enter into a range of relationships.

The research available on the relationship between the two, where these are found in the same language and/or language family, points to a contrastive or an allophonic relationship. In the former, pre-aspirated consonants are found to contrast with pre-glottalised consonants. This has been attested for sonorants, as in Shehret [29] and Huatla Mazatec [26, p. 220), but has not been reported for plosives to the best of my knowledge. [19, p. 340] discuss examples of aspiration and glottalisation being contrastive.

Where pre-aspiration and pre-glottalisation are allophonic, this relationship can be realised in several ways. Firstly, categorical allophony between the two has been found [7; 10: ch. 5; 13]. In their Manchester English data, [13] report (near-)categorical pre-glottalisation in word- and foot-final fortis plosives (*mat* [ma^{ʔ}t^{s}]), but pre-aspiration in word- and foot-medial fortis plosives (*matter* [ma^{h}t^{s}ə]) and in word- and foot-final fortis fricatives (*mass* [ma^{h}s]). This is also reported by [10: ch. 5] for Aberystwyth English and by [11] for various Welsh English accents. Furthermore, [7] report glottalisation in word- and foot-final fortis plosive environment but pre-aspiration in word- and foot-final fortis fricative environment in their Scottish English data. The two can therefore participate in categorically allophonic relationships conditioned by the prosodic environment and/or by the manner of articulation of the consonant involved.

These allophonic relationships, however, do not have to be categorical. [11] reports cases which present us with gradient allophonic constellations. For instance, a word- and foot-final fortis plosive can be associated primarily with pre-glottalisation, but not categorically so, reaching different rates of application with different speakers. Thus, both pre-aspiration and pre-glottalisation can occur in the same prosodic and segmental environment, with one being more preferred than the other.

Finally, historical discussions of pre-aspiration in some languages present us with a situation in which daughter language A shows pre-aspiration where daughter language B shows pre-glottalisation [9, p. 24, 29; 23, p. 154–155]. This diachronic perspective is particularly intriguing as it is not immediately obvious what a precursor to the two outcomes, pre-aspiration and pre-glottalisation, should be. Indeed, aspiration and glottalisation are generally seen as quite different in general discussions of laryngeal contrasts and phonatory settings ([1, p. 102; 8, p. 4, 63; 16, p. 325], but see [14, p. 205; 27, p. 431]).

Although (pre-)aspiration and pre-glottalisation have been seen as mutually exclusive on the whole,

implicitly or explicitly (e.g. [19]), [10, ch. 5; 11] nevertheless makes a cursory comment on cases in which pre-aspiration and pre-glottalisation are not only found in the same prosodic and segmental environments, but also within the same *token*. Similar findings have also been reported by [29] for one speaker of Mehri in the context of consonantal sonorants. Following up on [11], this paper addresses the following questions, using acoustic analyses of a range of Welsh English accents:

- How often do pre-aspiration and pre-glottalisation co-occur in the same tokens?
- What is the phonetic realisation of such cases?

2. METHODOLOGY

2.1. Tokens

The tokens analysed here are taken from the dataset presented in [11]. As Table 1 shows, each participant produced a range of foot- and word-final fortis plosives (/p, t, k/) and one fortis fricative (/s/) in words of a CVC structure. These words were uttered once in isolation, leading to 71-74 words per speaker (due to the occasional presence of a postvocalic /r/, in which case the token was excluded). The dataset comprises of 3306 tokens in total.

Vowel	/p/	/t/	/k/	/s/
/a/	*cap*	*mat*	*back*	*lass*
	map	*cat*	*lack*	*mass*
	sap		*mac*	
/ɛ/	*rep*	*let*	*neck*	*guess*
		pet		*less*
/ɪ/	*lip*	*lit*	*Nick*	*miss*
/ɒ/	*lop*	*lot*	*lock*	*loss*
/ʌ/	*sup*	*but*	*luck*	*bus*
		hut		*fuss*
/ʊ/		*foot*	*cook*	
		put	*look*	
		soot	*took*	
/aː/	*carp*	*art*	*lark*	
	harp	*heart*		
/iː/	*leap*	*beat*	*leak*	*lease*
		meet	*leek*	
/ɜː/	*burp*		*lurk*	*verse*
/oː/	*dorp*	*taught*	*auk*	
	thorp	*wrought*		
/uː/	*loop*	*lute*	*Luke*	*loose*
/aɪ/	*ripe*	*light*	*like*	*lice*
/aʊ/		*lout*		*louse*
/əʊ/	*lope*	*mote*	*oak*	
/eɪ/	*nape*	*late*	*fake*	*face*

Table 1: Words by segmental properties; from [11].

The participants comprise of 45 L1 and L2 speakers of Welsh English. They were born in a range of towns and regions in Wales, UK. The dataset is balanced for gender, but the vast majority of the speakers are L1 (rather than L2) speakers of Welsh. See [11] for more details.

2.2. Data processing

All speakers were recorded reading the same list of words, only part of which is presented and analysed here (as well as in [11]). H4 Zoom Handy recorder was used with a head-mounted AKG C520 microphone. The data was manually annotated and inspected in Praat [2]. Considering the nature of the phenomena of interest (see Section 3), no inferential statistical analyses were conducted. However, see [11] for statistical analyses of pre-aspiration application with respect to the participants' demographics.

2.3. Pre-aspiration

Pre-aspiration was defined as a period of (mostly) glottal friction found in sequences of vowels and phonetically voiceless obstruents. More specifically, voiced and voiceless aspects of this friction were distinguished, following e.g. [10]. The voiceless component is labelled as 'pre' in Fig. 1, while the voiced component, realised as local breathiness, is labelled 'br'. For more details on the relationship between the two, see [10, ch. 3].

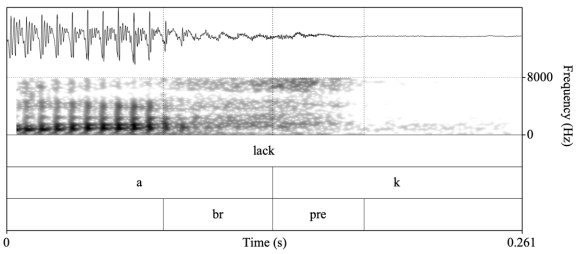

Figure 1: Local breathiness and pre-aspiration. Aberystwyth English speaker.

2.4. Pre-glottalisation

Pre-glottalisation was defined in line with [11, 13] as an aperiodic vocal fold vibration and/or as a sudden drop in f_0. The former is illustrated in Fig. 2. Crucially, glottalisation was only considered to be (sub)segmentally relevant if it occurred towards the end of the vowel, in line with [13]. 545 cases (17%) of the tokens showed vowel-final glottalisation, 514 found in plosives (19% of the plosives) and 31 in fricatives (5% of the fricatives). The 545 cases of vowel-final glottalisation present a conservative

number, as many of the whole-vowel cases affect words with vowels of very short durations, such as *put*.

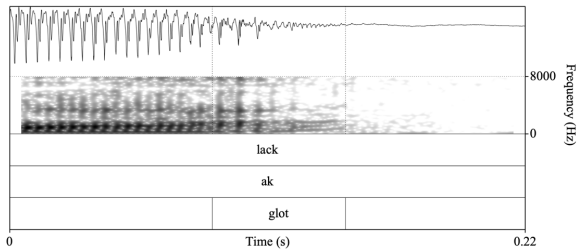

Figure 2: Pre-glottalisation. Dolgellau English speaker.

2.5. Whispery/breathy/lax creak

Whispery creak is a compound phonation [21, p. 161], which combines whisper and creak and manifests itself through noisiness more intense than that of breathiness [3, p. 53, 56, 124; 21, p. 45, 112, 121]. Importantly, "[t]he transition from breathing to breath to whisper can be thought of as an incremental narrowing of the airway from most open to moderately open to constricted" [3, p. 53], which is also reflected in gradient transitions from breathiness to whisperiness in the acoustic signal. The acoustic data analysed here reveals a considerable variation in what could be seen as compound types involving creakiness and breathiness and/or whisperiness [22, 28]. A rich palette of what could be described as whispery, breathy, and lax creak [6] is therefore observed.

3. RESULTS

Pre-aspiration is found in 1846 tokens, i.e. in 56% of the data (62% of the plosives, n = 1643; 32% of the fricatives, n = 203). Every speaker pre-aspirates. In contrast, 10 of the speakers never pre-glottalise, and 15 speakers produce only 1-3 tokens with pre-glottalisation. Pre-glottalisation therefore occurs less frequently than pre-aspiration, with 545 tokens being pre-glottalised in total (17%; 19% of the plosives, n = 514; 5% of the fricatives, n = 31).

181 tokens are both pre-aspirated and pre-glottalised, amounting to 5% of the overall data (Fig. 3). Of the 542 fricatives, 10 show both pre-aspiration and pre-glottalisation (2% of the fricatives). Of the 2655 plosives, 171 display the co-occurrence of the two (6% of the plosives). It needs to be borne in mind that "pre-aspiration" refers to voiceless abduction, i.e. not instances of pre-aspiration realised as voiced, i.e. as local breathiness. This means the numbers of co-occurrence reported here are conservative.

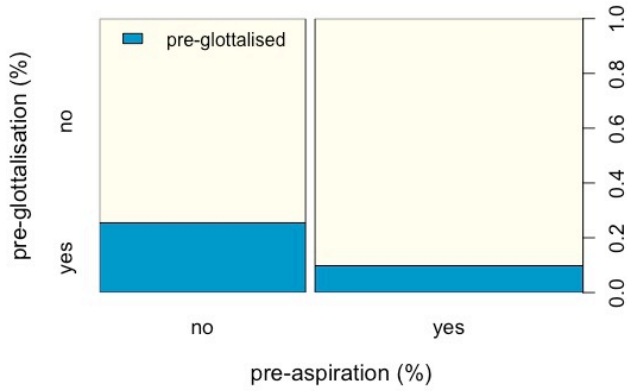

Figure 3: Co-occurrence of (voiceless) pre-aspiration and pre-glottalisation within a token.

Where pre-aspiration and pre-glottalisation occur in the same token, this can take on the following forms. Limiting ourselves to narrowly defined pre-aspiration as voiceless, the vast majority of cases present us with sequences in which we find glottalisation overlaid with aspiration, which is frequently followed by local breathiness and subsequently by voiceless pre-aspiration, or more rarely directly by voiceless pre-aspiration. The number of tokens in which pre-aspiration and pre-glottalisation co-occur increases if instances with local breathiness (voiced pre-aspiration) are considered. Of the 544 cases with pre-glottalisation, the sequencing of the laryngeal phenomena described above applies to 306 cases with local breathiness. Some examples of variably simultaneous glottalisation and aspiration are shown in Fig. 4-7.

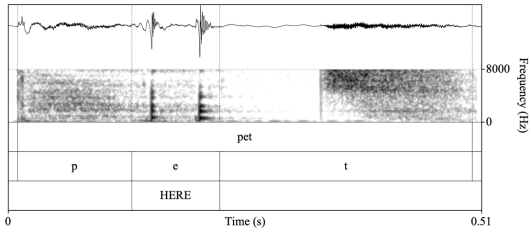

Figure 4: Glottal friction overlapping with glottalisation. A speaker from Yr Wyddgrug / Mold. Token excluded from quantitative analyses (whole vowel affected).

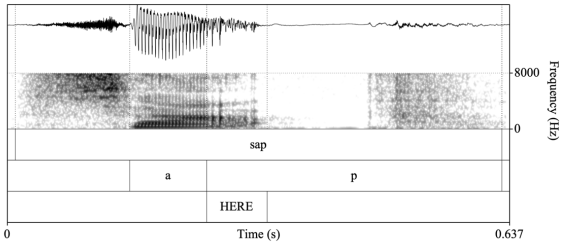

Figure 5: Glottal friction overlapping with glottalisation. A speaker from Dolgellau.

In contrast, only 19 tokens show a much more neatly separated sequence of glottalisation, local breathiness, and pre-aspiration. Few tokens digress from the pattern showing a progression from glottalisation to aspiration: A) 4 tokens show breathiness (some of which is followed by pre-aspiration), which is then followed by glottalisation; B) 23 tokens show breathiness followed by glottalisation overlaid with aspiration (4 of which include pre-aspiration following as the last laryngeal event); C) 3 cases present us with glottalisation overlaid with breathiness which is followed by pre-aspiration with glottal flatulence [25, p. 60]. Finally, 121 tokens display glottalisation with no visible aspiration, and 64 tokens present us with slack glottalisation, or lax creak, mirroring the slack profile of the vowel.

Within themselves, all of these profiles further show a range of gradient possibilities as to the amount and intensity of glottalisation and aspiration present, and these also vary durationally. The data further suggests that the onset of local breathiness, and that of pre-aspiration broadly defined, may be associated with barely noticeable irregularity in the periodicity of the signal. These minor irregularities can become more noticeable and be recognised as more canonical glottalisation (Fig. 6) by the analyst. As Fig. 7 shows, this glottalisation can manifest itself as durationally more prominent. The very short glottalisation durations of the type shown in Fig. 6 could be brought about by relatively sudden abduction, i.e. by a relatively abrupt change of the articulatory settings.

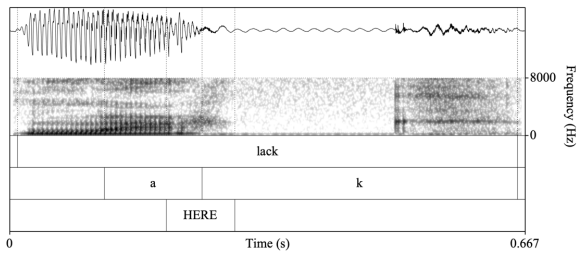

Figure 6: Glottal friction overlapping with glottalisation. A speaker from Clynderwen.

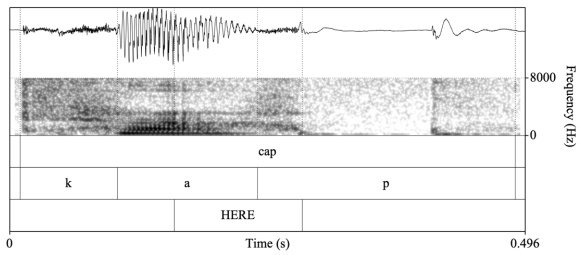

Figure 7: Glottal friction overlapping with glottalisation. A speaker from Caerphilly.

4. DISCUSSION

In this study, whispery creak, breathy creak, and lax creak emerge as phonatory settings which can be meaningful for our understanding of subsegmental phonatory phenomena, and not only paralinguistic phenomena [3, p. 127; 21, p. 122, 140]. This being the case, the co-occurrence of pre-aspiration and pre-glottalisation reported here should be considered in accounts of diachronic patterns whereby a reconstructed pre-aspirated/(pre-)glottalised obstruent gives rise to a pre-aspirated obstruent in daughter language A but a (pre-)glottalised obstruent in daughter language B (e.g. Western Yugur and Tuva; [10, ch. 5]). The two phenomena are necessarily not contrastive in such cases, but rather seem to serve the same articulatory and phonological goal, at least in the obstruent environment. This is also in line with [19, p. 327–350], according to whom [hʔ] and [ʔh] never contrast.

The fact that pre-aspiration and pre-glottalisation can co-occur simultaneously in the same token points out that the glottal continuum model of voice quality [20] is not the most optimal model regarding *phonetic* (as opposed to phonological) typology, as acknowledged in previous work ([3, 5, 12]).

Finally, the results reported here raise the question of what whispery creak and breathy creak are. Although clear definitions of whispery creak are readily available [3, 21], these refer to canonical whispery creak. Canonical whispery creak involves epilaryngeal constriction and should be accompanied by a more turbulent airflow and higher-intensity friction in the acoustic signal. However, research has repeatedly shown that canonical realisations of phenomena are not necessarily what the analyst deals with. A case in point is the glottal stop [5, p. 11]. In the same vein, breathiness can encompass realisations with higher-intensity friction as well as those where friction is practically absent [28]. Pre-aspiration has similarly been debated regarding the intensity and the source of its friction (e.g. [12]). With the acoustic data at hand, the realisations of pre-glottalisation and pre-aspiration often provide a gradient of slack, or lax, creak, and heavily fricated, or whispery, creak. Although [21, p. 113, 133] lists breathy creak as impossible, the data analysed here suggest that this setting is quite possible.

To conclude, the work presented here is used to explicitly state that, just like the glottal stop, creak, and breathiness can take on various shapes, so can whispery creak, breathy creak, and lax creak. The data further suggests that the compound phonatory settings of whispery/breathy/lax creak can be employed for non-paralinguistic purposes, albeit to a rather limited extent.

7. REFERENCES

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