
The realisation and phonetic features of the glottal stop in Bahdini Kurdish

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ABSTRACT

In Bahdini Kurdish (henceforth, BK), the realisation and the phonetic features of the glottal stop (GS) has not been extensively investigated and there is a debate about its phonemic status. In one hand, it is considered a phoneme that occurs only in a word-initial position. On the other hand, it is not considered a phoneme but optionally produced at the beginning of vowel-initial words and does not affect meaning. The study aims at identifying the realisation of this sound experimentally, analyses its acoustic features and whether it is affected by parameters such as vowel type, vowel position in the word and stress. The study is based on read speech produced by 10 BK native speakers. Then it is analysed phonetically using *Praat* to identify the presence/absence of the GS. Then the number of occurrences of the GSs are compared across vowel types, vowel position and stress. The results show that the GS is an epenthetic sound in BK that is inserted by the speakers to avoid onsetless syllables and to avoid vowel clusters. Different phonetic variations of the sound are realized in BK: A clear closure of the glottal stop, intermittent vocal folds vibrations during the GS closure, vocal folds vibrations start simultaneously with the GS release. It appears not to be affected by stress but by position, as it is found more medially in V+V contexts than initially, and vowel quality as it is produced more before low vowels than non-low vowels.

KEYWORDS

acoustic analysis; Bahdini Kurdish; glottal stop; stress; vowel type

Realització i característiques fonètiques de l'oclusiva glotal en kurd del Bahdinan

RESUM

En el kurd del Bahdinan (KB), la realització i les característiques fonètiques de l'oclusiva glotal (OG) no s'han investigat a fons i es qüestiona el seu estatus fonèmic. D'una banda, es considera un fonema que ocorre només en posició inicial de mot. De l'altra, no es considera un fonema sinó un fon produït a l'inici d'un mot començat per vocal. Aquest estudi té com a objectiu identificar la realització d'aquest so experimentalment, analitzar-ne les característiques acústiques i determinar si la seva aparició depèn de factors com ara el tipus de vocal, la posició de la vocal en el mot i la presència d'accent. A partir de la parla llegida de 10 parlants nadius de KB, s'identifica la presència/absència d'OG mitjançant *Praat*, i se n'estudien les ocurrencies segons tipus de vocal, posició de la vocal en el mot i presència o no d'accent. Els resultats mostren que l'OG és un so epentètic que els parlants de KB insereixen per evitar síl·labes sense inici i per evitar contactes vocàlics directes. En KB es troben diferents variacions fonètiques del so: una oclusió clara, vibracions intermitents de les cordes vocals durant l'oclusió, i vibracions de les cordes vocals iniciades amb la fase explosiva de l'oclusió. L'OG no sembla estar condicionada per l'accent, però sí per la posició en el mot (atès que es troba més en contextos V+V que no pas en posició inicial) i per la qualitat vocàlica (perquè es produeix més abans de vocals baixes que pas abans de vocals no baixes).

MOTS CLAU

anàlisi acústica; kurd del Bahdinan; oclusió glotal; accent; tipus de vocal

1. Introduction

Glottal stop (GS) has the characteristic of “a full closure of the vocal folds” (Ladefoged & Maddieson, 1996, p. 73). According to Crystal (1997, p. 170), it is defined as “the audible release of complete closure at the glottis”.

Different phonological status, functions and phonetic properties of GS have been recognized in world’s languages. It is identified as a regular stop consonant in languages such as in Hawaiian (Ladefoged & Maddieson, 1996, pp. 74–75), Arabic (Kasim, 2019), Nuuchahnulth, Nlaka’pamux, Tigrinya (Esling, 2003) and Lai (Roengpitya, 1997). While in other languages, the GS serves to demarcate the boundaries of phrases and other prosodic units as in German where a GS is inserted to avoid onsetless syllables at the beginning of a root or a prefix (Alber, 2001; Pompino-Marschall & Zygis, 2010) and in Anejoñ it appears in utterance-initial position (Lynch, 2000). In some other languages, GS functions more as a variation in phonation type, for example, in Huatla Mazatec it is recognized as laryngealisation of the following vowel or as creaky voice on an associated vowel as in Jalapa Mazatec (Ladefoged & Maddieson, 1996, p. 74). In some languages, the GS is altered by other segments as in Pima Bajo (e.g., /h/- vs. [ʔ]-alternation) (Fernández, 1996) or used as a segmental variant as in some forms of British English, the GS is used as a segmental variant of /t/, or instead of word-final or intervocalic /p/ and /k/ (Trudgill, 1974, p. 81). Additionally, its insertion may indicate grammatical functions in languages such as Nhandá as the GS is a marker of the irrealis mood, i.e., future, imperative, and purposive verb forms (Blevins & Marmion, 1995). Finally, the GS has phonotactic restrictions as in Nootka in which glottalized elements are banned from the coda (Shank & Wilson, 2000).

In Bahdini Kurdish (BK), the realisation and phonetic features of the GS has not been extensively investigated. The phonemic status of this sound is not clear. On one hand, it is considered a plosive

phoneme that occurs only word initially (Ali & Abdulla, 2019; Hamid, 2016). The occurrence of the GS [ʔ] is predictable initially: whenever a syllable does not start with other consonants, it is supposed to begin by [ʔ] since no syllable starts with a vowel. On the other hand, many linguists do not accept the GS as a phoneme according to principle of phonology because if we put it in a word or remove it cannot be a reason to change the meaning of the word (Ways, 1984; Muhammad, 2009).

The aim of this paper is to investigate the realisation and phonetic features of the GS in BK, one of the subdialects of Northern Kurmanji dialect of Kurdish. The study will look at the realisation of this sound experimentally and will look at the phonetic variations of this sounds and whether its production depends on parameters such as vowel type, vowel position in a word (initial or medial) and stress. The study is an attempt to answer the following questions:

- a) Is GS realised in the beginning of vowel-initial words and in medial positions intervocalically?
- b) What are the functions of the GS at the beginning of vowel-initial words and in medial position intervocalically?
- c) What are phonetic features of the GS in BK?
- d) Is GS affected by vowel type, vowel position and stress?

The paper is organized as follows. In section 2, we provide a brief overview of studies on GSs in other languages and in Kurdish. Section 3 introduces the experimental design of the present study and section 4 provides the results. The discussion is given in section 5 and the main conclusions of the paper are summarized and discussed in section 6.

2. Literature review

Previous works on Kurdish GS are generally descriptive and intuitive, i.e., they lack experimental (acoustic) evidence (Ali & Abdulla, 2019; Hamid, 2016; Muhammad, 2009; Ways, 1984). It is claimed that the sound has a restricted distribution

as it occurs only at the beginning of vowel-initial words. Besides, the GS phonetic features and the effects of phonetic and phonological factors on the presence and/or absence of this sound are not investigated yet. This study is the first attempt to identify the realisation of the GS in BK, analyse its phonetic features acoustically and identify the effects of some factors (such as the type of the vowel, the vowel position in the word and stress) on the production of the sound.

GS appears before vowel-initial words and in intervocalic environments possibly in all languages, however the frequency of GS insertion in these contexts differ across languages (Garellek, 2012). GS before vowel-initial words is rare in Spanish, common in English (Garellek, 2012) and German (Pompino-Marschall & Zygis, 2010) an almost in all vowel-initial words in Czech. Similarly, GS in intervocalic environments seems to be morphologically conditioned in some languages such as Persian (the GS is inserted to resolve hiatus between two adjacent vowels in derivational prefix + base context) (Yazarlou, 2014) and in American English (GS is commonly inserted in vowel + vowel sequences across word boundaries) (Davidson & Erker, 2014). While in Dutch the GS is only inserted in hiatus position (Jongenburger & van Heuven, 1991).

A huge variability of GSs and glottalizations in their acoustic realization has been reported in previous studies (Yazarlou, 2014; Kasim, 2019). In Persian, different acoustic correlates of the sound are observed in intervocalic environments: a complete glottal closure and release, creaky voice, and a completely irregular vibration of the vocal folds (Yazarlou, 2014). Similarly, in Arabic, Kasim (2019) showed that the GS had measurable voice-onset time (VOT) in initial position, meanwhile it had great variability in medial and final position where there were intermittent vocal folds vibrations preceding, during and/or following the closure of the stop.

Furthermore, it has been shown that the production of the GS depends on different parameters such as

phrasal position, accented vs. unaccented syllable, segmental context, speech rate, dialect, speaker's gender, pause, prominence, phrasing and others (for Dutch: Jongenburger & van Heuven, 1991; for Finnish: Lennes, et al., 2006; for German: Pompino-Marschall & Zygis, 2010; for American English: Garellek, 2012; for Arabic: Kasim, 2019). In Dutch, factors such as speech pause, sonority of the pre-hiatus phoneme, prominence of the hiatus vowel, length of the words preceding and following the hiatus position affect the distribution of word-initial GS (Jongenburger & van Heuven, 1991). Besides, the distribution of word-initial GS in Dutch is rule-governed and a single rule that account for most cases of word initial GS distribution is identified. In casual Finnish conversation, GSs are primarily used as word boundary signals before vowel-initial words or during word search and incompletely produced words (Lennes, et al., 2006). It is found that GSs tend to be longer in the case of word search or a false start than in the case of vowel-initial words and they are rarely found immediately preceding a pause, but they are rather common in utterance-initial positions. Additionally, GSs with complete closure can be used for signaling one's intention to hold a turn in Finnish conversations. Moreover, the glottal marking in German ranges from glottal stop insertion via glottalization to no marking at all and the strength of marking is influenced by speech rate (the marking is stronger in slow speech than in fast speech), word type (content words are more strongly marked than function words), stress (stressed initial vowels are more strongly marked than unstressed ones) and the nature of the vowel (low vowels are more marked than non-low vowels) (Pompino-Marschall & Zygis, 2010). Furthermore, in American English, factors such as prominence and phrasing are very important in predicting full GS occurrence and that prominent word-initial vowels show acoustic correlates of glottal closure but not non-prominent phrase-initial vowels (Garellek, 2012).

Generally, it is claimed that there is a cross-linguistic tendency of GSs to co-occur with low vowels. Brunner and Zygis (2011) conducted a perceptual

experiment to test this feature. The study has shown that vowels are perceived lower in their quality if they are glottalized. It has been concluded that the co-occurrence of low vowels and GSs/glottalization could therefore be due to a reinterpretation of higher glottalized vowels as lower in their perceived height.

To sum up, previous studies have shown great variation in the realisation, function and acoustic features of the GS, even in the languages in which it is identified as a distinct phoneme (such as Arabic). Besides, its articulation is subject to variability as it is affected by different phonetic and phonological parameters. Still, it is not clear which of these factors are the most important in predicting GS occurrences.

3. Methodology

3.1. Speech material

The source of the data for the study comes from read speech that consists of a group of words designed by the researchers, shown in Table 1. According to the BK vowel system, there are eight vowels and three of them never occur word initially: /i, u, u:/ (Hasan, 2012). The experimental words are designed in which the vowels are found

at the beginning of the word and in the medial position between a prefix and vowel-initial root in two conditions when the first syllable is either stressed or unstressed. The total number of the words is 20. In this study, the words are written using the Kurmanji Latin writing system and their transcriptions are given using the IPA revised version symbols. The meanings of the words in English are also given.

3.2. Speakers

The read speech is produced by 10 educated BK native speakers: 2 males and 8 females. They are students and teachers at University of Zakho and their ages range between 19 to 23 years old. Those speakers live in different places within the Bahdini speaking area such as Duhok, Akre, Zakho and Amedi. Their participation is voluntary.

3.3. Tools and data collection procedures

The data collection procedures started in January 2020. The participants had been recorded individually using a MacBook pro computer, a Creative Headset HS-600 noise cancelling microphone and *Praat* version 6.1.16 (Boersma & Weenik, 1992–2020). Each speaker was given a paper with the words and asked to read them loudly in moderate speed. The required data was recorded directly on

Vowel	Stress	Initial			Medial		
		Word	Transcr.	Meaning	Word	Transc.	Meaning
i:\	Str.	îş	i:ʃ\	work	bêiş	/bei:ʃ/	without work
	Unstr.	înan	/i:na:n/	brining	lêinan	/lei:na:n/	making it suitable
a\	Str.	em	/am/	we	bêem	/beam/	without us
	Unstr.	enjam	/andʒa:m/	results	bêenjam	/beandʒa:m/	without results
a:\	Str.	av	/a:v/	water	bêav	/bea:v/	without water
	Unstr.	avdan	/a:vda:n/	watering	bêavî	/bea:vi:/	state of being without water
o\	Str.	ol	/ol/	doctrine	bêol	/beol/	without doctrine
	Unstr.	omêd	/omed/	hope	beomêd	/beomed/	without hope
e\	Str.	êş	/eʃ/	disease	bêêş	/beeʃ/	without disease
	Unstr.	êşan	/eʃa:n/	pain	bêêşan	/beeʃa:n/	without pain

Table 1. Experimental words used in the study.

Praat software with 44 kHz sample rate frequency and the same software was used for all display, playback and measurement procedures. The recordings lasted for one day and done in a quiet room at University of Zakho.

3.4. Procedures of data analysis

The recordings have been listened to by the researchers. Then, each word was separated and saved as a separate wav file using *Praat*. The files were given codes indicating the speaker id (i.e., S1, S2, S3, etc.), gender (i.e., M for male, F for female) and the word spelling (i.e., “S1M-înan”).

Each word was segmented and transcribed by the researchers as being unmarked (0) or marked by a GS (?). The data was also transcribed by other two trained phoneticians, and the inter-transcription reliability was derived. Checking *reliability* of extracting the data qualitatively is a significant methodological procedure during data analysis. According to Cohen et al. (2007, p. 146), reliability in qualitative and quantitative research is essentially “a synonym for dependability, consistency and replicability over time, over instruments and over groups of respondents”. For the data to be reliable, transcribers must be reliable either. That is, they have to follow the same instructions and apply the same categories. Such a procedure should be followed in even small-scale studies (Landis & Koch, 1977; Prasad, 2015). Inter-transcription reliability is statistically measured by Cronbach’s *alpha* coefficient, which ranges from 0.0 to 1.0. The researchers checked reliability for the data extracted by 3 transcribers who were given the recorded data, looking for glottal stops. After the data were inserted into SPSS software, it was found that the transcribers’ procedures were stable and consistent (Table 2).

Cronbach’s Alpha	No. of Transcribers
0.707	3

Table 2. Reliability statistics.

Once marked and unmarked cases of GS of each word are identified, by using *Praat*, the waveforms and spectrograms are used to analyse the phonetic features of the GS. Then, the next step of data analysis after transcription and phonetic analysis is the comparison. We compared the GS articulation of each sound of all speakers across positions: initial and medial and stress: stressed and unstressed. The purpose of this procedure is to find out the effect of position and stress on the GS articulation. Then, we compared the production of the GS at the beginning of each sound of all speakers across other vowel types. The purpose is to examine the effect of the vowel quality on the production of the sound. The results are presented in a form of a table to simplify the comparisons. The SPSS program is used for statistical purposes.

4. Results

4.1. Glottal stop realization

The results show that the GS is produced in most of the speakers’ productions of isolated words in initial and medial contexts. The total number of the examined words are 200 (20 isolated words produced by 10 speakers). Table 3 shows the rate of the production of the GS.

GS marking	Number	Frequency
0 (unmarked)	45	22.5%
? (marked)	155	77.5%
Total	200	100%

Table 3. Rate of GS produced in isolated words.

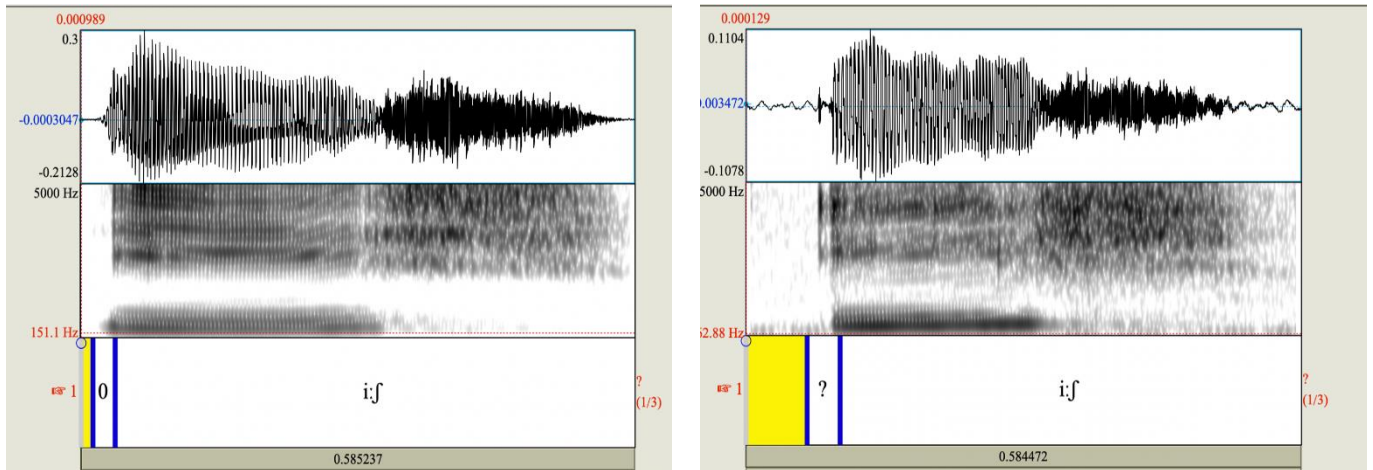


Figure 1. Production of the word *îş* by two speakers: without GS (left) and with GS (right).

The table illustrates that the GS is produced in most of the productions, but it is not contrastive. That is, it will not cause any change in meaning if a word is uttered with or without a GS. Figure 1 shows the productions of the word *îş* (‘work’) by two different speakers: without GS (left) and with GS (right). The meaning is not affected, which indicates that BK does not contrast the presence or absence of the GS before vowels both word-initially /#V/ and word-medially /V+V/.

4.2. Phonetic variations of the GS

Like previous studies on other languages, different phonetic variations of the GS are realized in BK. These variations are found in different contexts.

T1) The GS is realized by a clear closure of the GS followed by a post release period of voicelessness. It is represented by no waveform and appeared in the spectrogram by no pitch line (no fundamental frequency) and a sharp intensity ascending. Figure 2 displays a GS followed by a period of voicelessness as produced by one of the speakers. This variety has a measurable voice onset time (VOT, which is the duration of the period of time between the GS release and the beginning of vocal fold vibration). The VOT mean value was 32 ms.

T2) The most widely observed variation in the tokens is the appearance of intermittent vocal folds vibrations after the glottal closure release or during the GS closure. It is represented by irregular waveforms and as an interrupted pitch line in the spectrogram, the intensity is sharply ascending (sharply dropping in medial position) and no F0 could be obtained. Figure 3 illustrates the production of this phonetic variation of the GS in the word *ol* (‘doctrine’) in initial position (top) in which the GS release is followed by intermittent vocal folds vibrations and in the word *bêîs* (‘without work’) in medial position (bottom) in which intermittent vocal folds vibrations occur during the GS closure. In most cases, the closure release is not identified, and no measurable VOT can be obtained.

T3) Another variation of the GS observed in our data is when the vocal folds vibration of the following vowel starts simultaneously with the GS closure release. The GS release is followed immediately by regular waveforms and the F0 and intensity could not be obtained. In this variety, the closure release is followed by a very short VOT (mean average value: 15 ms). Figure 4 presents a GS immediately followed by the vocal folds’ vibrations of the following vowel as produced in the word *encam* by one of the speakers.

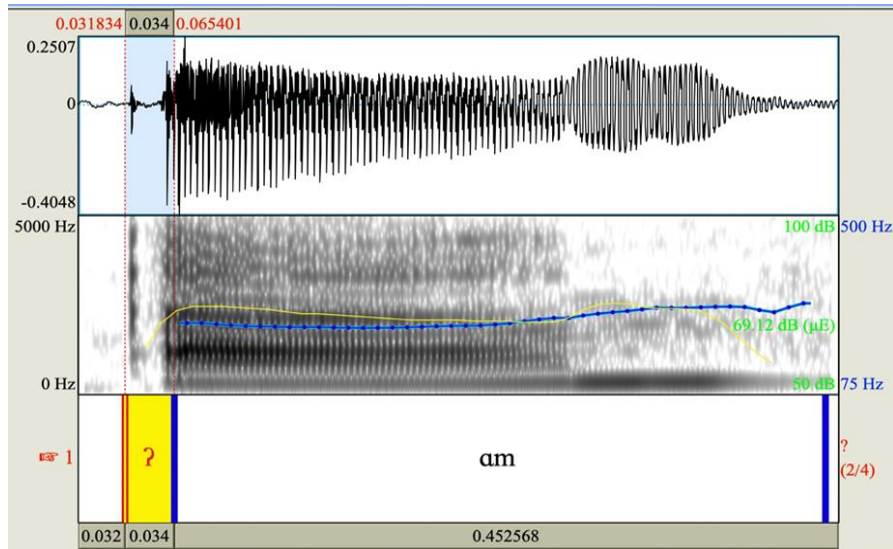


Figure 2. Production of the word *em* by one of the speakers with GS followed by a period of voicelessness and measurable VOT (34 ms) [T1].

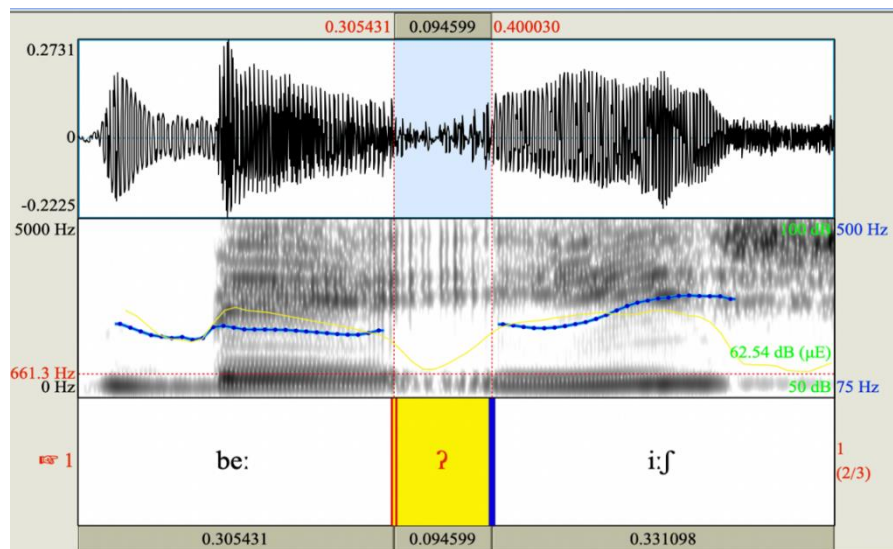
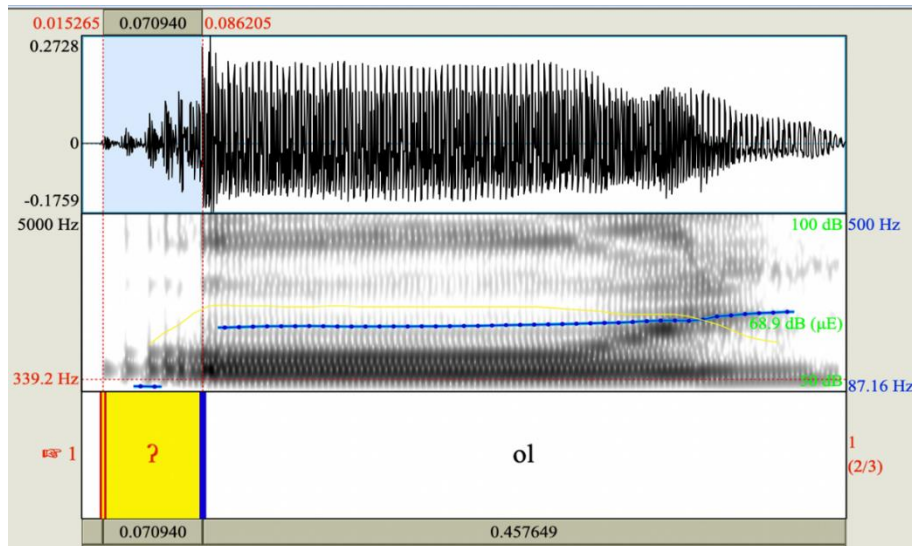


Figure 3. Intermittent vocal folds vibrations during the GS closure: in initial position (top; speaker HA) and in medial position (bottom; speaker BS) [T2].

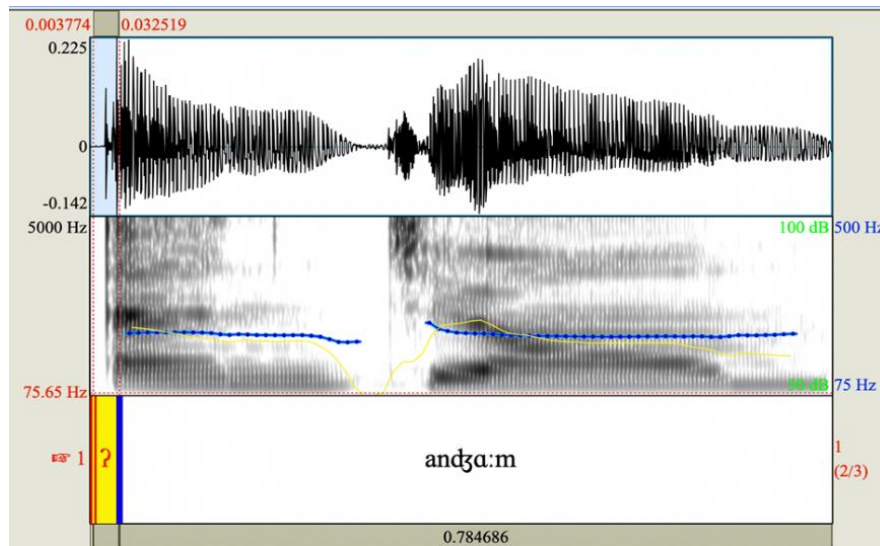


Figure 4. A GS immediately followed by the vocal folds' vibrations of the following vowel (speaker HA) [T3].

Phon. Type	Description	<i>N</i>	%
T1	glottal stop followed by a period of voicelessness	41	26.47
T2	intermittent vocal folds vibrations after the glottal closure release or during the glottal stop closure	91	58.70
T3	glottal stop immediately followed by the vocal folds' vibrations	23	14.83

Table 4. Rate of the occurrence of the GS variations (total *N* = 155).

Table 4 shows the rate of the occurrence of each of these variations. T2 (intermittent vocal folds vibrations after the glottal closure release or during the GS closure) is the most common variation (58.70% of the cases), followed by T1 (the GS is followed by a period of voicelessness; 26.47%) and T3 (the GS is immediately followed by the vocal folds vibrations; 14.83%).

4.3. Vowel position

Vowel position affects the production of the GS in Kurdish. The GS is found more in word medial V+V position between a CV prefix and a vowel-initial root than in word initial position. Table 5 shows the rate of the occurrence of GS according to the vowel position. The occurrences of the GS in the word-medial position is higher than in word-initially. A *t* test determined that the difference was statistically significant ($p < 0.05$). This illustrates that the GS has an important function in BK not identified before: it functions to avoid vowel clusters between a CV prefix and vowel-initial root.

Vowel position	<i>N</i>	<i>SD</i>	<i>p</i>
word-initial	68 / 100	0.47	.0012
word-medial	87 / 100	0.34	

Table 5. Rate of the occurrence of the GS according to vowel position.

We examine the found phonetic types in each position. Table 6 illustrates that vowel glottal stop followed by voicelessness (T1) is the most common phonetic type of GS word-initially, while the GS with intermittent vocal folds (T2) got the highest number of occurrences in medial position.

Vowel position	T1	T2	T3	Total
word-initial	27	22	20	69
word-medial	14	69	3	86
Total	41	91	23	155

Table 6. Distribution of the GS phonetic types according to vowel position.

4.4. Vowel quality

The results of the study indicate that the occurrence of GS differ across vowel types. Table 7 indicates the rate of the production of the GS according to the vowel types. The table shows that rate of the occurrence of the GS before vowel types. A one-way ANOVA stated that the difference is statistically significant ($p = .03036$).

Vowel	N	M	SD	F	p
/i:/	25 / 40	.600	.4961	2.7312	.0304
/a/	34 / 40	.875	.3349		
/a:/	33 / 40	.825	.3848		
/o/	33 / 40	.825	.3848		
/e/	30 / 40	.750	.4385		

Table 7. Rate of the occurrence of the GS according to the vowel quality.

We further examined whether the difference between low vowel /a, a:/ and non-low vowels /i:, o, e/ is significant (Table 8). The mean values indicate that GS is more frequent before low vowels, and that the difference is significant ($p = .0383$).

Vowel type	N	M	SD	F	p
Non-low /i:, o, e/	88 / 120	.725	.4484	4.3516	.0383
Low /a, a:/	67 / 80	.850	.3593		

Table 8. The rate of the occurrence of the GS between low and non-low vowels.

4.5. Stress

As for stress, the results show that it does not affect GS marking in BK. As Table 9 shows that the number of occurrences of the GS is higher in unstressed condition than in the stressed one. The table illustrates that in Kurdish, the vowel-initial unstressed syllables are more marked with glottal stop than the stressed ones. A statistical t test is performed to identify whether the difference is significant. This difference is considered to be not statistically significant (p value is more than 0.05).

Stress	N	SD	p
Str.	75 / 100	.44	.3997
Unstr.	80 / 100	.40	

Table 9. The rate of the occurrence of the GS according to stress.

5. Discussion

The study indicates that the presence or absence of GS in BK does not contrast meaning. It is difficult to find minimal pairs with GS word initially with other consonants because as the study shows it appears mostly before vowel-initial words but it is not obligatory as these words can also be produced without a GS. Thus, we looked at the presence and absence of the GS in vowel initial words and how that affects meaning. The production of the vowel-initial words with a GS or without created two words that differ only in the presence of the GS and there is no difference in meaning between the two words, e.g., /andʒa:m/ and /ʔandʒa:m/ have the same meaning (result). These words created near minimal pairs like those in Arabic /ʔalba:n/ (diary foods) and /alba:n/ (the ben-tree) (Al-Wahy, 2021), but they differ in that in BK the difference is not contrastive while in Arabic it is contrastive. Near minimal pairs are defined as ‘pairs which would be minimal except for some evidently irrelevant difference’ (Hays, 2009, p. 36). They can be used to discover contrastive phonemes in a language. This technique is used because there are no strict minimal pairs when one item has the GS and the other has another phoneme. These near minimal pairs are found in English as well /fa:m/ and /a:m/, where the presence of an extra sound before the vowel is contrastive (Al-Wahy, 2021). Besides, it is rare for a language to contrast between GS marking and 0 marking in onsets because of the difficulty in producing regular phonation in phrase initial position (Garellek, 2013). This result supports the previously claim (Ways, 1984, Muhammad, 2009) that the GS is uttered at the beginning of vowel-initial words and it is not contrastive. or medially to separate two vowels.

Before vowel initial words or utterances, the GS is inserted commonly by the speakers to avoid onsetless syllables. BK does not prefer syllables to start with a vowel, thus a GS is uttered at the beginning of these syllables to satisfy this feature. Generally, there is a cross-linguistic preference for syllables with onsets which is expressed by the onset constraint: syllables must have onsets (Uffmann, 2007; Blevins, 2008). Thus, the GS insertion is used as a strategy to satisfy this onset constraint. In other words, the inserted GS acts as the onset of the vowel-initial syllable or of the second vowel in a V+V sequence. The presence of the word initial GS is common in Kurdish as in many languages of the world. A common phenomenon referred to as word-initial glottalization by Garellek (2013) that is near a universal property. Taylor (2002, p. 88) uses the term ‘filled-onset requirement’ to refer to the phenomenon of the insertion of a consonant before vowel-initial words, i.e., according to the requirement if a word starts with a vowel, a consonant must be used to fill the onset position. In BK, vowel-commencing words are mostly pronounced with a GS before the vowel because no other consonant /j, or w/ can work in this environment. BK seems to be a kind of languages like Arabic and English (Al-Wahy, 2021) in which the syllable cannot start with a vowel. Thus, syllable structures such as V, VC or VCC are not permitted in Kurdish either word initially or word medially (intervocally or not intervocally). For example, the first syllable of the word /andʒa:m/ (result) can be uttered with a GS in word initial position or in word medial position intervocally as in /beʔandʒa:m/ (without result) or not intervocally as in /darʔandʒa:m/ (result of). The GS is not part of the phonemic structure of the word, i.e., it is not a real consonant, but is inserted to fill the onset position (Al-Wahy, 2021).

In V+V medial position, the GS does not only function as the onset of the second vowel, but also it is inserted to avoid vowel clusters. Usually, languages do not tolerate vowel clusters: two vowels occurring consequently. When two vowels occur together, languages adopt different strategies to resolve this hiatus. One of these strategies is that a

GS is inserted to break the vowel sequence which is found in languages like Dutch (Jongenburger & van Heuven, 1991), English (Lee, 2018). This important function of GS in BK has not been identified before in previous studies: it functions to avoid vowel clusters between a CV prefix and vowel-initial root. This result is consistent with studies showing increased rates of GS at vowel-vowel hiatus (Umeda, 1978; Pierrehumbert & Frisch, 1997). This consonant epenthesis to resolve vowel hiatus is found in languages such as Malay (Ahmad, 2001), Ilokano, Selayarese, Tunica and Indonesian (Lombardi, 2002). Kurdish uses different strategies to avoid vowel sequences such as vowel deletion and glide insertion (Hasan & Rasheed, 2016). Unlike Dutch in which the GS is inserted in hiatus position only (Jongenburger & van Heuven, 1991), in BK it is inserted in initial and in hiatus position as well. This study has examined the GS epenthesis in one morphological condition (between a CV prefix and vowel-initial root), further studies are required to examine whether GS is inserted in other morphological conditions.

Thus, GS appears to be non-phonemic epenthetic sound in BK. We can formulate a rule for glottal stop insertion in BK in initial and medial positions:

- i. $\emptyset \rightarrow /ʔ/ / [\#V_]$
- ii. $\emptyset \rightarrow /ʔ/ / [...V_ V...]$

The study showed that there is variability of GSs and glottalizations in their acoustic realization. Different phonetic variations of the GS are realized in BK: A clear closure of the GS, intermittent vocal folds vibrations during the GS closure and vocal folds vibrations start simultaneously with the GS release. The first variation (clear closure of the GS) and the third (vocal folds vibrations start simultaneously with the GS release) have measurable VOT, however, they differ in that in the second the VOT is very short. The second variety (intermittent vocal folds vibrations during the GS closure) has mostly no clear closure release and unidentifiable VOT. Besides, the study shows that a clear closure of the GS is found more in initial position, while intermittent vocal folds vibrations during the GS

closure appears more frequently in medial position. Garellek (2013) shows that the production of the GS manifests variability, and he concludes that “this variability appears... to be mostly random” (p. 132).

Finally, the presence and/or absence of the GSs is also subject to variation as it is affected by different parameters examined in this study. Position seems to affect the GS realization as it is found more commonly in word medial V+V positions than in word initial position. Vowel quality affects the GS in BK and especially low vowels are more marked with glottal stop than non-low vowels. Thus, BK, like German (Pompino-Marschall & Zygis, 2010), also has the tendency to produce the GS with low vowels which seems to be a universal feature (Brunner & Zygis, 2011). However, it is not affected by stress. It is claimed that prosodic features such as stress are known to be strong predictors of glottalization in other languages such as German (Pompino-Marschall & Zygis, 2010) and English (Pierrehumbert, 1995; Dilley et al., 1996; Garellek, 2012). Unlike the previous studies in other languages and similar to Persian (Yazarlou, 2014) in BK, it does not seem to be the case as GS is not affected by stress and it is more common in unstressed vowel-initial syllables. This result needs to be further investigated in different prosodic conditions.

6. Conclusion

The study analysed the GS realisation and phonetic features in one variety of Kurdish, namely Bahdini. It is found that GS is a non-phonemic epenthetic sound in BK that is inserted by the speakers to avoid onsetless syllables at the beginning of a word, in medial positions whether intervocalically or not and to avoid vowel clusters in intervocalic environments. The study is limited to words out of context: vowel initial simple words and words with a prefix + vowel-initial root. It is recommended to investigate GS in words in context and in other morphological conditions.

The study showed that there is variability of GSs and glottalizations in their acoustic realization as different phonetic variations of the GS are realized in BK. Finally, the presence and/or absence of the GSs is also subject to variation as it is affected by different parameters such as: position (found more in word medial V+V positions than in word initial position), vowel quality (low vowels are more marked with glottal stop than non-low vowels). However, it is not affected by stress.

The results contribute to analyse the phonetic realisations and features of this sound in BK. It is suggested to investigate the phonetic features of this sound in other dialects of the language to identify the status of this sound in Kurdish language as a whole. They also have an important implication for phonological studies, namely, it shows that GSs/glottalizations are conditioned by the segmental position and context. It needs to be further studied whether GS in Kurdish is affected by speech rate and other phonological factors.

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