

THE EFFECT OF WORD-INITIAL GLOTTALIZATION ON WORD MONITORING IN SLOVAK SPEAKERS OF ENGLISH

JAN VOLÍN

MÁRIA UHRINOVÁ

RADEK SKARNITZL

Institute of Phonetics, Faculty of Arts, Charles University in Prague

Abstract

The study investigates the impact of glottal elements before word-initial vowels on the speed of processing of the phrases taken from natural continuous speech. In many languages a word beginning with a vowel can be preceded by a glottal stop or a short period of creaky voice. However, languages differ in the extent of use and functions of this glottalization: it may be used to mark the word boundary, for instance, or to add special prominence to the word. The aim of the experiment was to find out whether the presence of the glottal element can influence reaction times in a word-monitoring paradigm. Users of different languages – Slovak and Czech learners of English, as well as native speakers of English – were participating in perception testing so that the influence of the mother tongue could be determined. The results confirm the effect of both glottalization and the L1 of the listeners. In addition, a significant effect of test item manipulations was found. Although the phrases with added or deleted glottal stops displayed no obvious acoustic artefacts, they produced longer reaction times than items with naturally present or absent glottalizations. We believe that this finding underlines the importance of inherent stress patterns, whose alterations lead to the increase in processing load.

1. Introduction

Linguists of most methodological backgrounds have a similar concern. Whether they are generativists, structuralists or constructionalists, they have to establish the inventories of items that are relevant for language communication. The research in sound patterns of languages of the past decades has shown that it is unproductive to remain stuck with narrowly defined phonemes and ignore rich symbolic structure provided by other speech phenomena. Descriptive units, whose distinctive power rightfully draws attention of language users, can change lexical meanings, but cannot explain on their own why some speakers communicate more effectively, are better accepted, and induce more cooperative behaviour than others (Local 2003; Hawkins 2003).

One of the elements that occur in most languages with non-phonemic status and still could influence intelligibility of speech and the smooth flow of communication with all its consequences is the glottalization of word-initial vowels. In this study, the term

glottalization will be used for glottal stops or perceptually equivalent glottal events, e.g., creaks, rapid drops in F0 or intensity, etc., which precede words beginning with onsetless syllables. Languages differ in the extent of use and roles or functions of such glottalizations (e.g., Przedlacka and Ashby 2011; Gordon and Ladefoged 2001; Redi and Shattuck-Hufnagel 2001; Kohler 1994). While in some they can be treated as external juncture signals that indicate an important autosemantic morpheme boundary, in others they may add special prominence to words with which they are used. In such cases the prosodic structure or the semantics of the utterance may be reflected. In phonological terms, the word-initial prevocalic glottalization can be viewed as a specific treatment of onsetless syllables in critical positions (Schwartz 2011).

While the production of glottal elements is often noted and explored, the perceptual aspect of the problem remains unclear. It might be hypothesized that speakers who regularly produce glottalizations would rely on their presence in the speech signal when they have to process it. By analogy, the greatest sensitivity can be expected in those rare languages where glottal stops act as phonemes. However, English is described as a language where word-initial prevocalic glottalization is facultative, and it is only used to emphasise a word if such an emphasis is contextually appropriate (Wells 1990: 327; Cruttenden 1994: 155). It is even recommended to foreigners to avoid production of glottal elements before most of the words beginning with vowels (especially frequently occurring grammatical *of, in, is, are, a, and,* etc.) to prevent unnatural “choppy” flow of speech (O’Connor 1980: 101). In such circumstances, inappropriate presence of glottal elements might even hinder mental processing of speech since it produces unnatural or unpredictable rhythmic configurations.

As our ultimate concern is English as a foreign language, the matter is even more complicated. Foreign speakers of English try to model the speech behaviour of native speakers, yet they struggle with production stereotypes from their own mother tongue. The extent to which they either benefit or suffer from the presence of glottal elements in speech can thus differ depending on their native situation.

In our previous study, we found significant differences between Czech and Spanish speakers of English (Bissiri et al. 2011). Spanish learners of English, in whose L1 glottalization is used infrequently and mostly as a marker of emphasis, benefited less from the presence of word-initial glottalizations than native speakers of Czech, which uses glottalization frequently as a signal of juncture. However, these results are difficult to interpret unambiguously since apart from differences in the general use of glottalizations, Spanish differs from Czech typologically. The phonotactic patterns and the prosodic plan of the two languages endow the learners of English with quite different predispositions. Moreover, the EFL teaching in the two countries seems to draw on different resources: both the general motivation of students and the teaching methods may not be comparable.

Therefore, we decided to examine the differences between reaction times to words with and without glottalization in Slovak speakers of English. Slovak is in many features similar to Czech (they both are Western Slavonic languages) and speakers of these languages are able to reasonably communicate even without special language instruction. Also, the EFL methodology is essentially the same in the two countries: the Czechs and Slovaks had lived under one central government until 1989 and they keep sharing many of their social and cultural traditions. On the other hand, the two languages

differ in the exploitation of word-initial glottal stops: the use of glottalization in Slovak is reportedly low and word-initial vowels regularly cause assimilation of voicing of the final consonant of the preceding word. This means that rather than providing the onsetless word-initial syllable with a glottal consonant-like element, the speakers of Slovak prefer to tie the word-initial vowel quite firmly to the preceding consonant. For instance, the word *tak* [tak] in the Slovak phrase

(1) *tak ale nie* [tag_ale nie] (in Engl. *but not this way*)

will be pronounced with [g] due to the tightly adhering [a] of the following word. The similarly sounding phrase in Czech, on the other hand, will contain glottalization and the preceding word-final [k] will remain voiceless:

(2a) *tak ale ne* [tak ʔale ne] (in Engl. *but not this way*)

Even in the case of less careful pronunciation where the glottal element might be missing, the assimilation of voicing will not happen (again, cf. Geoff Schwartz' concept of onsetless syllables).

The objective of our study is thus to investigate the influence of L1 on the perceptual impact of glottalizations in English while abstracting from profound differences in phonological systems (Spanish and Czech) and in language instruction. Slovak and Czech listeners will be compared mutually and against the benchmark performance of native English listeners.

We have stipulated two sets of hypotheses. The first set concerns the influence of glottalization, and the null hypothesis states that there is no effect of the presence or absence of a word-initial glottal element on reaction times when monitoring the speech signal for target words. An alternative hypothesis says that the presence of glottalization highlights the target word thus facilitating its perception. Reaction times in such a case should be shorter. Another alternative would argue that the presence of the glottal segment breaks the natural flow of English (as argued in some pronunciation textbooks) and produces the effect similar to that reported by Buxton (1983): rhythmically impaired utterances lead to longer reaction times in word-monitoring experiments.

The second set of hypotheses concerns the mother tongue of the EFL learners. The null hypothesis would deem it irrelevant. The first alternative would suggest that the Czech listeners will benefit more from the presence of glottal stops as they use them on a regular basis in their mother tongue. The second alternative would argue that the Slovak listeners, who only use glottal stops to highlight words (similarly to the English) will have shorter reaction times to words with glottal segments than the Czech listeners, to whom the glottalization of word-initial vowels does not signal anything special.

2. Method

The experiment was based on the word-monitoring paradigm (Kilborn & Moss, 1996). In this design, respondents are given a target (a word usually printed on a computer screen) and they listen to auditory stimuli for that target. Their task is to press a

designated key as soon as they detect the word. Their reaction time (or the so-called latency) is measured from the acoustic onset of the word to the moment when the key was pressed. We used the DMDX software – a package developed specifically for reaction time measurements (Forster & Forster, 2003).

Natural continuous speech provided the material for the stimuli. Five native speakers of southern variants of British English read news bulletins that were earlier broadcast at the BBC World Service. Forty-eight phrases were extracted from the recordings such that the target words could not be guessed from the semantic cues, i.e., all common collocations of the target words were avoided. For instance, in the phrase *Arafat last month as partial promised reforms* the conjunction *as* was the target. Clearly, the extraction of the sequence from a longer sentence does not help the listeners to guess when the target word might come. Similarly, in the phrase *with ten men after the striker Thierry Henry* the listeners were asked to react to the word *after*. The targets were placed anywhere between the second and the fifth stress-group. Distractors with the target in the first stress-group were only used to keep the listeners alert, but were not analyzed. Some more distractors were prepared with consonants in the word-initial position so that the listeners would not figure out the nature of the true targets.

One half of the true targets occurred naturally with glottal stops, the other half without them. These 48 items were processed in sound editing software to create artificial stimuli with the opposite value of glottalization, i.e., the naturally occurring glottal stops were deleted and the items without glottal stops were provided with an spliced one. Obviously, all possible care was taken to produce items that could not be recognized as artificial, i.e., the items were without clicks and other discontinuities, with smooth transitions of formants and the fundamental frequency track. These manipulations were carried out with the help of Praat, Sound Forge, and Matlab software packages.

Altogether, 96 targets and 36 fillers were used in the perceptual testing. The listeners were 90 adults in three equally-sized groups by their L1. Thirty were native English students and employees of a British university, 30 Czech and 30 Slovak learners of English. They were tested individually through headphones in a sound treated booth.

3. Results

The results confirm previous findings of the positive effect of glottalizations on the latencies: the words with pre-glottalized word-initial vowels are spotted faster than words linked to the preceding words. Repeated measure ANOVA returned highly significant effect of glottalization: $F(1, 87) = 481.4$; $p < 0.001$. Figure 1 indicates that the latencies were about 450 ms and items with glottal stops were spotted about 60 ms faster than the items without it.

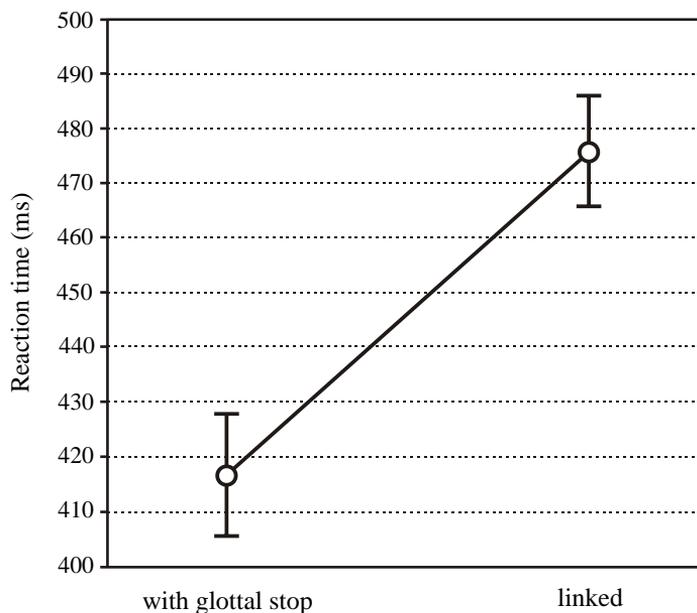


Figure 1: Mean reaction times of all listeners to words with (on the left) and without (on the right) the word-initial pre-glottalization.

The main effect of the mother tongue (the between-group factor) was also found highly significant: $F(1, 87) = 11.96$; $p < 0.001$. Post-hoc pairwise comparisons revealed that the English listeners were significantly faster than both the Slovak and Czech listeners, while Czechs and Slovaks did not differ significantly from each other. Although the difference between the latter groups was not statistically significant, Figure 2 shows that the Slovaks were on average faster than Czechs. That, however, does not address the hypotheses about the influence of glottalization and, therefore, the interaction between the variables is of interest. Analysis of variance returned significant interaction between the mother tongue of the listeners and the glottalization variable: $F(1, 87) = 7.26$; $p = 0.0012$. Figure 2 indicates that this result is again caused by the difference between the English on the one hand, and the Czech and Slovak on the other hand. Although there are allegedly differences in the production of the word-initial glottalization between Czech and Slovak, we found no difference in perceptual testing between the speakers of these two languages.

In addition to this main outcome, we carried out some further analyses to find out, whether the reaction times could have been influenced by any of our captured linguistic or other variables. These analyses were also based on ANOVA for repeated measures, but were calculated for individual test items rather than for individual subjects.

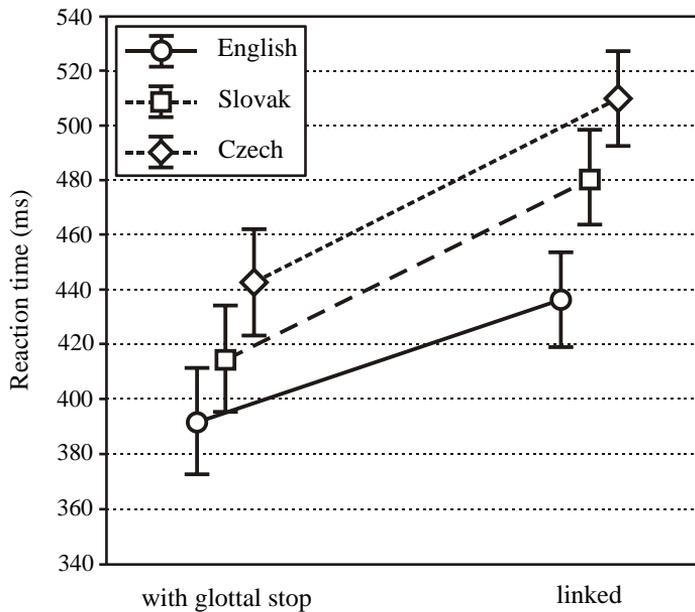


Figure 2: Interaction between the variable of the mother tongue and glottalization. Mean reaction times of the three listener groups to words with (on the left) and without (on the right) the word-initial pre-glottalization.

First of all, we found a significant effect of word stress. Reactions to words with stressed initial vowels were faster: $F(1, 3740) = 25.1$; $p < 0.001$. Figure 3 displays the mean reaction times which suggest that the English listeners benefited more from the presence of stress than the other two groups, whose behaviour with respect to word stress was again very similar. There was no significant interaction between stress, mother tongue and glottalization ($p = .86$).

We also decided to test the effect of the target position in the phrase. The factor of position had four levels: the items in the second stress-group were labelled *early* (no first stress-group targets were tested), the third stress-group was *mid*, the fourth was *late-mid*, and the remaining items were *late*. Unlike the findings in Buxton (1983), our results did not show any interesting trend. The *early*, *mid* and *late-mid* positions led to practically the same result and only the *late* position produced significantly longer reaction times.

Similarly, we did not find any significant difference between reactions to structural words (e.g., conjunctions, prepositions) and content words (e.g., nouns, adjectives). Semantic status obviously did not matter in the word-monitoring task. This may have been caused by the fact that the test items were extractions from longer sentences and their semantics was damaged: the price we had to pay to meet the requirement of unpredictability of the targets.

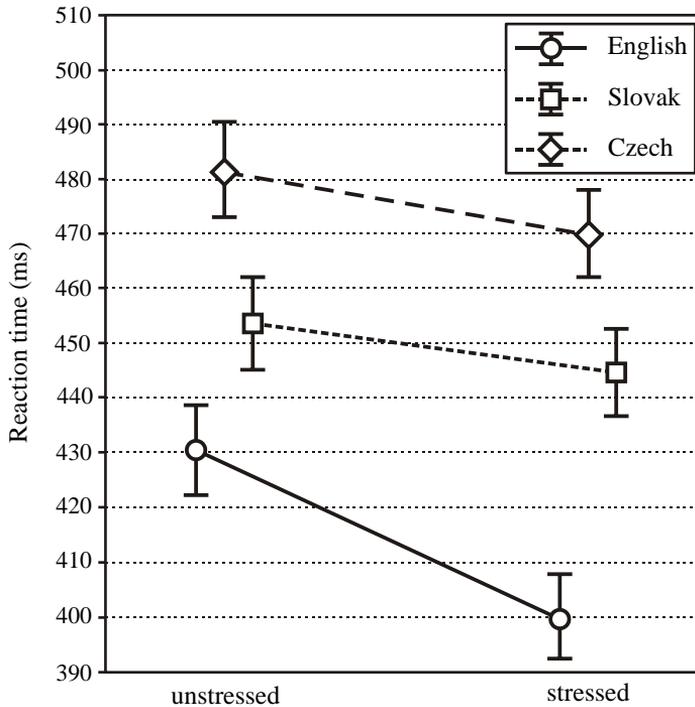


Figure 3: Mean reaction times of the three listener groups to words with stressed initial vowel (on the right) and with unstressed initial vowel (on the left).

The last variable we tested was that of *manipulation*. Our set of 96 items consisted of 48 instances of natural production of glottalization or natural linking (24+24). The other half of the test items had glottal stop either edited out or added (again 24+24). Although the manipulated items did not exhibit any consciously perceivable artefacts, we wanted to know whether there was any difference in reaction times to them. Figure 4 shows that manipulation indeed matters and there is even highly significant interaction between this variable and glottalization: $F(1, 3734) = 144.6$; $p < 0.001$. The items in which glottal stops were edited out behaved in the same way as the analogical natural items, but the items where the glottal stop was added led to slower reactions compared with items where glottal stop was naturally present. This result is discussed below.

4. Discussion

The presence or absence of the glottal element before a word-initial vowel influences the perceptual processes in all three language groups. However, our new group of listeners – the Slovaks – did not produce results similar to the Spanish sample we investigated previously. Although the Slovak listeners should differ from the Czech ones in the same direction as the Spanish, they did not produce a similar effect, they did not differ significantly from the Czech listeners. A possible explanation is that mutual contacts of

Czechs and Slovaks which are, for instance, reflected in the fact that they do not have to learn each other's language and still understand each other without difficulties, overrule the influence of the native language on the perception of a facultative prosodic marker like the glottal stop before a word-initial vowel. Perhaps the Spanish, who should be using glottalization similarly to the Slovaks, interact less with speakers of languages where glottalization is common. (The French, for example, are known to link words very consistently without glottalizing the onsetless syllables.) Another explanation could be that despite the traditional descriptions in grammar books the younger generation of Slovaks uses more glottal stops than the older generations used to. This possibility is supported by our informal observation but has to be verified empirically.

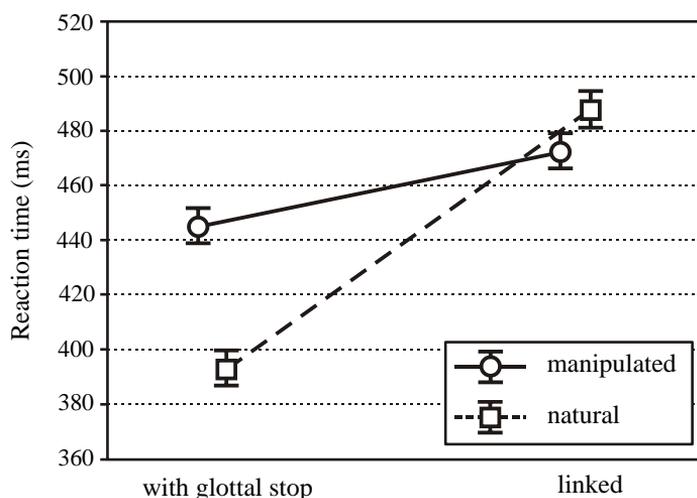


Figure 4: Mean reaction times of the listeners to words with (on the left) and without (on the right) the word-initial pre-glottalization according to the manipulation status of the item.

The general effect of stress confirms the expectations based on the earlier work of other researchers, but smaller impact of stress on Czech and Slovak listeners is, to our best knowledge, a new empirical finding. However, the effect of the target position in the phrase and the effect of the semantic status of the words were not confirmed. As stated above, we assume that the semantic unpredictability of the carrier phrases could have caused this result.

On the other hand, we found a significant effect of test item manipulations. Although the phrases with added glottal stops displayed no obvious acoustic artefacts, they produced longer reaction times than items with naturally present glottalizations. We believe that this finding underlines the importance of inherent stress patterns of a language, whose alterations leads to the increase in processing load (*cf.* Buxton, 1983).

Acknowledgment

The research was supported by the internal grant of the Faculty of Arts, Charles University in Prague. The authors would also like to thank to M-P. Bissiri who, as the

intern at the Institute of Phonetics in Prague at the time of the initial stages of the study, collected some of the data.

References

- Bissiri, M. P., Lecumberri, M. L., Cooke, M. and Volín, J. 2011. The Role of Word-Initial Glottal Stops in Recognizing English Words. In: *Proceedings of the 12th Annual Conference of ISCA Interspeech*: 165-168. Florence: ISCA.
- Buxton, H. 1983. Temporal predictability in the perception of English speech, In: A. Cutler and D. R. Ladd Eds.) *Prosody: Models and Measurements*: 111-121. Berlin: Springer-Verlag.
- Cruttenden, A. 1994. *Gimson's Pronunciation of English*. London: Edward Arnold.
- Dilley, L. Shattuck-Hufnagel, S. and Ostendorf, M. 1996. Glottalization of word-initial vowels as a function of prosodic structure. *Journal of Phonetics* 24: 423-444.
- Forster K.I. and Forster, J.C. 2003. DMDX: A Windows display program with millisecond accuracy. *Behavior Research Methods, Instruments, & Computers*, 35/1: 116-124.
- Gordon, M. and Ladefoged, P. 2001. Phonation types: a crosslinguistic overview. *Journal of Phonetics* 29: 383-406.
- Hawkins, S. 2003. Roles and representations of systematic fine phonetic detail in speech understanding. *Journal of Phonetics* 31: 373-405.
- Kilborn, K. and Moss, H. 1996. Word Monitoring. *Language and Cognitive Processes* 11/6: 689-694.
- Kohler, K. 1994. Glottal stops and glottalization in German. *Phonetica* 51: 38-51.
- Local, J. 2003. Variable domains and variable relevance: interpreting phonetic exponents. *Journal of Phonetics* 31: 321-339.
- O'Connor, J.D. 1980. *Better English Pronunciation*. 2nd Edition. Cambridge: CUP.
- Przedlacka, J. and Ashby, M. 2011. Acoustic correlates of glottal articulations in Southern British English. In: *Proceedings of ICPhS XVII*: 1642-1645. Hong Kong: IPA.
- Redi, L. and Shattuck-Hufnagel, S. 2001. Variation in the realization of glottalization in normal speakers. *Journal of Phonetics* 29: 407-429.
- Schwartz, G. 2011. Final devoicing in Polish English: Segmental or prosodic error? *Presentation at Accents 2011*, Lodz: UoL.
- Wells, J.C. 1990. *Longman Pronunciation Dictionary*. Harlow: Longman.