A NOTE ON LARYNGEAL PULSING IN (SOME) VOICED STOPS

Kemmonye C Monaka
University of Botswana
Department of English
monaka@ub.ac.bw

Abstract
This paper presents an objective depiction of pulsing of the vocal folds during the production of voiced sounds in a language. The depiction is made by means of the electro-laryngograph, an equipment which non-invasively monitors vocal fold activity and provides detailed presentation of the delicate activity of the vocal folds during speech. With regard to learning and teaching, the paper briefly mentions how information derived from the electro-laryngograph can be valuable in teaching corrective vocal pathology and also to people interested in learning foreign languages.

Keywords: voiced sounds, the larynx, the laryngograph, resonance, the oral cavity

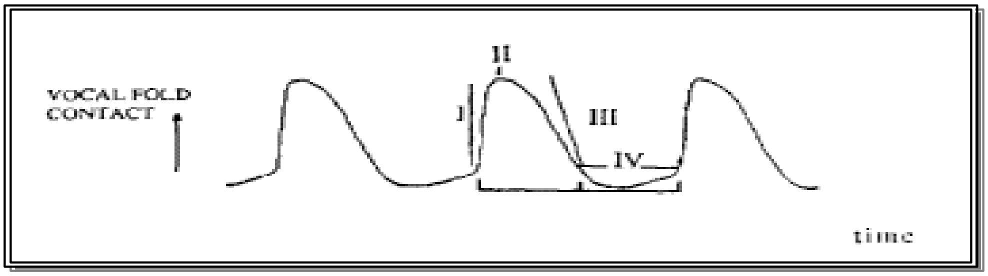
Introduction
The voicing structure of some of the languages of the world has been determined on the basis of subjective auditory-impressionistic methods. These sounds can be studied objectively by inspecting vocal fold behaviour during their production using the electro-laryngograph (Zielińska & Brzdęk, 2015), a device which non-invasively provides indirect observation of vocal fold activity by means of two gold-plated guard-ring electrodes placed lightly on the skin on each side of the neck (Fourcin & Abberton, 1971). Consider Fig. 1

Figure: 1: The laryngograph processor

Source: rose-mediacl.com

The gold-plated guard ring electrodes detect electric signal[1] when the vocal folds are in contact, and register an output waveform of the laryngograph, (Lx), which appears in the form of traces. The waveform plots the varying electric flow between the electrodes as a function of time. A hypothetical Lx waveform is shown in Figure 2.

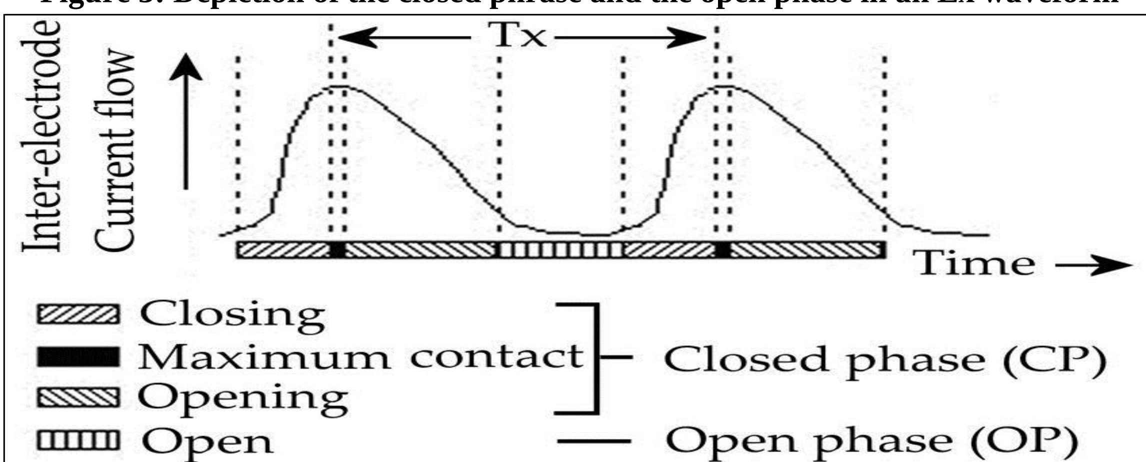
Figure 2: A hypothetical Lx waveform



Source: Abberton et al. (1989, p.285)

Each trace represents a single vibratory cycle and has four phases in modal phonation. There is the closing phase (I) which is typically marked by a generally steep, upward deflection. Then there is maximum contact (II) when the vocal folds are fully shut. The third phase is the opening phase (III) which is typically shown by a relatively gradual slope. The last phase is the open phase (IV) when the vocal folds are fully open. Phases I through III together constitute the closed phase (CP) since these parts of a cycle all have some measure of contact between the vocal folds. Phase IV represents the open phase (OP) since there is no contact between the vocal folds at this point (Abberton et al. 1989). Consider Figure 3.

Figure 3: Depiction of the closed phrase and the open phase in an Lx waveform



Source: Howard (2007, p. 3)

[1] The amount of electricity passing through the vocal folds is very small.

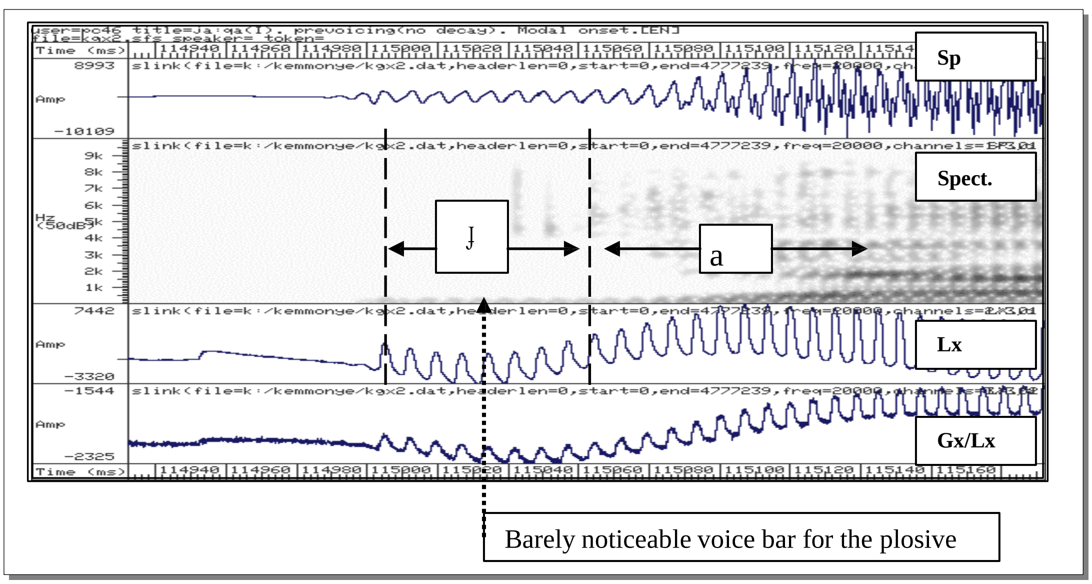
Voiced sounds are depicted by the presence of Lx traces in a waveform. The absence of traces in the Lx output indicates that there is no vibration of the vocal folds and thus that the sound being articulated is voiceless.

2.0 Some observations on pulsing for some Shekgalagari voiced plosives

A laryngograph was used to study the voicing structure of Shekgalagari plosives which had only been described on the basis of auditory-impressionistic methods. The study produced four signals being the Gx which monitors gross displacement of the larynx in speech and additionally depicts vocal fold activity (Gx/Lx), the Lx signal for vocal fold activity (Lx) and the acoustic signals: the spectrogram (Spect) and the speech pressure waveform (Sp). The focus here will be on the Lx signal only and its depiction of voicing with particular focus on the voiced plosives.

The plosives under study were produced in word-initial position in a token said in isolation and within a carrier sentence. Two types of waveforms were obtained when the token containing the plosive was said in isolation. In the first type of waveform voicing was observed throughout the stop occlusion. This is shown in Figure 4.

Fig. 4: Continuous voicing during the occlusion for the voiced palatal plosive [ɟ]

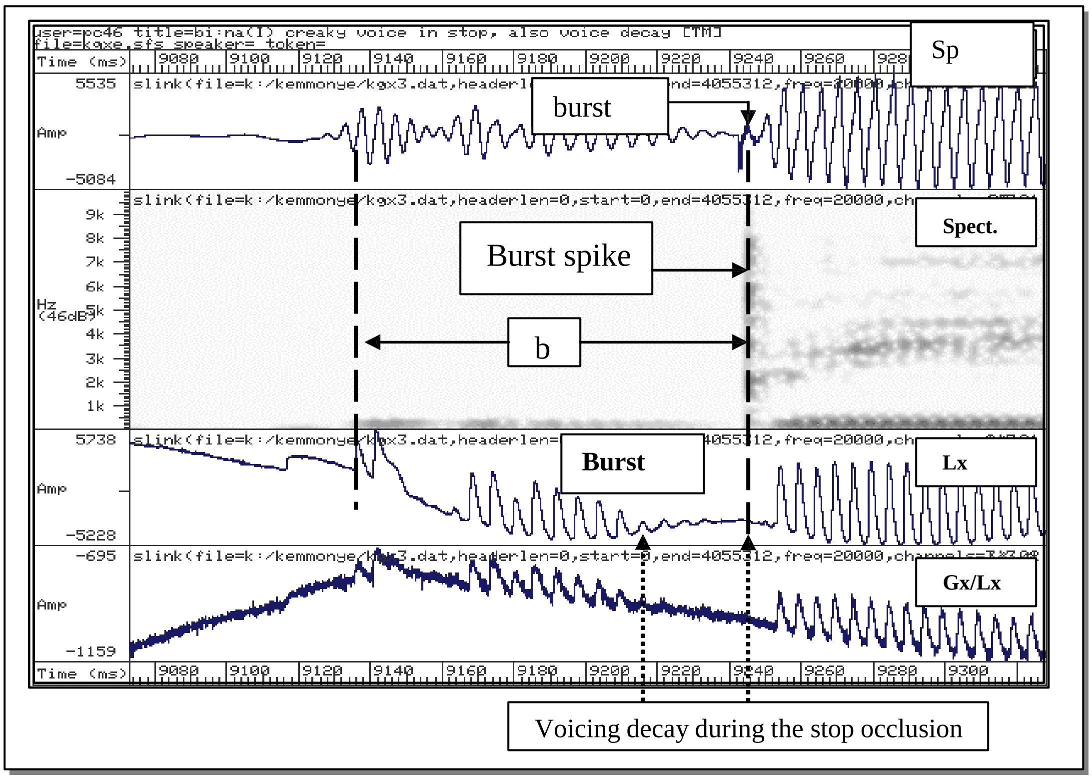


Note: the position of the stop burst indicating the end of the stop was determined by means of playback.

It can be seen from Figure 4 that the mode of voicing was regular as indicated by rising steepness of the Lx, with the closing phase being more rapid than the opening downward slope. The cycles are also periodic. It can further be seen that voicing continues throughout the stop constriction and into the vowel.

In the second type of waveform irregular voicing and voicing decay was observed towards the end of the stop occlusion. This is shown in Figure 5.

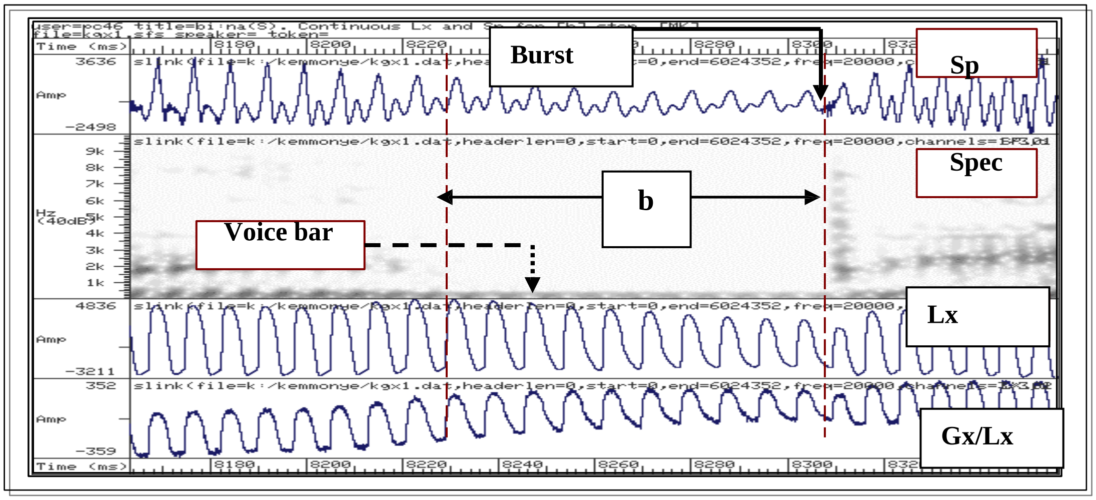
Fig. 5: Irregular voicing and voicing decay during the closure for the voiced plosive [b]



Irregularity in the voicing of the stop is noted in the shapes of the Lx traces which are different in shapes and sizes, and voicing decay is observed in the traces dying out towards the end of the period corresponding to the plosive. Unlike in Figure 4, here, voicing during the stop occlusion is clearly not continued into the vowel because glottal pulsing gradually declines and eventually dies out before the burst is released.

Within a carrier sentence regulation phonation was observed during the stop closure and continued into the vowel. Consider Figure 6.

Figure 6: Continuous voicing during the occlusion for the voiced plosive [b] in a carrier sentence



In Figure 6, modal phonation is again observable in the shapes of the Lx traces which are considerably regular from cycle-to-cycle. The reduction of the sizes of the traces towards the end of the stop can be explained in aerodynamic terms, where the amount of air from the lungs is considered diminishing leading to traces with smaller amplitude.

Implications for Learning and Teaching

Since Lx provides a clear depiction of contact, opening and open phases of vocal folds, it can provide detailed information for various types of voice or registers: breathy voice, creaky voice, falsetto, normal voice, etc. It thus provides reliable information in cases where there is abnormality of vocal pulsing. Information derived from the Lx can further be valuable in diagnosing vocal pathology. The information can also be valuable to people interested in learning foreign languages. Target Lx waveforms can be displayed on the monitor for the patient or language learner, and they can compare their own waveforms to the target waveform and make corrective adjustments (Abberton & Fourcin, 1997). In the process, hearing disorders can also be addressed.

Conclusion

This article presented a brief discussion of vocal fold pulsing in the production of voiced sounds, with particular focus on some Shekgalagari plosives. The study was made by means of the electro-laryngograph which non-invasively monitors activity in the vocal folds when speech is made. It reported that the laryngograph output showed traces when voice is made, further that in some cases there could be voice decay in sounds that are nonetheless voiced. The article reported that, in regard to learning and teaching, the Lx waveform can be valuable not only in teaching corrective vocal pathology but also for people interested in learning foreign languages.

References

Abberton, E. M. Howard, D., & Fourcin, A. (1989). Laryngographic assessment of normal voice: A tutorial. *Clinical Linguistics and Phonetics*, *3*, 281-296.

Abberton, E & Fourcin, A. (1997). Electropalatography. In M. J. Ball & C. Code (Eds.), Instrumental *Clinical Phonetics* (pp.119-148). Croom Helm: Whurr Publishers

Fourcin, A.J.C. & E. Abberton (1971). First application of a new laryngograph. *Medical and Biological Illustration, 21*, 172-182.

Howard, D. (2007). Larynx closed quotient variation in quartet singing. Paper presented at the 19th international congress on acoustics. Madrid, 2-7 September 2007.

Zielińska, J., & Brzdęk, E., (2015). The application of laryngograph in research of quality of speech signal. The electroglotography method. *Proceedings of the 11th International Conference on Cellular and Molecular Biology, Biophysics and Bioengineering (BIO '15)* Seoul, South Korea September 5-7, (pp. 34-38).