

Relationship between perceived vocal registers and glottal flow parameters

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Professional singers need good control of voice production in modal and in falsetto registers
Sudden register changes = "Break" in the voice

Voice timbre differences between registers occur because of the voice source changes

There is a lack of experimental data regarding the voice source characteristics of registers and their relationship with perceived vocal registers

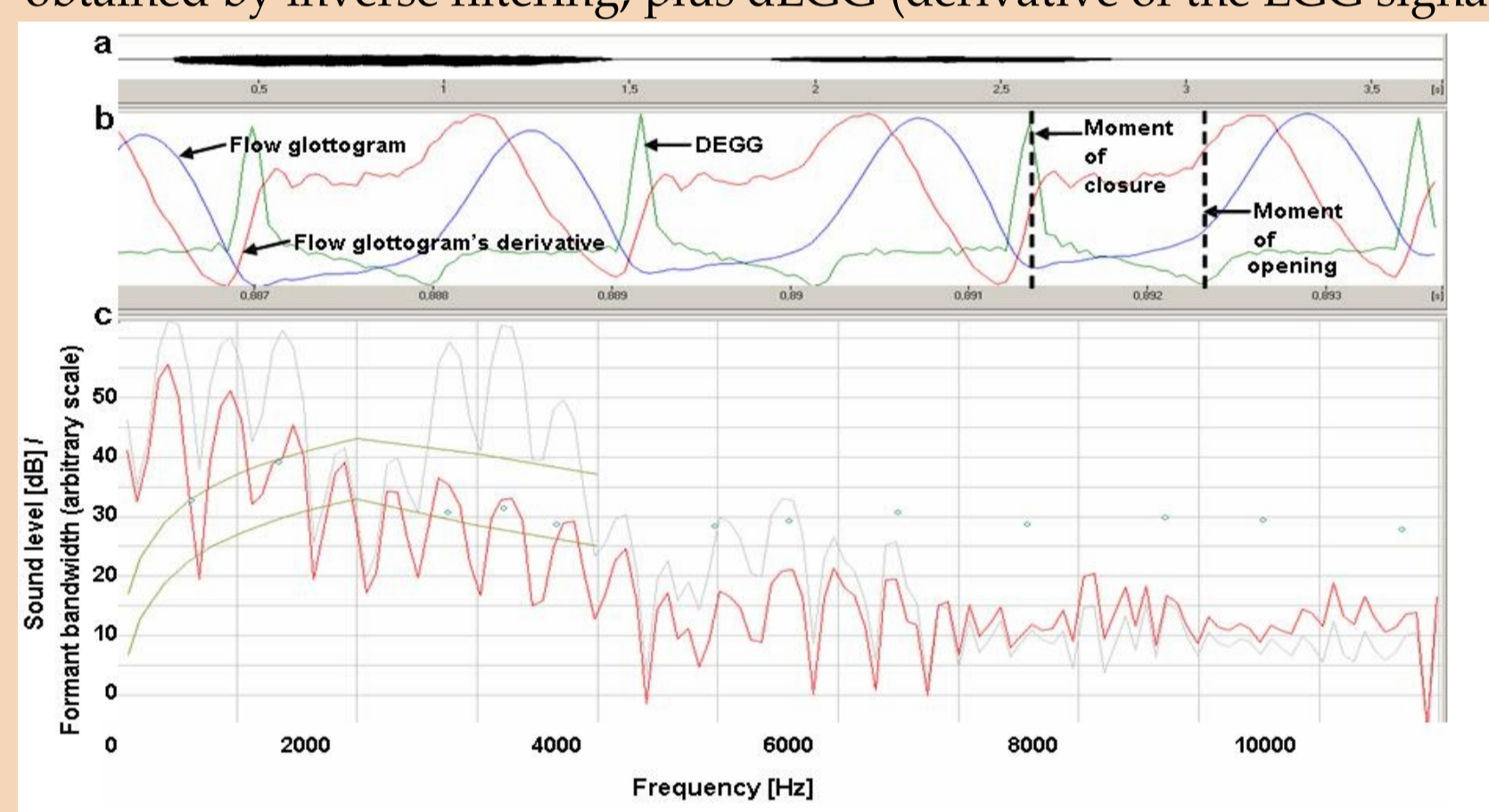
AIM

To compare the perception of modal and falsetto registers with voice source properties.

METHOD

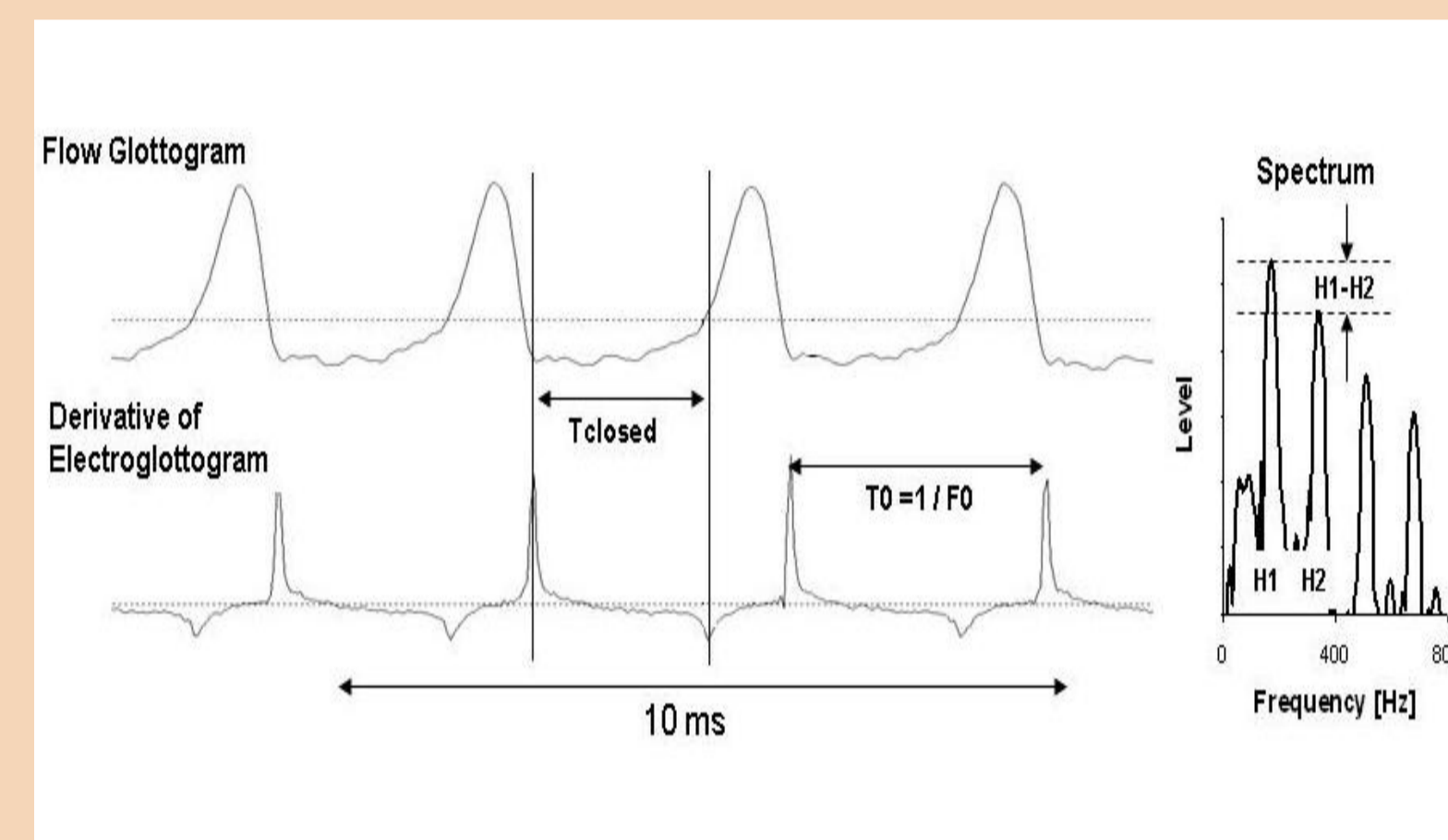
A total of 80 vowel sounds sung by 10 male singers 40 in modal and 40 in falsetto register were analyzed by inverse filtering and electroglottography and classified as modal or falsetto register by sixteen experts. Glottal flow waveform parameters and registers classification were compared.

Waveform and spectrum of voice source obtained by inverse filtering, plus dEGG (derivative of the EGG signal)



Measured Flow Waveform Parameters

- Duration of the closed phase (T_{cl}) and the closed quotient (Q_{closed}), i.e., the ratio between the duration of the closed phase and Period length (T_0)
- The level difference between the two lowest partials ($H1-H2$)

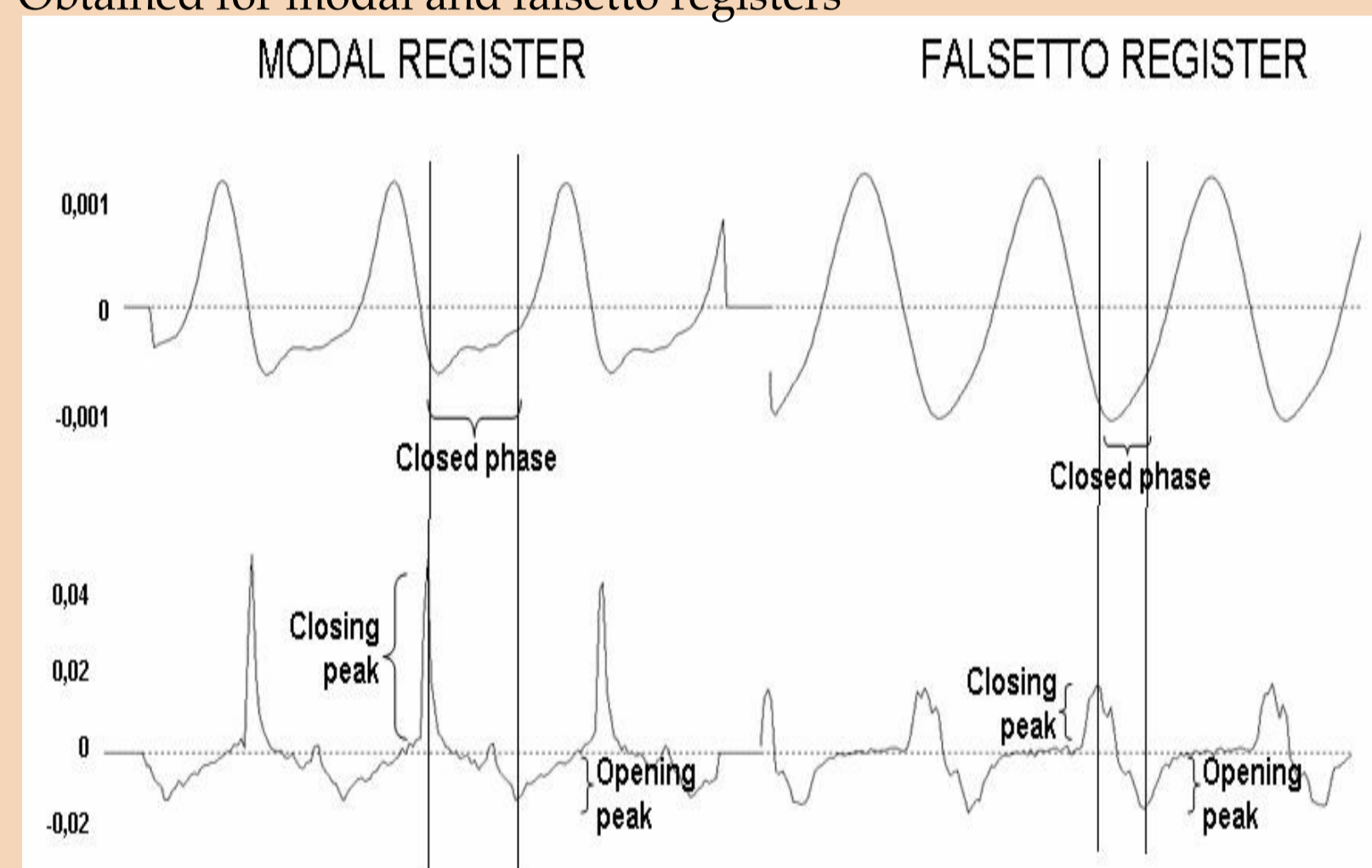


Flow parameter values measured in modal and falsetto registers for the ten singers.

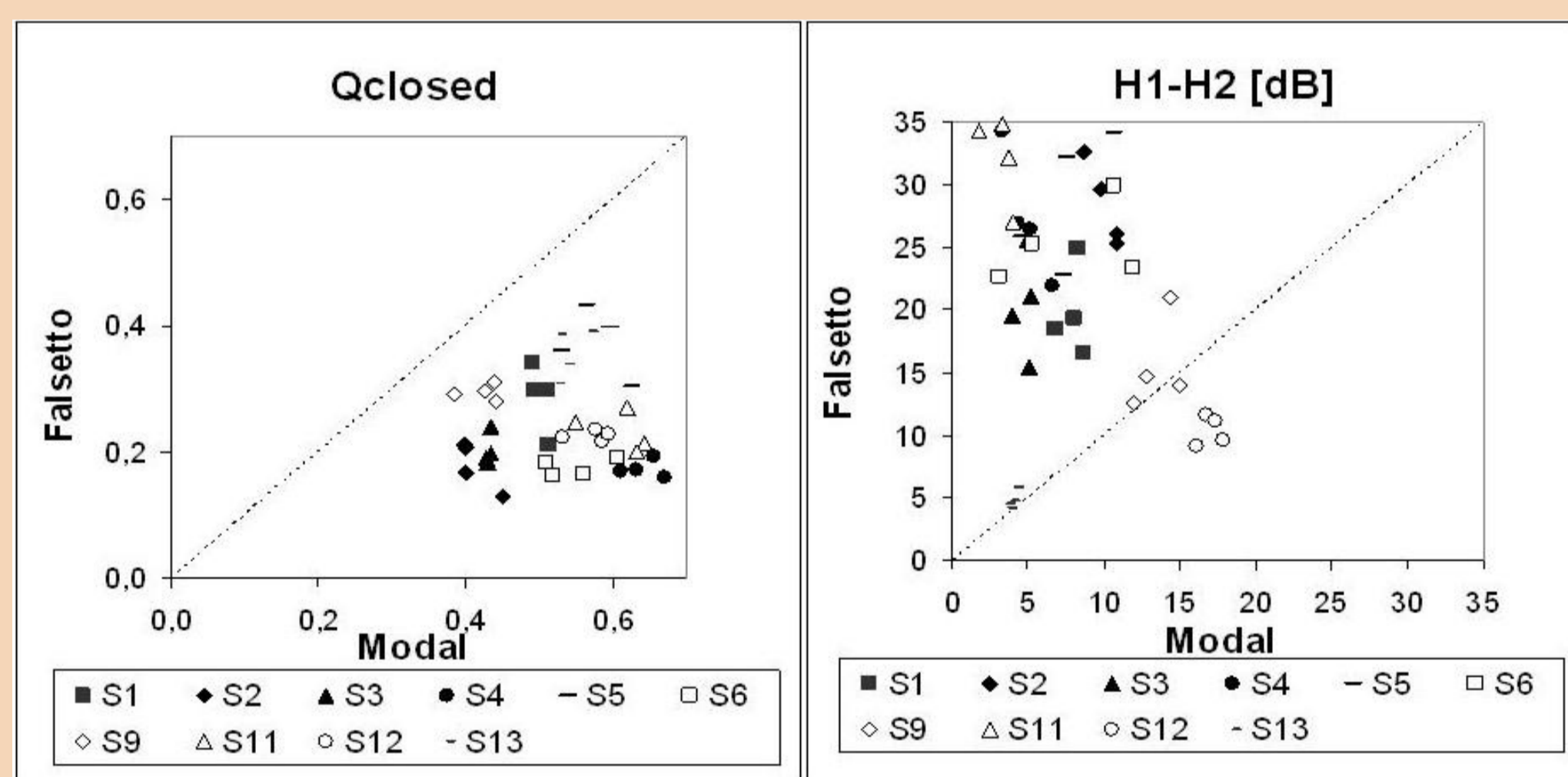
Acoustic Data

RESULTS

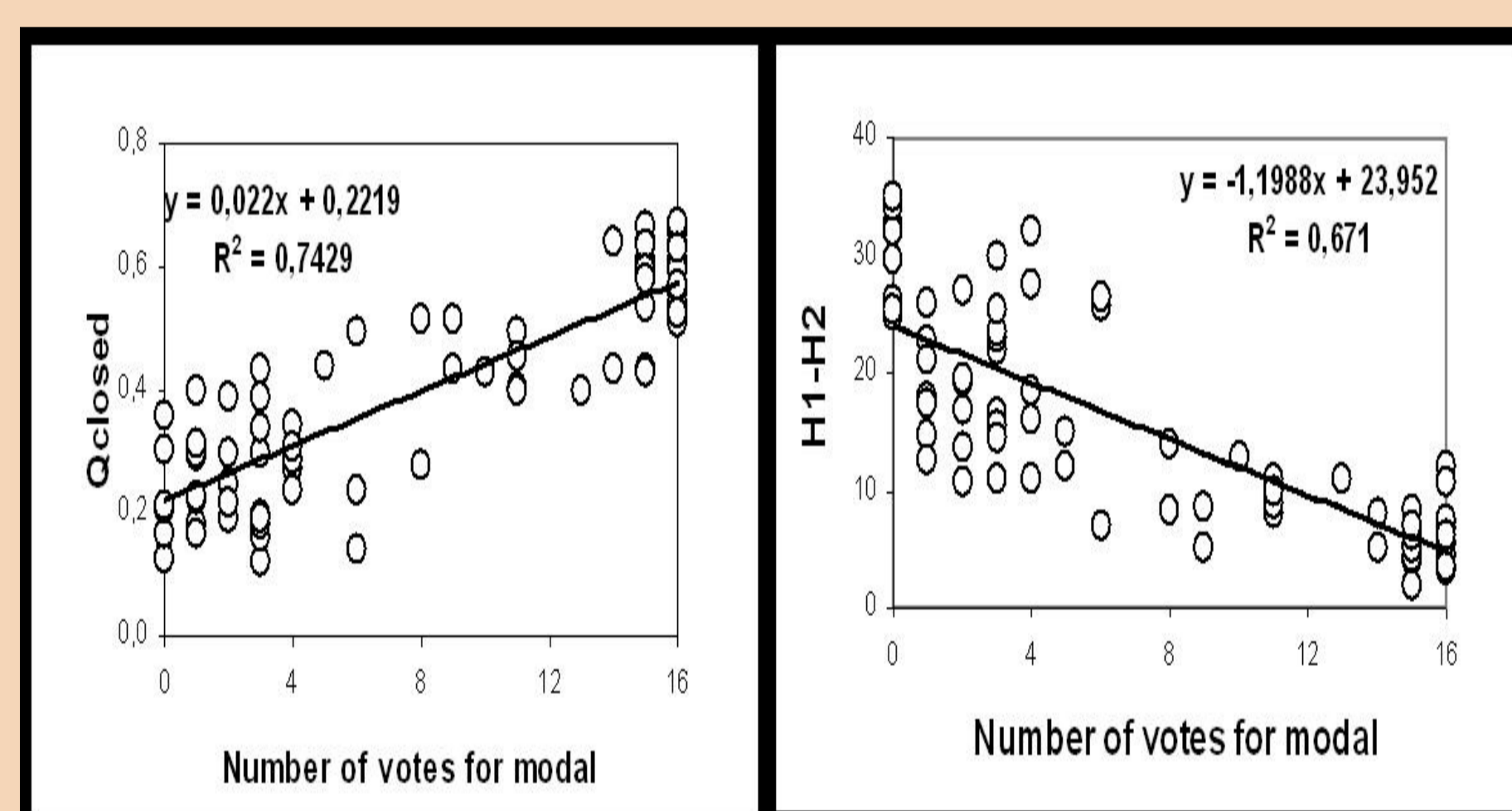
Typical examples of wave forms Obtained for modal and falsetto registers



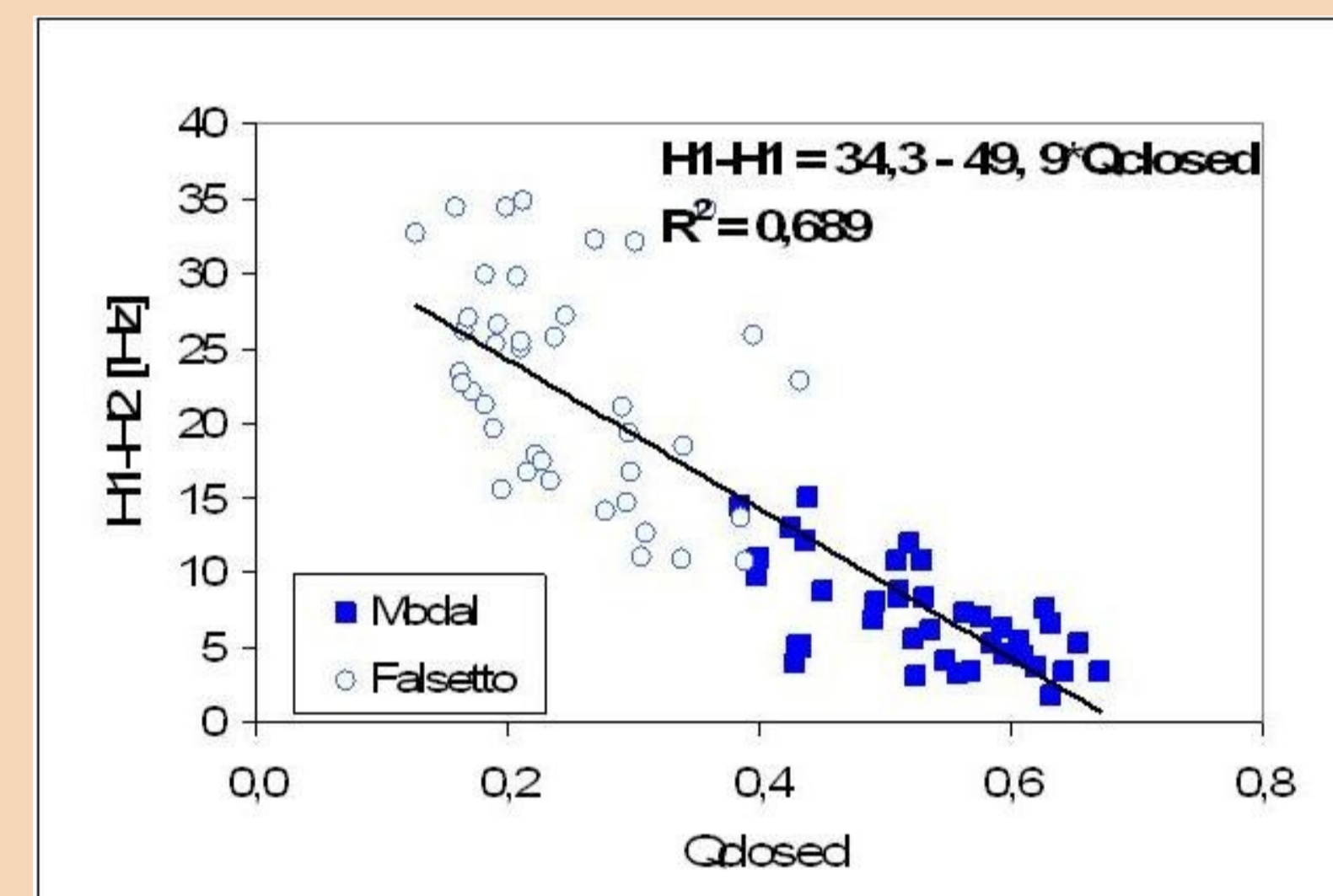
Modal register: clear closed phase + strong positive peak at glottal closing + weaker peak at glottal opening in the dEGG.
Falsetto register: no abrupt change from the closed to the open phase + shorter closed phase + similar dEGG peaks smaller at glottal closing and opening.



Relationships between Classification and Acoustic Data



Q_{closed} and H1-H2 as functions of the number of votes for modal register



Correlation between the Q_{closed} and H1-H2

DISCUSSION

The physiological origin of the observed voice source differences between modal and falsetto registers could be related to the shape and mode of vibration of the vocal folds in both registers. Thin vocal folds should be associated with a smaller time lag between the upper and the lower layers of the folds, resulting in a more symmetrical waveform, typically found in falsetto. By contrast, thick vocal folds with lengthening of the closed phase should be associated with longer time lag between the vocal fold layers, making the waveform less similar to a sine wave, as commonly found in modal register. Thus, the more sinusoidal falsetto waveform would explain why the H1-H2 level difference was much greater in falsetto than in modal and also the correlation between Q_{closed} and H1-H2.

The variation in quantity between voice source properties in the different registers among singers is not surprising, considering that our subjects differed considerably with regard to voice training and experience of singing. On the other hand, quite small voice source differences between registers could result in timbral differences difficult to be perceived.

Indeed, the listening test showed that our singers produced a number of tones that were not unanimously classified as either falsetto or modal registers. In about 20% of the cases nearly half of the judges came up with different classifications, suggesting that the timbral contrast between the two registers was quite substantial in some subjects but rather slight in other subjects.

The cases of disagreement could result from poor skill in voice control. Also, it could be possible that the listeners found it easier to hear that a tone was produced in modal than in falsetto register. A third possibility is that some singers actually used a voice source that combined characteristics of the modal and falsetto registers, varying each of flow glottogram parameters continuously and performing timbral differences between registers by a gradual rather than an abrupt change. This ability would cause the listeners difficulties in their classification.

In any event, our results appear to challenge the idea that modal and falsetto registers are necessarily associated with clear timbral differences, suggesting that category perception of registers is not always feasible.

CONCLUSION

- The modal register presented greater Q_{closed} and less dominant fundamental as compared to falsetto register;
- The tones with a high value of Q_{closed} and low values of H1-H2 were typically associated with high number of votes for modal register, and vice versa;
- The Q_{closed} parameter presented the strongest correlation with the results of the register classification test;
- Some tones were not unanimously classified as neither as modal nor as falsetto, suggesting that classification of registers in terms of perceptual category is not always feasible.

