Focus and Gender Tonal Interactions

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ABSTRACT

This study is an acoustic investigation of Greek intonation as a function of speaker gender (female vs. male) as well as focus production. Five female and five male speakers produced a set of sentences with no specific focus as well as variable focus distribution. The results indicate that female tonal production is on the average about 60% higher than male tonal production. The effect of focus distribution has both local and global tonal correlates but there is no significant interaction between gender and focus in the logarithmic data.

1. INTRODUCTION

The present study is an acoustic investigation of Greek intonation as a function of speaker gender, i.e. female vs. male, and focus, i.e. neutral vs. initial and final focus. The main question thus concerns two aspects of tonal production, i.e., first, a fairly physiological aspect with reference to female and male tonal production and, second, a sociolinguistic aspect with reference to female and male tonal production as a function of focus.

Female intonation is usually higher than male as a result of different laryngeal sizes between female and male speakers. Beyond this general physiologically-determined tonal production very little is known with reference to female and male tonal variations across different languages as well as the interactions between gender distinctions and prosodic categories. The present study is an attempt to produce new knowledge in this area which may also enlighten linguistic typology as well as sociolinguistic variation of prosodic distinctions.

Usually, focus has both local and global acoustic correlates in many languages, including Greek ([1], [2], [3]. The local correlates are related to lexical prosodic categories, i.e. stress. In Greek, a stressed syllable of the focus domain is locally correlated with an expansion of the tonal range whereas the global correlates extend beyond the domain of lexical level and encompass the entire prosodic phrase. The global tonal range is thus fairly compressed, as a rule, and this is most evident on the right of the local realization of focus ([1]). In a recent study on tonal perception in Greek and Swedish, where tonal correlates of focus productions were manipulated and resynthesised, both local and global tonal correlates showed significant effects in focus perception [4].

2. EXPERIMENTAL PROCEDURES

The speech material consists of the test sentence *Mona went to Monaco* in Greek, i.e. /i mona pige sto monako/ in Greek. The test sentence was produced in three different ways, i.e. fairly neutrally or with alternative focus in *Mona* and *Monaco*. The neutral production had no context whereas the focus productions were preceded by a question which elicited focus on either *Mona* or *Monaco*, i.e. *who went to Monaco*? and *where did Mona go*?

Ten native speakers, five female and five male students in Athens, Greece, produced the test material in ten repetitions. The speakers had oral instructions to produce the speech material in three different ways, i.e. in accordance with the linguistic context and focus distribution, in one coherent utterance, at a normal tempo.

The speech material was directly recorded on computer disk and was analysed with Waveserfer ([5]). Measurements were taken at (1) *tonal onset*, (2) *peak Mona F0*, (3) *peak Monaco F0,* and *tonal offset*. Statistical t-tests and ANOVA analysis were carried out with StatView ([6]) and the results are presented in the following section.

3. RESULTS

The results are presented in Table 1 as well as Figures 1-6. Table 1 shows the mean female and male tonal productions and in the last column the ratio between the two which varies from 1.55 to 1.66 with reference to measurements of tonal onset, peak Mona F0, peak Monaco F0 and tonal offset. Paired t-tests showed highly significant differences among all four points of measurements (at 0.0001 level).

Table 1. Female and male data (Hz) as well as ratio of tonal onset, peak Mona F0, peak Monaco F0 and tonal offset.

	Female	*Male*	*Ratio*
Onset	191.0	115.0	1.66
Mona	219.0	141.0	1.55
Monaco	207.0	127.0	1.62
Offset	157.0	97.0	1.61
Total	193.5	120.0	1.61

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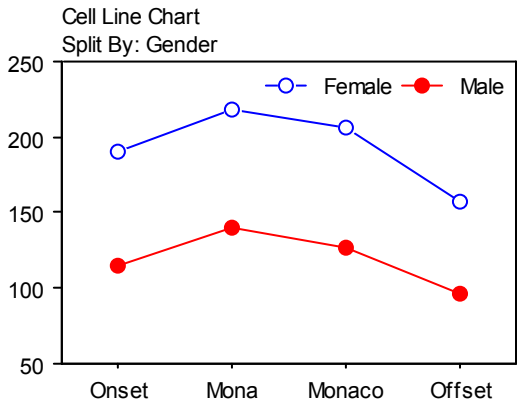

Figure 1a. Linear data of tonal onset (Onset), peak Mona F0 (Mona), peak Monaco F0 (Monaco) and tonal offset (Offset) as a function of female and male tonal production.

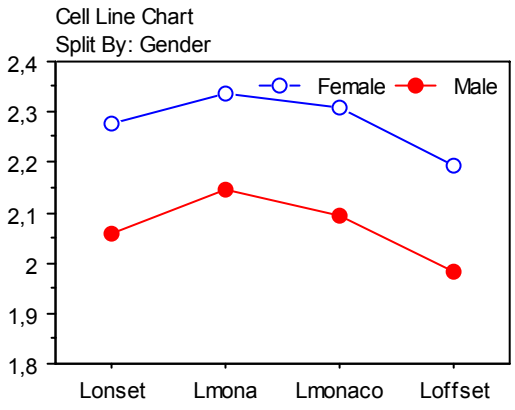

Figure 1b. Logarithmic data of tonal onset (Lonset), peak Mona F0 (Lmona), peak Monaco F0 (Lmonaco) and tonal offset (Loffset) as a function of female and male tonal production.

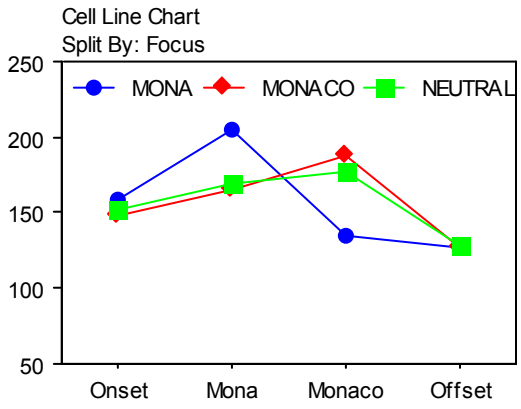

Figure 2a. Linear data of tonal onset (Onset), peak Mona F0 (Mona), peak Monaco F0 (Monaco) and tonal offset (Offset) as a function of focus distribution (see text).

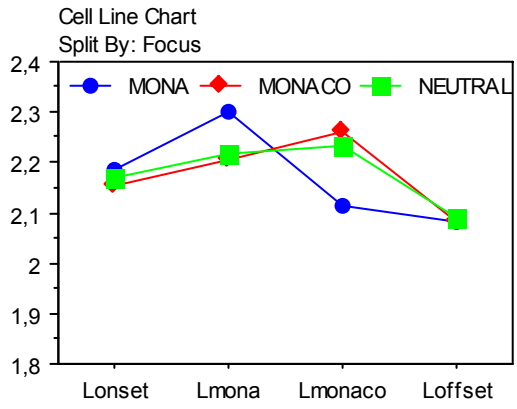

Figure 2b. Logarithmic data of tonal onset (Lonset), peak Mona F0 (Lmona), peak Monaco F0 (Lmonaco) and tonal offset (Loffset) as a function of focus distribution (see text).

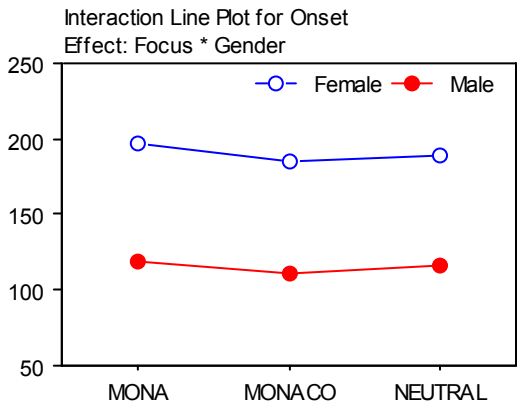

Figure 3a. Linear data of tonal onset as a function of focus (capital letters) and gender (female vs. male) tonal production.

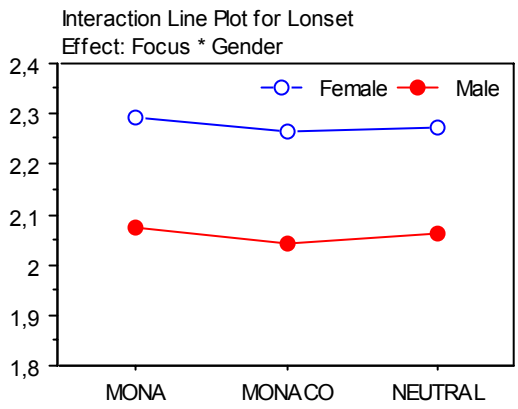

Figure 3b. Logarithmic data of tonal onset as a function of focus (capital letters) and gender (female vs. male) tonal production.

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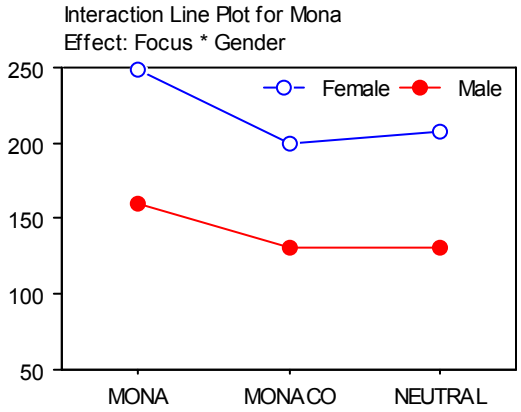

Figure 4a. Linear data of peak Mona F0 as a function of focus (capital letters) and gender (female vs. male) tonal production.

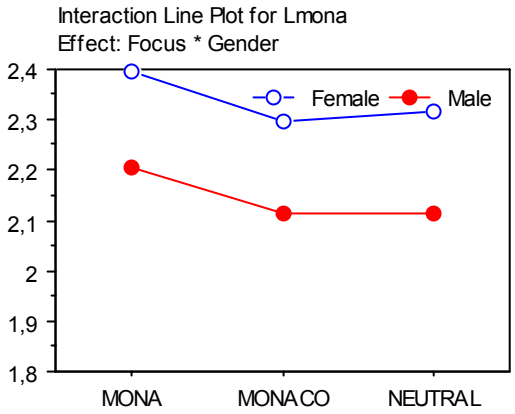

Figure 4b. Logarithmic data of peak Mona F0 as a function of focus (capital letters) and gender (female vs. male) tonal production.

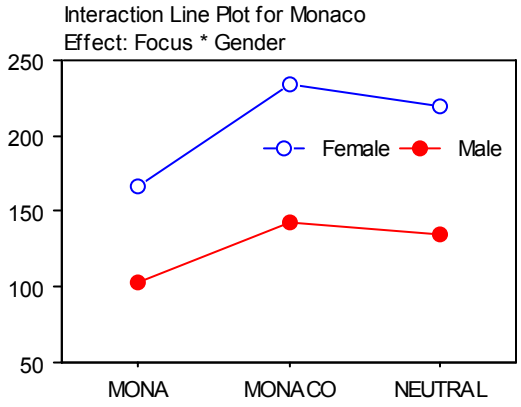

Figure 5a. Linear data of peak Monaco F0 as a function of focus (capital letters) and gender (female vs. male) tonal production.

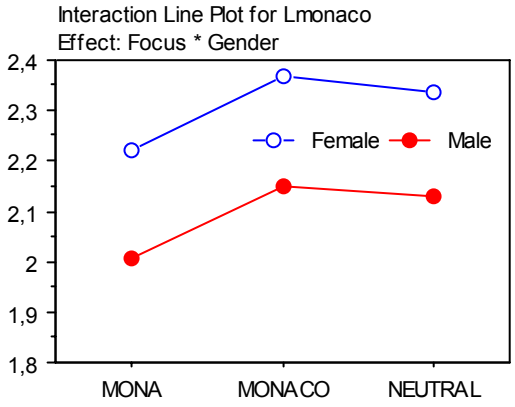

Figure 5b. Logarithmic data of peak Monaco F0 as a function of focus (capital letters) and gender female vs. male) tonal production

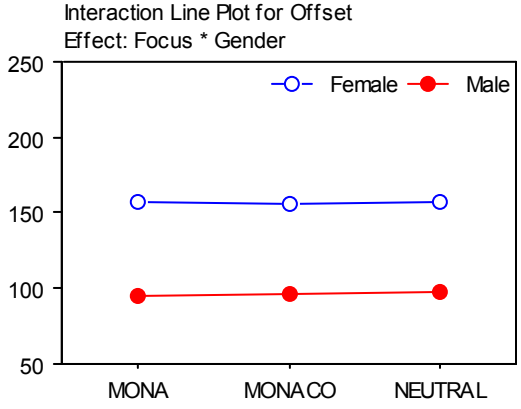

Figure 6a. Linear data of tonal offset as a function of focus (capital letters) and gender (female vs. male) tonal production.

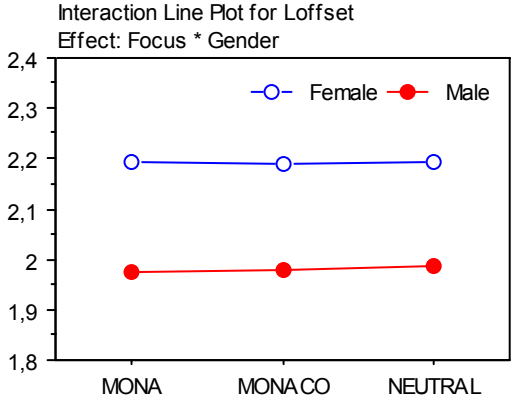

Figure 6b. Logarithmic data of tonal offset as a function of focus (capital letters) and gender (female vs. male) tonal production.

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Figure 1 shows linear data of the speech material on the left (fig. 1a) and logarithmic data on the right (fig. 1b), as a function of female and male tonal production (see also table 1). There is an anathetic tonal structure from tonal onset onto the stressed syllable of Mona, whereas the opposite structure, i.e. a catathetic one, is evident from Mona onto the stressed syllable of Monaco and a further tonal lowering from Monaco to tonal offset. As mentioned above, all four measurement points reach a high significant level.

Figure 2 shows linear data of the speech material on the left (fig. 2a) and logarithmic data on the right (fig. 2b), as a function of focus production, i.e. neutral, Mona-focus and Monaco-focus. The neutral production as well as the Monaco-focus production have fairly similar structures, with right tonal dominance, whereas the Mona-focus production has a local tonal range expansion in combination with a postfocus deaccentuation.

Figure 3 shows linear data on the left (fig. 3a) and logarithmic data on the right (fig. 3b) of tonal onset, as a function of focus and gender tonal production. ANOVA showed significant effects for both focus ($F=8.6$, $p<0.0002$) and gender ($F=1497.2$, $p<0.0001$), but no significant interaction between the two. Scheffe's post-hoc tests were significant between Mona-focus and Monaco-focus ($p<0.0002$) as well as between Mona-focus and neutral ($p<0.04$) but not between Monaco-focus and neutral. Both linear and logarithmic data had the same results.

Figure 4 shows linear data on the left (fig. 4a) and logarithmic data on the right (fig. 4b) of peak Mona F0, as a function of focus and gender tonal production. ANOVA showed significant effect of focus ($F=175.2$, $p<0.0001$) and gender ($F=1710.7$, $p<0.0001$) as well as significant interaction between the two ($F=8.7$, $p<0.0002$) for the linear data. The logarithmic data showed fairly the same effect for gender and focus but no significant interaction.

Figure 5 shows linear data on the left (fig. 5a) and logarithmic data on the right (fig. 5b) of peak Monaco F0, as a function of focus and gender. ANOVA showed significant effect of focus ($F=291.0$, $p<0.0001$) and gender ($F=1753.8$, $p<0.0001$) as well as significant interaction between the two ($F=18.1$, $p<0.00021$ for the linear data. The logarithmic data showed fairly the same effect for gender and focus but no significant interaction between the two.

Figure 6 shows linear data on the left (fig. 6a) and logarithmic data on the right (fig. 6b) of tonal onset, as a function of focus and gender tonal production. ANOVA showed significant effects for gender ($F=839.6$, $p<0.0001$), but not for focus. There was no significant interaction. Both linear and logarithmic data had fairly the same results.

In summary, the results of the present study indicate that focus has both local and global effects whereas female tonal production is about 60% higher than male one. One interesting aspect is however the tonal onset, which may also be a tonal correlate of focus production. Another interesting aspect is the differences in the statistic analysis between the linear and the logarithmic data, especially with regards to the interactions between focus and gender: significant interactions of the linear data were neutralised in the logarithmic data.

4. CONCLUSIONS

The results of the present investigation indicate that female tonal production is on the average about 60% higher than male tonal production. The production of focus has both local and global tonal effects, which may be evident even at tonal onset, but there is no significant interaction between gender and focus in the normalised data.

REFERENCES

[1] A. Botinis, *Stress and Prosodic Structure in Greek*, Lund University Press, 1989.

[2] A. Botinis, B. Granström and B. Möbius, "Developments and paradigms in intonation research", *Speech Communication* 33, 263-296, 2001.

[3] D. Hirst and A. Di Cristo, *Intonation: A survey of Twenty Languages*, Cambridge University Press, 1998.

[4] A. Botinis, R. Bannert and M. Tatham, "Contrastive tonal analysis of focus perception in Greek and Swedish", in A. Botinis (ed.), *Intonation: Analysis, Modelling and Technology*, Dordrecht: Kluwer Academia Publishers, 2000.

[5] K. Sjolander and J. Beskow, *WaveSerfer*, http://www.speech.kth.se/wavesurfer/, 2003.

[6] *StatView software*, Version, 5.01, SAS Institute, Cary, NC, USA, 1998.