Methodological Perspectives on Second Language Prosody

Papers from ML2P 2012

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edited by
Maria Grazia Busà, Antonio Stella

cleup

Prima edizione: novembre 2012

ISBN 978 88 6129 937 5

Coop. Libraria Editrice Università di Padova
Via Belzoni – 118/3 – Padova (Tel. 049/650261)
www.cleup.it

ARTICULATORY TIMING OF TONES IN L2 GERMAN INTONATION

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ABSTRACT

This study aims at analyzing the differences in the alignment of pitch accents in Italian and German, as produced by native Italian speakers from Lecce area (South Italy) with different competence of L2 German. The pitch accents under investigation are produced in initial position in contrastive focus sentences and are realized differently in the two languages. The alignment of the tonal targets is explored from an articulatory point of view, exploiting acoustic and articulatory data of native and non-native productions acquired by the 3D Electromagnetic Articulograph (Carstens AG500). In this paper some results are presented, which show that the correct alignment of the tones with the articulatory gestures is performed only by the speaker with a high competence level, who aligns the tones as the German native speaker does. Moreover, the analysis of alignment from an articulatory point of view seems to show extremely stable patterns for evaluating the anchoring of the tones with the segmental material.

Keywords: Tonal alignment, articulatory timing, L2 intonation, German, Lecce Italian.

1. INTRODUCTION

The degree of influence of the native phonetic/phonological system on L2 productions depends on the competence level of the speaker. It plays an important role on the typology and the amount of errors that a speaker could produce. Mennen [6], comparing different investigations on the production of foreign language intonation, identifies a series of features influenced by the L1. She divides them in phonological and phonetic errors. Phonological errors consist in the use of a category instead of another one and stem from intonational differences in the inventory of phonological tunes and in the assigned pragmatic meaning. An example is the use of rises where native speakers would use falls and vice versa. Phonetic errors stem from a difference in the phonetic realization of an identical phonological tune shared by both the native and the target language. Examples of phonetic influences are the use of a different pitch range or of a different slope of a rise.

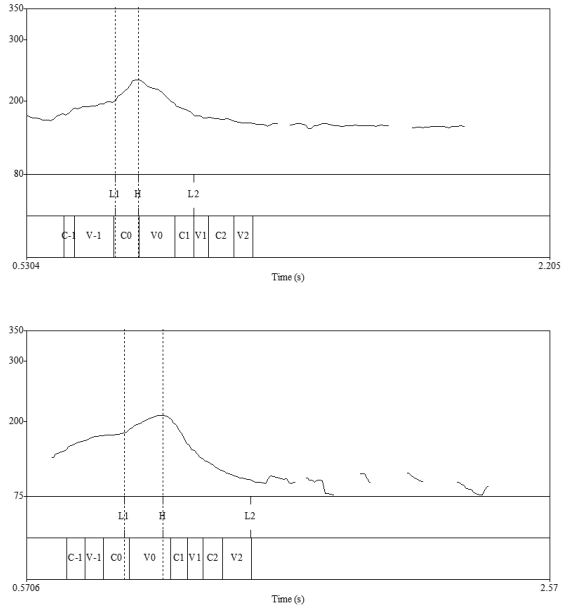
Studies by Ueyama [10] tried to point out that the degree of influence of the native prosodic system on L2 prosody is correlated to the stage of L2 acquisition reached by the speaker. In her results, Japanese speakers of L2 American English acquire phonological characteristics of L2 prosody before the phonetic ones. Furthermore, a correct phonetic implementation of the intonational categories may be reached only by highly competent speakers. It should also be taken into consideration that not all the phonetic features of the L2 could be learned even by speakers with very advanced competence. Mennen [5] shows that very proficient L2 speakers transfer the phonetic characteristics of a pitch accent from L1 to L2, if both intonational systems share the accent (and its pragmatic meaning) and implement it in similar but not identical ways. In this case, the speaker would need specific exercise to acquire the fine phonetic detail and avoid the L1 transfer.

This study analyses the differences in alignment of pitch accents produced in L2 German by speakers of Lecce (South Italy) with different competence of L2 German (low and high). The pitch accents are investigated in sentences with contrastive focus on the initial constituent, which seems to be produced differently in the two languages. In Lecce Italian a rising-falling H*+L accent is exploited [9]: the low target at the beginning of the rise is aligned with the onset of the syllable and the peak is aligned with the onset of the vowel (see Fig. 1, top panel). On the contrary, in Standard German, a rising accent is exploited, labeled as L+H* or L*+H [1, 4]: the first low target occurs immediately before the onset of the tonic vowel and the peak is aligned at the end of the tonic syllable (see Fig. 1, bottom panel).

The hypothesis is that only native Italian speakers with high competence of L2 German are able to align the tonal targets correctly, while speakers with lower competence exploit the native tonal category, transferring the alignment pattern of the pitch accent from the L1 to the L2.

This hypothesis is tested on acoustic and articulatory data, relating the F0 contour with the opening and closing gestures of the articulators involved in the production. The analysis is conducted in the framework of *Articulatory Phonology* [2]. The articulatory analysis of intonation proved useful in the investigation of cross-linguistic differences [3, 7; among others] and seems to highlight more stable results than the acoustical-based investigation.

Figure 1: Productions of the initial accent in narrow-contrastive focus condition by a native Lecce Italian speaker (top panel) and a native German speaker (bottom panel).



2. METHOD

2.1. Corpora

The productions were elicited using two corpora (one per language). Each corpus consists of 4 mini-dialogues of 2 question-answer pairs. Each pair is built in such a way that in the first answer a non-contrastive sentence is produced, while in the second one the same statement is produced with a contrastive pitch accent on the first costituent (see Table 1 for a corpus sample). Thus, the initial pitch accent occurs on a target pseudo-word, specifically created for an articulatory analysis, which consists of sequences of labial or alveolar gestures for the production of [m] or [l], and tongue body gestures for the productions of [i-a] or [a-i] vowels. Each word is interpreted as a proper name stressed on the ante-penultimate ([mi.'ma.li#la]-[mi.'mal.mi#la]) or penultimate ([mi.'ma.li.la]-[mi.'mal.mi.la]) syllable. The accent is expected to be associated with the second syllable [ma] or [mal]. In this paper, only the [mi.'ma.li.la] condition will be discussed. In some cases, references to the closed syllable condition [mi.'mal.mi.la] will be added. A discussion of the whole data set, dealing with the rising tonal gesture, is reported in [8].

Table 1: Examples of the mini-dialogues.

ITA	A: Che cosa è successo? B: La **Mimalila** beve la coca. A: La Mimolila beve la coca? B: No, la **Mimalila** beve la coca.
DEU	A: Was ist los? B: Die **Mimalila** bedeckt die Tische. A: Bedeckt die Mimolila die Tischel? B: Nein, die **Mimalila** bedeckt die Tische.

Each mini-dialogue was presented at random by a monitor placed at 1,5 m distance from the subject. The A sentences of each mini-dialogue, i.e. the questions, had been previously produced by a native speaker and recorded, in order to be reproduced during the experimental session; thus, the subject listened to the question A and answered using the B sentence.

3 speakers participated in the experiments:

- 1LC: M, 19, Lecce Italian speaker with low competence of L2 German: no linguistic certification, no experience in Germany.
- 2HC: F, 25, Lecce Italian speaker with high competence of L2 German: C1 certification, Erasmus experience in Berlin.
- CTR: F, 22, native German speaker from Chemnitz, Erasmus student in Lecce.

2.2. Acoustic and articulatory data

Acoustic and articulatory data were acquired at CRIL Research Centre (Università del Salento, Lecce), using the 3D Electromagnetic Articulograph (AG500 - Carstens) in a quiet and noiseless room. The movements of the oral articulators were tracked exploiting a set of 10 sensors glued as follows (Fig.2):

- 4 sensors on the mid-sagittal plane of the tongue (Fig 2, right);
- 2 sensors at the center of the vermillion border of the lips (Fig 2, left)
- 1 sensor below the lower incisors;
- 1 sensor above the upper incisors + 2 sensors behind the ears (at the basis of the temporal bone), used for the normalization of the head movements.

The acoustic data were labeled with PRAAT, using a two-tier textgrid, where the first tier reports the onset and the offset of each segment of the target word, and the second one reports the onset and offset of both rise and fall of the pitch accent.

As for the articulatory labeling, the data were labeled with the MASSA software, developed at

the CRIL Research Centre, which allows the plotting and the labeling of the position and velocity tracks of each articulator using the AG500 data. All opening and closing gestures involved in the production of the target word were labeled on the vertical displacement tracks of 3 sensors (see Fig. 2):

- LL: lower lip sensor for the production of [m].
- TT: tongue tip sensor for the production of [l].
- TD: tongue body sensor for the production of the vowel gesture, ([i-a] if opening gesture, [a-i] if closing gesture).

112 tokens were labeled for each Italian speaker (4 target words x 2 focus conditions x 7 repetitions x 2 languages) and 56 tokens for the German speaker (4 target words x 2 focus conditions x 7 repetitions).

Figure 2: Sensors glued on the oral articulators. LL, TD, and TT are the ones analyzed.

2.3. Measures and statistical analysis

For each target word, the temporal measures (in ms) of the following landmarks were computed:

- Zero velocity and maximum velocity of each articulatory gesture of LL, TD, and TT;
- Onset and offset of each segment of the word;
- The three tonal targets of the pitch accent.

The lag computation between tonal targets and articulatory landmarks, and the related statistical analysis were performed with a MatLab script, which performs a normalization of all the temporal landmarks of articulatory gestures, segments and pitch accents, to the acoustic onset of the target word. Then, it computes the following means: the duration of each articulatory gesture with the position in time of its peak velocity, the duration of the segments, and the position of the tonal targets. Intervals and points are plotted on a diagram composed of 5 tiers (segments, tones, LL, TD, TT) synchronized with each other in function of time. The articulatory anchor of each tonal target is defined as the nearest articulatory landmark to the target for the three articulators considered. For each anchor found and each articulator, the temporal lag between the anchor and the tonal target is computed (if the lag is positive, the anchor follows the target, and vice versa). A t-test per independent samples is performed separately for each group in order to evaluate the lag between tonal target and articulatory anchor in the repetitions. The lack of a significant difference ($p>.05$) is interpreted as a tendency of the target to align to the anchor found.

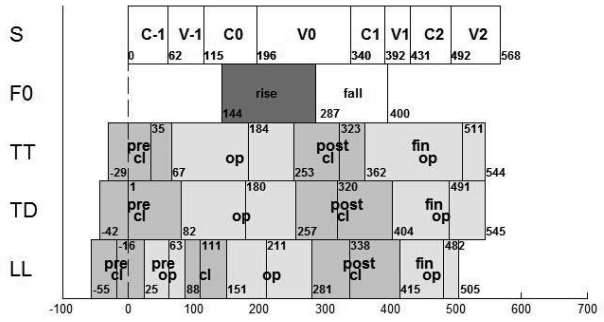
3. RESULTS

Anchors are indicated using a three-parts label. The first indicates the syllable where the gesture occurs (pre=pre-tonic; ton=tonic[1]; post=post-tonic; fin=final), the second refers to the type of gesture (op=opening; cl=closing), and the third refers to the type of landmark (vmin=zero velocity; vmax=peak velocity). The mean lag of the anchor and the *p*-value of the t-test are also indicated.

3.1. Native Italian

In the productions by 1LC (Fig. 3) the rising accent seems to be aligned to the opening gesture of the lips for the release of the occlusion of [m] in tonic syllable. Indeed, the low target is aligned with the maximum closure of LL (ton-cl-vmin; lag=7ms; p=.647) and the peak is aligned with the maximum aperture (ton-op-vmin; lag= -6ms p=.746). The end of the fall seems to be anchored with the end of the [a-i] vowel gesture, when TD reaches the maximum constriction in the oral cavity for the production of the post-tonic vowel (post-cl-vmin; lag= 4ms; p=.844).

Figure 3: Alignment pattern of the native Italian productions by speaker 1LC.

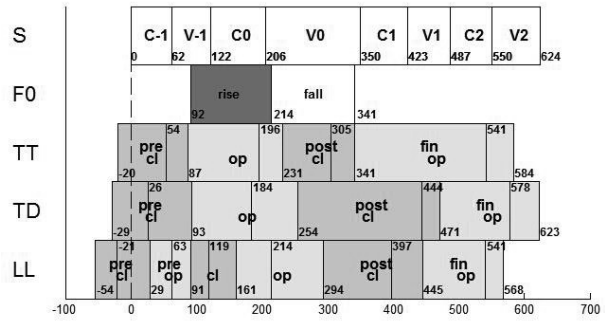


In the productions by 2HC (Fig. 4) the onset of the rise is aligned with the onset of the LL closing gesture, i.e. the maximum labial constriction for [m] (pre-op-vmin; lag=1ms; p=.997) and with the onset of the TD opening gesture (pre-cl-vmin; lag=1ms; p=.963) for the production of the tonic vowel. F0 peak shows a tight alignment with the peak velocity of the LL opening gesture (ton-op-vmax; lag= 1ms; p=.929). Dynamically, the peak velocity point represents the start of the deceleration phase of the articulator when it

[1] In the diagrams the label "ton" is implied.

approaches the target. The offset of the fall shows a tendency to be aligned with the offset of the TT closing gesture (post-cl-vmin; lag = 0ms; p=.997), but this behavior is not attested in all the experimental conditions.

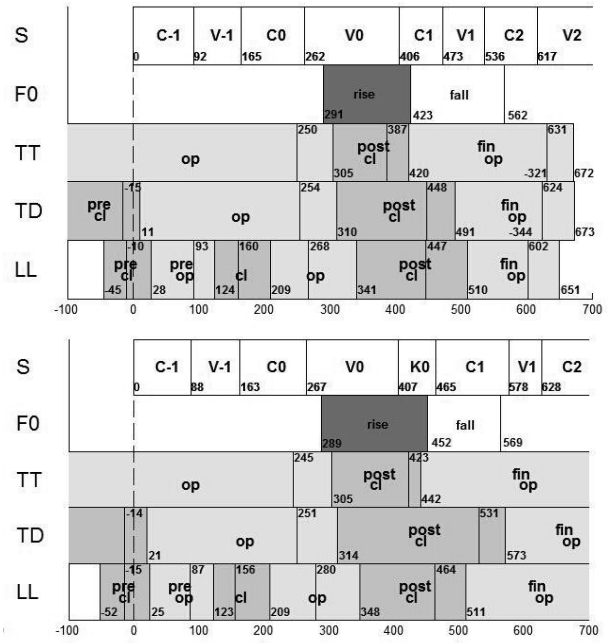
Figure 4: Alignment pattern of the native Italian productions by speaker 2HC.



3.2. Native German

The productions by CTR (Fig. 5, top panel) in native German show a different articulatory alignment with respect to the native Italian productions.

Figure 5: Alignment pattern of native German productions by speaker CTR. Top panel: open syllables; bottom panel: closed syllables.



The rise of the accent seems to be synchronized with the TT constriction gesture for the production of [l] in the post-tonic syllable. In this case, the low target shows wider lag values from the onset of the gesture (ton-op-vmin; lag= 14ms; p=0.044), while the peak seems to be more tightly anchored with the offset (post-cl-vmin; lag= -3ms; p=0.754). The offset of the fall is not aligned at a specific point in the case of open syllables, while in closed syllables (Fig. 5, bottom panel) it seems to be aligned with the TD maximum closure of the post-tonic syllable (post-cl-vmin; lag= 4ms; p=.889), i.e. the maximum constriction for [i] in the [a-i] sequence.

3.3. Non-native German

In the productions by 1LC (Fig. 6), the onset of the rising gesture is aligned with the onset of the LL opening gesture (ton-cl-vmin; lag= -7ms; p=0.479), while the accentual peak is aligned with the TT maximum closure in the post-tonic syllable (post-cl-vmin; lag= 4ms; p=0.860), i.e. the maximum constriction for the production of [l]. The offset of the fall shows a quite regular alignment: in case of ante-penultimate syllable, it is aligned with the maximum TD aperture of the final syllable (fin-op-vmin; lag= -7ms; p=0.721), i.e. the end of the word.

Figure 6: Alignment pattern of the non-native German productions by speaker 1LC.

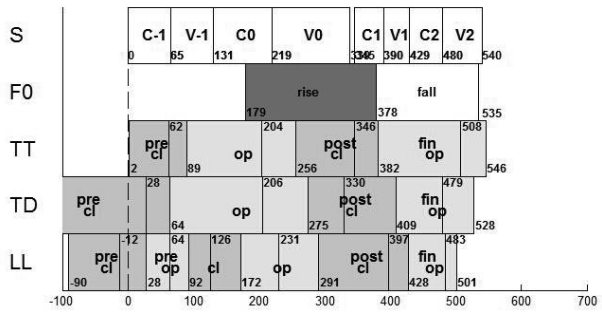
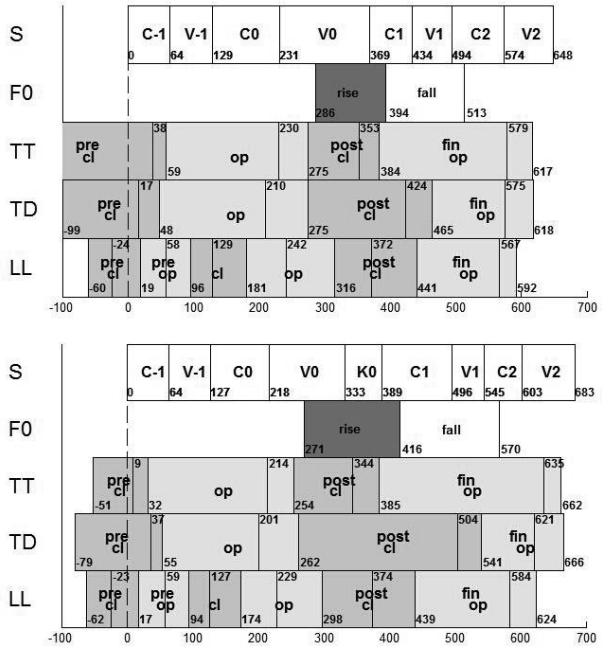


Figure 7: Alignment pattern of thenon-native German productions by speaker 2HC. Top panel: open syllables; bottom panel: closed syllables.



In the productions by 2HC (Fig. 7, top panel), the rise of the accent seems aligned with the TT constriction gesture for the post-tonic [l]: the onset of the rise is aligned with the onset of the gesture (ton-op-vmin; lag= -11ms; p=.164), while the peak is aligned with the offset (post-cl-vmin; lag= -10ms; p=.501). The offset of the fall does not show a specific articulatory anchoring, at least in open syllable. On the contrary, in closed syllable condition (Fig. 7, bottom panel) it seems aligned with the offset of the TD closing gesture for the post-tonic [i], even if with a wide lag value (post-cl-vmin; lag= -29ms; p=.148).

4. DISCUSSION AND CONCLUSIONS

In the production of initial contrastive accent by native Lecce Italian speakers, different alignment strategies of the tones with the articulatory landmarks appear. In particular, the tonal contour exploited by 2HC can be considered a typical realization of a H*+L accent used in contrastive focus condition, as the peak is retracted until the onset of the acoustic syllable. However, in both speakers, the main articulatory reference for the alignment of the rise are the gestures involved in the production of the tonic syllable, in particular the opening gesture of the lips for [m]. A retraction in 2HC with respect to 1LC is detectable also on the fall of the accent: the end of the fall is anchored to the end of a lingual movement (TD for 1LC and TT for 2HC) but no speaker shows a stable anchoring point with the articulators.

The productions by the native German speaker show a completely different alignment pattern. The rising accent L+H* seems to be systematically synchronized with the gestures involved in the production of the post-tonic syllable, i.e. the closing gesture of the tongue tip for [l]. The end of the fall shows a high variability and, in case of closed syllables, it is aligned with the end of the vocalic gesture of the post-tonic syllable.

Comparing the realizations in native German and non-native German, the speaker with low competence level reflects a realization that partially adhere to the native productions. Indeed, while the onset of the rise is anchored at the same articulatory landmarks in L1 and L2 (the onset of the labial opening gesture of the tonic syllable), the peak is anchored with the same articulatory landmark of the native German, i.e. the maximum constriction of TT for the production of [l] in the post-tonic syllable. It is possible that 1LC does control only the alignment of the peak because of its acoustic salience and cannot control the position of the low tone. Hence, the productions show only a partial transfer of native features of the pitch accent, opening the possibility of the existence of an intermediate level of acquisition.

A correct alignment of the tones is performed by 2HC, who shows the complete acquisition of the fine phonetic details of the pitch accent. The tonal targets are aligned at the same articulatory landmarks in the native German productions of CTR and the non-native German productions of 2HC: The rise is synchronized to the closing gesture involved in the production of [l] in the post-tonic syllable, while the fall shows a high variability as in the other cases, but the same tendency to anchor with the end of the vocalic gesture of the post-tonic syllable emerges in the German productions of the two speakers in closed syllable condition.

Further research will be carried out to increase the number of speakers for the two levels of competence, and to obtain a more fine-grained differentiation in competence, in order to highlight a possible intermediate step of acquisition of tonal alignment features. The investigation using articulatory data seems to be powerful in highlighting stable patterns of alignment, which could give us a deeper understanding of the acquisition processes of L2 intonation.

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