

## On the articulatory bases of prominence in Italian

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### *R sum*

*Dans ce travail on propose l tude des caract ristiques cin matiques de la prominence accentuelle en Italien, et comprendre comment les variations induites par la structure prosodique s expliquent dan le cadre de la thorie Task Dynamics. Les r sultats ont montr que la prominence accentuelle aux diff rents niveaux de la hi rarchie prosodique est produite par des m canismes diff rents.*

This study reports the first results of a research aimed to investigate how segmental variation is conditioned by prosody in Italian, by examining the acoustic and articulatory properties of syllables that are prominent at different levels of the prosodic hierarchy (Nespor & Vogel, 1986; Beckman & Pierrehumbert, 1986). At word level we compared unstressed and lexically stressed syllables; at intermediate/intonational level we compared unaccented (lexically stressed) and accented syllables.

Our previous work on Italian (Vayra & Fowler, 1987; Vayra & Fowler, 1992) shows both acoustic (duration, F0, amplitude, F1) and articulatory (jaw displacement) evidence that unstressed vowels are shorter in duration compared to stressed ones and exhibit reduction in the height dimension, involving the global gesture for the vowel (Vayra, Avesani & Fowler, 1999). Moreover, jaw kinematics and EPG data show more displacement for the opening gesture in stressed vowels independently of vowel height (Farnetani & Faber, 1992; Magno Caldognetto et al., 1995, Farnetani & Vayra, 1996). As for the higher levels of the prosodic hierarchy though, while a rich literature exists on the intonational properties of accented syllables and on their segmental alignment (e.g. D Imperio, 2002) no kinematics data are available that clearly distinguish stressed and accented syllables.

In order to examine prosodically-induced articulatory variations we looked at the kinematics of the lip opening and closing movements occurring in CVCV(C)CV pseudo-words (where C = /b, m/), produced by two subjects in medial position of declarative sentences. The penultimate syllable of the pseudo-words can be unstressed, stressed or accented in a contrastively focussed constituent. Sentences have been embedded in short dialogues in order to elicit the intended focus interpretation. Articulatory data have been collected by an automatic optotracking movement analyzer for 3D kinematics data acquisition (ELITE) , which also allows a synchronous recording of the acoustic signal. The data we report on here are relative to Lower Lip movement and Lip Aperture.

The major questions we address in this work are: i) which are the kinematic characteristics of prosodically conditioned prominence in Italian, and ii) how can prosodically-induced kinematic variations be accounted for by parameter settings in a mass-spring gestural model (e.g. Browman and Goldstein, 1990; Saltzman and Munhall, 1989; Saltzman, 1995; Cho, in press).

Results show that different kinematic properties distinguish unstressed, stressed and accented syllables, but that these properties vary in the two subjects. The contrast between unstressed and stressed syllables is determined by the properties of the opening gesture: the lower acoustic duration of the unstressed syllable is related to the shorter, narrower and stiffer opening gesture. A single dynamical parameter setting cannot be singled out as an absolute underlying mechanism for both speakers. A change in intergestural timing or a change by shrinking of the opening gesture seem to be the likely dynamical mechanisms which underly the production of an unstressed syllable, indicating a truncation or a proportional reduction of the opening gesture in unstressed syllables. In contrast, accented syllables show more displacement both in the opening and in the closing gestures compared to stressed ones. In terms of dynamical parameter settings, for one speaker a pure change in target can be posited as the single absolute underlying mechanism for the opening gesture, with peak velocity and displacement raising proportionally without a change in duration, and as the most likely mechanism for the closing gesture. For the other speaker, while the opening gesture of the accented syllable can be modelled by positing a change in target, the closing gesture appears to be induced by a pure change in stiffness.

Our results show that different dynamical mechanisms underly the production of prominence at different levels of the prosodic hierarchy; and that when a stressed syllable becomes accented, its prominence is induced both by its laryngeal and supralaryngeal properties.

## References

- BECKMAN, M. & PIERREHUMBERT, J. (1986). Intonational Structure in Japanese and English, *Phonology Yearbook*, 3: 255-309.
- BROWMAN C., & GOLDSTEIN L. (1990). Tiers in articulatory phonology, with some implications for casual speech. In J. Kingston, M. Beckman (eds), *Papers in Laboratory Phonology I: Between the Grammar and the Physics of Speech.*, Cambridge, U.K., Cambridge University Press.
- CHO, T. (in press)° Manifestation of Prosodic Structure in Articulation: Evidence from Lip Kinematics in English.° *Laboratory Phonology 8* , Berlin/New York, Mouton de Gruyter.
- D IMPERIO, M. (2002) Language-specific and universal constraints on tonalalignment: the nature of targets and anchors . In *Speech Prosody 2002. Proceedings of the 1st International Conference on Speech Prosody*, pp. 101-106.
- FARNETANI E. & FABER A. (1992). Tongue-jaw coordination in vowel production: isolated words vs. connected speech, *Speech Communication*, 11:410-410.
- FARNETANI E. & FABER A. (1996). The role of prosody in the shaping of articulation in Italian CV syllables, in *From Control Strategies to Acoustics. Proceedings of the 1st ESCA Tutorial and Research Workshop on Speech Production Modeling* (Aurans, Francia, 21-24 maggio 1996): 9-12.

- FARNETANI E. & VAYRA M. (1996), The role of prosody in the shaping of articulation in Italian CV syllables, in From Control Strategies to Acoustics. In *Proceedings of the 1<sup>st</sup> ESCA Tutorial and Research Workshop on Speech Production Modeling* (Aurans, Francia, 21-24 maggio 1996): 9-12.
- MAGNO CALDOGNETTO, E. VAGGES, K. & ZMARICH, C. (1995). Visible articulatory characteristics of the Italian stressed and unstressed vowels. In *Proceedings of the XIII International Congress of Phonetic Sciences*, 1:366-369.
- NESPOR, M. & VOGEL, I. (1986). *Prosodic Phonology*, Dordrecht, Foris Publications.
- SALTZMAN, E. (1995). Intergestural timing in speech production: data and modeling. In *Proceedings of the XIII International Congress of Phonetic Sciences*, 2:84-91.
- SALTZMAN, E. L. & MUNHALL, K. G. (1989). A dynamical approach to gestural patterning in speech production. *Ecological Psychology*, 1, (4), 333-382.
- VAYRA, M. & FOWLER, C. (1987). The word level interplay of stress, coarticulation, vowel height and vowel position in Italian. In AA. VV., *Proceedings of the XI International Congress of Phonetic Sciences IV*. Tallinn, Estonia, URSS: Academy of Sciences of the Estonian S. S. R., 24-27.
- VAYRA, M. & FOWLER, C. (1992) Declination of supralaryngeal gestures in spoken Italian, *Phonetica*, 49, 1:48-60.
- VAYRA, M., AVESANI, C. & FOWLER, C. (1999). On the phonetic bases of vowel-consonant coordination in Italian: a study of stress and compensatory shortening. In *Proceedings of the XIV International Congress of Phonetic Sciences*, 1:495-498.