

## Coupling of Tone and Oral Constriction Gestures in Italian and German

Speech can be decomposed into invariant phonological units, *articulatory gestures* which are coordinated in time (Browman & Goldstein 1989). This coordination is modelled using a planning model of speech timing (Browman & Goldstein 2000; Goldstein et al., to appear; Nam & Saltzman 2003). Gestures are associated with planning oscillators (or clocks) that are coupled with each other in a pattern specified by a *coupling graph*, assumed to be part of an utterance's phonological representation.

More recently, attention has been turned to *tonal gestures*, representing both lexical tones (Gao 2008 for Mandarin Chinese) and intonational tones (Mücke, Nam, Prieto & Goldstein 2009 for Catalan and German). The latter involves post-lexical pitch accents, in particular the rising pitch accent L+H\*. This pitch accent is analysed as a *low gesture* with its target reached at the minimum in the F0 contour, immediately followed by a *high gesture*, beginning at the F0 minimum and reaching its target at the F0 maximum (see Figure 1).

Two types of coupling structures have been proposed for this pitch accent: (a) In Catalan, the onset of the *high gesture* is coupled in-phase to the vowel gesture. Thus, all gestures (high tonal, vocalic and consonantal) start simultaneously. On the acoustic surface, the F0 minimum occurs just before or at the beginning of the accented syllable (e.g. in Greek (Arvaniti, Ladd, Mennen 1998) and Spanish (Prieto & Torreira 2007)). (b) In German rises, both the *low* and the *high tonal gestures* are coupled in-phase to the vowel and sequentially to one another. This competitive coupling results in a rightwards shift of the H gesture. On the acoustic surface, the F0 minimum occurs considerably later.

In the present study, we investigate the coordination between tonal and oral constriction gestures in rising pitch accents in Italian (Bari variety) and compare them with rising pitch accents in German (Northern variety). We recorded one native speaker each of Italian and German using a 2D Electromagnetic Articulograph. Target words included CVCV sequences, with two places of articulation (labial and alveolar) and alternating vowels (/i/-/a/), both in focal and prefocal accents.

*Preliminary results:* The gestural score in Figure 2a visualizes the gestural timing in the Italian target sequence /la 'lina/ (focal accent). It shows for the lexically stressed syllable that the onsets of the consonantal (alveolar closure), vocalic (palatal narrow) and tonal (high) gestures all coincide (mean CV lags 9ms, mean TV lags 7ms). Figure 2b illustrates the timing in German, where the onset of the high tonal gesture is later (mean TV lags 81ms). We attribute this to the topological difference in coupling graphs between Italian and German.

Furthermore, we found phonetic variation due to physiological constraints: CV lags and TV lags are smaller in syllables with low vowels [a] than high vowels [i] since the former involve an extensive tongue movement (see Löfqvist & Gracco 1998, Solé & Ohala 2006).

This study supports the findings in Mücke, Nam, Hermes & Goldstein (to appear) that the coordination of an intonational tone gesture with a particular syllable in the utterance should not reach down to modify the intrasyllabic coupling relations that define that syllable. In contrast to tone languages such as Mandarin Chinese the coupling of pitch accent tones to syllables must occur post-lexically.

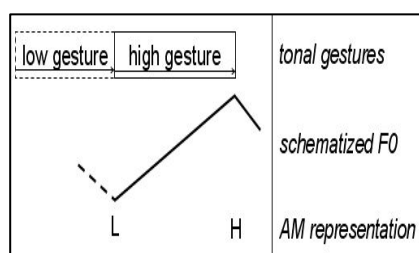


Figure 1: Levels of representation for tonal gestures

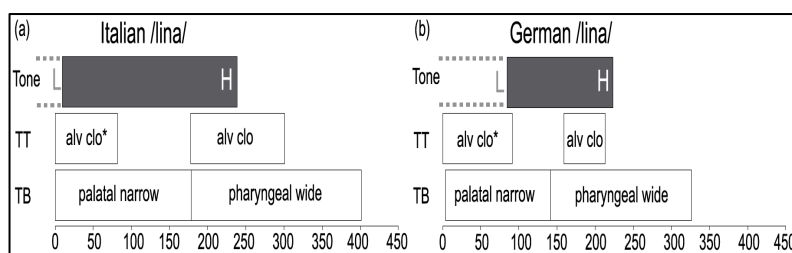


Figure 2: Gestural Score for /'lina/ in (a) Italian /la 'lina/ and (b) German /da 'lina/, based on means for 10 and 7 repetitions respectively