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# RHYTHMIC AND PROSODIC CONTRAST IN VENETAN AND SICILIAN ITALIAN*

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## Abstract

We compared the Italian of speakers from the Veneto, in the north of Italy, and from Sicily, in the far south, looking for evidence of rhythmic and prosodic differences. We found no reliable differences in scores for rhythm metrics (VarcoV, %V, VarcoC) for Venetan and Sicilian, with both varieties having scores similar to French and indicative of a greater durational marking of stress than Spanish. However, we found much stronger prosodic timing effects in Sicilian Italian, with stressed vowels in nuclear utterance-final position twice as long as in prenuclear utterance-medial position. We also found evidence of differential patterns of vowel reduction: Sicilian showed greater modulation of F1 and F2 values according to stress and prosodic position, indicating greater vowel centralisation in prosodically-weak contexts than in Venetan Italian. Overall, the results indicated greater prosodic contrast in southern Italian, and suggest that multiple factors contribute to the perception of rhythmic differences.

## 1. *Introduction*

### 1.1 *Rhythm metrics and rhythmic typology*

Alternation between stressed and unstressed syllables has been held to underpin listeners' perception of speech rhythm and of rhythmic differences between languages, at least for the well-studied languages of Europe. It is certainly the case that Romance languages such as Spanish have less durational contrast between stressed and unstressed syllables than Germanic languages such as English (e.g. Dauer, 1983). Germanic languages tend to have more complex syllable onsets and codas than do syllable-timed languages, particularly in stressed syllables. They also tend to have more marked vowel reduction in unstressed syllables, associated with a greater difference in stressed-unstressed vowel duration. Rhythm metrics such as VarcoV (standard deviation of vocalic interval duration divided by the mean) and %V (proportion of total utterance duration comprised of vocalic intervals) exploit this variation to differentiate languages like Spanish and French from Dutch and English (Ramus et al., 1999; Dellwo & Wagner, 2003; White & Mattys, 2007a). Such results offer some support for the "syllable-timed" vs "stress-timed" typological distinction (Pike, 1945), but gradient variation in scores between languages within "rhythm classes" suggests that rhythm cannot simply be classified dichotomously, at least from a production perspective. Furthermore, it is clear that isochrony of syllables in "syllable-timed" languages or of stress-delimited feet in "stress-timed" languages, which was originally held to underpin this categorical distinction, is not observed in speech production (e.g. Dauer, 1983).

Gradient variation in rhythm scores is also evident within languages. For example, Singapore English, which has been described as relatively "syllable-timed" (e.g. Tongue, 1974), was shown to have a lower vocalic pairwise variability index

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(nPVI_V: mean durational difference between successive pairs of vocalic intervals) than standard southern British English (Low, Grabe & Nolan, 2000). A subsequent study indicated, however, that the difference in scores was relatively small compared to that between, for example, Spanish and English (Grabe & Low, 2002). In other cases, the rhythmic contrast within languages has been found to be more marked: Welsh Valleys English, suggested to be relatively "syllable-timed" (e.g. Mees & Collins, 1999), was shown to have VarcoV and %V scores intermediate between standard southern British English and Castilian Spanish (White & Mattys, 2007b). Sometimes differences between accents of a language defy simple classification along a stress-timed vs syllable-timed continuum of rhythm scores, however: for example, European Portuguese has been shown to have higher variation in consonantal interval duration than Brazilian Spanish, but lower variation in vocalic interval duration (Frota & Vigário, 2001).

Differences in rhythm scores have been shown to be predictive of listeners' discrimination. Ramus, Dupoux and Mehler (2003) utilised resynthesised speech, comprising sequences of monotone *sasasa* syllables with the durational values of the original vowels and consonants. They showed that listeners can discriminate *sasasa* speech from languages with distinct rhythm scores (e.g. English and Spanish), but not languages with similar rhythm scores (e.g. English and Dutch). By comparing *sasasa* utterances from different varieties of the same language, White, Mattys, Series and Gage (2007) controlled for the possibility of perceptual distinctions being cued by cross-linguistic differences in the syntagmatic arrangements of stressed and unstressed syllables – a property not explicitly captured by rhythm metrics – and found that listeners can discriminate Welsh Valleys and standard southern British English. The test was more stringent than that provided by Ramus et al.: speech rate was normalised and all utterances were trimmed to the same number of syllables, thus removing utterance-edge durational information, such as might be provided by differential patterns of final lengthening. Discrimination performance was poorer than in Ramus et al.'s study, but still reflected differences in rhythm scores.

Contrasts in the duration of stressed and unstressed vowels, as measured by VarcoV, and in the relative distribution and duration of vowels and consonants, as measured by %V, appear therefore to be significant factors in the perception of rhythmic contrasts. However, the fact that the minimal task utilised by White et al. (2007) was more difficult than the similar discrimination experiments of Ramus et al. (1999), indicates the importance of additional temporal information that is not reflected in the durational contrasts of stressed and unstressed vowels and consonants. Furthermore, there are many sources of non-durational information that may contribute to listeners' perception of rhythm, including intonation and intensity variation, as well as segmental cues to stress.

### 1.2 *Temporal and non-temporal correlates of rhythm*

Spanish and English, at least among languages so far studied with rhythm metrics, seem the most opposed in terms of the durational marking of lexical stress. As well as a high durational contrast between stressed and unstressed syllables, English has substantial lengthening of pitch-accented (i.e. phrasally-stressed) syllables, which extends to other syllables within the pitch-accented word (e.g. Turk & White, 1999). In addition, onset consonants are longer at the start of words than word-medially (e.g. Oller, 1973) and vowels and coda consonants are longer at the end of phrases than phrase-medially (e.g. Wightman, Shattuck-Hufnagel, Ostendorf &

Price, 1992). Outside of the temporal domain, English reduced vowels, which occur in almost all unstressed syllables, are greatly centralised, in addition to being much shorter than stressed vowels.

Lexical stress in Spanish is also associated with a degree of lengthening, particularly in word-final syllables, but the size of the durational contrast between stressed and unstressed syllables is small (e.g. Delattre, 1965). In a recent study, for example, Ortega-Llebaria and Prieto (2007) report 7 ms stress-related lengthening for penultimate syllables and 15 ms for final syllables, much less than the durational difference between full and reduced syllables in English. Despite the small degree of temporal stress contrast, it should be noted that Ortega-Llebaria and Prieto (2009, this volume) find that Spanish speakers use duration as a cue to stress, contrasting with English speakers for whom vowel quality is a stronger stress cue. With regard to vowel quality in Spanish, Ortega-Llebaria and Prieto found a small effect of stress on the realisation of word-final vowel [o], which was slightly more centralised in unstressed syllables, but no effect on penultimate [i], which lacked any contrast in its realisation between stressed and unstressed syllables. Higher-level durational effects are attenuated in Spanish: in the same study, Ortega-Llebaria and Prieto found word-final syllables lengthened very slightly (by 6 ms on average) when pitch-accented, and penultimate syllables showed no significant lengthening at all. Furthermore, Frota, D'Imperio, Elordieta, Prieto and Vigário (2007) found that only 40% of intonational-phrase boundaries were marked by final lengthening in Castilian Spanish, compared with, for example, 100% of boundaries for Catalan.

As Frota et al. acknowledged, controlled studies are required for a true comparison both of the frequency and magnitude of boundary-related lengthening in Romance languages. However, it may be noted that Catalan has significant vowel reduction in unstressed syllables, unlike Spanish, and has been considered a less "syllable-timed" language, a claim empirically supported by the single-speaker data of Grabe & Low (2002). Frota et al. also found that 100% of IP-boundaries were marked in the Italian of Neapolitan speakers, which, as discussed below, is one of the southern varieties of Italian that have been held to be "stress-timed". Thus, greater evidence for final lengthening was found in languages (Catalan, Neapolitan Italian) held to be less "syllable-timed" than Spanish.

Results for rhythm metrics such as nPVI-V and VarcoV (e.g. Grabe & Low, 2002; White & Mattys, 2007a, 2007b) clearly point to gradient distinctions in rhythm between and within languages. In addition, differences between languages suggested by rhythmic typology, and supported by rhythm scores, appear to correlate – particularly at the English and Spanish extremes – with differences in the overall use of duration as a cue to structure: languages like English utilise a high durational contrast in delimiting lexical and higher-level prosodic structure, whereas languages like Spanish utilise low durational contrast for the same purpose.

As discussed above, the dichotomous typology of "stress-timed" vs "syllable-timed" and the isochrony this typology implies are empirically unsupported. It may be more useful to think of languages differing in the degree to which they utilise durational and segmental contrast to indicate both stress and higher-level prosodic structure.

### 1.3 *The phonetic basis of Italian rhythm*

Here we examine the contribution of durational and segmental factors to the perceived rhythmic difference between northern and southern Italian. We look for

evidence of variation in the exploitation of contrast, both durational contrast and contrast in vowel quality. Italian, although another Romance language generally held to be "syllable-timed", differs from Spanish in having vowels that vary significantly in duration as a result of lexical stress and other phonological factors. Italian vowels are longer in stressed open syllables than in closed syllables or in unstressed open syllables, and this is especially the case when this stressed open syllable is in word-penultimate position (D'Imperio & Rosenthall, 1999). Indeed, Bertinetto (1980) claims that vowel duration is the most important parameter for the perception of stress in Italian. As suggested by Russo and Barry (2004), this phonetic lengthening of stressed vowels is likely to influence vocalic variability scores (e.g. VarcoV) away from the extreme low of Spanish. Likewise, the existence of geminate consonants in Italian leads one to expect a relatively high degree of variation in consonantal interval durations, and a lower %V score than would otherwise be predicted for a Romance language.

Despite the durational cues to stress, standard Italian (e.g. that of Tuscany) has generally been described as "syllable-timed", as have varieties of northern Italian. In contrast, several sources have suggested that southern Italian tends towards "stress-timing" (e.g. Grice, D'Imperio, Savino & Avesani, 2004; Russo & Barry, 2004 also cite Romito & Trumper, 1993, and Trumper, Romito & Maddalon, 1991), although objective perceptual tests of such rhythmic differences appear to be lacking.

Various phonetic processes in southern Italian serve to increase contrast between stressed and unstressed syllables. Russo and Barry (2004) report gradient variation in the degree of reduction of word-final unstressed vowels, which ranges from shortening and centralisation to devoicing to deletion. The elision of voiced vowels also serves to increase the complexity of consonant clusters, creating heavy or superheavy syllables not licensed in standard Italian phonology (Russo & Barry, 2004). A similar process is observed in European Portuguese, as contrasted with Brazilian Portuguese where epenthetic vowels may actually interrupt and thereby simplify consonant clusters (Frota & Vigário, 2001). Consonant interval durations are made more variable by the fact that lexical geminates are longer in southern Italian, and by *raddoppiamento fonosintattico*, a post-lexical gemination process not present in northern varieties of Italian, whereby word-initial consonants are significantly lengthened in certain circumstances (e.g. after certain words, or less consistently, when following a final stressed vowel – cf. Lopocaro, 1997; Payne, 2005).

### 1.4 *Experimental aims*

We are not aware of any systematic attempt to quantify rhythmic differences between northern and southern Italian using rhythm metrics such as VarcoV and %V, beyond a preliminary study (Barry, Andreeva, Russo, Dimitrova, & Kostadinova, 2003) on pre-labelled corpora of spontaneous speech. A range of rhythm metrics were applied to compare Italian speech from Bari and Naples (southern) and Pisa (central, close to standard Italian), together with varieties of German and Bulgarian. Their results were inconclusive, however, partly as a result of speech rate differences between the corpora and also perhaps due to labelling discrepancies between corpora.

Here we report a three-part investigation into rhythmic and prosodic differences between northern and southern varieties of Italian. Our working hypothesis was that southern Italian speakers should show higher indices of contrast on all of the following measures.

*Rhythm scores.* We utilised rhythm metrics to quantify the degree of variation in vocalic interval duration (VarcoV) and the relative balance of vocalic and intervocalic intervals (%V). We chose these metrics as they have been shown to be the most discriminative between languages (White & Mattys, 2007a). These metrics have also distinguished accents of English held to differ rhythmically (White & Mattys, 2007b). Importantly, they are robust to variation in speech rate (White & Mattys, 2007a), at least for languages so far studied.

In contrast, metrics of consonantal interval duration have been shown to be problematic. Scores for non-rate-normalised metrics (ΔC: standard deviation of consonantal interval duration; rPVI-C: mean durational difference between successive pairs of consonantal intervals) have clear inverse correlations with speech rate. Rate normalisation, for example, in VarcoC (standard deviation of consonantal interval duration divided by the mean) appears to remove much of the linguistically-relevant differences between samples (White & Mattys, 2007a), as had been previously suggested by Grabe and Low (2002). Despite this caveat, we thought it necessary to include a rate-insensitive metric of consonantal interval variation – VarcoC – given the differences in distribution and magnitude of geminate consonants between northern and southern Italian.

*Prosodic timing analysis.* We compared the degree of structurally-determined lengthening in northern and southern Italian. Specifically, we measured stressed vowel duration in utterance-medial words carrying a prenuclear pitch accent and utterance-final words carrying a nuclear pitch accent.

*Vowel reduction analysis.* We investigated the degree of centralisation of stressed and unstressed vowels in the two varieties. We measured the formant structure of stressed, pre-stress and post-stress vowels for two different levels of prominence in the phrase: prenuclear utterance-medial and nuclear utterance-final.

## 2. *Method*

### 2.1 *Participants*

We recorded six native speakers of Italian from the Veneto, in the north east of Italy, and six from Sicily, in the far south. All speakers had been brought up in the regions in which they were recorded, and none reported any speech or hearing impediments. The Veneto speakers were recorded by the first author at the University of Padua and the Sicilian speakers were recorded by the second author at the University of Palermo and the University of Catania. All speakers were paid a small honorarium for their participation.

### 2.2 *Materials*

*Rhythm sentences.* To obtain rhythm scores, we recorded each speaker reading the same set of five sentences. Following the methodology used in White and Mattys (2007a, 2007b), we designed these sentences to exclude approximants as far as possible. This was to facilitate the segmentation of the recorded utterances into vocalic and consonantal intervals. The sentences were:

*Davide insegna matematica come tutti i suoi amici.*
"David teaches maths like all of his friends."

*Quando c'è così tanta gente in città vado in montagna.*
"When there are so many people in the city I go to the mountains."

*Giovedì ho visto Donata Zanzetti e Amanda Baggio in tivù.*
"On Thursday I saw Donata Zanzetti and Amanda Baggio on the telly."

*Hanno mangiato una zuppa di cozze e un piatto di pesce fritto.*
"They ate mussel soup and a plate of fried fish."

*Se non dici dove sono i cappotti, non possiamo uscire.*
"If you don't say where the coats are, we can't go out."

*Prosodic-timing sentences.* To obtain measurements of the magnitude of prosodic timing effects, we contrasted a series of target words in prenuclear utterance-medial position and nuclear utterance-final position. The target words (with position of lexical stress illustrated) were: *'bada*, *candi'tissimi*, *'fata*, *fa'tale*, *'fatta*, *'fichi*, *'miti*. Because there was the possibility of sentences being realised as two or more intonational phrases, we used capital letters to indicate the desired placement of phrasal stress. We hoped thereby to forestall the possibility of a major prosodic boundary being realised after the target word in the prenuclear utterance-medial context. The target words carried prenuclear accent in this context, but, as described below, we successfully avoided the realisation of a phrase-final nuclear accent on the target words in these tokens. These are the sentences, with target words shown here in bold (they were not presented in bold for participants):

*Non **bada** TANTO al Signor GADDA.*
"He's not so concerned about Mr Gadda."

*Ai suoi **canditissimi** SORRISI non ci **BADA**.*
"He takes no notice of her very clear smiles."

*Pensava ai suoi fitti CAPELLI e sorrisi **CANDITISSIMI**.*
"He was thinking about her thick hair and very candid smiles."

*La **fata** GIOVANE aveva capelli FITTISSIMI.*
"The young fairy had very thick hair."

*Non riusciva a dipingere i fittisimi CAPELLI della **FATA**.*
"He couldn't paint the fairy's very thick hair."

*È **fatale** DAVVERO mangiare troppi **FICHI**.*
"Eating too many figs is really fatal."

*Era **fatta** BENE e l'effetto fu **FATALE.***
"She had a good figure and the effect was irresistible."

*I **miti** DANESI raccontano di come la terra è **FATTA**.*
"Danish myths tell of how the earth is made."

*Questi **fichi** D'INDIA sono veramente dei **MITI**.*
"These prickly pears are really legendary."

As can be seen, because of the way the materials were constructed, several sentences contained both an utterance-medial prenuclear target word and a (different) utterance-final nuclear target word.

*Vowel-reduction sentences.* To obtain estimates of vowel reduction effects, we recorded eight sentences which had been designed to contain the vowels /i/ and /a/ in various degrees of lexical and phrasal prominence. The word-level stress contrasts are illustrated in Table 1.

| | *Pre-stress* | *Stressed* | *Post-stress* |
|---|---|---|---|
| /i/ | f **I** ch i ss i m i | f **I** ch i | f i ch **I** |
| /a/ | b **A** d a r e / b **A** d a t e | b **A** d a | b a d **A** |

Table 1: *Lexical contexts for the stressed and unstressed vowels measured in the vowel reduction study. The vowels investigated are shown underlined, in bold and capitalized.*

The phrase-level prominence conditions were: i) prenuclear accent, utterance-medial position; ii) nuclear accent, utterance-final position. These are the sentences, with target words shown here in bold (once again, they were not presented in bold for participants):

*Non **badate** TANTO a diventare RICCHI.*
"Don't be too concerned about becoming rich."

*Per diventare ricchi DAVVERO non ci dovete **BADARE***
"To get really rich, you shouldn't care so much."

*Non **bada** TANTO al Signore GADDA.*
"He's not so concerned about Mr Gadda."

*Ai suoi canditissimi SORRISI non ci **BADA**.*
"He takes no notice of her very clear smiles."

*Solo i **fichissimi** ragazzi della CITTÀ hanno capelli FITTI.*
"Only the really cool city kids have thick hair."

*Quel badalucco INGLESE non aprezza questini arancini **FICHISSIMI**.*
"That English waste of space doesn't appreciate these really cool 'arancini'."

*Questi **fichi** D'INDIA sono veramente dei MITI.*
"These prickly pears are really legendary."

*È fatale DAVVERO, mangiare troppi **FICHI**.*
"Eating too many figs is really fatal."

Some of these sentences and target words were also used in the prosodic timing analyses. As discussed above, block capitals were used to indicate the desired placement of the main phrasal stresses.

### 2.3 *Recordings*

All speakers read all sentences. The rhythm sentences were presented on a single sheet of paper, preceded by another five sentences which were not analysed for this experiment. The prosodic-timing and vowel-reduction sentences were printed together in random order on a separate sheet of paper, plus two other sentences.

The prosodic-timing and vowel-reduction sentences were read first. These were followed by a task in which participants described a route around a fictional map. The participants then read the rhythm sentences plus fillers. Finally, the prosodic-timing and vowel-reduction sentences were read again. The second reading of the sentences was not used in the analyses reported here.

Prior to reading the sentences, participants were instructed to take as much time as they wished to familiarise themselves with the sentences, and then to read the sentences out loud, at a normal rate and in a conversational style. They were told to avoid pausing within sentences, but to make a brief pause between sentences and to repeat any sentence in which they made an error. For the prosodic-timing and vowel-reduction sentences, participants were directed to the words in capital letters as being the most important words in the sentences. This was intended to prevent utterance-medial targets carrying nuclear accents or being followed by phrase-boundaries.

The experimenter monitored the productions and asked speakers to repeat sentences when they were misread. The experimenter gave no other instructions regarding the reading of the sentences.

All recordings took place in a quiet rooms, using good quality microphones, and were made directly to disk at sample rates of 32 kHz or higher.

### 2.4 *Measurements*

*Rhythm analysis.* We followed the methodology of White & Mattys (2007a, 2007b), dividing each utterance into vocalic and intervocalic intervals based on inspection of the waveform and wideband spectrogram using Praat (http://www.fon.hum.uva.nl/praat/). Full details of the segmentation criteria used are given in White & Mattys (2007a).

The vowel and consonant interval durations for each utterance of each speaker were measured. We used these durational data to calculate the rhythm metrics VarcoV, %V and VarcoC. VarcoV is the standard deviation of vocalic interval duration divided by the mean (and multiplied by 100). VarcoC is the standard deviation of consonantal interval duration divided by the mean (and multiplied by 100). %V is the proportion of utterance duration comprised of vocalic intervals. We also calculated the overall speech rate for each utterance, as the number of syllables divided by the utterance duration.

*Prosodic-timing analysis.* Using Praat, we measured the duration of the vowel in the stressed syllable of each target word in the two prosodic contexts through inspection of the waveform and wideband spectrogram.

*Vowel-reduction analysis.* Using Praat, the speech recordings were segmented and values for F1 and F2 were measured using the formant-tracking function of the software and checked by hand against the spectrogram for accuracy. Since the identity of preceding and following consonants influences formant transitions into and out of the vowel in question, formant values were taken only at the middle of the vowel, where consonantal effects were expected to be less strong.

## 3. *Results*

### 3.1 *Results: Rhythm scores*

Table 2 shows the mean rhythm scores for VarcoV, VarcoC and %V, together with the mean speech rates. Results of By-Subjects comparisons for each measure are also shown. None of the expected differences in rhythm scores are evident in Table 2. If Sicilian Italian were more "stress-timed" than Venetan Italian, it should have higher VarcoV and VarcoC scores and lower %V. The only reliable difference was that the speech of Sicilian Italian was significantly faster than that of Venetan Italian.

| | *Venetan Italian* | *Sicilian Italian* | *t-tests* |
|---|---|---|---|
| VarcoV | 50.3 | 47.3 | $t(10) = 1.57, p > .10$ |
| VarcoC | 45.7 | 48.2 | $t(10) = 1.39, p > .10$ |
| %V | 46.7 | 45.7 | $t(10) = .62, p > .10$ |
| Speech rate (syl/sec) | 6.2 | 7.4 | $t(10) = 2.58, p < .05$ |

Table 2: *Rhythm metric scores and speech rates for Venetan and Sicilian varieties of Italian. Results of By-Subjects two-tailed t-tests are shown in the final column.*

As shown in Figure 1, reliable differences have been previously been found between and within languages using, as in the current study, six speakers for each group reading five sentences each. In particular, using this methodology, Welsh Valleys English was shown to have significantly higher %V and significantly lower VarcoV than standard southern British English (White & Mattys, 2007b). Thus, the lack of significant differences here is unlikely to be an issue of statistical power.

Pairwise comparisons indicate that both Venetan Italian and Sicilian Italian had higher VarcoV scores than Castilian Spanish [Venetan vs Castilian: $t(10) = 4.48$, $p = .001$; Sicilian vs Castilian: $t(10) = 2.37$, $p < .05$]. VarcoV scores for both Venetan and Sicilian Italian were not significantly different from those for French, and clearly much lower than those for standard English and Dutch. The %V scores for Venetan and Sicilian Italian were not significantly different from those for Spanish or French, but clearly higher than those for Dutch and English. Thus, VarcoV is the more discriminative metric here, suggesting a gradient of rhythm, with lesser temporal stress contrast in Spanish than French or either variety of Italian, but with no temporal rhythmic distinction between the Italian varieties.

VarcoC scores, while numerically supportive of greater contrast in Sicilian Italian (48.2 compared with 45.7 for Venetan Italian), were not significantly different. This is somewhat surprising given the greater incidence of post-lexical gemination in southern Italian, and the greater magnitude of geminates in general. It may be that different materials eliciting more lexical and post-lexical geminates would produce reliable differences in scores, although VarcoC has not previously been shown to manifest predicted discrimination patterns (e.g. White & Mattys, 2007a).

Thus, rhythm scores did not support any differentiation between Venetan and Sicilian in terms of their degree of temporal stress contrast, with both varieties appearing rhythmically similar to French. What then underpins the perception of so-called "stress-timing" in southern Italian varieties, such as Sicilian? In the following sections, we consider localised rather than global measures of temporal contrast, as well as non-temporal contrasts in vowel realisation.

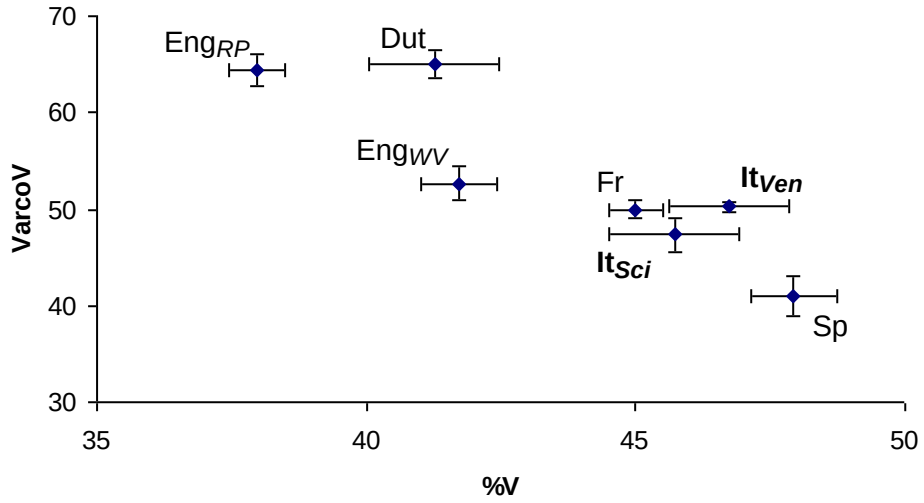


Figure 1: *VarcoV vs %V (and standard error bars) for Venetan Italian (**It**$_{Ven}$) and Sicilian Italian (**It**$_{Sci}$). Scores for standard varieties of Dutch (Dut), French (Fr), British English (Eng$_{RP}$) and Spanish (Sp), plus Welsh Valleys English (Eng$_{WV}$) are shown for comparison (White & Mattys, 2007a, 2007b).*

3.2 *Results: Prosodic timing*

As described above, stressed-vowel duration was measured for seven words in prenuclear utterance-medial and nuclear utterance-final vowels. Table 3 shows mean stressed vowel duration for these target words in Venetan and Sicilian Italian. A By-Subjects repeated measures ANOVA showed a main effect of Position (prenuclear utterance-medial, nuclear utterance-final) [$F(1,10) = 171.97$, $p < .001$], but no main effect of Accent (Venetan, Sicilian) [$F(1,10) = 0.12$, $p > .10$]. There was a significant interaction between Position and Accent [$F(1,10) = 23.17$, $p = .001$].

| | *Prenuclear utterance-medial* | *Nuclear utterance-final* |
|---|---|---|
| *Venetan Italian* | 95 (7) | 130 (7) |
| *Sicilian Italian* | 72 (5) | 146 (10) |

Table 3: *Mean stressed vowel duration in ms (standard errors in parentheses) according to prosodic position and accent of Italian.*

The nature of the interaction is evident from inspection of the means in Table 3. In utterance-medial position, stressed vowels were 33 ms longer in Venetan than in Sicilian Italian, reflecting the finding reported above that the speech rate of the Sicilian speakers was faster than that of the Venetan speakers. In utterance-final position, however, the position was reversed: vowels in utterance-final syllables were 16 ms longer in Sicilian than in Venetan Italian. Both varieties showed vowel lengthening in nuclear utterance-final words, but the magnitude of the effect was much greater in Sicilian (75 ms vs 35 ms in Venetan).

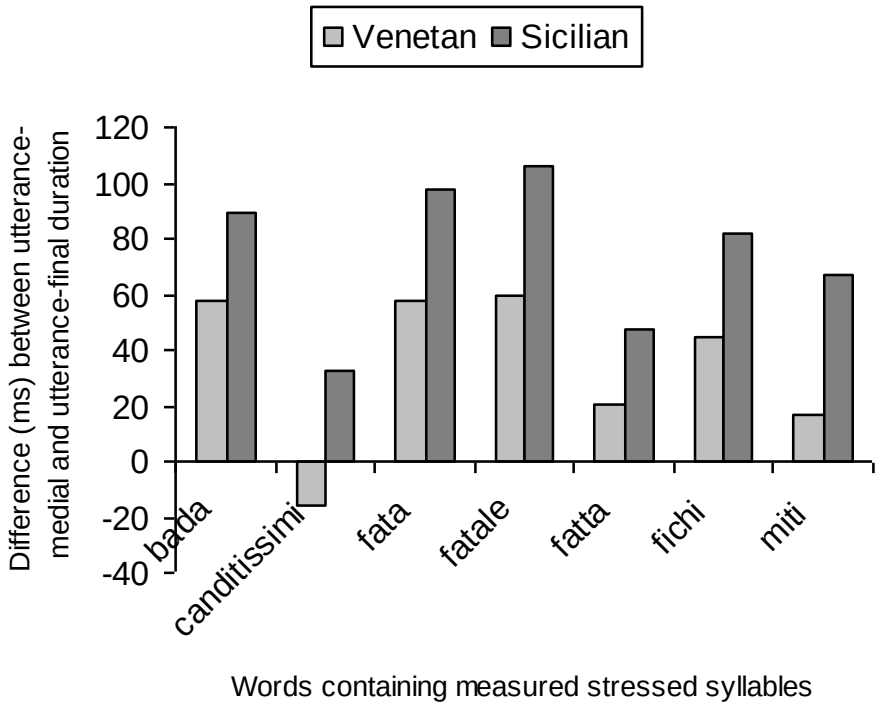


Figure 2: *Mean durational difference (ms) between stressed vowels in prenuclear utterance-medial position and nuclear utterance-final position.*

Figure 2 illustrates the nuclear final-lengthening effect on a word-by-word basis. As can be seen, for all words, the durational difference in stressed-syllable vowel duration between medial and final position was greater for Sicilian than Venetan speakers. A By-Subjects two-tailed t-test on the mean differences confirmed the reliability of this pattern [$t(10) = 4.81$, $p = .001$].

The difference in the *proportional* nuclear accent/final lengthening effect was particularly marked. As reported above, the rate of speech was greater in Sicilian and so the utterance-medial vowels were much shorter. As a proportion of utterance-medial duration, the nuclear accent/final lengthening of Sicilian stressed vowels was 104%, compared with 38% for Venetan stressed vowels.

Thus, although the results of the rhythm metrics analysis did not support the hypothesised distinction between northern and southern varieties of Italian, the prosodic-timing analysis does support the more general contrast hypothesis. There is much greater prosodic lengthening – in nuclear-accented utterance-final position – in Sicilian than in Venetan Italian. This echoes the finding, discussed above, of much greater prosodic lengthening effects in high stress-contrast English than in low stress-contrast Spanish. (Direct numerical comparison between these studies is not possible, due to differences in experimental design.) Unlike English and Spanish, the difference in prosodic lengthening between Venetan and Sicilian was not paralleled by differences in the rhythm scores.

### 3.3 *Results: Vowel reduction*

Both Venetan and Sicilian Italian showed some evidence of phonetic vowel reduction in unstressed vowels when compared with stressed vowels. Figure 3 shows mean values for F1 and F2 in /i/ and /a/ according to stress condition and prosodic position for Venetan Italian; Figure 4 shows the same data for Sicilian Italian. We assessed the effect of three independent variables – Stress (stressed, pre-stress, post-stress), Position (prenuclear utterance-medial, nuclear utterance-final) and Accent (Venetan, Sicilian) – separately for F1 and F2, using By-Subjects repeated measures ANOVAs. Post-hoc Tukey HSD pairwise comparisons were calculated separately for each accent group, as differences in formant frequencies between accent groups are not theoretically interesting for this study.

*Vowel /i/*. Overall, the trend was for a higher F1 and lower F2 in pre-stress and post-stress /i/ compared with stressed /i/, suggesting a more centralised production for unstressed /i/ (in Figures 3 and 4, grey triangles and squares are closer to the intersection than grey circles). With regard to the effect of prosodic position, vowels in nuclear-accented words, other things being equal, have more extreme articulation than those in prenuclear, phrase-medial words (grey filled symbols are further from the intersection than are grey open symbols).

For F1, there was a main effect of Stress [$F(2,20) = 19.39$, $p < .001$], a main effect of Position [$F(1,10) = 32.97$, $p < .001$], and a main effect of Accent [$F(1,10) = 24.17$, $p = .001$]. There were no significant interactions, but pairwise comparisons revealed that the only reliable difference in F1 frequency was in nuclear position for Sicilian, where F1 was significantly lower in stressed syllables than in post-stress syllables ($p < .05$). In the same position, the difference in F1 between Sicilian stressed and pre-stress syllables almost attained significance at the $p < .05$ level. Thus, for Sicilian but not for Venetan, stressed /i/s in nuclear position tend to have more extreme articulation than pre-stress or post-stress vowels. This is in line with the contrast hypothesis: the southern variety shows greater articulatory distinction according to prosodic position.

For F2, there were main effects of Stress [$F(2,20) = 140.95$, $p < .001$], Position [$F(1,10) = 143.46$, $p < .001$] and Accent [$F(1,10) = 24.04$, $p = .001$]. There were significant interactions between Stress and Accent [$F(2,20) = 11.36$, $p = .001$] and between Position and Stress [$F(2,20) = 3.65$, $p < .05$]. Pairwise comparisons showed that, for Venetan, there was a distinction between prenuclear and nuclear stressed vowels, with nuclear stressed vowels having higher F2 ($p < .05$), suggestive of more extreme articulation. Sicilian showed a similar nuclear vs prenuclear distinction for stressed vowels ($p < .01$) and a distinction in pre-stress vowels as well, with higher F2 values in nuclear than prenuclear position ($p < .01$).

Within prenuclear vowels, Venetan distinguished stressed vowels and post-stress vowels ($p < .05$), with the difference between stressed and pre-stress vowels almost attaining significance ($p < .10$); Sicilian distinguished stressed vowels from both pre-stress and post-stress vowels (both $p < .01$). Within nuclear vowels, Venetan distinguished stressed vowels from pre-stress and post-stress vowels (both $p < .01$); Sicilian likewise distinguished these categories (both $p < .01$). In all cases, stressed /i/ vowels had higher F2, indicative of more extreme articulation. Additionally, in Sicilian, pre-stress vowels had higher F2 than post-stress vowels ($p < .01$).

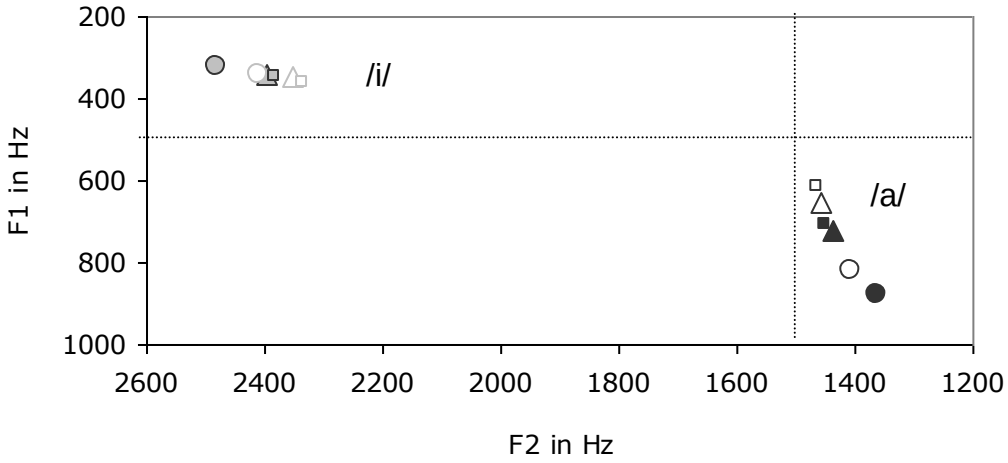


Figure 3. *Mean vowel positions in F1/F2 plane for Venetan Italian. Filled symbols: nuclear utterance-final; open symbols: pre-nuclear utterance-medial. Circles: stressed syllables; triangles: pre-stress syllables; squares: post-stress syllables. Hairline intersection = vowel plane centre.*

The F2 results for /i/ suggest more differentiation according to stress condition and utterance position, for both Venetan and Sicilian, than do the F1 results. However, there are larger absolute F2 differences for Sicilian and reliable differentiation across more categories, as suggested by the interaction between Stress and Accent (Sicilian vs Venetan).

*Vowel* /a/. Overall, the trend was for a lower F1 and higher F2 in pre-stress and post-stress /a/ compared with stressed /a/, suggesting a more centralised production for unstressed /a/ (in Figures 3 and 4, black circles are further from the intersection than are black triangles and squares). There was also a general trend for post-stress vowels to be more centralised than pre-stress vowels (black triangles are further from the intersection than black squares). With regard to the effect of prosodic position, vowels in nuclear utterance-final words, other things being equal, have more extreme articulation than those in prenuclear utterance-medial words (black filled symbols are further from the intersection than black open symbols).

For F1, there was a main effect of Stress [$F(2,20) = 949.10$, $p < .001$], a main effect of Position {$F(1,10) = 586.28$, $p < .001$] and a main effect of Accent [$F(1,10) = 721.33$, $p < .001$]. There was also a significant interaction between Position and Accent [$F(1,10) = 23.93$, $p = .001$]. The effect of Position is evident in the post-hoc comparisons between prenuclear and nuclear position: for both Venetan and Sicilian, /a/ vowels in nuclear-accented words have higher F1, indicative of more extreme articulation, than equivalent vowels in prenuclear words, whether stressed (Ven: $p < .05$; Sic: $p < .01$), pre-stress (Ven: $p < 05$; Sic: $p < .01$) or post-stress (Ven: $p < .01$; Sic: $p < .01$).

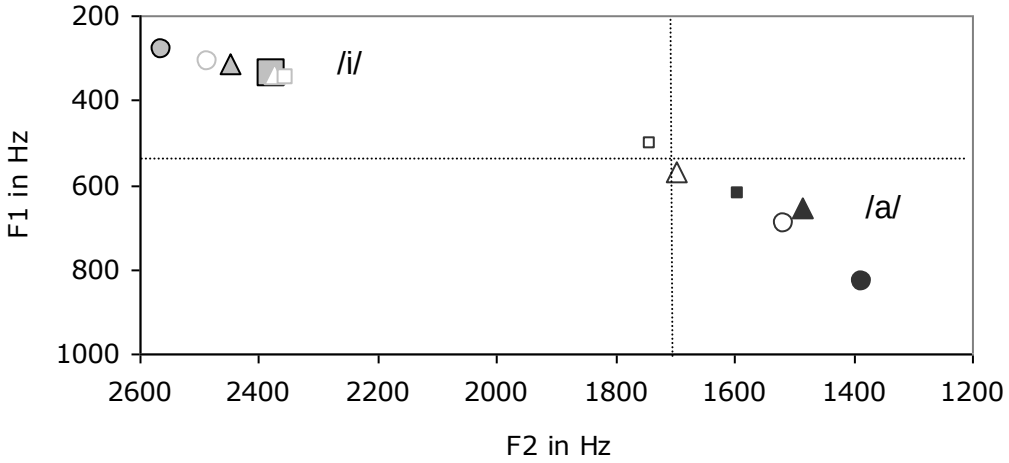


Figure 4. *Mean vowel positions in F1/F2 plane for Sicilian Italian. Filled symbols: nuclear utterance-final; open symbols: pre-nuclear utterance-medial. Circles: stressed syllables; triangles: pre-stress syllables; squares: post-stress syllables. Hairline intersection = vowel plane centre.*

There was an effect of Stress within nuclear words for both Venetan and Sicilian, with stressed vowels having higher F1 than pre-stress or post-stress vowels ($p < .01$ for all comparisons). The same stress distinctions – stressed vowels having higher F1 than pre-stress or post-stress vowels – were also found in prenuclear words ($p < .01$ for all comparisons). The only point of between-accent differences for F1 in the /a/ vowel was that Sicilian speakers also distinguished pre-stress and post-stress vowels in prenuclear position, with the former having higher F1 ($p < .01$).

Thus, results for /a/ F1 do not greatly distinguish Venetan and Sicilian, with both accents marking stressed vowels with more extreme articulation, and all types of vowels in nuclear position having more extreme articulation than equivalent prenuclear vowels.

For F2, as with the other formant measures, there were main effects of Stress [$F(2,20) = 196.26$, $p < .001$], Position [$F(1,10) = 125.11$, $p < .001$] and Accent [$F(1,10) = 354.29$]. There were also interactions between Position and Accent [$F(1,10) = 67.83$, $p < .001$] and Stress and Accent [$F(2,20) = 45.49$, $p < .001$], and a three-way interaction between Position, Stress and Accent [$F(2,20) = 4.40$, $p < .05$]. For /a/ F2, the only distinction made by Venetan speakers was in nuclear position, where stressed vowels had lower F2 than either pre-stress or post-stress vowels (both $p < .01$), suggesting the latter were more centralised. Sicilian speakers also showed these distinctions in nuclear position (both $p < .01$), where, in addition, pre-stress vowels had lower F2 than post-stress vowels ($p < .01$).

The full range of distinctions according to stress position was also made in prenuclear words by Sicilian speakers: stressed vowels had lower F2 than both pre-stress and post-stress vowels (both $p < .01$); pre-stress vowels had lower F2 than post-stress vowels ($p < .01$). Finally, nuclear position was marked by lower F2 than prenuclear position for all stress conditions – stressed, pre-stress, post-stress – by Sicilian speakers (all $p < .01$).

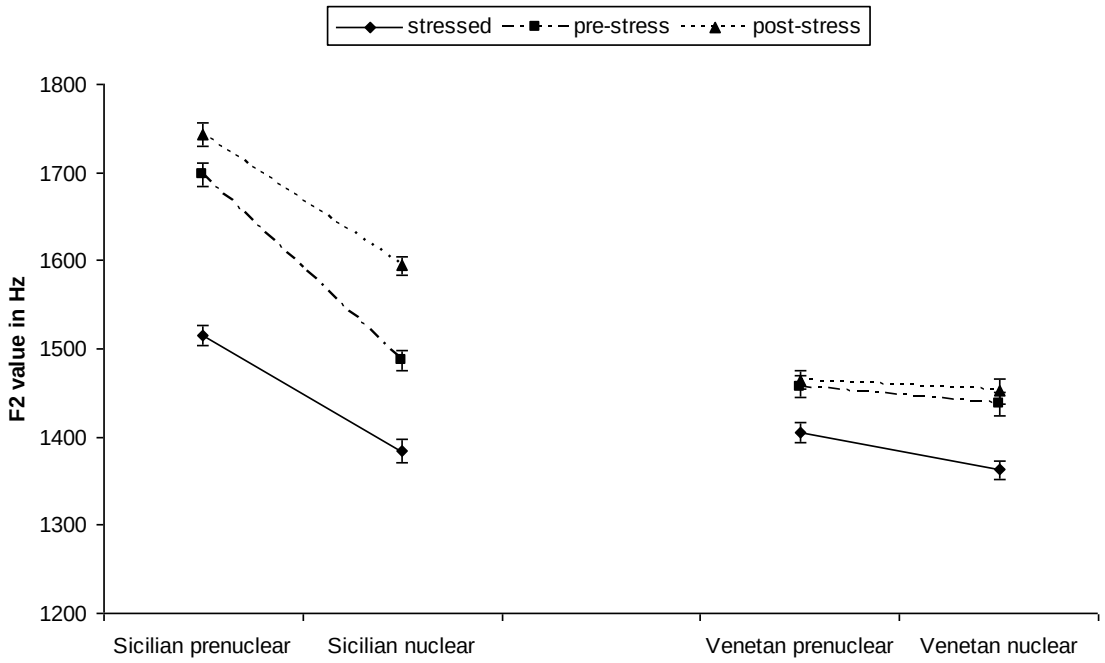


Figure 5: *Mean F2 values in Hz for /a/ according to stress and prosodic position.*

The results for F2 for the /a/ vowel provide the strongest support for the contrast hypothesis: stress was marked with more extreme articulation in both nuclear and prenuclear positions by Sicilian speakers, who also marked nuclear accent with more extreme articulations for both stressed and unstressed vowels. In contrast, Venetans only marked stress by more extreme articulation in nuclear position and did not further distinguish vowels in nuclear and prenuclear words. These patterns are illustrated in Figure 5.

Overall, these results strongly suggest that Sicilian phonetically distinguishes different parts of the intonational phrase to a greater extent than does Venetan. The greater centralisation of vowels in prenuclear position correlates with our findings on greater phrase-final lengthening in Sicilian, a relationship that may have a biomechanical interpretation. There is strong evidence for a linear relationship between duration and formant displacement, with shorter vowels tending to undergo more formant displacement – in the direction of centralization – than longer vowels (Lindblom 1963; Moon & Lindblom 1994). With less time available for the realization of the vocalic gesture, hypo-articulation occurs, resulting in target undershoot. Ortega-Llebaria & Prieto (2007: 173) find a similar correlation of vowel duration and centralization in Spanish, although the distinctions according to lexical stress and prosodic position are relatively small compared with those found here for Italian, in particular for Sicilian.

## 4. *Discussion*

Southern Italian (e.g. Sicilian) has been frequently described as more "stress-timed" than northern Italian (e.g. Venetan). Evidence from previous studies suggests, however, that differences in language rhythm may be a matter of degree rather than categorical. In addition, there is evidence, particularly from the comparison between English and Spanish, that high durational contrasts between stressed and unstressed syllables co-occur with large contrasts in prosodically-governed vowel centralisation

and with the existence of large prosodic lengthening effects. We therefore looked for evidence of rhythmic, prosodic and segmental contrasts between Sicilian and Venetan Italian.

Perhaps surprisingly, we found no evidence from VarcoV and %V scores of Sicilian Italian being rhythmically distinct from Venetan Italian, even though the same measures (and sample size) highlighted clear differences between and within languages in previous studies. Furthermore, the fact that Venetan Italian had rhythm scores that are close to French, and with somewhat higher temporal stress contrast than Spanish, seems to accord with expectations based on the phonetic characteristics of stress production in these languages. Thus, the result for Sicilian Italian, which was located in the same VarcoV vs %V rhythm space as Venetan Italian, may be regarded as reliable.

It is possible that there may be greater differences in rhythm scores between other varieties of Italian than those we have chosen. For example, discussing "stress-timing" in southern Italian, Russo and Barry (2004) presented evidence from the Italian of Bari and Naples. Most natives of these regions speak both Italian and the local Barese or Neapolitan dialects, and these dialects – which greatly influence the form of spoken Italian in these regions – form part of the "Upper-Meridional" group of dialects in Italy, which are distinct from the dialects of the far south, including Sicilian. Further investigation of a broader spectrum of standard Italian varieties and, for comparison, dialects, is needed to provide a clearer picture of rhythm variability in Italian.

Despite the lack of evidence for high temporal stress contrast between Sicilian and Venetan Italian, we did find a marked amplification in prosodic lengthening for Sicilian Italian. Stressed vowels in nuclear utterance-final words were more than twice as long as the same vowels in prenuclear utterance-medial words. For the same prosodic contrast, stressed vowels in Venetan Italian were lengthened by just over a third of their utterance-medial duration. It seems likely that this difference in prosodic timing would confer a more contrastive quality to Sicilian, although perceptual tests, for example using the *sasasa* resynthesis technique, would be required to determine whether such differences alone allow listeners to discriminate the two varieties. Of course, it would be expected that prosodic contrast in vowel duration would be reflected in a measure of such variation, with the greater nuclear accent/final lengthening in Sicilian contributing to a higher VarcoV score than for Venetan. However, nuclear accent/final lengthening only applies once per utterance, and thus may not have a major impact on the overall standard deviation of vocalic interval duration.

Furthermore, it may be noted that the precise nature of the lengthening effect observed here is uncertain. Because we did not want to constrain speakers' productions excessively – in the interest of generating naturalistic speech – two possible sources of lengthening were confounded: the contrast between prenuclear-accented and nuclear-accented syllables, and the contrast between utterance-medial and utterance-final syllables. This may have some relevance to rhythmic typology. Prosodic timing effects can clearly be divided into domain-head effects (e.g. stress-related lengthening, accentual lengthening) and domain-edge effects (e.g. word-initial lengthening, phrase-final lengthening). Extrapolating from the case of lexical stress, Beckman (1992) speculates that head effects tend to be specific to "stress-timed" (i.e. high temporal stress contrast) languages, whereas edge effects may be more or less ubiquitous. This contention makes distinct predictions from our contrast hypothesis,

which predicts that high temporal stress contrast languages should show more marked prosodic lengthening effects across the board (i.e. both domain-head and domain-edge effects). An obvious direction for future research would be to test the predictions of the contrast hypothesis and the heads/edges hypothesis by comparing the magnitude of domain-head and domain-edge effects in rhythmically-distinct languages or varieties.

Data from Frota and Vigário (2001) suggest that the hypothesised lower contrast ("syllable-timed") Brazilian Portuguese actually has more widespread final lengthening than higher contrast ("stress-timed") European Portuguese, a result apparently opposed to the contrast hypothesis. However, although consonant interval duration is indeed more variable in European Portuguese, scores for vowel duration variation are actually higher for Brazilian Portuguese, indicating not only that the factors contributing to rhythmic perception may be partially independent, but also that the magnitude of prosodic timing effects may be calibrated in relation to vowel rather than consonant duration patterns.

Our contrast hypothesis is quite well supported by the results for vowel reduction. We looked for evidence of more centralised articulations for unstressed vowels compared with stressed vowels and for vowels in prenuclear utterance-medial words compared with nuclear utterance-final words. We found evidence for both – centralisation in unstressed vowels and centralisation in prenuclear position – from F1 or F2 values for both /i/ and /a/, but the pattern was not wholly consistent. In all cases where we found reliable differences, however, there was greater and more reliable contrast in formant frequencies in Sicilian Italian than in Venetan Italian. In Sicilian Italian, there was also evidence for an articulatory contrast between pre-stress and post-stress syllables – greater centralisation in the latter – which was absent in Venetan.

English-speaking linguists have inferred from the relative prominence of stressed syllables in Germanic languages that stress is more perceptually salient than in Romance languages. However, as Arvaniti (1994) points out, stressed syllables are in fact highly salient to native speakers of languages like Spanish, Italian or Greek, who are sensitive to misaccentuations in minimal pairs such as the Spanish '*como* (I eat) vs *co*'*mo* (she ate). The hypothesis that rhythmic, prosodic and segmental contrasts are all attenuated in such languages fits with this observation: native speakers may have become attuned during language acquisition to expect relatively small durational differences to be linguistically meaningful, whereas speakers of high stress-contrast languages such as English or Dutch cannot perceive such fine durational distinctions in speech. This perceptual hypothesis awaits further testing.

## 5. *Conclusions*

Our results suggest that not all perceptually-salient rhythmic differences are captured by duration-based rhythm metrics, and provide a further challenge to the notion that rhythmic variation is based on categorical differences in relative durations. Furthermore, they suggest that the perception of rhythmic variation may be determined by a combination of factors including syllable structure, segmental and prosodic timing, and the relationship between prosodic structure and vowel and consonant fortition/lenition. Syntagmatic differences in stress distribution between languages, not examined here, may also be a covariate. The cumulative effect of these factors produces rhythmic templates which are variety-specific but may cluster, at least perceptually, around rhythmic types.

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