

DANIELE SANTINI, GIOVANNA LENOCI, GIOVANNA MAROTTA,
PIER MARCO BERTINETTO

Repeated Vowels in Italian: An exploratory study

This paper addresses the articulatory realization of repeated identical vowels in Italian, such as they exist in root-internal position (e.g. *coorte* ‘cohort’, *Sabara* ‘id.’) or across a morpheme boundary (*atee* ‘atheists.F’, *coordinare* ‘to coordinate’). In structural terms, these vowel sequences give rise to a hiatus, but their actual realization is variable. At fast speech rate, they may collapse into a single vowel also in terms of total duration. In careful speech, however, they retain a much longer duration than their single vowel counterparts (cf. *corte* ‘court’, *Sara* ‘id.’). In addition, and crucially for our purpose, they may exhibit some hints at rearticulation at the boundary between the first and the second vowel. Some evidence that this may indeed occur was found by means of the UTI technique in a corpus of carefully produced speech.

Key words: repeated identical vowels, hiatus, Ultrasound Tongue Imaging (UTI), articulation.

1. Introduction

The Italian phonotactics admits quite a number of abutting vocoids, i.e. both true vowels and vocoidal approximants. In Italian, the difference between these two kinds of segments is not particularly large in terms of phonetics, but is quite remarkable vis-à-vis their function in syllable structure, where (for most theorists) only true vowels can be part of the nucleus. Regarding phonemic interpretation, one has to distinguish between hiatuses and diphthongs (or, more rarely, triphthongs, as in *continuiamo* /kon.ti.'nwja.mo/). The latter canonically involve the approximants /j w/, although not all sequences of a high vocoid and a vowel should be so analyzed. In particular, whenever a high vocoid is stressed, it must be a syllable nucleus, instead of an on/off-glide (e.g., *sfarfallio* ‘flickering’ and *bue* ‘ox’, with stress on, respectively, /i/ and /u/). Actually, as various authors have noted (Bertinetto, 1981: 158; Marotta, 1985; 1987; 1988; 2010a; 2010b; Bertinetto, Loporcaro, 2005), the decision about the actual phonemic interpretation can in some cases depend on speech rate, with faster rates favouring the diphthongization of a len-to speech hiatus. This may create, for some words, a sort of incumbent ambiguity, because the speed parameter is inherently gradual, despite the all-or-none nature of the phonemic status. Indeed, the possible ambiguity between diphthong and hiatus has often been exploited in traditional Italian poetry, by means of the opposing devices of synaloepha and dieresis, respectively turning a hiatus into a diphthong, and a diphthong into a hiatus. The latter is, admittedly, a more artificial phenomenon, only pertaining to the domain of metrical performance, yet it is massively present in the versification of the major Italian poets. Consider, for example, the following

two lines from Foscolo's sonnet *Alla sera* 'To the evening', which feature dieresis on *quiete* 'stillness' and synaloepha on *reo* 'guilty' and *lui* 'he/him':

Forse perché della fatal quiete (line 1)
questo reo tempo, e van con lui le torme (line 11)

It is important to observe that synaloepha can arise even in the absence of high vocoids (as in *reo* above), which would be the natural candidates to the role of vocoidal approximant. A special case of often ambiguous treatment can also be found at the boundary between a vowel-ending prefix and a vowel-initial root, where the propensity to give rise to a diphthong, once again irrespective of the nature of the vocoids concerned, depends (besides speech rate) on the degree of familiarity (Bertinetto, Gili Fivela, 1999: 134). Indeed, *coabitare* 'to coinhabit' has a higher chance to be considered a four-syllabic word than *coibentare* 'to insulate (w.r.t. temperature)', despite the presence of an unstressed high vocoid in the latter word.

Vocoidal sequences occur with considerable frequency in Italian. Marotta (1985) reports the results of a count based on the 1984 edition of the Ragazzini Dictionary of the Italian language, which yielded 17121 lemmas with two or more adjacent vocalic graphemes, disregarding purely orthographic (hence not phonemic) <i>. This corresponds to slightly more than 30% of the whole data-base used, consisting of 56359 entries. Salza (1986), as reported in Salza (1991), states that the Italian lexicon contains up to 167 different vocoidal combinations (106 bi-, 45 tri-, e 16 tetra-vocoidal combinations).

Needless to say, the various combinations of vowels occur with different frequency, and some of them are definitely dispreferred. In particular, and in agreement with a strong universal tendency, no Italian diphthong consists of homorganic vocoids (hence, */ji ij wu uw/). More generally, according to Chiari (2002: 221), the overall number of hiatuses in Italian is not very large. Despite this, the Italian lexicon admits the existence of hiatuses in a number of cases, of which Marotta (1987: 870) itemizes the most relevant ones. Such sequences can of course also arise postlexically at word boundaries, with variable phonetic consequences, such as elision or creation of (possibly non-canonical) diphthongs (Marotta, Sorianello, 1997).

The special topic addressed in this investigation is the phenomenon of abutting identical vowels, that we shall call 'repeated vowels', whose actual realization is a matter of performance variability. They can also be created postlexically at word boundaries (as in *buona amica* 'good.F friend.F'), often giving rise to elision. In this paper we concentrate, however, on word-internal repeated vowels, of the sort that one can find root-internally in words such as *Sabara* 'id.' and *coorte* 'cohort', or across a morphological boundary in words such as *atrii* 'entrance halls' and *atee* 'atheists.F'. The frequency of such sequences varies (Viviani, 2011):

- <aa> and <uu>¹ are definitely rare, with the latter one only found in words of Latin origin (*perpetuum*);

¹ In the first part of this paper we transcribe repeated middle vowels as orthographic sequences (by means of angled brackets), because their phonemic implementation can vary, both between words and across Italian dialects. But see §2.1 for further qualifications.

- <oo> is slightly more frequent, but this is mostly due to the word *zoo* ‘id.’ in its function as either prefixoid (*zoologico* ‘zoological’) or as member of a compound (*protozoo* ‘protozoa’); in addition, it can be found in words containing the prefix *co-* (*cooperare* ‘to cooperate’, *cooptare* ‘to coopt’);
- <ee> is comparatively more frequent, considering the plural of feminine nouns ending in *-ea* (*maree* ‘tides’) or the feminine plural of adjectives with masculine singular in *-eo* (*atee* ‘atheists.F’);
- similarly, <ii> is mostly found in the plural of words ending in *-io*, provided <i> marks a true vocoid rather than being a mere orthographic marker of palatality, and to the extent that this sequence is not reduced, which is often the case in unstressed position (cf. *negozio/negozi* ‘shop/-s’, as opposed to *zio/zii* ‘uncle/-s’); moreover, <ii> can occur in the preterite first person singular of third conjugation verbs (*partii* ‘I left’).

As the last examples show, stress location can have a strong impact on the phonetic realization of a repeated vowels sequence. Stress on the first <i> of *zii* and *partii* contributes to hiatus preservation, whereas lack of (primary) stress on <oo> in *zoologico* and *cooperare* may pave the way, at very fast rate, to reduction to a single vowel, which is indeed the normal fate of *negozio/negozi* ‘shop/-s’ and similar words (*monopolio* ‘monopoly’, *cappio* ‘noose’ etc.).

When a sequence of identical vocoids consists of true vowels, it gives rise, structurally speaking, to a hiatus, i.e. a disyllabic sequence. Actually, Valesio (1967) interpreted such sequences as phonologically long vowels, but to our knowledge this position has not been shared by any later study, since the absence of phonemic vowel quantity in the Italian phonology is unanimously assumed as a solid fact. But although the phonological interpretation of identical repeated vowels is not an issue, their phonetic realization remains a poorly investigated topic. As far as we know, this is the first study addressing it from the articulatory point of view.

In a nutshell, the research questions that we set to ourselves were:

RQ1: Do repeated vowels differ in terms of duration vis-à-vis the corresponding single vowels (at least in carefully produced speech)?

RQ2: Are there any hints of a sort of ‘rearticulation’ at the boundary between two repeated vowels?

RQ3: Can an Ultrasound Tongue Imaging (henceforth, UTI) analysis effectively enhance our knowledge about sequences of identical vowels?

2. Method

2.1 Corpus

As precondition of this work, a list of words containing repeated vowels (thus, excluding diphthongs) was built, with each word contrasted with a similar one presenting a single vowel in the same (or at least very similar) phonotactic environment

(e.g.: *Sabara* 'id.' ~ *Sara* 'id.', *coorte* 'cohort' ~ *corte* 'court', *ree* 'guilty.F.PL' ~ *re* 'king'). This allows one to compare the acoustic and articulatory production of /VV/ ~ /V/ (where /VV/ should be read, here and in the remaining of this paper, as /V_xV_x/). In addition, with respect to stress position, the list contained three types of /VV/ hiatus: Unstressed (N 10), Stressed on V1 (N 10), and Stressed on V2 (N 8). Table 1 reports the whole corpus. Since all target sequences consist of true vowels, from now on we will place them within slashes to underline their phonemic status.

It was initially decided to analyze one pair for each type in Table 1. Where we had to make a choice, we gave precedence to the most frequent and familiar words (for example, *sciita* ~ *gita* was preferred to *piissimo* ~ *Trissino*). In just one case we selected two pairs (*veemente* ~ *demente*, *linee* ~ *trine*) because their frequency and familiarity was considered roughly comparable. Among these initially selected items, we took into further consideration only those in which the comparative evolution of the articulatory gesture for the single and the repeated vowels presented significant differences. These were detected through visual inspection of the splines generated by the UTI equipment; all authors took part in this procedure. We thus selected the following 13 pairs: *corte* ~ *coorte* (speakers 2, 3, 6), *là* ~ *Laa* (speakers 2, 3, 4, 6), *re* ~ *ree* (speakers 2, 4, 6), *spinetta* ~ *lineetta* (speakers 4, 6), *atri* ~ *patrii* (speaker 6), *numero* ~ *duumviro* (speakers 4, 6). Considering that each pair was produced by 6 speakers, our selection consisted of 13% of the initial corpus. Due to space limitations, in this paper we will only present the pairs *là* ~ *Laa* (speaker 2); *re* ~ *ree* (speaker 4); *atri* ~ *patrii* (speaker 6); *corte* ~ *coorte* (speaker 3); *numero* ~ *duumviro* (speaker 4).

2.2 Participants

The list of stimuli was read by 6 participants, all born and raised in northern Italy. This choice was made because speakers of central Italy distinguish the quality of stressed middle vowels according to etymological criteria, as e.g. in *ree* [rɛɛ] 'guilty.F.PL' or *ninfee* [nim'fɛ:ɛ] 'water lilies', whereas for speakers of northern Italy (except the Veneto area) the quality of such vowels merely depends on phonotactic reasons and, crucially for our purposes, does not vary between the stressed and the unstressed vowel in the /'VV/ and /V'V/ sequences of our corpus. This precaution allows us to confidently use, in the remaining of this paper, a trustworthy phonemic representation also for the middle vowels /e o/. The participants (5 females and 1 male) were from Lombardia (3), Piemonte (2) and Liguria (1). Their ages at the time of the recordings were in the range 21 to 24 years. They all had university education; they had a clear pronunciation and no one presented heavy dialect features. Since, however, the performance of two of them was judged not perfectly satisfactory on all tokens produced, the analyses were only carried out on the 4 best speakers.

The subjects were instructed to read the whole list three times at comfortable pace, with no emphasis whatsoever. They also read twice the same target words as included in short sentences, although the articulatory analysis of repeated *vs* single vowels in sentence context has not yet been carried out. Hence, the duration data reported below for /VV/ ~ /V/ refer to isolated words (see § 3.1).

Table 1 - *Experimental list of words contrasting repeated (left) vs single vowels (right), divided by stress configuration*

UNSTRESSED HIATUS		UNSTRESSED VOWEL	
/ii/	<i>patrii</i> 'pertaining to motherland (M.PL), <i>arbitrii</i> 'arbitrary acts'	vs /i/	<i>atri</i> 'entrance halls, <i>ladri</i> 'thieves'
/ee/	<i>linee</i> 'lines, <i>veemente</i> 'vehement'	vs /e/	<i>trine</i> 'ornamental laces, <i>demente</i> 'demented'
/aa/	<i>sahariano</i> 'Saharian, <i>Nausicaa</i> '(person name)'	vs /a/	<i>Mariano</i> '(person name), <i>Marica</i> '(person name)'
/oo/	<i>cooptare</i> 'to coopt, <i>coordinare</i> 'to coordinate, <i>Alcinoo</i> '(person name)'	vs /o/	<i>lottare</i> 'to fight, <i>scorporare</i> 'to extract'
/uu/	<i>duumvirato</i> 'duumvirate'	vs /u/	<i>duplicato</i> 'duplicate(d)'
STRESSED HIATUS ON V1		STRESSED VOWEL	
/ii/	<i>sentii</i> 'I felt, <i>addii</i> 'farewells, <i>pii</i> 'pious.M.PL, <i>trii</i> 'trios, <i>rimii</i> 'deferments'	vs /i/	<i>senti</i> 's/he felt, <i>addi</i> 'on the date, <i>pipi</i> 'pee'
/ee/	<i>ree</i> 'guiltiy.F.PL, <i>cee</i> 'eel's newborns, <i>dee</i> 'goddesses'	vs /e/	<i>re</i> 'king, <i>c'è</i> 'there is'
/aa/	<i>Laa</i> '(person name)'	vs /a/	<i>là</i> 'there'
/oo/	<i>Coo</i> '(person name)'	vs /o/	<i>Po</i> '(river name)'
/uu/	...	vs /u/	...
STRESSED HIATUS ON V2		STRESSED VOWEL	
/ii/	<i>piissimo</i> 'very pious, <i>sciita</i> 'Shiite'	vs /i/	<i>Trissino</i> '(person name), <i>gita</i> 'excursion'
/ee/	<i>lineetta</i> 'small line'	vs /e/	<i>spinetta</i> 'spinet, <i>Linetta</i> 'little Lina (person name)'
/aa/	<i>Sahara</i> 'id.'	vs /a/	<i>Sara</i> 'id.'
/oo/	<i>coorte</i> 'cohort, (io) <i>coopto</i> 'I coopt, <i>Laocoonte</i> '(person name)'	vs /o/	<i>corte</i> 'court, <i>copto</i> 'coptic, <i>arconte</i> 'archon'
/uu/	<i>duumviro</i> 'duumvir'	vs /u/	<i>numero</i> 'number'

2.3 Experimental Procedure

The recordings were carried out in the anechoic booth of the ELiTe section of the SMART lab of Scuola Normale Superiore, Pisa. Prior to that, the participants were familiarized with the task and the experimental procedure. They were assisted to wear a helmet (Articulate Stabilisation Headset, produced by Articulate Instruments Ltd., 2008) to which a micro-convex ultrasound probe was attached (Mindray probe 65EC10EA). This guaranteed controlled distance and orientation of the probe with respect to the palate of the speaker independently of head movements. The probe was held under the chin and yielded a mid-sagittal configuration of the tongue (Fig. 1).

The ultrasound images generated by a Mindray UTI system were acquired at a frequency rate of 60 MHz and synchronized with the audio signal through a syn-

chronization unit (Synch Bright-up unit). The speakers were asked to read the list of the stimuli, with three repetitions of each item in pseudo-random order. The UTI recording session lasted approximately 40 mins and all subjects successfully completed the task. The ultrasound data were recorded and analyzed by the Articulated Assistant Advanced software (AAA; Articulate Instruments Ltd., 2007).

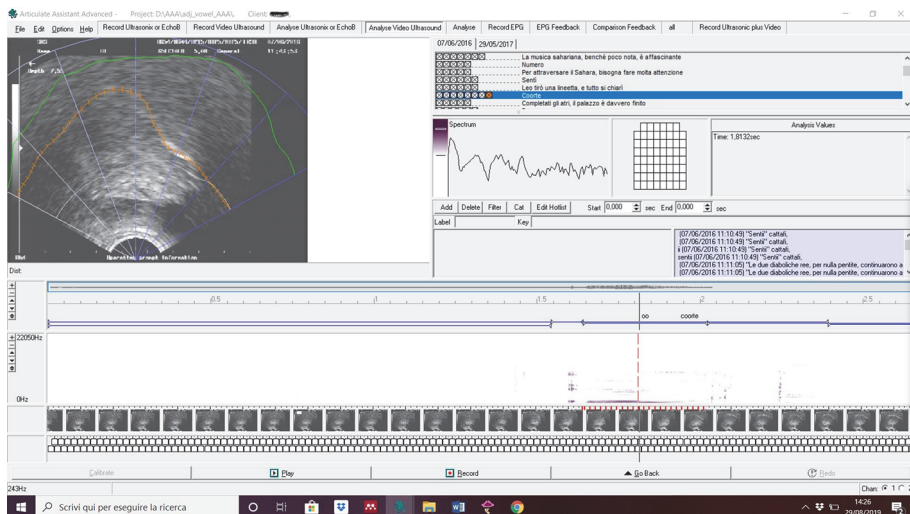
2.4 Analysis

For each participant and each /VV~/V/ sequence, all items were first auditorily inspected for correct pronunciation. No production had to be rejected.

First, by means of the Praat facility (Boersma, Weenink, 2001), all target vowels were segmented on the acoustic signal and labelled appropriately. Conventional manual segmentation (Salza, 1990) criteria were used to measure vowel duration, taking into account the first and last glottal pulse of the relevant intervals.

The annotations were then imported into the AAA software for articulatory processing. At each sampling point within the acoustic interval of the target vowels, a semi-automatic tongue contour (splining), with subsequent manual correction, was fitted to the UTI images. The splines were plotted into the AAA workspace for qualitative analysis of the dynamic evolution of the tongue gesture. Vowel durations were computed by means of the AAA 'Export data' function.

Figure 1 - AAA window showing, at the bottom, the spectrogram with phonetic labelling and segmentation of an /oo/ sequence; at the top, the ultrasound frame (and the corresponding spline) of the tongue at the selected UTI frame, as produced by a single speaker



3. Results

The research questions of the present work, as itemized at the end of §1, converge on the goal of finding out whether there is any difference in the phonetic realization

of repeated *vs* single vowels, at least in carefully produced laboratory speech. To this purpose, two kinds of analyses were designed:

1. an acoustic analysis of the vowel interval durations (§ 5.1);
2. a qualitative examination of UTI images (§ 5.2), to find out whether there are any hints at a sort of 'rearticulation' within the repeated vowels interval.

3.1 Measure of durations

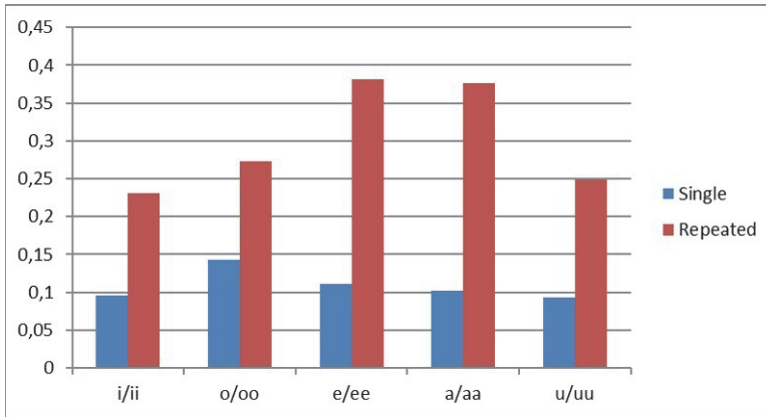
For each speaker, we calculated the mean vowel duration (in ms) of the three repetitions of each isolated item. To allow the comparisons between /VV/ ~ /V/, the acoustic data of all participants were pooled together in the analysis (Figure 2) and compared within each single *vs* repeated vowel pair (Table 2). An anonymous reviewer suggested to us to normalize the individual absolute durations. However, considering the small number of observations and, most importantly, the consistent convergence of the individual behaviours, we prefer to leave this move to a future expansion of this investigation.

Table 2 - *Number of tokens (3 repetitions for each of the 4 selected speakers), mean and standard deviation of /V/ and /VV/ durations (in ms) for each vowel pair. P-value indicate the significance level of the t-test*

/V/ ~ /VV/	N	Mean (ms)	p-value
/a/	12	0.102 ± 0.035	
/aa/	12	0.378 ± 0.081	***
/e/	12	0.105 ± 0.034	
/ee/	12	0.381 ± 0.058	***
/i/	12	0.096 ± 0.045	
/ii/	12	0.231 ± 0.055	***
/u/	12	0.094 ± 0.029	
/uu/	12	0.249 ± 0.028	***
/o/	12	0.143 ± 0.037	
/oo/	12	0.272 ± 0.030	***

With the partial exception of /oo/ ~ /o/, the average duration of the single vowels is less than half the average duration of their repeated counterpart (Fig. 2). The t-test analyses show that these differences are statistically significant ($p < .001$).

Figure 2 - Compared average duration for single (blue) and repeated vowels (red)



This result is confirmed by the analysis performed on the same items as produced by the same speakers in sentence context: the average /V/ ~ /VV/ ratio across all vowels and speakers is 0,54 in sentence context, as against 0,38 in isolated words. Hence, although the duration contrast between repeated *vs* single vowels is predictably less sharp in sentence context, it is nevertheless quite robust in the corpus used.

3.2 Articulatory analyses

In this section we present the results of the qualitative inspection of the selected UTI images collected from the individual speakers. For space reasons, we only report a few representative graphs of the comparisons between the /V/ ~ /VV/ tongue profiles. Since the UTI and audio signals were synchronized, the tongue profiles follow the temporal evolution of the gesture: the blue and green lines refer, respectively, to the initial and final phase of the articulation, while the red lines refer to the middle phase. Furthermore, the blue and green thick dotted lines indicate the absolute first and absolute last profile in the vowel interval. The respective number of profiles differs for single *vs* repeated vowels, because the /V/ interval is of course significantly shorter. However, in order to make the visual inspection easier, in the repeated vowels figures we only reported one spline every second one. For this reason, the distance between two successive profiles is 16 ms in the /V/ figures, and 32 ms in the /VV/ ones. To help the reader in the inspection of the actual gestural evolution, we added numbers in the repeated vowel figures to mirror the progression of the actual splines (only odd numbers are shown, because we report one profile every second one).

Figure 3 presents the tongue splines for the pair /e/ ~ /ee/ in the words *re* 'king' (top) and *ree* guilty.F.PL' (bottom). As can be seen, the tongue tip and body remains approximately stable during the entire articulatory gesture of the single vowel (*re*), while the root shows progressively less peripherality, although the displacement is relatively small. The overall gesture of the repeated vowels (*ree*) appears to be more mobile and, above all, it exhibits detectable signs of rearticulation. While

the tongue tip gesture shows progressive centralization, the body expands at first its peripherality, but then turns to a slightly more centralized position; similarly, and most significantly, the tongue root reaches its most centralized position in the middle portion of the /VV/ interval to then exhibit a kind of backward movement towards the end, witnessing a tendential rearticulation of the gesture.

Figure 3 - *Tongue splines (with tongue tip to the right of the images and tongue root to the left) for the single vowel /e/ (top) and the repeated vowels /ee/ (bottom) as produced by speaker 4. The numbers in the repeated vowel figure, indicate the temporal progression of the tongue gestures. See the beginning of § 3.2 for further details*

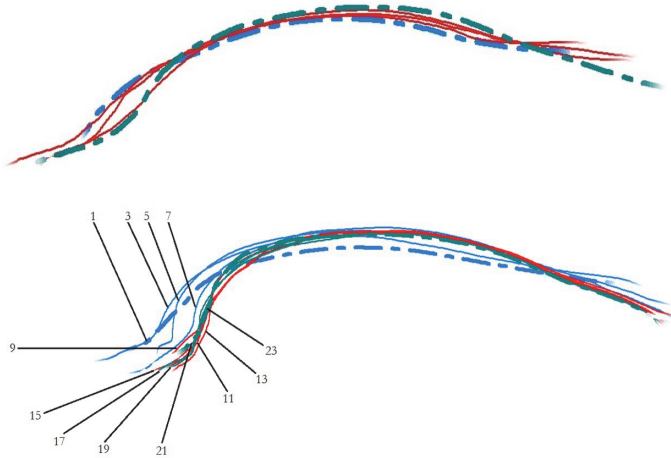


Figure 4 compares the tongue dynamics for /a/ ~ /aa/ in *là* ‘there’ (top) and *Laa* ‘(person name)’ (bottom). The tongue gesture for the single vowel appears to be quite dynamic: the tongue tip is initially higher, due to coarticulatory effects, to lower and remain stable throughout the middle and final part of the gesture, while the root, and even more the body, rise to a peripheral position. In the repeated vowels, the tongue tip follows the same pattern as the single vowel, again owing to coarticulatory reasons, while the body and the root are very dynamic and show some hint at rearticulation. The body starts from a lower position, travels towards the peripheral space in the central phase of the gesture and then slightly moves back during the final phase; the root also starts from a more central position and reaches topmost peripherality during the central phase, to then return to the initial position in the final phase.

Figure 4 - Tongue splines (tongue tip to the right) for the single vowel /a/ (top) and the repeated vowels /aa/ (bottom) as produced by speaker 2

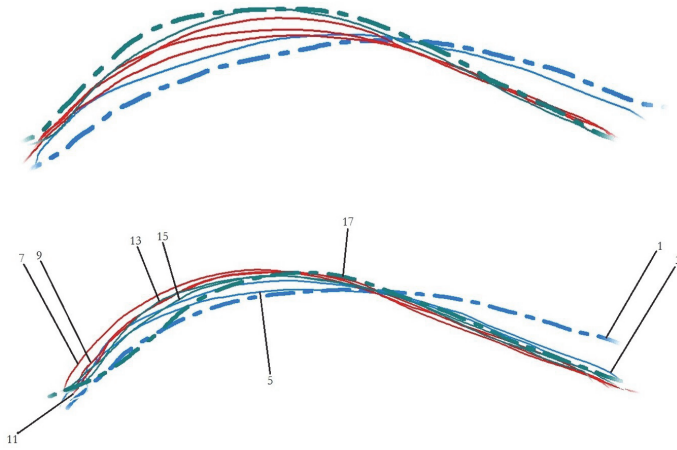


Figure 5 compares the tongue dynamics for the pair /i/ ~ /ii/ in *atri* ‘entrance halls’ (top) and *patrii* ‘pertaining to motherland (M.PL)’ (bottom). For the single vowel, a limited tongue movement can be observed in the root, with more peripherality in the initial phase, which then decreases as the gesture unfolds. As for the body and tip, they remain relatively stable during the whole gesture. A similar trend can be observed for the repeated vowels counterpart: the tongue root shows the highest dynamism, moving from a more peripheral position to a less peripheral one in the middle of the interval, to then rise again at the end (unlike its single counterpart). The body and tip of the tongue show a rather stable pattern during the whole gesture, with however a slightly higher degree of peripherality in the middle of the interval, which confirms the tendency towards rearticulation.

Figure 5 - Tongue splines (tongue tip to the right) for the single vowel /i/ (top) and the repeated vowels /ii/ (bottom) as produced by speaker 6

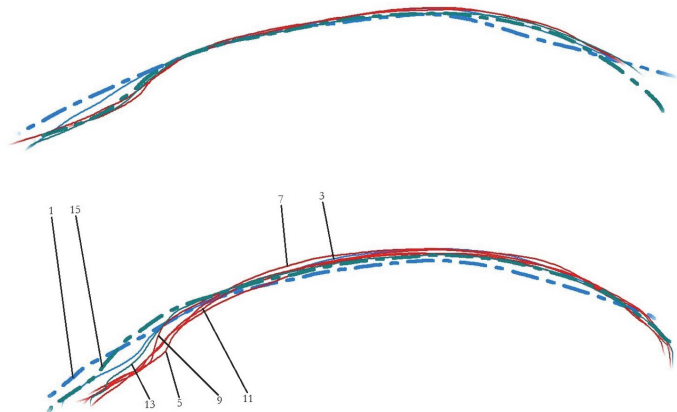
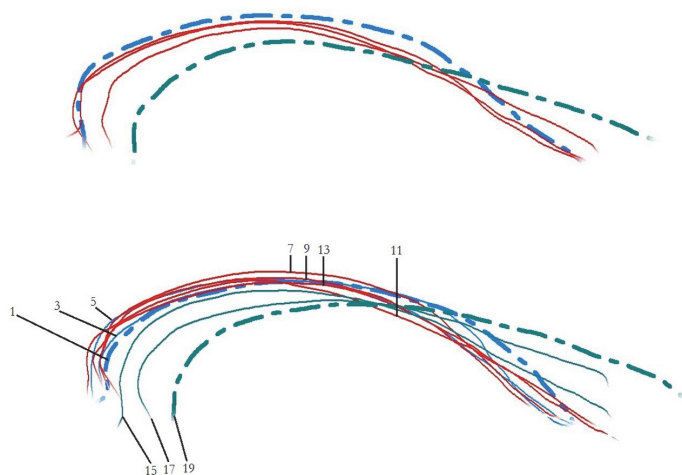


Figure 6, comparing the tongue dynamics for the pair /o/ ~ /oo/ in *corte* ‘court’ (top) and *coorte* ‘cohort’ (bottom), offers the most striking example of gestural rearticulation. With the single vowel /o/, the tip of the tongue shows a stable movement from less to more peripheral, coupled with a symmetrically opposite movement of the body and the root. With the repeated vowels, the gestural dynamics exhibits a similarly opposite movement of the tip as opposed to body and root, but in addition it shows a remarkable rearticulation in the middle phase of the gesture, which overcomes the absolute initial position (see the red central profiles as contrasted with the blue dotted line).

Figure 6 - Tongue splines (tongue tip to the right) for the single vowel /o/ (top) and the repeated vowels /oo/ (bottom) as produced by speaker 3



4. Discussion and conclusion

The durational data reported in § 3.1 provide a positive answer to the first research question (RQ1) announced at the beginning of this paper. Similarly, the data reported in § 3.2 add a positive answer to RQ2, lending support to the hypothesis that the repetition of two adjacent identical vowels may give rise, in Italian, to a detectable gestural rearticulation, approximately occurring in the middle portion of the whole vowel interval. When this occurs, the speaker adjusts the articulators so as to partially restart the gesture. We can thus safely state that, at least in careful pronunciation, the gestural dynamics underlying the production of Italian repeated identical vowels should not be interpreted as the mere prolongation of the corresponding single vowel gesture.

Needless to say, not all production tokens are equally explicit in this respect and this lack of systematicity invites some caution. First of all, the corpus used for our investigation consists of carefully produced speech. At faster rates, and above all in hypoarticulated speech, it is unlikely that the same results would arise. Besides, even in our carefully articulated speech not all instances showed the same amount

of rearticulation. As observed in § 2.1, the most remarkable instances amounted to a mere 13% of the produced tokens. Although this should not be intended in the sense that 87% of the tokens exhibited no evidence thereof, it is nevertheless apparent that not all rearticulation gestures were equally notable. Nevertheless, since the one at stake is a gradual phenomenon, we surmise that, by means of more refined methods of investigations, the articulatory contrast underlying /VV/~V/ may be effectively measured in a much larger proportion of cases. What one has to consider, at any rate, is the fact that the articulatory difference between repeated and single vowels should not be seen in terms of dynamic *vs* static articulation, but rather in the presence *vs* absence of a specific type of articulatory dynamics in the middle portion of the vowel interval. The extent to which this behaviour is typical of the Italian speakers, as opposed to speakers of other languages, is a matter to which we cannot provide an answer at the present stage, in the absence of specifically designed contrastive studies.

A further matter of caution concerns the variable phonotactic structure of our experimental items, with regard to both the preceding and the following consonant (or consonant cluster). The only way to overcome this problem would consist in using a set of non-words, with strictly controlled phonotactics. However, this would introduce a high degree of artificiality, which would deplete the very essence of our research enterprise. As is well-known, real words give rise to deep-rooted articulatory routines, unlikely to be activated by non-words. This is especially the case for frequent words, as some influential authors have shown (see at least Bybee, Hopper, 2001 and Pierrehumbert, 2002).

The limited goal of this investigation was, at any rate, to prove that the gesture underlying repeated vowels should not be understood as a mere prolongation of the corresponding single vowel gesture, and from this point of view the results can be seen as quite conclusive. Although mere gestural prolongation cannot be excluded in all instances, especially so in fast speech, we found solid evidence that Italian speakers show some tendency to produce two successive vowel gestures, rather than simply keeping a single gesture for a longer duration. However, we prefer to speak of 'rearticulation' instead of referring to two separate articulatory targets, because all we can detect is a partial gestural reorientation, rather than two successive gestures.

Since the UTI technique proved successful in detecting observable differences between /VV/ and /V/ words, we can conclude that also RQ3 received a positive answer. However, one should observe that the experimental technique used here only allows inspection of the supralaryngeal activity. Further research should investigate what happens at the laryngeal level, where specific adjustments might occur. We hope to be able to address this issue in future work by synchronizing UTI with laryngographic analysis.

In addition, it will also be advisable to extend the investigation to words uttered in (semi-)spontaneous speech. Finally, it is necessary to investigate the role of stress. As the reported examples show, stress may fall on the first vowel (e.g. *ree*), on the second one (e.g. *coorte*), or on neither (e.g. *atrii*). This may have consequences on

the overall gestural evolution, and indeed we have some initial evidence that this might be the case. Since, however, we could only compare different vowels in different phonotactic and prosodic positions, for the time being we cannot draw any solid generalization.

Note, finally, that when the second repeated vowel coincides with a morpheme marker (as in *re-e* 'guilty-F.PL'), there might be a stronger tendency to protect its articulatory salience, as compared to morpheme-internal /VV/ sequences. Ideally, within a larger corpus, also based on more speakers and more repetitions per speaker, one could make use of mixed statistical models to pinpoint the individual contribution of the various factors involved.

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