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Context and co-text influence on the accuracy production of Italian L2 non-native sounds

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Abstract

Accuracy in production of non-native sounds is analyzed by considering the influence of L1, context and co-text on Italian L2 speech. While the L1 influence is often described in the literature, careful investigations on how production accuracy may change in different contexts and co-texts are needed. This paper describes two experiments on how French learners of Italian as L2 (advanced/beginners) realize geminates depending on different contexts (the global contexts, e.g., the tasks) and co-texts (the amount of information available syntagmatically).

Acoustic data acquired by recording 4 advanced and 4 beginner Italian-L2 learners (and 3 Italian natives as control) were analyzed as for the duration of the target consonant and preceding vowel, as well as speech articulation rate, taken as indexes of geminate production accuracy.

Results confirm the strongest influence of L1 in beginners' production, and depict a complex interplay of context and co-text. Adding information in co-text may induce different effects on speech production, depending on the local context, that is on the speakers' communication needs during speech production. Specifically, a "rich" co-text may favor a decrease in production accuracy or, on the contrary, an increase, depending on the need the speaker have to highlight/contrast information.

Index Terms: Italian-L2 geminates, context, co-text, speech accuracy

1. Introduction

In Italian, the duration of consonants is a linguistically relevant cue, as words differ in their meaning in case a singleton (C) or a geminate (CC) consonant appears [1]. The duration of the preceding vowel also changes, with shorter vowels followed by CC and longer vowels before C [1,2,3]. Contrary to Italian, French does not show consonant gemination (except for the uvular approximant for the opposition between the imperfect tense and the conditional mood; e.g., *pourait vs. pourrait*) [4]. For this reason, the production of CCs may be problematic for French learners of Italian L2, possibly depending on their proficiency level being a factor that can have an impact on non-native sounds pronunciation [5, 15, 16]. The accuracy in speech production may be observed paying attention on how specific target words are produced as well as on the effort required in production, which may influence speech articulation rate.

However, the context in which communication takes place and the information available to speakers affect speech production and are exploited in speech comprehension, as they play a role in the coding and decoding of the linguistic message (see the Hypo- & Hyper-speech theory [7]). It is quite complex to define what the context and the information available are. In [8], for instance, a distinction is made between a global and a local context. The global context is given *a priori*, it refers to the setting in which the communication takes place, the participants' role, the surrounding situation in which "a word" is used [8]; in experimental terms, we could take it as the experimental task. The local context is built by the ongoing sharing of information between speakers. Among the information available to speakers, we also identify the co-text, that is the linguistic environment of a word [9] or the information syntagmatically available in the text. In this respect, the co-textual information available affects, or builds, the local context independently of the global one. Thus, both the context (the task), and the co- text may be relevant in speech production and perception [8], affecting also L2 speech.

Given the role of context and co-text in speech production and perception, it is clear that we do not only rely on speech accuracy to reach our communication goals. It is also clear that our accuracy may change. Thus, it would be interesting to understand the impact of the context and co-text on speech and its efficacy. As far as English is concerned, some works in the literature report that phonetic and phonological errors affect only about 22% of L2 speech comprehension [10,11]. Thus, a question arises if there is an impact of context and co-text on L2 speech, which could possibly also put the above-mentioned percentages under a different light. For instance, a lower degree of accuracy in Italian L2 geminates may depend on the global context as well as on the amount of information available in co-text, with a different actual impact on the coding of Italian words and sentences. Along the same line, a lack in accuracy may not have the same impact in the recovering of meaning across different contexts and co-texts.

Within a wider project focusing on both production and perception, in this paper we focus on the former and check if and how context and/or co-text affect accuracy in L2 productions by learners characterized by a different level of proficiency, exposure to and use of the Italian L2.

2. Goals and hypotheses

The main goal of the study is to investigate the production accuracy of L2 geminates, by observing a) the relation between two different phonetic-phonological systems (here, French L1 and Italian L2), and paying attention to b) speakers with different proficiency levels in Italian L2 (beginners and advanced learners), and c) different contexts (here the tasks), and co-text (here the richness or lack of information available syntagmatically). As for a) it is hypothesized that French learners may reduce CCs to Cs, due to the influence of their L1 system, especially in the case of b) beginners. As for c), in general a greater accuracy is expected in simpler tasks (global context), and when the co-text information creates a local context that requires a stronger effort and attention on behalf of the speakers in order to convey the message without

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ambiguity. Overall, the segment duration is considered as an index of speech accuracy, as well as articulation rate, being related to the effort due to speech accuracy.

3. Method

Eleven subjects participated in the experiment (females, age 21-26). Namely, eight French learners of Italian L2 were recruited among the Erasmus students at University of Salento. They were divided into 2 groups, that is beginner (4, 3 from Nantes,1 from Nancy) and advanced learners (4, 2 from Nancy, 2 from Paris) on the basis of their previous knowledge of Italian and of the exposure to Italian variety spoken in Lecce (Southern Italy) and on the amount of time they had spent in Italy during their stay. Beginners studied Italian up to 2 years, they were recorded after 3-4 months from arrival and during their stay they preferred to speak in English; while advanced had studied Italian from 5 to 7 years, they were recorded 5-6 months after arrival and they were used to speak in Italian during their stay. A control group of Italian L1 University students was also included (3 Maglie, Lecce).

The phonemes of interest were /t, d, s, n, l, r/, both as singletons (C) and geminates (CC), where only /r/ is not shared by the two phonological systems (French rather shows /ʁ/). For each phoneme, two minimal pairs were found among frequent real words which are part of the vocabulary of our subjects (except for /d/, which only shows one minimal pair).

Two tasks were designed. Task I was a simple task, in which subjects were asked to read aloud one word or two consecutive words; task II was a more complex task, in which subjects were asked to read and understand a question in order to adequately reply, by reading aloud the related answer. In each task, both a poor and a rich co-text was proposed. In the poor co-text, there was no information available, besides orthography, on the target word meaning; the target word, that is one of the two members of the minimal pair chosen in relation to C/CC target consonant, was elicited as single word (Task I) or within a carrier sentence (Task II). On the contrary, additional information was added in the rich co-text, as both members of the minimal pairs were read aloud (to favour their differentiation, Task I) or the question induced the reader to select one member because of its meaning (Task II).

Table 1: *Sample of context and co-text conditions*

Context	**Co-text**	**Examples**
Task I	poor	se[t]e *thirst* se[tt]e *seven*
	rich	se[t]e, se[tt]e *thirst, seven*
Task II	poor	Cosa hai detto? Ho detto a Maria **sete**/**sette** di nuovo *What did you say?* *I told Mary thirst/seven again*
	rich	Qual è il tuo numero fortunato? Il **sette** è il mio numero fortunato *What is your lucky number? My lucky number is seven* Perché bevi così tanto? Dopo la corsa ho una **sete** incredibile *Why do you drink so much water? After running I have an exaggerated thirst*

A perceptual check was performed by both authors, who independently verified the realization of singletons and geminates. Acoustic data were then segmented in PRAAT [12] in order to segment and label boundaries of phrase and word within sentences, and segmental boundaries within the sequence /'C1V1C2V2/ (where C2 was C or CC). Acoustic measures were related to: a) the normalized duration of both the target consonant C2 and the preceding vowel V1 (target segment duration/word duration), and b) the articulation rate (AR, number of syllables/word duration).

As for statistical tests, mixed models were performed using the lme4 package [13] for R [14]. P-values were obtained using the chi-square test implemented in the *Anova()* function. For statistical analysis in task I (4.1) and II (4.2), fixed factors were subject group (beginner, advanced and native), phoneme (/l, n, r, d, t, s/), sequence (C *vs* CC) and co-text (poor *vs* rich). Analysis in 4.3 were run separately as for the poor and the rich co-text, adding the context as a factor (task I *vs* task II). Random effects were speakers as random intercept and random slope with co-text or context. Significance ($p<0,05$) was assessed using the Likelihood ratio and the pairwise comparisons were conducted using the Tukey test. Due to word limit restrictions, we omit the statistical results concerning the phoneme factor, which is always significant.

4. Results

4.1. Task I

Apart from natives, who always realize CCs and Cs accurately, the perceptual check showed that beginners realize a greater number of degemination in both co-texts (poor= 34.85 %; rich= 37.12%) as well as gemination cases (poor= 29.55%; rich= 15.16%); advanced learners are more accurate, showing lower percentages for both degemination (poor= 1.52%; rich=6.06%) and gemination (poor=21.21%, rich=11.36%). For both learning groups, the realization of Cs improves from poor to rich co-text, as the rich co-text facilitates disambiguation between CCs and Cs.

Table 2: *Percentages of realization of CC and C inpoor and rich co-text by learners.*

Co-text	**Poor – Task I**			
Sequence	Geminate		Singleton	
Realization	CC	C	C	CC
Advanced	98.48%	1.52%	78,79%	21.21%
Beginner	65.15%	34.85%	70.45%	29.55%
Co-text	**Rich - Task I**			
Sequence	Geminate		Singleton	
Realization	CC	C	C	CC
Advanced	93.94%	6.06%	88.64%	11.36%
Beginner	62.88%	37.12%	84.84%	15.16%

A difficulty may be represented by the phoneme type. For beginners the most difficult phoneme is /r/, which is degeminated in 75% and 70.83% of cases in the poor and rich co-text respectively. This may be due to the fact that the Italian /r/ is different from the French /ʁ/ (besides the various phonetic realizations). Gemination occurs mainly for /l/ and /t/ in both learning groups (for advanced, poor: /l/= 33.33% and /t/=37.5%, rich: /l/= 20.83% and /t/ 16.6%; for beginner, poor: /l/ 41.66% and /t/= 54.16%; rich: /l/=25% and /t/=37.5%).

C2 duration: Cs show a significantly shorter duration than CCs in both co-texts (poor: $\chi2(1)=19.677$ p=,000, -0.118 S.E. 0.016; rich: $\chi2(1)=21.262$ p=,000, -0.14 S.E.0.02). Moreover, only for the rich co-text, the subject group is significant too ($\chi2(2)=5.86$ p=,005) as natives show a shorter duration than learners, as well the interaction between the subject group and sequence type ($\chi2(2)=13.083$ p=,001) as natives realize Cs and CCs with a larger difference in C2 duration than learners (Figure 1). As for Cs, C2 duration changes depending on the co-text ($\chi2(1)=4.26$ p=,003), the subject group ($\chi2(2)=6.89$ p=,003) but no interaction is found: duration is shorter in rich co-text (-0.011 S.E. 0.004) and natives have significantly shorter duration than the both learners' group (-0.07 S.E. 0.03). As for CCs, the duration changes significantly only as for the subject group ($\chi2(2)=6.18$ p=,004) as beginners show a shorter duration than advanced learners (-0.066 S. E. 0.022).

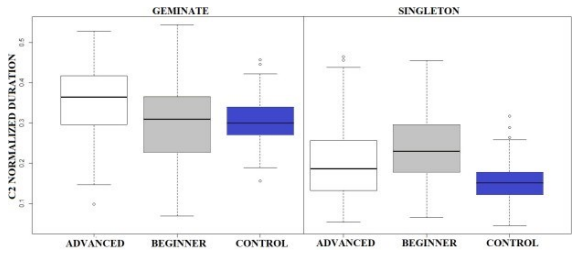

Figure 1: *C2 normalized duration for CC (left) and C (right)in poor-co-text.*

V1 duration: V1 has a significant longer duration in V1Cs than in V1CCs in both poor ($\chi2(1)=16.063$ p=,000; +0.0.6 S.E.0.01) and rich co-texts ($\chi2(1)=14.58$ p=,000; +0.06 S.E. 0.010). The subject group is not significant, but it interacts with co-texts (poor: $\chi2(2)=11.598$ p=,003; rich: $\chi2(2)=6.198$ p=,004), as in poor co-text the difference in V1 duration between the sequences V1Cs and V1CCs is smaller for natives and beginners compared to that of advanced learners; in the rich co-text natives show a larger difference while beginners show a smaller difference than that of the advanced learners when producing the sequences V1Cs and V1CCs. Results for the co-text factor are not significant.

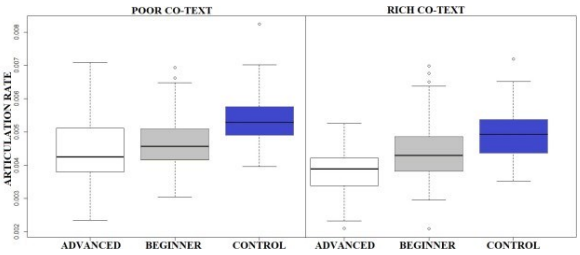

Figure 2: *C2 normalized duration for CC (left) and C (right)in poor-co-text.*

Articulation rate: AR is higher for words with Cs rather than CCs in both co-texts (poor: $\chi2(1)=22.47$ p=,001, +0.0063 S.E. 0.007; rich: $\chi2(1)=4.77$ p=,002, +0.0039 S.E. 0.0016) and for natives, who speak faster than learners (poor: $\chi2(2)=8.72$ p=,01, +0.0094 S.E. 0.0024; rich: $\chi2(2)=10.19$ p=,006, +.00010 S.E. 0.003); the interaction is not significant. Moreover, AR varies significantly as for the co-text in both sequences (C= $\chi2(1)=9.96$ p=,0001; CC= $\chi2(1)=4.35$ p=0,03) since it is slower in rich co-text (C=-0.0046 S.E. 0.0016; CC: -0.0027 S.E. 0.009) – Figure 2; the subject group is significant (C= $\chi2(2)=8.47$ p=,0014; CC= $\chi2(2)=7.98$ p=0,01), as natives speak faster than both learning groups, but not the interaction.

4.2. Task II

Apart from natives, who always realize CCs and Cs accurately, advanced learners realize CCs as expected in both co-texts (poor=96.96%; rich=92.04%), but they realize a higher number of degemination in rich co-text (paying more attention in the poor one). As for beginners, as many as half of the cases of CCs are degeminated (poor=51.52%, rich=49.24). There are also some cases of gemination mainly in poor co-text by both learning groups (advanced=26.89%, beginner=30.69%). As in task I, it is above all the realization of Cs that improves from the poor to the rich co-text.

Table 3: *Percentages of realization of CC and C inpoor and rich co-text by learners.*

Co-text	**Poor – Task II**			
Sequence	Geminate		Singleton	
Realization	CC	C	C	CC
Advanced	96.96%	3.04%	73.11%	26.89%
Beginner	48.48%	51.52%	69.31%	30.69%
Co-text	**Rich – Task II**			
Sequence	Geminate		Singleton	
Realization	CC	C	C	CC
Advanced	92.04%	0.96%	89.01%	10.99%
Beginner	50.76%	49.24%	87.12%	12.88%

C2 duration: Cs show a significantly shorter duration than CCs in both poor and rich co-texts (poor: $\chi2(1)=14.93$ p=,000; -0.090 S.E. 0.016; rich: $\chi2(1)=14.029$ p=,0001, (-0.080 S.E. 0.015). The subject group is not significant but a significant interaction is found for both co-texts (poor: $\chi2(2)=14.80$ p=,0006; rich: $\chi2(2)=13.05$ p=,001) as the difference in duration between Cs and CCs is smaller for natives and longer for beginners. As for co-text, a significance is found only for geminates as the duration differs only for the subject group ($\chi2(2)=12.45$ p=,000) as beginners show a shorter duration than the other two groups (-0.055 S.E.0.013) – Figure 3.

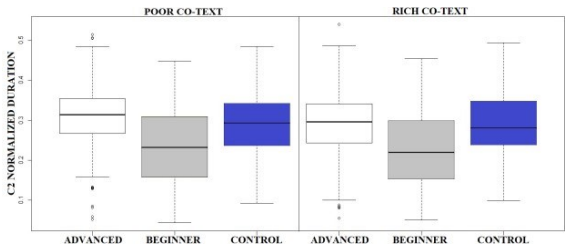

Figure 3: *C2 normalized duration for CC (left) and C (right)in poor-co-text.*

V1 duration: in poor co-text, V1 duration is significantly longer for V1Cs sequence rather than in V1CCs one ($\chi2(1)=12.082$ p=,0005; +0.046 S.E. 0.009) and for natives $\chi2(2)=8.937$ p=,01; +0.023 S.E. -0.007); the interaction is significant too ($\chi2(2)=9.46$ p=,008) as both natives and beginners show a smaller difference in duration V1C *vs* V1CC than that of the advanced learners. In rich co-text, V1 changes significantly only for the sequence type ($\chi2(1)=8.47$ p=,003)

since its duration is longer for V1Cs (+0.032 S.E. 0.0091). As regards the co-text as factor, it not found any significance neither for singleton nor for geminates.

Articulation rate: in both co-texts, AR differs significantly as for the sequence type (poor: $\chi2(1)=13.34$ p=,0002; rich: $\chi2(1)=14.14$ p=,0001) as it is faster for Cs (poor: +0.0072, S.E. 0.0014; rich: +0.0085 S.E. 0.0016) and for the subject group (poor: $\chi2(2)=6.72$ p=,03; rich $\chi2(1)=9.21$ p=,0009) as natives speak faster (poor: +0.0021 S.E. 0.006; rich 0.0016 S.E. 0.004); it is also found a significance for the interaction (poor: $\chi2(2)=6.82$ p=,03: rich: $\chi2(2)=9.47$ p=,0008) as the difference on AR is smaller for natives and beginners than that for advanced. Further, the co-text reaches the significance for both Cs and CCs sequences since AR is faster in rich-co-text (Cs: $\chi2(1)=6.93$ p=,008; +5.28 S.E.1.7; CCs= $\chi2(1)=5.94$ p=,01; +0.004 S.E.0.001). Moreover, the subject group is significant only for CCs ($\chi2(2)=7.11$ p=,02) and AR is faster for beginners compared to both groups (+0.008 S.E. 0.005). The tests for interaction are not significant.

4.3. Task I vs Task II

C2 duration: results are significant only in case of CCs sequence and C2 duration varies significantly in both co-texts as for the subject group (poor: $\chi2(2)=6.27$ p=,04; rich: $\chi2(1)=13.64$ p=,0001) since the advanced learners produce a longer duration than the two other groups (poor: +0.18 S.E. 0.03; rich: +0.16 S.E. 0.08) and as for the context (poor: ($\chi2(1)=12.90$ p=,0001; rich: $\chi2(1)=12.51$ p=,0004) since the duration is longer in task I than in task II in both co-texts (poor= +0.043 S.E. 0.008; rich=+0.061 S.E. 0.012). The interaction between context and subject group is also significant (poor: $\chi2(1)=8.38$ p=,01; rich: $\chi2(1)=8.16$ p=,01) as beginners show a larger difference when producing CCs in task I and task II than that of natives and advanced in both co-texts.

V1 duration: V1 duration in V1Cs sequence differs significantly as for the subject group in both co-texts (poor: $\chi2(2)=12.65$ p=,0001; rich: $\chi2(2)=8.17$ p=,01) as the beginners show a shorter duration (poor:-0.051 S.E. 0.013; rich:-0.031 S.E. 0.013) than the other two groups. The context has a significant effect on V1 duration followed by Cs in both poor ($\chi2(1)=10.18$ p=,0001) and rich co-text ($\chi2(1)=4.76$ p=,0002) since V1 is longer in task I (poor= +0.026 S.E.0.006; rich = +0.026 S.E.0.006). The interaction is not significant neither the results for the sequence V1CCs.

Articulation rate: In both poor and rich co-texts, AR differs significantly according to the context for both Cs (poor: $\chi2(1)=7.41$ p=,0001; rich= $\chi2(1)=20.51$ p=,002) and CCs (poor: $\chi2(1)=7.12$ p=,002; rich= $\chi2(1)=12.89$ p=,0004) as the AR is always slower in task I (poor - Cs=-0.0084 S.E. 0.0026; CCs=-0.0075 S.E. 0.002; rich – Cs=-0.0018 S.E. 0.0023; CC=-0.0014 S.E. 0.028). AR differs also for the subject group for both Cs (poor: $\chi2(2)=6.70$ p=,03; rich: $\chi2(2)=10.46$ p=,005) and CCs (poor: $\chi2(2)=7.53$ p=,02; rich: $\chi2(2)=9.22$ p=,001) as the AR is faster for natives (poor – Cs: +0.0088 S.E. 0.003; CCs:+0.0088 S.E. 0.002; rich – Cs: +0.0095 S.E. 0.002; CCs:(+0.0078 S.E. 0.003). Tests for interaction are not significant.

5. Discussion and conclusion

The perceptual check preceding the acoustic analysis showed that learners realize some cases of degemination or inappropriate gemination in both tasks, i.e., they either reduced geminates to singleton or realized some singletons as geminates. Degemination is more frequent and is affected by the proficiency level, since more cases are observed in beginners' than in advance learners' production (34.85% in task I and 51.52% in task II *vs* 1.52% in task I and 3.04% in task II). Learners show more difficulties in producing the geminate /r/ as the phoneme is not shared by the two phonological systems (though few cases of germination in French related to /ʁ/ for the opposition imperfect tense *vs* conditional mood). As for acoustic measurements, C2 and V1 duration vary depending on the sequence type, since C2 duration is longer for CCs than Cs and V1 is longer when followed by Cs than CCs, independently from co-text and context. However, in both tasks, geminates show a significantly shorter duration in beginners' than in advanced learners' and natives' productions, while advanced learners differentiate Cs from CCs to a greater extent as for both C2 and V1 duration. As for the articulation rate, generally, natives speak faster than learners. Thus, our hypotheses on French learners reducing CCs to Cs, especially in the case of beginners, is confirmed. Results are also in line with the main L2 models (e.g., Flege's [15, 16]), as learners show a different degree of accuracy according to their proficiency level, to the exposure to L2, as well as to the use of the target language.

As for the impact of context and co-text, the situation is less clear-cut than we hypothesized. Results about the interaction between context and accuracy show that C2 duration for CCs and V1 duration for Cs are longer in task I than in task II for both poor and rich co-texts, pointing to a higher accuracy in the simpler task. Consistently, the articulation rate is slower in task I than in task II in both poor and rich co-texts. However, as for the interaction between the co-text and accuracy, the parameter of articulation rate seems to be more affected than duration and, further, it seems to point in different directions depending on the task. Indeed, in task I articulation rate is slower in the rich co-text than in the poor one. On the contrary, in task II the articulation rate is faster in the rich co-text rather than in the poor one. According to our interpretation, though, this is not due to the task (global contexts), but rather to the different needs induced by the co-textual information (that is the actual local context built thanks to the co-text) in the two tasks: in task I, the simple one, the rich co-text creates an opposition between two terms, inducing the speaker to highlight them, possibly through hyperarticulation; in task II, the more complex task, the rich co-text (sentence) rather helps the speaker in conveying the message, favouring the expected hypoarticulation.

To sum up, the influence of mother tongue features on learners' production is clear (in line with hypothesis a) and above all for beginners (in line with b). Further, (c) there is a complex interplay between context and co-text, since accuracy seems to be greater in task I, that is when the task (global context) is simpler. However, the co-text affects the local context, acting differently in the two tasks. This is shown only by the articulation rate, which is slower in the case of a rich co-text in task I, but faster in the same co-text condition in task II. This means that the co-text affects the local context as the speakers need to highlight differences between two consecutive words representing a minimal pair, putting a stronger effort in production. It is then not a matter of task (global context), but rather of communication needs (which may be part of the local contexts related to co-text information), as the same happens in the case of utterances (similarly to our Task II) in which the greatest the prominence, the longest and more displaced is the speech gesture [17].

6. References

[1] A. Esposito, M.G. Di Benedetto, "Acoustical and perceptual study of gemination in Italian stops", *Journal of the Acoustical Society of America*, 106 (4), pp. 2051-2062, 1999.

[2] P. M. Bertinetto, *Strutture prosodiche dell'italiano*, Firenze, Accademia della Crusca, 1981.

[3] M.G. Di Benedetto, D. Domenicali, "Effect of consonant gemination on vowel coarticulation", *The Journal of the Acoustical Society of America,* 123(5), p.3075, 2008.

[4] A. Battye, M. Hintze, P. Rowlett, *The French language today: A linguistic introduction*, London, Routledge, 2003.

[5] J. G. Hansen Edwards, M. L. Zampini, *Phonology and second language acquisition*, John Benjamins, Amsterdam, Netherlands, 2008.

[6] M. Derwing and M. J. Munro, *Pronunciation Fundamentals. Evidence-based perspective for L2 Teaching and Research*, Amsterdam, Netherlands, John Benjamins, 2015.

[7] B. Lindblom, "Explaining phonetics variation: a sketch of the H&H theory", *Speech production & speech modelling*, Hardcastle & Marchal (eds.), Dordrecht,pp. 403-439, 1990.

[8] V. Akman., C. Bazzanella, "The complexity of context: guest editors' introduction", *Journal of Pragmatics*, 35, 321-329, 2003.

[9] P. Faber and P. Léon-Araúz, "Specialized knowledge representation and the parametrization of context*"*, *Frontiers in Psychology*, 7:196, 2016.

[10] M. Derwing and M. J. Munro, "Second language accent and pronunciation teaching: A research-based approach", *TESOL Quarterly*, 39, 379-397, 2005.

[11] Munro, M. J., & Derwing, M., "Foreign accent, comprehensibility, and intelligibility in the speech of second language learners", *Language Learning*, 49, pp. 285-310, 1999.

[12] P. Boersma and D. Weenink, Praat: doing phonetics by computers, version 6.1.09, 2020.

[13] D. Bates, M. Mächler, B. M. Bolker, S. C. Walker, "Fitting Linear Mixed-Effects Models Using lme4", *Journal of Statistical Software*,67 (1), 1-48, 2015.

[14] R Core Team, R: A Language and Environment for Statistical Computing, R Foundation for Statistical Computing, Vienna, Austria, 2015.

[15] J. E. Flege, J. Hillenbrand, "Limits on pronunciation accuracy in adult foreign language production", *JASA*, 76, pp. 708-721, 1984.

[16] J. E Flege, "Second-language speech learning: findings and problems", *Speech perception and linguistic experience. Issues in cross-languages research*, Strange W. (Ed.), York Press, Timonium (MD), pp. 233-277, 1995.

[17] C. Avesani, M. Vayra, C. Zmarich, "On the articulatory bases of prominence in Italian", in *Proceedings of ICPhS*, Saarbrücken, Germany, pp. 981-984, 2007.