Devoicing of sibilants as a segmental cue to the influence of Spanish onto current Catalan phonology

Ariadna Benet, Susana Cortés and Conxita Lleó
University of Hamburg, Germany

This article presents production data of sibilant segments by Catalan speakers in a Spanish-Catalan bilingual context. Catalan includes voiced sibilants in its sound system, whereas Spanish only has voiceless ones. Subjects come from two areas of Barcelona differing in the degree of presence of Spanish. Based on previous results on vowel production, we predict that Catalan sibilants, especially the voiceless ones, will be less often produced in a target-like manner in the more Spanish-speaking area, and especially in the younger groups (3–5 and 19–23 years old). Our results confirm this prediction for /z/, whereas for the affricate /dʒ/ percentages of target-like production are low in all groups. These results are accounted for by several internal and external linguistic factors.

Keywords: Catalan, Spanish, sibilants, voicing, markedness, complexity, language contact

1. Introduction

The study presented here has been carried out within the research project "Phono-prosodic development of Catalan in its current bilingual context."[1] This project has

1. The project, conducted by Conxita Lleó, belongs to the Collaborative Research Center on Multilingualism (Sonderforschungsbereich 538 "Mehrsprachigkeit"), hosted at the University of Hamburg, Germany. In the first place, we thank the Center and its sponsors, the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and the University of Hamburg, for their support. We also thank Anna Schreibweis, Anni Sell, Jorge Vega and Genís Ventura for their essential work transcribing and coding the data. The data collection would not have been possible without the kind collaboration of the subjects from Barcelona; we deeply thank them all. Finally, we thank the editors of this volume, who invited us to participate with the present study. This paper is a revised version of a presentation given at the *International Conference on Multilingual Individuals and Multilingual Societies* (Hamburg, October 2010).

been devoted to examining the production of Catalan phonological segmental categories that do not have equivalent counterparts in the Spanish inventory. Suprasegmental categories involved in intonation, as well as lexical phenomena, such as gender, differing also from Spanish, and lexical loans, have also been included in the project, which has focused on the Catalan spoken in two different areas of Barcelona.

This metropolis, which, according to the Statistics Department of the Barcelona City Council (Departament d'Estadística de l'Ajuntament de Barcelona 2010), has about 1,6 million inhabitants, is the capital of the autonomous region of Catalonia, located in the North East of Spain. Both Catalan and Spanish are official languages, thus bilingualism, with different degrees of dominance of one or the other language, is a very common situation for the majority of speakers. According to the "Statistics on the uses of languages" (Institut d'Estadística de Catalunya 2008), on the question as with which language speakers identify most, 46.5% of the population of Catalonia consider it to be Spanish, 37.2% state it is Catalan and 8.8% give both languages as answer; and 6.4% of the population identify themselves with other languages like Arabic, Romanian and other immigration languages (1% of the answers to the questions were not available). The areas of Barcelona under study differ on the degree of presence of Spanish: Gràcia and Eixample are traditionally Catalan districts located side by side in the city center, whereas Nou Barris is a new district created during the nineteen sixties in the outskirts of the city with the purpose to host thousands of new-comers from the rest of Spain. In fact, according to the Catalan Linguistic Census (Institut d'Estadística de Catalunya 2001), the population from Nou Barris shows one of the lowest percentages of oral and written competence in Catalan, whereas the inhabitants of Gràcia and Eixample are among those with the highest percentages. In our project, speakers are divided into three age groups: children (G1), young adults (G2) and older adults (G3). See Section 2.1 for details.

1.1 Catalan sibilants

Catalan has a complete system of eight sibilants, four voiced and four voiceless: /z/, /ʒ/, /dz/, /dʒ/ vs. /s/, /ʃ/, /ts/ and /tʃ/, respectively. However, in the dialectal variety of central Catalan, especially in Barcelona, phonologists have noted that a process of devoicing of /dʒ/ appeared in the second half of the 20th century. That is, /dʒ/ has been reported to become voiceless [tʃ] in intervocalic position (Veny 1998: 36). Thus, it is reported that in Barcelona words like *rellotge* 'clock' or *metge* 'medical doctor' are produced as [rəˈʎɔtʃə] instead of [rəˈʎɔdʒə], and [ˈmetʃə] instead of [ˈmedʒə]. The devoicing of /z/ has also been pointed out, but this process appears to have been introduced later on, and it occurs in various geographical variants of Eastern Catalan, not only in Barcelona (see Lleó 2006). These two phonemes, /z/ and /dʒ/, are the only ones considered in this article, for the following reasons. They have a very broad distribution, occurring word-initially and word-medially, between vowels, as well as following or preceding a

consonant.[2] As far as the other segments are concerned, the phoneme /dz/ is rather infrequent, and it is not found in simple words forming part of young children's vocabularies (see Badia Margarit 1965 for details on the distribution of sibilants). The phoneme /ʒ/ is often produced as an affricate in initial position, and medially after a nasal, which means that several words containing this underlying segment have been added to the words containing underlying /dʒ/ (see list of words in Appendix).

1.2 Research questions

One of the general predictions of the project is that the speakers from Nou Barris will show a Catalan speech production with more Spanish features, due to the more intense contact that they have with this language in comparison to the speakers from Gràcia and Eixample. We consider two types of factor as responsible for the different outcomes: on the one hand, external linguistic factors like education and degree of exposure to each one of the languages in contact; on the other hand, we take into account internal linguistic factors like frequency, markedness, and complexity.[3] Especially the notion of *markedness* constitutes a pre-requisite to determining those areas that are more vulnerable to influence under language contact (Lleó 2006). Here, it is used in the same sense as in Lleó, Cortés & Benet (2008: 188), following Jakobson (1941/1968). Specifically, we consider that marked entities presuppose unmarked ones in a typological, diachronic and acquisition sense. Typologically, unmarked segments appear more frequently than marked ones in the world's languages; moreover, a language is able to contain a marked entity, only if the corresponding unmarked entity is also contained in that same language; thus, diachronically a language will develop a certain marked entity only if it also contains the corresponding unmarked one; and in L1 acquisition, unmarked entities are acquired earlier than marked ones.

Taking this into consideration, the Catalan phonological system is in some respects more marked than the Spanish one. For instance, as far as vowels are concerned: whereas the Spanish system has only five vowels, the Catalan system has eight vowels, exhibiting two opening degrees in the mid vowels as well as schwa, which is typologically a marked vowel (Maddieson 1984, Lleó, Cortés & Benet 2011). The vowels existing in Catalan and not in Spanish, and at the same time implying more markedness, are /ɛ/, /ɔ/ and [ə]. Results on vowel production from this research project (Cortés, Lleó & Benet 2009, Lleó et al. 2008, Lleó, Benet & Cortés 2009) have shown that children (G1) and young adults (G2) in Gràcia have a statistically significantly higher percentage of Catalan target-like production for each of the three vowels than the same age groups in Nou Barris. This was so regardless of the specific language (or languages) spoken at home, especially regardless of the language spoken by the mother.

2. In word-final position, all obstruents are voiceless in Catalan due to the process of syllable final devoicing (see Bonet & Lloret 1998: 103ff).

3. The notion of complexity will be defined and dealt wih in Section 4.

In this article we focus our attention on the production of the Catalan sibilants /z/ and /dʒ/ in both areas of Barcelona and in the three age groups mentioned. Taking the results of vowel production into account, one plausible hypothesis is that these Catalan sounds, which do not exist in the Spanish phonological system, will be less often produced in a target-like manner in Nou Barris than in Gràcia and Eixample, due to the stronger dominance of Spanish in the first mentioned district. And according to the results on vowels, this difference between both areas will be clearer in the two younger age groups, G1 and G2. By investigating the results on sibilant production, we want to continue the line of research that we applied to vowels, unraveling those Catalan sounds that are more vulnerable to the influence of Spanish, and enlarging our search for the factors explaining such influence.

Summarizing, the goal of this article is to test two hypotheses, namely:

H1 Catalan sounds, which do not exist in the Spanish phonological system, will be less often produced in a target-like manner in Nou Barris than in Gràcia and Eixample.
H2 The difference between these two areas will be larger in both younger age groups, G1 and G2.

The article has the following structure. In the next section, the precise groups of subjects and the method of data collection are described. In Section 3, we present the results of the data production on sibilants. Section 4 discusses the results and answers the questions brought up in this Introduction. Finally, our conclusions are presented in Section 5.

2. Methodology

2.1 Subjects

The speech of 120 subjects was individually recorded, and relevant utterances were auditorily and acoustically analyzed. The subjects belong to two different areas of Barcelona: a) the districts of Gràcia/Eixample[4] – an area with a low degree of presence of Spanish – and b) Nou Barris – a district with a very high degree of presence of Spanish. The subjects within districts were divided into three age groups:

- G1: children between 3 and 5 years old.
- G2: young adults between 19 and 23 years old.
- G3: adults between 32 and 40 years old.

4. Due to the similarity of results between both districts obtained in preliminary studies and since Gràcia and Eixample are neighboring districts, we consider both of them as one area here, with 20 subjects in each age group as a whole.

Each of the six groups (three age groups and two areas, namely Gràcia/Eixample and Nou Barris) is composed of 20 subjects. In all groups the language of the subject's parents has been kept balanced as far as possible, so that half of the group has a Catalan-speaking mother and the other half a Spanish-speaking mother. The language of the father has also been controlled for, although we have considered the mother's language as the crucial one, assuming that she is the main caretaker in the child's first years. Each group differs as to the amount of Catalan received during socialization and formal education: the subjects in G3 went to school at the end of Franco's dictatorship, when teaching Catalan and instruction in Catalan was forbidden; those in G2 have received their whole compulsory education in Catalan, and G1 are at pre-school level, where the educators speak in Catalan, but at this age children have not yet learned to read or write, so no spelling pronunciation effects are expected to be found in their speech. All subjects participating in the study have been exposed to Catalan from birth, and can thus be considered to be native speakers of Catalan. We tried to balance each group with an equal number of males and females. However, in the oldest group, whose members are the mother or father of the subjects in G1, many more women were interviewed. The purpose of this imbalance was to prioritize analyzing the speech of the mother than that of the father, considering that the mother spends more time with the children in most cases, and thus provides a great deal of input. Table 1 displays the proportion of males and females in each group.

In order to build the groups of children, we contacted several schools in the areas to be investigated. In Gràcia and Eixample, we interviewed children of the state schools CEIP (Centre Públic d'Educació Infantil i Primària 'State School for Infant and Primary Education') Patronat Domènech, CEIP Josep Maria Jujol, CEIP Ramon Llull, CEIP Fort Pienc, and the private school IPSI. In Nou Barris the children attended the state school CEIP Gaudí and the private one Sant Lluís. The teachers chose the children suitable for our study depending on their willingness to talk as well as on their parents' language (and, of course, with previous consent of the parents). Through the teachers we were also able to contact the mother or father of each child to be interviewed in order to plan and perform interviews with them. The latter constituted the G3 groups. As for the G2 subjects, they were contacted through sportclubs, public libraries, language schools and youth associations in their district. All interviews took place in Catalan.

Table 1. Subjects by gender in each age and district group

	G1	**G2**	**G3**
Gràcia/Eixample	8 males 12 females	8 males 12 females	3 males 17 females
Nou Barris	12 males 8 females	10 males 10 females	5 males 15 females

2.2 Materials and equipment

Elicited words contained the target segments /z/ and /dʒ/ in intervocalic position, in order to avoid spurious phenomena not relevant to the study of sibilant devoicing. In the case of /z/, the position between vowels was selected for the following reasons. In Spanish, the voiced alveolar fricative /z/ does not exist as a phoneme but is traditionally said to occur as an allophone of /s/ before voiced consonants, both word internally and across word boundaries. This is the result of a voice assimilation process, by which a word like *mismo* /ˈmismo/ 'same' is said to be pronounced [ˈmizmo] (Hualde 2005: 159). However, it has been shown that the assimilation is incomplete and gradual, depending on various phonetic and prosodic factors (Romero 1999, Campos Astorkiza 2010). Thus, it is not only the case that the phoneme /z/ does not belong to the Spanish inventory; the segment [z] is hardly present, either, as in the assimilatory contexts, where it was traditionally claimed to appear, voicing is generally not complete (Romero 1999). Anyhow, given the presence of such assimilation process in Spanish, which might give place to [z], the position between vowels seemed to us the clearest one for [z], to exclude the voiced sibilant in Spanish. In the case of [dʒ], the intervocalic position was the clearest one as well, given the various voicing assimilation processes of Catalan clusters. Thus, all target words had the target sibilants between vowels, and none of the target words contained the voiced sibilants before a voiced (or voiceless) consonant. As all subjects were to produce the same set of target words, we chose simple words that could be part of a young children's lexicon (see list of words in Appendix). The audio files were recorded using a Sony ECM-CS1 unidirectional lapel microphone plugged into a portable Hi-MD Walkman MZ-RH10 Sony Mini-Disc recorder.

2.3 Procedure and analysis

Words containing the target segments were elicited by picture naming and by some specific questions for those target words that were not depictable. Each word was expected to be produced only once, thus no repetitions were elicited. Interviews were run individually in the best acoustic conditions available to optimize the acoustic quality of the recordings. The high quality of the recordings allow not only for the auditory but also for the acoustic analysis of the data. The sessions took place in a quiet room at the school, in the institution where the subject was met or at his/her flat. The total recorded data amounts to about 100 hours, 45–60 minutes of interview per speaker. The target words for this specific study on sibilants were extracted out of the whole interview.

Data were auditorily analyzed and transcribed by two native speakers of Catalan with phonetic expertise, a student in linguistics and one of the first two authors. In ambiguous cases, transcriptions were complemented by acoustic measurements, which were carried out by a student in phonetics and the second author. As voicing is the crucial distinctive feature of the segments under study, i.e. the feature to be investigated (given that the voiceless counterparts of sibilants are also part of the Spanish

inventory of phonemes), the glottal pulses and the voice report functions in Praat (Boersma & Weenink 1992ff) were used as aiding tools for this analysis. Those few cases that remained unresolved were excluded from further analysis.

3. Results

The results of the mixed (i.e., auditory and acoustic) analysis of /z/ are shown in Figure 1 and those of /dʒ/ in Figure 2. According to Figure 1, the differences between /z/ production across districts reach significance in the two younger generations, Gràcia/Eixample always taking the lead with regard to the production percentages of Catalan segments over Nou Barris [(G1: χ^2 (1, N = 40) = 35.374; p < .0001), (G2: χ^2 (1, N = 40) = 37.673; p < .0001)]. As in our previous studies on vowel production (Cortés et al. 2009, Lleó et al. 2008, 2009 and 2011), no significant difference was found across districts in the oldest generation. This is the most homogenous group as far as percentage of target-like production of the segments under study is concerned. These results show the same trend already observed in our just mentioned previous studies on the production of vowels by the same population (see Figure 3, below).

Figure 2 displays no statistically significant differences in the target-like production of the affricate /dʒ/ across districts within age groups. The first thing to be noticed is that the percentages of target-like production for /dʒ/ are in general very low, only reaching 50% and beyond in the case of G2. Another feature to be noticed in relation to the production data of the affricate is the high variability in its output. That is, in the case of /z/, subjects either produced [z] or [s]; however, instead of producing /dʒ/, they produced its voiceless counterpart, [dʃ], and also voiced and voiceless fricatives or approximants, as e.g. [ʃ], [ʒ], [z], [s], [j] or [ð]. As voicing was the main feature of interest in this study, all realizations were divided into voiced or voiceless, and all voiced outputs counted as target-like, provided that they were sibilants, regardless of being fricatives or affricates. Accordingly, productions with the approximant, non-sibilant [j], like the non-target [raˈjɔdja] (for the target [rəˈʎɔdʒə] *rellotge* 'clock') were excluded from the countings.

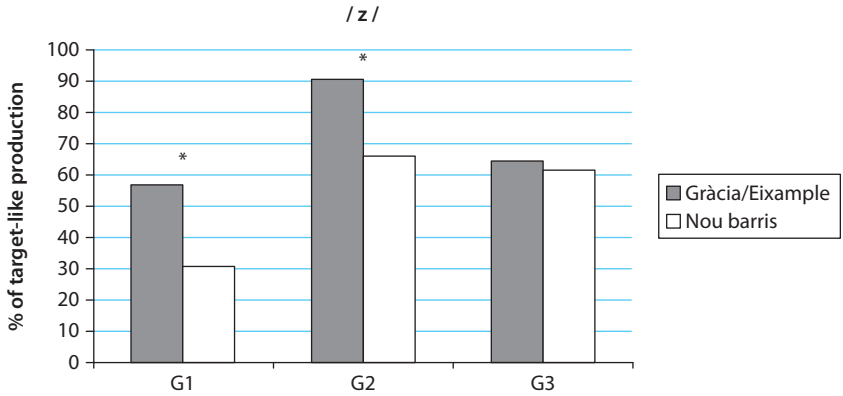

Figure 1. Percentages of /z/ target-like production

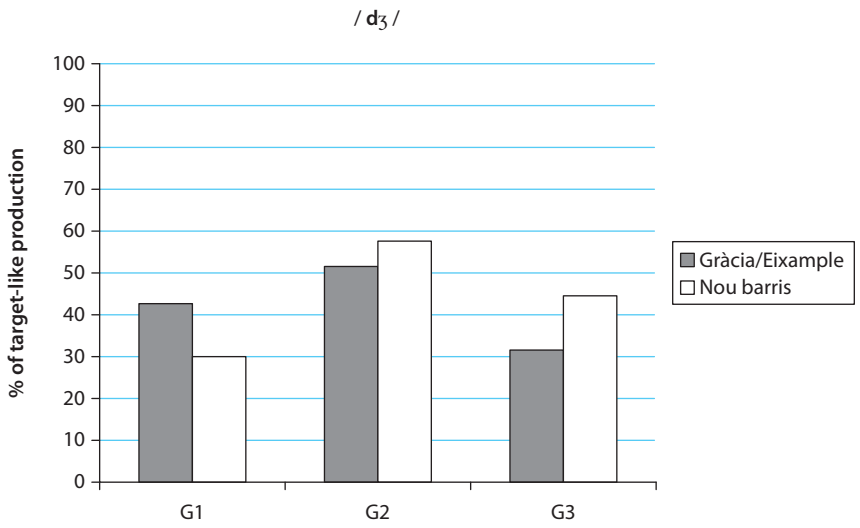

Figure 2. Percentages of /dʒ/ target-like production

When comparing the results of the group production of /z/ with those of /dʒ/ a very clear difference is apparent. Overall, target-like production of the affricate is lower than that of /z/ in most groups, as observed in a comparison of Figure 1 and 2. In the groups of younger adults (G2) and older adults (G3), the production is lower in Gràcia/Eixample than in Nou Barris, which has never been the case in the data of other segments under study. Nevertheless, differences across districts do not reach significance. Although in terms of percentages, the differences in some cases seem to be large enough, the number of items elicited for the affricate was very small and that is why a difference of 11%, as in G1 in Figure 2, does not reach significance.

4. Discussion

Results presented in the previous section have shown that the target-like production of /z/ by children (G1) and by young adults (G2) is significantly higher in Gràcia/Eixample than in Nou Barris. As for older adults (G3), they do not show statistically significant differences between districts. This pattern exactly parallels that of vowel production (as shown in Figure 3), and strongly confirms our two hypotheses: H1 predicted more target-like production in Gràcia/Eixample than in Nou Barris, and H2 expected to find this difference in the two younger generations, G1 and G2. In Figure 3, the results for /ɛ/ are presented (results for the other vowels were very similar and the statistical differences were identical). The results for target-like production of the vowel /ɛ/ also show a statistically significant difference across districts in G1 and G2, Gràcia/Eixample showing much higher values than Nou Barris, whereas the difference of G3 across districts does not reach significance. Something parallel is obviously

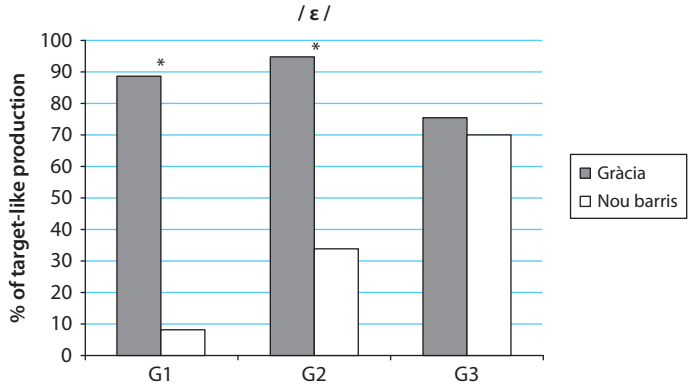

Figure 3. Percentages of /ɛ/ target-like production (from Lleó et al. 2008: 200)

taking place in relation to the production of /z/. This parallelism strongly confirms our hypotheses. That is, for G1 and G2, the dominant language in the district seems to be the key factor for the difference in the production of the Catalan phonemes (both, the vowel /ɛ/, and in the present study, the sibilant /z/): if Spanish is more present in the speaker's social environment, it is more likely that he or she will not produce a voiced sibilant and his/her production will converge with the Spanish one.

One of the conclusions of our results both on vowel and voiced sibilant production is that for children as well as for young adults, the dominant language of the district (for these age groups that mainly means the language at school and its environment) seems to have a stronger influence on their speech production than the input they receive at home. However, the groups of adults (G3) do not display statistical differences for any of the three vowels or sibilants across districts, thus showing that the dominant language in the district does not play a role for them. We assume that their speech production, at least for these segments, is conditioned by the district where they grew up, which generally does not correspond to the district where they live now. The different results obtained in the two areas of Barcelona, Nou Barris on the one hand, and Gràcia/Eixample on the other hand, has been explained by a combination of internal and external linguistic factors in the situation of language contact, which can potentially lead to phonological change (Lleó & Cortés in press).

Additional factors to play a role in the linguistic change may be the marked and complex character of the target Catalan segments. On the one hand, voiced obstruents are more marked than voiceless ones (see, e.g., markedness convention XXI in Chomsky & Halle 1968: 406). In the Introduction, unmarked segments have been typologically defined as those appearing more frequently in the languages of the world. Maddieson (1984)'s survey based on 317 languages offers reliable information on the frequency of segments, which can be interpreted in terms of markedness. From this point of view, we can ascertain that voiced sibilants are more marked than voiceless ones, as e.g. voiceless /s/ occurs in 276 languages (87.1% of languages of the survey),

whereas voiced /z/ only occurs in 97 languages (30.6%). The voiceless affricate /tʃ/ appears in 141 languages (44.5%), and the voiced one /dʒ/ in only 80 languages (25.2%).

Moreover, in Catalan, sibilants involve complexity, which we define on the basis of form variation. That is, lexical items involving allomorphy and/or allophony, and thus violating Uniformity, are considered to be complex. Kenstowicz (1997: 139) gives following definition. "Uniform Exponence: a lexical item (stem, affix, word) has the same realization for property P in its various contexts of occurrence". According to this, forms should not change between input and output and should not alternate. This definition applies to the sibilants in the following manner. On the one hand, any sibilant consonant at the end of a word is voiceless in Catalan, as in this language a process of final devoicing applies to all obstruents (see Bonet & Lloret 1998: 103ff). On the other hand, word-final sibilants become voiced through the sandhi process of resyllabification, by which the sibilant preceding a word that begins with a vowel changes from the coda to the onset position of the following syllable, and it concomitantly becomes voiced. For example, the [s] in the article *les* ('the' plural feminine) becomes [z] when the following noun starts with a vowel: *les amigues* /ləs#ə.ˈmi.ɣəs/ 'the (girl) friends' is thus pronounced [lə.zə.ˈmi.ɣəs]. The duality of form ([ləs] alternating with [ləz]) resulting from this process of voicing violates Uniformity. The resyllabification of sibilants without voicing, resulting from Spanish influence (Spanish does not have either voiced sibilants nor the sandhi voicing process), has as a concomitant result the avoidance of Uniformity violations.

In order to have an effect, this internal factor of complexity must act together with the external factor of the Spanish dominance in the district. The similar results in both G3 groups can be due to a biographical reason: some of the subjects of this age group were not born in the district where they live now, but they have grown up in another part of the city, where the sociolinguistic context could have been very different from that where they live now.[5] Thus, in G3 the dominant language in the district does not seem to play such a crucial role as in G1 and in G2. At least not anymore, but it might have in the past.

In spite of the overall similarities between the results on /z/ and those on vowels, the G1 results on /z/ are different from those of vowels in one respect: the G1 age group in Gràcia/Eixample reaches a lower target-like production with the sibilant than with the open mid vowels /ɛ/ and /ɔ/. The reason could be developmental: according to Grunwell (1982) for English, children produce [s] at age 3;0 – 3;6, before they produce [z] at ages 3;6 – 4;0 and 4;0 – 4;6. According to Bosch (1987) for Catalan, /s/ is acquired at 4 years and /z/ at 5 years. The children in the group of Gràcia/Eixample have a mean age of 4;5 (and the mean age of the Nou Barris group was 4;10). Thus it is plausible that

5. In the results of the Catalan vowels, G3 mean production was also very similar in both areas, but individual values showed lower target-like production for some of the speakers from Nou Barris and higher for some from Gràcia (Lleó et al. 2008: 205). This is not the case in the individual results of the sibilant /z/.

this voiced sibilant has not been (completely) acquired by some of the younger children yet. In fact, another important observation is that both in Gràcia/Eixample and in Nou Barris, G2 has a higher percentage of target-like production than G1. This result also agrees with those of vowels, as G2 reached higher percentages of target-like vowel production than G1. This difference between the age groups G1 and G2 is also to be attributed to the positive effect of school in Catalan, beside that of media and other social agents.

As for the affricate /dʒ/, the results have shown a different pattern from that of the sibilant /z/ and that of vowels: the target-like production is low overall and there are no significant differences across districts within age groups. The variability of the output forms of the target sound was also quite different from that of the target /z/. While in the case of /z/ the alternative output was always its voiceless counterpart [s], the target /dʒ/ produced a wider variety of answers: the most frequent ones were [tʃ], [ts], [dʃ], [dz], [z], [ʒ] or the target-like [dʒ]. As already mentioned, because voicing was the crucial target feature of our study, when the output was one of the voiced sibilants, it was considered target-like. In spite of this, the results do not reach more than 60% of target-like production (G2 in Nou Barris has the highest percentage with 58%). Several factors could explain these general low results. First, as pointed out in the Introduction, in the dialectal variety of Barcelona, [dʒ] has been reported to become voiceless in intervocalic position (Veny 1998: 36). This happens, for instance, in the word *rellotge* [rəˈʎɔdʒə] 'clock', which was contained in the list of elicited words. Second, although the voiced and voiceless affricates have a contrastive function in Catalan and they can occur in the same context (for instance, in *dutxar* [duˈtʃa] 'to take a shower' vs. *jutjar* [ʒuˈdʒa] 'to judge'), the frequency of the voiced one is not very high (Badia Margarit 1965). Third, the marked character of this voiced affricate can be argued to be a further factor both for the low results and also for the tendency to devoicing in the variety of Barcelona.

A fourth reason for these low results among all groups can be the aforementioned voiced realization resulting from the sandhi process of voicing. Because words containing the target sound /dʒ/ are not numerous in young children's lexica, elicitation of this sound also included combinations of two words, as e.g. *vaig anar* 'I went', the first one ending with the target sound, followed by a word starting with a vowel, or with a voiced consonant, as in *vaig menjar* 'I ate'. The production of such combinations of words involves the process of voicing described above, in this same section. For instance, the auxiliary verb of the past form *vaig* 'I go' ends in an underlyingly voiced fricative: /ˈbaʒ/, as evidenced by certain verb forms, as e.g. [ˈbaʒi] '(I/he/she) go(es)' (Pres. Subj.). This consonant is devoiced and affricated in word final position: [ˈbatʃ] 'I go'. However, if followed by a word beginning with vowel, it becomes voiced: *vaig anar* [ˌbadʒəˈna] 'I went'. According to Nguyen, Wauquier, Lancia & Tuller (2007), the production of segments resulting from sandhi processes in French entails more difficulty than that of a segment in its lexical form because of an added complexity in cognitive processing. Thus, the elicitation of words with target [dʒ] involved a higher degree of

complexity, when compared to the elicitation of /z/ (and that of vowels), because the latter phoneme occurs more frequently in lexical items, and could be produced without involving the sandhi process of devoicing. Finally, the high variability in the answers for the target [dʒ] could be related to the general marked character of affricates (see Maddieson 1984).

In view of these results, linguistic external factors like dominant language in the district or education in Catalan do not seem to play a role for the target-like production of the affricate /dʒ/. Instead, complexity and markedness are the decisive factors. However, this is not the same for the sibilant /z/ (and for the vowels), since for this phoneme the dominant language in the district as well as schooling in Catalan can be argued to have a clear effect on the results, which have showed statistically significant differences across groups depending on external linguistic factors. Thus, certain segments may be dispensed with by the bilingual speaker on the basis of internal factors, like markedness and complexity. Only those segments that do not succumb to such internal factors may receive the beneficial effect of external factors, like language dominance in the district, school, media, etc.; see Lleó & Cortés (in press) for an attempt to weigh external factors in the bilingual Catalan-Spanish context.

5. Conclusion

The production of voiced sibilants, /z/ and /dʒ/, by different age groups in Gràcia/Eixample and Nou Barris has led to two different types of results. On the one hand, the production of /z/ keeps a parallel pattern to that of vowels, showing significant differences across districts in the two youngest generations. This result confirms the initial hypotheses, based on the results on vowel production, namely, that for the youngest generations the factor of the language dominance in the district is the most influential one. On the other hand, the production of /dʒ/ does not show differences across districts, diverging from that of other segments that belong to the Catalan inventory, but not to the Spanish one, namely, the open mid vowels and schwa reported in previous studies stemming from our project. Besides, the indexes of target-like production are considerably lower and the alternative responses to the target segment are much more varied for the affricate than for the fricative. The difficulties in the production of this affricate have been accounted for in terms of markedness, complexity and cognitive processing load. Whereas the production results of this Catalan affricate seem to be conditioned by the internal linguistic factors of markedness and complexity, the results of the fricative /z/ respond to the impact of external linguistic factors like the dominant language of the district.

References

Badia Margarit, A. M. 1965. Problemes de la commutació consonàntica en català. *Boletim de Filologia* 21: 213–335.

Boersma, P. & D. Weenink. 1992ff. *Praat: Doing Phonetics by Computer* (computer program). <http://www.praat.org>

Bonet, E. & M. R. Lloret. 1998. *Fonologia catalana*. Barcelona: Ariel.

Bosch, L. 1987. *Avaluació del desenvolupament fonològic en nens catalanoparlants de 3 a 7 anys*. Barcelona: PPU.

Campos Astorkiza, R. 2010. Voicing assimilation and prosodic structure in Spanish. *Journal of the Acoustical Society of America* 128: 2288.

Chomsky, N. & M. Halle. 1968. *The Sound Pattern of English*. New York NY: Harper & Row.

Cortés, S., C. Lleó & A. Benet. 2009. Gradient merging of vowels in Barcelona Catalan under the influence of Spanish. In *Convergence and Divergence in Language Contact Situations* (Hamburg Studies on Multilingualism 8), eds. K. Braunmüller & J. House, 185–204. Amsterdam: John Benjamins.

Departament d'Estadística de l'Ajuntament de Barcelona. 2010. *Figures of Barcelona: Population*. <http://www.bcn.cat/estadistica/angles/dades/sintesi/images/sintesi1.pdf> (18 June 2012).

Grunwell, P. 1982. *Clinical Phonology.* London: Croom Helm.

Hualde, J. I. 2005. *The Sounds of Spanish.* Cambridge: CUP.

Institut d'Estadística de Catalunya. 2001. *Població segons coneixement del català. Recomptes. Població de 2 anys i més Barcelona. Distribució per districtes.* <http://www.idescat.cat/territ/BasicTerr?TC=5&V0=8&V1=08019&V3=876&V4=17&ALLINFO=TRUE&PARENT=1&DISTRI=TRUE&CTX=B> (18 June 2005).

Institut d'Estadística de Catalunya. 2008. *Població segons llengua d'identificació Catalunya.* <http://www.idescat.cat/territ/BasicTerr?TC=5&V0=3&V1=3&V3=3171&V4=3173&ALLINFO=TRUE&PARENT=25&CTX=B> (18 June 2012).

Institut d'Estudis Catalans. 2011. *Versió electrònica de la Gramàtica de la llengua catalana*. <http://www.iecat.net/institucio/seccions/filologica/gramatica> (2012).

Jakobson, R. 1941/1968. *Child Language, Aphasia and Phonological Universals* (translated by A. R. Kuler). The Hague: Mouton, 1968. (*Kindersprache, Aphasie und allgemeine Lautgesetze*. Uppsala: Almqvist & Wiksell, 1941).

Kenstowicz, M. 1997. Uniform exponence: Exemplification and extension. In *Selected Phonology Papers from HO-T97* (University of Maryland Working Papers in Linguistics 5), eds. V. Miglio & B. Moren, 139–155. College Park MD: University of Maryland.

Lleó, C. 2006. Fenòmens evolutius i d'ús oral del català des de la finestra psicolingüística de l'adquisició bilingüe. In *Actes del 13è Col·loqui internacional de llengua i literatura catalanes (AILLC)*, eds. S. Martí, M. Cabré, F. Feliu, N. Iglesias & D. Prats, 361–385. Barcelona: Publicacions de l'Abadia de Montserrat.

Lleó, C., A. Benet & S. Cortés. 2009. Límits de la normalització lingüística: Vocals vulnerables en el català de Barcelona. In *Variació, poliglòssia i estàndard* (Biblioteca Catalànica Germànica 7), eds. J. Kabatek & C. D. Pusch, 157–180. Aachen: Shaker.

Lleó, C. & S. Cortés. In press. Modelling the outcome of language contact in the speech of Spanish-German and Spanish-Catalan bilingual children. In *Special Issue on Language Competition and Linguistic Diffusion: Interdisciplinary Models and Case Studies,* eds. J. Kabatek & L. Loureido. *International Journal of the Sociology of Language.*

Lleó, C., S. Cortés & A. Benet. 2008. Contact-induced phonological changes in the Catalan spoken in Barcelona. In *Language Contact and Contact Languages* (Hamburg Studies on Multilingualism 7), eds. P. Siemund & N. Kintana, 185–212. Amsterdam: John Benjamins.

Lleó, C., S. Cortés & A. Benet. 2011. Reanalitzant la vocal neutra barcelonina. In *Noves aproximacions a la fonologia i morfologia del català: Volum d'homenatge a Max W. Wheeler*, eds. M. R. Lloret & C. Pons, 321–351. Alacant: Institut Interuniversitari de Filologia Valenciana.

Maddieson, I. 1984. *Patterns of Sounds*. Cambridge: CUP.

Nguyen, N., S. Wauquier, L. Lancia & B. Tuller. 2007. Detection of liaison consonants in speech processing in French: Experimental data and theoretical implications. In *Segmental and Prosodic Issues in Romance Phonology* (Current Issues in Linguistic Theory 282), eds. P. Prieto, J. Mascaró & M. J. Solé, 3–23. Amsterdam: John Benjamins.

Romero, J. 1999. The effect of voicing assimilation on gestural coordination. In *Proceedings of the 14th International Congress of Phonetic Sciences (ICPhS 99)*, ed. J. J. Ohala, 1793–1796. Berkeley CA: University of California, Department of Linguistics.

Veny, J. 1998. *Els parlars catalans*. Mallorca: Moll.

Appendix

Lists of words containing the target segments /z/ and /dʒ/ elicited from the subjects that participated in the study.

Words with [z]			**Words with [dʒ]**		
[dəˈzembrə]	*desembre*	'december'	[ˌmidʒˈdiə]	*migdia*	'noon'
[ˌdozuˈseʎʃ]	*dos ocells*	'two birds'	[ˌbaɖʒəˈna]	*vaig anar*	'I went'
[əzmurˈza]	*esmorzar*	'breakfast'	[ˌbaɖʒməɲˈʒa]	*vaig menjar*	'I ate'
[ˈmuzikə]	*música*	'music'	[rəˈɾɔɖʒə]	*rellotge*	'clock'
[pɾinˈsɛzə]	*princesa*	'princess'			
[ˈrɔzə]	*rosa*	'rose'			
[ˈzebɾə]	*zebra*	'zebra'			
[ˈzɛɾu]	*zero*	'zero'			
[ˈzo]	*zoo*	'zoo'			