Markedness Effects in the Acquisition of Voiced Stop Spirantization by Spanish-German Bilinguals

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1. Introduction

It is widely believed that continuants are more marked than stops, and that this is clearly reflected in first language acquisition (Jakobson 1941). Thus young children begin producing stops earlier than fricatives; a well-known process of stopping, by which stops are substituted for fricatives has been often documented in early first language acquisition (see e.g. Smith 1973). In Optimality Theoretic terms, markedness constraints outrank faithfulness constraints, and it is thus to be expected that if a language contains fricatives or spirants in its inventory, children acquiring that language will go through a phase of stopping, because a universal constraint banning fricatives will outrank the constraints that require faithfulness to input fricatives. This type of situation is to be found in Spanish, which has an obligatory allophonic rule of voiced stop spirantization in certain contexts, especially in postvocalic position and after certain sonorants. The question thus arises whether Spanish children begin by producing stops instead of spirants. Theories of markedness have also pointed out that there is a tendency to assimilation between features of neighboring segments. For instance, Stampe (1969) argues that although voiceless obstruents are less marked or more natural than voiced obstruents, this is only true from a paradigmatic perspective. Syntagmatically, a voiced obstruent between vowels may be less marked than a voiceless one, because it shares the feature [voiced] from the vocalic context. Children may be thus confronted with these two tendencies, the voicelessness and voicing of the obstruent, and favor one or the other. In the case of Spanish spirants we are confronted with this type of situation: stop obstruents are less marked in certain contexts, for instance initially, but in other contexts, as e.g. after a vowel, continuants might be preferred.

The purpose of this paper is to test such predictions with evidence on the acquisition of Spanish in a bilingual situation, i.e. by children that acquire Spanish and German simultaneously. Do Spanish-German bilingual children substitute spirants with stops in Spanish? Or do they produce spirants in a targetlike manner? With these questions in mind we examine the acquisition of spirants and voiced stops by three Spanish-German bilingual children, aged 1;3 to approximately 4;0. In order to achieve a general perspective of their acquisition process, we also analyze their acquisition of voiced stops in German, a language without spirantization. To be able to understand and interpret acquisition by bilinguals, it is convenient to compare it with acquisition of the same sounds and processes by monolingual children. We will thus draw information on the acquisition of voiced stops and their corresponding spirants by three monolingual Spanish children, as well as on the acquisition of voiced stops by three monolingual German children. A first brief report on these studies has appeared in Rakow & Lleó (2003). We will see that monolingual Spanish children produce spirants from the start and that monolingual German children only produce stops; spirants are present, but in negligible numbers. The comparison of these findings with stop-spirant production by the Spanish-German bilinguals will give a different picture: bilinguals oscillate in Spanish in their rates of spirantization, reducing them after having reached high

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rates. These results can shed light on theoretical issues of both acquisition in general and bilingualism in particular. Do the languages of the bilingual develop independently or do they interact? How does the bilingual child organize his/her two phonological systems? In what sense is markedness an influential factor in bilingual development?

The paper is organized as follows. After a description of the process of spirantization in Spanish the remainder of section 1 discusses issues of acquisition within Optimality Theory: spirants are more marked than plosives, but only in certain contexts, and we will show how the theory is able to account for this duality. Section 2 presents data on the acquisition of voiced plosives and spirants by three Spanish-German bilinguals, three Spanish monolinguals and three German monolinguals; the latter group, by not having to acquire spirants, serves as a control group. In section 3 we will discuss our results in relation to issues of markedness and acquisition. The focus will lie on the simultaneous acquisition of two phonological systems, one with spirantization and the other one without. Section 4 presents the conclusions.

1.1 Spanish spirantization

Both German and Spanish have the voiced stop consonants /b d g/, which are produced as the voiced stops [b d g] in German,[1] whereas in Spanish they may be produced as such or as the spirants [β ð ɣ] depending on the context. All analyses modeled on structuralist phonology posit an obligatory allophonic rule of voiced stop spirantization, by which Spanish /b d g/ appear phonetically as stops in certain contexts and as spirants (or continuants) [β ð ɣ] in other contexts. Descriptions of the distribution of the stop versus spirant allophones suggest that stops occur after a pause or nasal segment, and in the case of /d/ only, after /l/; spirants occur elsewhere, although there exists a great deal of dialectal variation (see Hammond 1976, Harris 1984, Lozano 1979). In postvocalic position spirants are obligatory, whereas particularly in postconsonantal position there is much dialectal variation. As far as absolute initial position, although it is in general taken as a context for the appearance of plosives, Macken & Barton (1980) report that in Mexican Spanish spirants may also be produced there to a considerable rate. Hence, the present study concentrates on the sole obligatory context in which spirantization occurs in all dialects -- intervocalic position.

Several analyses have been provided for spirantization in Spanish. Within Generative Phonology there has been a certain debate about whether the underlying segment should be [-cont] or [+cont]. Whereas most phonologists prefer the [-cont] obstruent and adhere thus to a process of spirantization, Hammond (1976) proposes the spirant in the underlying representation, bound to a process of fortition. With the advent of Autosegmental Phonology and the Theory of Underspecification, a process of spirantization based on spreading of the feature [+cont] to the right has been formulated by Harris (1984), as shown in (1) below, inspired by Mascaró (1984). The target segment is only characterized as [+obstr, +voiced], but not specified for continuant, since the only continuant consonants in Spanish are /f θ s x/, hence all voiceless. That is, the target segment undergoing spirantization is underspecified for the feature [cont], neither [+cont] nor [-cont] in the underlying representation, and it becomes [+cont] if it is in the relevant context, following a segment specified for [+cont]. Otherwise, universal principles of Underspecification will attribute the specification [-cont] to segments that do not satisfy the structural description of the spirantization rule (1), e.g. those segments that, because of being in absolute initial position or after a nasal, are not submitted to the rule.

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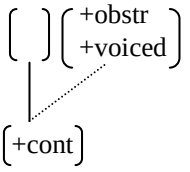
[1] Although in target German there is no spirantization, sporadically labials may be spirantized between vowels in very fast and informal speech. As for coronals, they may sporadically be flapped between vowels in North Germany (see Meinhold & Stock 1980: 142 ff. and Werenitsch 1999: 376).

(1)



The rule expressed in (1) spreads the feature [+cont], associated with the left-hand segment, to the right and associates it to the following segment, which is only specified for the features [+obstr, +voiced], because the sole voiced obstruents in Spanish are the stop-spirant pairs. At the same time, the target segment in (1) cannot contain less specifications than those two: e.g. [+voiced] cannot be omitted, because only the voiced stops are submitted to the process, whereas the voiceless stops /p t k/ are not. The treatment of voiced stops after liquids is debatable, and different solutions are found in the literature, by which /l/, which combines with following stops or spirants, depending on the Place of Articulation of the following consonant -- [lβ], [1ɣ], but [ld] -- has been characterized as either [+cont] in Harris (1984) or as [-cont] in Mascaró (1991).[2] Notice that after /ɾ/ only spirants are generally found: [ɾβ], [ɾð] and [ɾɣ]. This would seem to suggest that /ɾ/ must be underlyingly specified as [+cont] in Spanish, which is also a point of debate. We will not try to solve these theoretical problems here, as they are not directly relevant to our acquisition study; Spanish children do not produce many codas at first, so that the relevant words, with [l] or [ɾ] in coda position will be seldom represented, and as mentioned above, we will concentrate on the position after vowels as the prototypical position in which spirantization takes place in all dialects.

A further point to notice in relation to (1) is the fact that it presupposes a theory of Radical Underspecification, which postulates voiceless obstruents as universally unmarked. This is implied by the formulation of (1) that only spreads [+cont]. In case a segment does not become [+cont] by spreading, e.g. in absolute initial position, it automatically becomes [-cont], since as Harris (1984:153) states, this value will be specified by universal markedness principles. We turn to markedness in the next subsection.

An aspect that has not been included in the formulation of spirantization in (1) is that from the point of view of Autosegmental Phonology, it describes a post-lexical process. Rule (1) is thus not only applicable within words, but also across word-boundaries. Taking into consideration prosodic constituents, as they are postulated in Prosodic Phonology (Nespor & Vogel 1986), we can say that the range of application of spirantization in Spanish is the whole Intonational Phrase (see Lleó & Vogel in press, for an analysis of spirantization in the context of L2). This means that in Spanish underlying voiced stops are produced as spirants after a vowel, regardless of the presence of a word- or phrase-boundary preceding the spirant.

1.2 Markedness, Optimality Theory and acquisition

Since Jakobson (1941) formulated his laws of solidarity, it is generally accepted that stops are less marked than fricatives (and spirants) and that children in their early productions replace fricatives by stops (Smith 1973, Vihman 1996). This well-established finding makes us wonder how very young Spanish-speaking children will pronounce the pairs of sounds constituted by a stop and a spirant. Since spirants are more marked than stops, we would predict that in the earliest stages of acquisition, Spanish-speaking children

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[2] Mascaró (1991), in fact, does not phonologically classify /l/ as [-cont], but bases his analysis on phonetic criteria. According to him (1991:176), the decisive factor for spirantization consists in whether there is airflow "at the place of articulation of the spirantizing consonant", and "in the dental region, there is no airflow during the articulation of [l]."

substitute stops for the spirants. This should in principle be the case, in a monolingual as well as in a bilingual situation.

There is another proposal in relation to markedness, though. Stampe (1969) criticized Jakobson's concept of markedness for being exclusively paradigmatic and proposed the notion of naturalness, based on syntagmatic relations. Adapting Stampe's proposal it can be said that markedness or naturalness relations are also defined by neighboring relationships. Accordingly, a [-cont] consonantal sound may be defined as unmarked in general, but a certain consonantal sound may tend to assimilate to a [+cont] neighboring sound, e.g. a vowel, and thus [+cont] may be more natural intervocalically. This is obviously the situation we have in the case of Spanish spirantization. An output [+cont] obstruent that results through the application of the spreading rule (1) is more natural than a [-cont] sound in the same context. This notion of naturalness should predict that Spanish children produce spirants targetlike. It is obvious that these two notions of markedness are different and make different predictions, which in certain contexts may even be contradictory predictions, as for instance in the position after a vowel.

Optimality Theory (OT) is specially well-suited to expressing such contradictory facts, and we will refer to this model as providing the basis for a theory of acquisition. In OT, both notions, Jakobsonian markedness and Stampe's naturalness have a direct interpretation as markedness constraints, one referring to inventory markedness (preference for noncontinuants) and the other one to contextual markedness (preference for identity of features in a given context). This proposal can be formalized in terms of the following two constraints, equivalent to those proposed by Lombardi (2000) and (1999), respectively:

(2) *[cont]

(3) AGREE$_{[cont]}$

Constraint (2) states that sounds characterized as continuants are rejected. We assume that there are further markedness constraints banning other classes of sounds, as for instance *[stop], which rejects sounds characterized as plosives. The preference for stops over fricatives is defined by the universal ranking (4),

(4) *[cont] » *[stop]

by which the ban against [cont] outranks the ban against [stop] and thus states the unmarkedness of stops over continuants. Constraint (3) requires that contiguous segments share the feature [cont], and hence gives preference to assimilation or linking of the feature [cont] between vowel and consonant. These two constraints, (2) and (3), account for the preference of either stops or continuants depending on the context. It should be noticed that (3) constitutes a subset of (2), since (3) is not applicable in absolute initial position, whereas (2) is applicable all over. The question must thus be posed, which constraint is the dominating one? Obviously, in a language in which (2) were to dominate (3) only plosives would appear. This entails that in a language like Spanish, in which spirants appear in certain contexts, constraint (3) must outrank (2), in order to block the effect of the general constraint (2) in precisely those contexts. Accordingly, where (3) is not relevant, plosives make their appearance, whereas in contexts in which spirantization is applicable, and (2) and (3) are in contradiction, the outranking of (3) over (2) is manifest. The following tableau illustrates the dominance relations between these two constraints in the target language, Spanish. Notice that in initial position, where (3) is not relevant, it must nevertheless dominate (2), since there is only one single hierarchy in the grammar. We have included a general faithfulness constraint, IDENT[cont], simply stating that the output value of the feature [cont] should coincide with that of the input. As we have mentioned in relation to (1) above, Underspecification Theory posits underlying representations lacking a specification for [cont]: in the contexts in which the spirantization rule is not applicable, universal conventions predict that obstruents are preferably non-continuant. In Optimality

Theory, the production of such voiced plosives is automatically defined by the general constraint hierarchy (4), without need to appeal to underspecification, an often debatable concept (Kenstowicz 1994:506ff). Accordingly, the input in tableau (1) contains voiced stops, characterized as [-cont], and the faithfulness constraint, IDENT[cont], applies to such inputs. Faithfulness does not seem to have a decisive role in Spanish, though, as most of the job is done by the markedness constraints; the same results of tableau (1) would be achieved if IDENT[cont] were placed after *[cont]. (The tableaux follow the conventions, which are by now standard in OT.)

Tableau (1) for Spanish *dedo* ['deðo] 'finger' in the target/adult language

/'dedo/	AGREE[cont]	IDENT[cont]	*[cont]	*[stop]
☞ ['deðo]		*	*	*
['dedo]	*!			* *
['ðeðo]		* *	*!*	
['ðedo]	*!	*	*	*

The preference for unmarked segments and structures at the initial stage of acquisition is accounted for in Optimality Theory. There is a well-known proposal in this theory (Gnanadesikan 1995), which states that at the beginning of language production, markedness constraints outrank faithfulness constraints. This implies that the constraint IDENT[cont] should not have any effect at the early stage of acquisition, and thus be placed at the end of the hierarchy. However, there are two markedness constraints that are relevant here, (2) *[cont] and (3) AGREE[cont]. As we have just seen, their ordering in the target language must be AGREE[cont] outranking *[cont]. An important question regarding acquisition is whether the ranking relation of these two markedness constraints in the initial state is the same as in the adult language. This must be answered by means of the acquisition data, in the sense that the massive presence of plosives in the children's productions would indicate the outranking of *[cont] -- and thus support the hierarchy *[cont] » AGREE[cont], as well as (4) *[cont] » *[stop] -- whereas the presence of spirants postvocalically would show that the context-sensitive constraint, AGREE[cont] dominates the general constraint *[cont].

Before looking at the data, though, we would like to clarify what the expectations as regards the hierarchy of these two markedness constraints should be in the initial state according to the theory. Since Optimality Theory makes us expect the most unmarked elements to emerge at first, it is plausible to expect that initially the most general markedness constraint, *[cont], should be the dominating one. A child with a dominating *[cont] growing up surrounded by Spanish will hear many data that contradict such a constraint. That is, those words that have undergone spirantization will tell him/her that *[cont] must be demoted. This idea is in agreement with Levelt & van de Vijver (1998), Boersma and Levelt (1999), Boersma and Hayes (2001) and Broselow (2004), according to which "the acquisition of ranking is error-driven: upon encountering forms that are inconsistent with the grammar, learners will change constraint rankings so as to maximize the fit between grammar and data" (Broselow 2004:58). Moreover, in the model of acquisition proposed by these authors constraint ranking is sensitive to the frequency of certain categories in the input data. A more general constraint is violated more often than a less general constraint and will thus be demoted more rapidly. It is thus to be expected that although *[cont] should at first be dominating, given the numerous contradictory data that this constraint encounters in a language like Spanish, children acquiring Spanish will soon demote it.

Some clarification is also required by the notion of "input". We can assume that very young children have not yet figured out the spirantization analysis, i.e. that although they

hear stops and spirants, at the beginning they might not be able to place the stop/continuant pairs b/β, d/ð and g/ɣ as each belonging to a single phonological category. We rather expect that very young children take adult productions at face value, as the inputs to their infantile productions. This idea has a long tradition in phonological acquisition (see, for instance, Ingram 1974). Accordingly, in the following tableaux we consider the adult phonetic or output form to be the input form to the child's grammar. Tableau (2a) corresponds to the hierarchy that we have defended for the initial state, with *[cont] dominating AGREE[cont], whereas Tableau (2b) has the reverse hierarchy: AGREE[cont] dominates *[cont]. The latter hierarchy should be interpreted as the result of demoting the general constraint, once the child has been confronted with the numerous spirants of Spanish. Notice that faithfulness is not operative and has thus been placed at the end of the hierarchy.

Tableau (2a) for Spanish *dedo* ['deðo] 'finger' in child language: *[cont] » $\text{AGREE}_{[\text{cont}]}$

/'deðo/	*[cont]	$\text{AGREE}_{[\text{cont}]}$	*[stop]	$\text{IDENT}_{[\text{cont}]}$
['deðo]	*!		*	
☞ ['dedo]		*	* *	*
['ðeðo]	* *!			*
['ðedo]	*!	*	*	* *

Tableau (2b) for Spanish *dedo* ['deðo] 'finger' in child language: $\text{AGREE}_{[\text{cont}]}$ » *[cont]

/'deðo/	$\text{AGREE}_{[\text{cont}]}$	*[cont]	*[stop]	$\text{IDENT}_{[\text{cont}]}$
☞ ['deðo]		*	*	
['dedo]	*!		* *	*
['ðeðo]		*!*		*
['ðedo]	*!	*	*	* *

In Tableau (2a), with an outranking *[cont], the winner is a form with two voiced stops, whereas in Tableau (2b) the winner contains an initial voiced stop and a medial continuant or spirant. The latter clearly evidences that both constraints are operative, but AGREE[cont] is the dominating one. A similar result with a targetlike spirant could also be obtained if Faithfulness dominated Markedness, by which IDENT[cont] would dominate *[cont]. However, the assumption that Faithfulness is outranked by Markedness is a well-behaved one, and it should not be arbitrarily suspended.

2. The study

With the aim of finding out how children acquire a language with spirantization, especially in combination with another language without spirantization, three different studies were designed with three groups of children: three monolingual Spanish children (aged 1;3 to 3;0) growing up in Spain, three monolingual German children of the same age growing up in Germany, and three Spanish-German bilingual children (aged 1;3 to 4;0) growing up in Germany. There were several reasons why we wanted to focus the study on the bilingual group. First, because case studies must be limited in number and there is a lot of individual variation in the acquisition process, it is a wide-spread stance in the bilingualism literature that the bilingual child serves as her own control and thus circumvents the problem of individual variation bound to monolinguals (see De Houwer 2000). Second, if stopping is a general process and markedness plays an important role in

first language acquisition, the combination of two languages, with and without spirantization, within the same individual may shed light on the driving force of markedness. This will be the case if the two languages develop differently in the bilingual child and in the monolinguals as regards spirantization. The latter implies that there is a certain interaction between the two languages of the bilingual, that is, that they do not develop completely independently of each other. Such interaction has been reported in numerous studies on bilingual phonological acquisition (see, for instance, the contributions in Lleó & Kehoe, eds., 2002). In summary, studying bilingual groups can be decisive to understand the role of markedness in acquisition. Concomitantly, the findings on monolingual acquisition are essential for bilingual studies as a base of comparison.

The questions we want to ask have been outlined in section 1: a) Do children acquiring spirants produce them as such, or do they substitute stops for spirants? b) Are the allophones produced in the correct contexts, i.e. spirants after vowels and stops in initial position? c) Are the postvocalic allophones produced as spirants regardless of the presence of a word-boundary? d) Do bilinguals acquire spirants in a different way or do they follow a different pattern than monolinguals? e) Is there an evolution in the pattern of stop/spirant production in the sense that the rate of spirantization increases across time?

2.1. Data and methodology of analysis

All children were audio- and video-recorded fortnightly in their homes from the beginning of word production, in unstructured play situations, while interacting with an investigator and one of the parents. Following testing, all sessions were glossed and phonetically transcribed by two transcribers (one native speaker of German and the other, a native speaker of Spanish) and all productions were entered into a database. Reliability tests for transcriptions resulted in very high percentages of agreement. Intra-transcriber reliability as regards plosives and spirants amounted to 100% in both languages. Inter-transcriber reliability reached 100% for German and 88.1% for Spanish. Target words containing plosives or their corresponding spirants were selected from the data sessions. Only sessions containing a minimum of 10 such target words were considered. For the evaluation of spirants vs. plosives, only two contexts were taken into account: absolute initial position and the context between vowels, both within words and across word boundaries.

The bilingual children were visited by two separate teams, a German- and a Spanish-speaking team, and the two languages were recorded separately. Only Spanish words spoken in Spanish sessions and German words spoken in German sessions were included in the study. Although the study focuses on the bilinguals, we first present the monolingual data and then turn to the bilingual findings.

2.2 Monolingual results

Figure 1 shows the percentages of target spirants and target plosives produced correctly -- according to whether the target features [cont] and [Place] were faithfully produced -- by the group of Spanish children, in three-monthly periods. The missing point for stops in Figure 1 is due to very low numbers of target segments in the relevant context. Some examples of spirantization by Spanish children are shown in (5), where the first column contains the orthographic form, the second column corresponds to the adult output, which according to our discussion in section 1.2 also serves as the input to the child form, represented in the third column:

(5)

cabeza	[kaβeθa]	[gaβɛsa]	head	Miguel 2;3
nada	[naða]	[naða]	nothing	José 1;10
tortuga	[toɾtuɣa]	[dotuɣa]	a turtle	Miguel 2;6
otro gato	[otɾo ɣato]	[hotoɣako]	another cat	José 2;3

Figure 2 shows the percentages of initial voiced plosives produced correctly as plosives and the percentages of intervocalic voiced plosives incorrectly produced as spirants by German children. Both figures show very high values of correct production of target plosives, especially in German, where they reach 100%. In Spanish correct production of plosives is relatively high, too, but notice that its rate is slightly reduced between 1;7 and 2;6, and drastically reduced at 2;7-2;9. The presence of spirantization is low in German, as it is predictable from markedness considerations: plosives are less marked than spirants, and given that no data in the target language contradict the ban against spirants, the constraint *[cont] keeps its outranking position in German. However, Figure 1 shows that the percentages of targetlike spirantization is very high in Spanish, beginning at the initial time points: it never appears below 60% and it soon reaches almost 80% (see also Soltau 2002).

There is some development in Spanish, but the initial point already reaches a very high value. Figure 3 shows the correct percentages of spirantization by each of the three Spanish children, José, María and Miguel. Interestingly, the individual development parallels the group development, too, as a comparison of the group values of Figure 1 and the individual values in Figure 3 clearly shows. The individual values in Figure 3 transparently show that the development is not completely linear: all children manifest a light decrease of spirantization, José and María at 2;1-2;3, and Miguel from 1;10-2;0 to 2;4-2;6. After that, all children reach more than 80% spirantization; in the case of José, there are no data available beyond 2;4-2;6. A comparison of spirant production in the Spanish and German groups by means of U-tests showed statistically significant values at points 1;10-2;0, 2;1-2;3 and 2;4-2;6: p=0.05. The development of voiced stop production by the Spanish monolingual group (Figure 1) is parallel to the development of spirant production until 2;4-2;6. Given that the production of spirants up to this point experienced a reduction, a possible trade-off with the plosive allophones was to be expected, but it did not take place. Interestingly, stop production over this period is also reduced. We will take up these points -- lack of trade-off and reduction of stops -- further in the discussion.

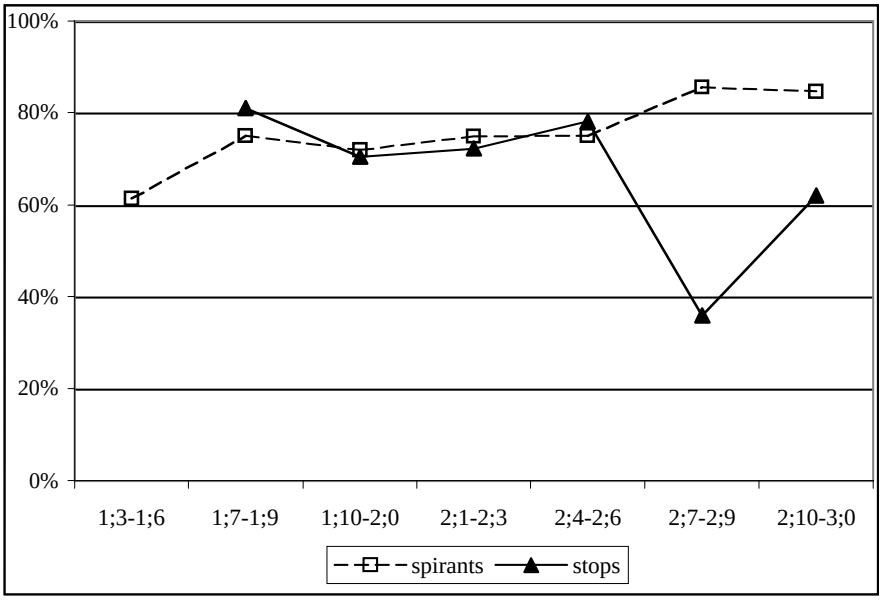

Figure 1: Percent of Voiced Stop and Spirant Production by the Spanish Monolingual Group across 3-Monthly Periods.

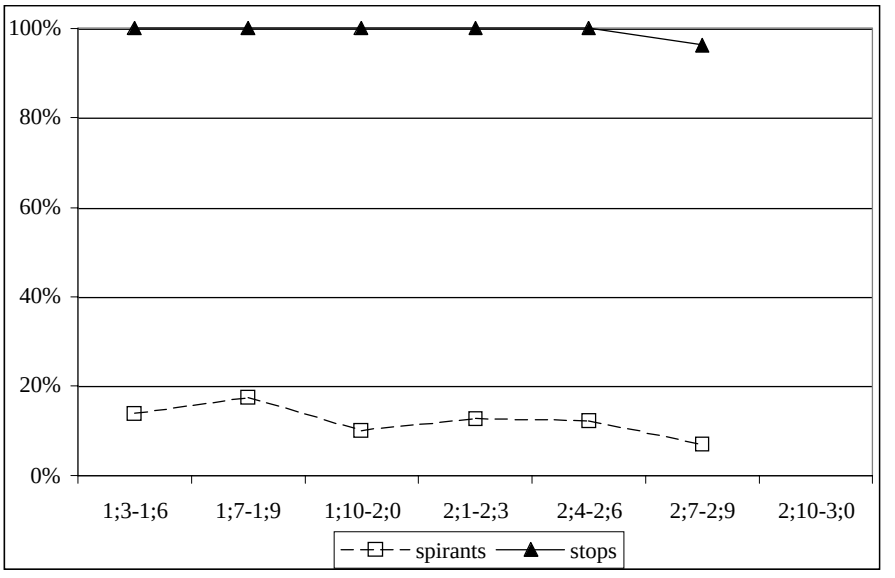

Figure 2: Percent of Voiced Stop and Spirant Production by the German Monolingual Group across 3-Monthly Periods.

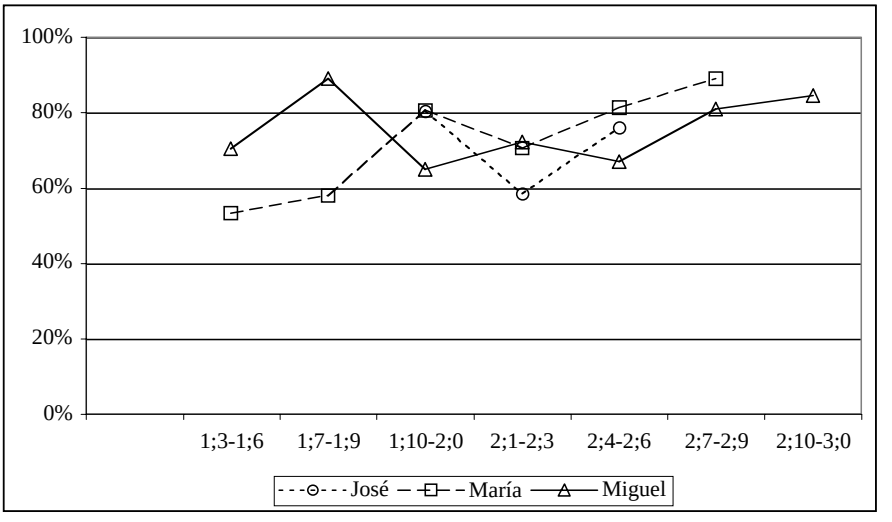

Figure 3: Percent of Spirant Production by the three Monolingual Spanish Children across 3-Monthly Periods.

Going back to the questions that prompted our study, the following can be stated. Do children acquiring spirants produce them as such, or do they substitute stops for spirants? Although according to markedness constraints, stops were predicted at the initial state, our data on monolingual Spanish show that children produce target spirants to a very high percentage. There is some substitution of voiced stops for spirants, but to a very low degree. Are the allophones produced in the correct contexts, i.e. spirants after vowels and stops in initial position? As explained above, the values for rates of spirant production correspond to the position after vowels, whereas those for plosives have been calculated in absolute initial position. This is in fact related to the following question about the context: Are the postvocalic allophones produced as spirants regardless of the presence of a word-boundary? In order to address this question, the contexts, in which spirants and the corresponding non-spirantized stops may appear, have been divided into three categories: after vowel preceded by a syllable boundary (within words), after vowel preceded by a word boundary (across

words) and in absolute initial position.[3] This information is given in Table 1 showing percentages of spirantization according to the three contexts for the three monolingual children, José, María and Miguel. (In this table "N" refers to all tokens eligible for spirantization.) Clearly, absolute initial position is the least affected of all: where the values of N are relatively high, only María shows an increase: at 2;7-2;9 out of 7 eligible tokens she has 85% of spirants in initial position. Although the number of eligible tokens is rather low, this high rate of spirants needs an explanation. All other values are relatively low: 40% or lower. In general, the most favored position for spirantization is within words, closely followed by the context across words. Miguel has higher values within words until 2;1-2;3, whereas after that there is a reversal, the values across word-boundaries being slightly higher. María has identical values in the two positions until 1;10-2;0, with an increase of the within-words position at 2;1-2;3, but a decrease in the following time spans. In the case of José, there are no great differences between both positions. In general, the results regarding context suggest that children do not seem to differentiate the two positions, within and across word-boundaries, treating spirantization as a general process, and disregarding prosodic boundaries.

Table 1. Percentages of spirantization according to context, within words, across words and in absolute initial position, for the three monolingual Spanish children.

José	**Within Words %**	**N**	**Across words %**	**N**	**Initial Position %**	**N**
1;4-1;6	100%	1		0	0%	4
1;7-1;9	17%	6		0	8%	37
1;10-2;0	81%	68	81%	54	29%	34
2;1-2;3	59%	76	64%	39	20%	10
2;4-2;6	80%	35	68%	19	67%	3

María	**Within Words %**	**N**	**Across words %**	**N**	**Initial Position %**	**N**
1;4-1;6	100%	14	100%	2	0%	4
1;7-1;9	100%	4	100%	10	100%	2
1;10-2;0	90%	33	90%	21	14%	7
2;1-2;3	85%	48	58%	19	25%	4
2;4-2;6	87%	67	97%	59	40%	5
2;7-2;9	93%	27	100%	20	85%	7

Miguel	**Within Words %**	**N**	**Across words %**	**N**	**Initial Position %**	**N**
1;4-1;6	95%	20	0%	7	0%	1
1;7-1;9	93%	15	85%	13	100%	3
1;10-2;0	100%	19	68%	19	75%	4
2;1-2;3	85%	34	78%	23	50%	4
2;4-2;6	73%	60	77%	60	19%	27
2;7-2;9	83%	29	100%	15	57%	7

2.3 Bilingual results

Figure 4 and 5 show the percentages of target spirants and target plosives produced correctly in Spanish and German, respectively, by the bilingual group in three-monthly periods. Figure 6 shows the individual spirantization values for each of the bilingual children. Some examples of spirantization in Spanish by Spanish-German bilingual children are shown in (6), where we follow the same order as in (5) above:

[3] Although in target Spanish the position after a Phrase-boundary is also eligible for spirantization, we have omitted it from the tables, as there were no relevant cases in the children's data.

(6)

bebe	[beβe]	[be.βe]	baby	Nils 1;8,28
otra vaca	[otra βaka]	[ʔo.tɐ βa.ka]	another cow	Simon 2;4,15
tambien	[tambjen]	[tam.bjen]	too	Simon 2;5,13
un helado	[un elaðo]	[ʔn he.la.ðo]	an ice-cream	Jens 2;4,27
dame	[dame]	[da.me]	give me	Simon 2;5,27
tortuga	[torɾtuɣa]	[tø.tu.ɣa]	turtle	Simon 1;10,30
gato	[gato]	[ga.t^{h}ø]	cat	Nils 1;8,3

Whereas Figure 5 shows that the bilingual group has very similar values for plosives as well as for spirants in German as compared to the monolingual German group, Figure 4 shows that in the Spanish of the bilingual group only the plosive allophones have values similar to those of the monolinguals; in fact, the rate of correct voiced stop production is slightly higher for the bilinguals. On the contrary, the values for spirants are lower: they begin as a group with about 60% at 1;7-1;9, they undergo a reduction and at 2;4-2;6 raise to reach the initial values again. After that point, the development of spirants in the bilingual group is completely different from that of the monolingual group, experiencing a drastic reduction. Figure 6 illustrates the development more precisely, plotting the values for each individual child separately. Here we see that until 2;4-2;6 the three bilingual children, Jens, Simon and Nils have a very similar development in Spanish to that of the monolinguals, José, María and Miguel, albeit with a slightly lower rate of spirants. It is striking to see that up to this point all bilinguals individually have similar developmental contours. Still more striking is the drastic reduction of spirantization experienced by all three bilingual children after 2;4-2;6, and the fact that the low percentages last for a long time. In fact, only Simon seems to develop into a higher rate of spirantization towards the end of the study, at 3;10-4;0; in the case of Nils, there are no more data available beyond 2;7-2;9. It is plausible to expect that these children will regain correct rates of spirantization later on, as anecdotal and intuitive experience with bilinguals who have learned their two languages simultaneously, like the children of the present study, does not point to lack of spirantization as a noticeable feature of their pronunciation. We intend to investigate this issue further, once more data become available.

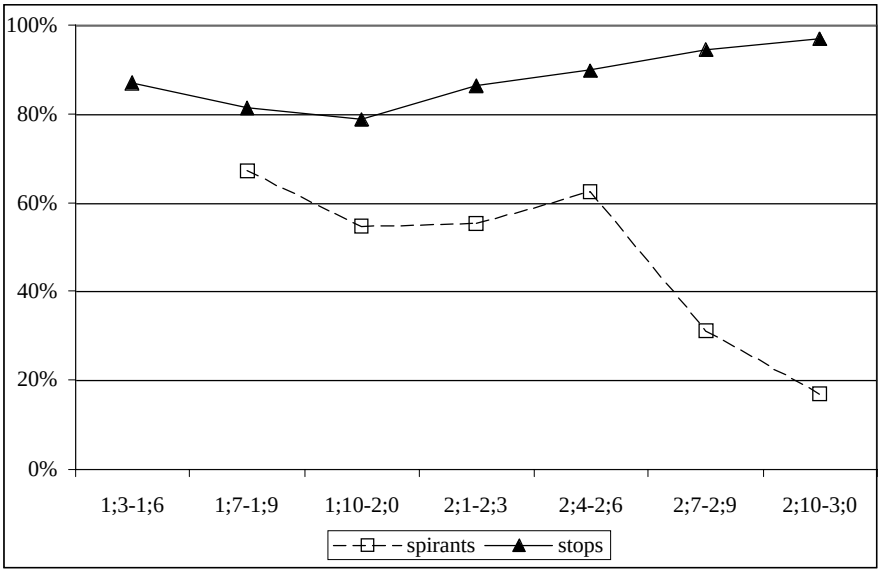

Figure 4: Percent of Voiced Stop and Spirant Production in Spanish by the Bilingual Group across 3-Monthly Periods.

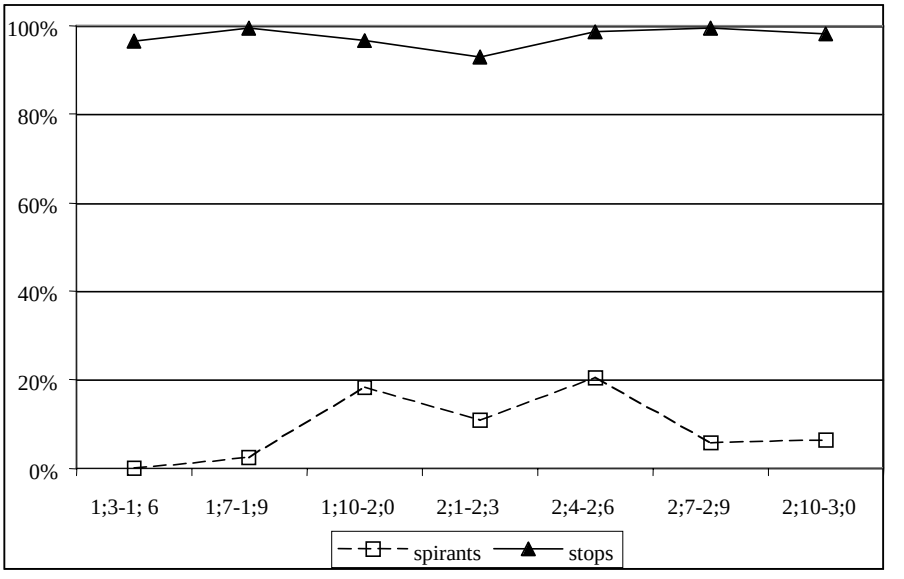

Figure 5: Percent of Voiced Stop and Spirant Production in German by the Bilingual Group across 3-Monthly Periods.

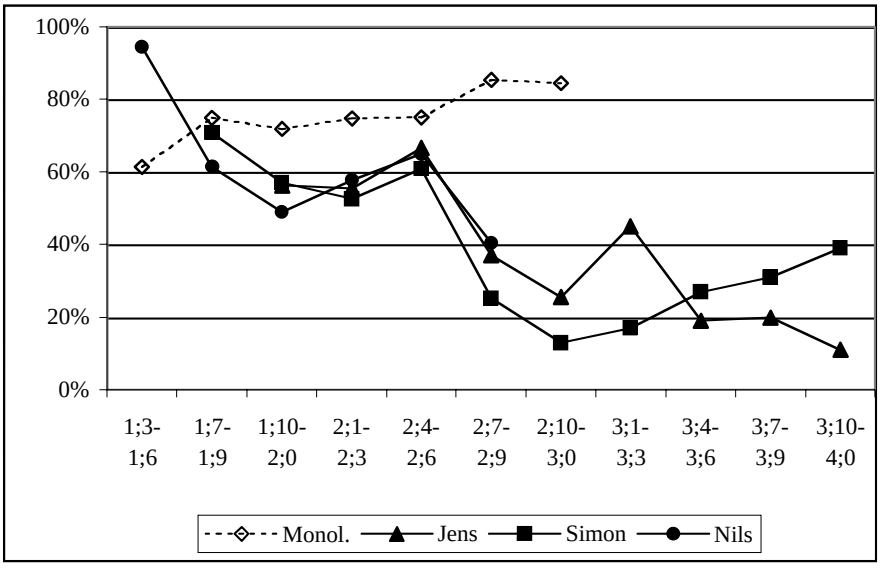

Figure 6: Percent of Spirant Production in Spanish by the three Bilingual Children across 3-Monthly Periods in Comparison with the Spanish Monolingual Group Development.

Relating these results to the questions we posed at the beginning of the study, we must state similar findings as far as correct production of spirantization: spirants are substituted by voiced stops to a certain degree, with higher percentages of voiced stop production than the monolinguals. As regards the contexts, in which the spirant and stop allophones appear, we have also divided them into the three different positions: after vowel within words, after vowel across word boundaries and in absolute initial position. This information is given in Table 2 showing percentages of spirantization according to the three contexts for the three bilingual children, Jens, Nils and Simon. As in the case of the monolinguals, the absolute initial position is the least favored position for spirants. As far as the other two

positions, Jens shows a clear preference for the position within words, whereas Nils and Simon do not generally show any preferences, with some variation from one time period to the next.

Table 2. Percentages of spirantization according to context, within words, across words and in absolute initial position, for the three bilingual children in Spanish.

Jens	**Within Words %**	**N**	**Across words %**	**N**	**Initial Position %**	**N**
1;4-1;6	100%	4		0	0%	3
1;7-1;9	100%	4		0	0%	1
1;10-2;0	60%	15	0%	1	14%	28
2;1-2;3	79%	19	25%	4	29%	14
2;4-2;6	72%	25	0%	3	8%	12
2;7-2;6	56%	36	24%	21	0%	7
2;10-3;0	26%	27	14%	14	0%	9

Nils	**Within Words %**	**N**	**Across words %**	**N**	**Initial Position %**	**N**
1;4-1;6	94%	18		0	25%	8
1;7-1;9	63%	38	0%	1	19%	68
1;10-2;0	46%	37	53%	15	33%	46
2;1-2;3	62%	61	45%	20	16%	55
2;4-2;6	74%	31	38%	8	34%	32
2;7-2;6	54%	28	0%	8	28%	29
2;10-3;0	14%	7	50%	2	11%	9

Simon	**Within Words %**	**N**	**Across words %**	**N**	**Initial Position %**	**N**
1;4-1;6		0		0		0
1;7-1;9	100%	15	0%	5	0%	25
1;10-2;0	50%	32	0%	1	3%	34
2;1-2;3	62%	29	64%	14	8%	12
2;4-2;6	66%	67	52%	52	14%	22
2;7-2;6	35%	48	28%	60	33%	6
2;10-3;0	13%	38	19%	36	0%	3

The remaining questions refer to bilinguals and to the process of acquisition: Do bilinguals acquire spirants in a different way or do they follow a different pattern than monolinguals? We have seen that at first the patterns followed by bilinguals are parallel to those of monolinguals, albeit reaching slightly lower rates of spirantization. But after 2;6, all three bilinguals experience a great deal of reduction in their rates of spirantization, from which only one of the children seems to clearly recover in favor of spirantization at about 4;0. This result is also related to the last question: Is there an evolution in the pattern of stop/spirant production in the sense that the rate of spirantization increases across time? In the case of the monolinguals we saw that the development was not completely smooth, although there was a clear tendency to increase the rate of spirantization towards the end of the study. In the case of the bilinguals, development has to be divided into two phases: the first one has a similar pattern to the monolingual one, but the second one shows an extreme reduction of the rate of spirantization. There is no tendency for growth during the whole time period. Correct rates of spirantization are clearly not acquired within the time span of the study, which does not preclude later acquisition. These findings are rather surprising and in need of explanation. We turn to a discussion and explanation in the next section.

3. Discussion

Our findings clearly show that monolingual Spanish children produce spirants targetlike to a very high degree from the earliest word production. This early production of spirants raises the question of markedness treated above, in relation to the two conflicting constraints, (2) banning spirants and (3) favoring continuants in contexts of spreading of [+cont]. In spite of [+cont] being marked, very young children produce spirants in contexts of [+cont] spreading. This implies that in Spanish children's grammars, constraint (3) favoring spirants dominates constraint (2) banning them, otherwise only stops would have been produced. These findings contradict the expectations we had: because (2) is a more general constraint, we had tentatively predicted that it would be the dominating constraint within the markedness constraints. This has been contradicted by the data. We may conjecture that the outranking of *[cont] over AGREE[cont] is only valid at the very initial stage, probably coinciding with babbling. As soon as production of words is attempted by the children, they confront much data in Spanish which are contradictory to the dominating role for the general markedness constraint (2) and soon demote this constraint. In fact, we had found out in an earlier study (Lleó et al. 1996) that already at the babbling stage, Spanish children produced a higher amount of fricatives than the German children. This result implies that the demotion of *[cont] begins very soon in the Spanish children's grammars, even earlier than at the one-word stage.

Even though constraints (2) and (3) are both markedness constraints, the least general of them, AGREE[cont], will outrank the more general one, if the target language requires it; that is, the relative position in the grammar is given by the outputs of the target language. There are other manifestations of such feature-agreement constraints in Spanish, i.e. those promoting the spread of voice, or of place features for nasals. Spanish is a language with high degrees of assimilation (Lleó & Vogel 2004), applying to large prosodic constituents, which means that the child is sensitized to the spreading of features, as in the present case of [+cont]. This situation does not necessarily require faithfulness to spirants, i.e., it is not a question of having a dominant faithfulness constraint, but it is rather the far-reaching processes of spreading that provide evidence to the child that sharing features is outranking. Accordingly, in the Spanish children's grammars sharing features outranks the ban against spirants, that is, AGREE[cont] outranks *[cont].

Given such high percentages of correct spirantization, as those reached by the monolingual Spanish children from the beginning of word production, it is somehow surprising that their rate of spirantization does not follow a linear development, but rather experiences a decrease, albeit a slight one. This state of affairs suggests that the outranking position of constraint (3) over (2) fluctuates for a while. We want to propose that the explanation for the fluctuations during a few months towards the end of the second or the beginning of the third year of life is due to a restructuring of the phonological system, especially with regard to the feature [cont] in the relevant input forms. If we go back to tableau (1) for the adult language and tableaux (2) for the child language, we will recall that the input forms were different: for the adult language we posited the voiced stop, whereas for child language we posited [+cont] in the input, as predicted by theories of child language phonology. The assumption is that children take the adult forms at face value, and use them as inputs to their grammar; in other words, they have not yet carried out a phonological analysis in the sense that they have not yet developed a phonemic category encompassing both the spirants and the voiced stops as two variants of the same category. Once they construct such categories, their input form ceases to be the spirant, and turns into a plosive or [-cont]. It is plausible to think that this process of substitution of the input forms is not done all at once, since it requires the establishment of the categories b/β, d/ð, g/ɣ, and there may be some oscillations until all input forms are correctly defined.

The pattern of development we are looking at corresponds to a typical U-shaped curve, although not a very pronounced one, with a light decrease of correct values. The interpretation of such U-shaped developments proposed by acquisition studies seems to

suggest the following analysis. We may want to argue that at first children produce many spirants in Spanish, because they just hear them. This would imply that children imitate what they hear. Later on, they undertake phonological analysis and make errors (Vihman 1996). Pursuing this idea would require positing faithfulness constraints exclusively, as that is what imitation means: rendering what one hears faithfully. However, we have already argued against such a dominating role for faithfulness at the beginning of word production for theoretical reasons. Moreover, producing imitated forms at first and only later on going into spontaneous production would compel us to assume that after a period of faithfulness, grammar with its markedness constraints is switched on. Such a discontinuity hypothesis is also to be rejected on theoretical grounds. An account based on restructuring of the system, with some changes to the input forms as the result of category building, and still provisory constraint hierarchies, has the virtue that it retains most hypotheses proven valid in the field. At first, only markedness constraints are active; on the one hand, markedness constraints are universal, but on the other hand their hierarchies are sensitive to frequencies in the input. Guided by the hierarchy AGREE[cont] » *[cont] » *[stop], the child produces pairs of sounds, [b]/[β], [d]/[ð], [g]/[ɣ], each belonging to a single category. The construction of phonological categories, though, presupposes some processing/evaluation of the data on the part of the child, and this requires time. Once the child reaches the linguistic knowledge that such pairs constitute categories, he/she is ready to change the underlying form: this does not need to be specified for the feature [+cont] in the spirantization contexts; all voiced obstruents can be defined as [-cont]; the rest is accomplished by the constraints. At this point errors may pop up both, because the child might posit input forms with the voiced obstruent arbitrarily specified as [-cont] or as [+cont], and at this point faithfulness constraints are becoming more dominant, and at the same time the ordering between AGREE[cont] and *[cont] is not definitively fixed.

Faithfulness constraints may be promoted at this age, because children are already reaching the end of their second year and are becoming aware of the forms of the target language. If some input voiced obstruents are characterized as [+cont], faithfulness will lead to output forms also specified as [+cont], and the input specification [-cont] may lead to more output cases of [-cont] than correct. Notice in this respect, that the rate of production of the plosive allophones also decreases, first in a parallel manner to the decrease of spirants, and then even much more drastically. The considerable reduction of correct plosive production at 2;7-2;9 in the Spanish monolingual data (see figure 1) shows that children are overdoing spirantization, too, and this must be effected by faithfulness, given input forms incorrectly defined as [+cont]. At the previous time points, they were underdoing it. This means that there are errors in both directions, errors in relation to spirants, but also errors in relation to stops. Such a result points to the reorganization of the system as the clue to the temporary regression: the child must classify the pairs of sounds as belonging to a single category and must apply the constraints to the correct inputs. The following tableaux exemplify possible wrong results of input forms with either voiced stops (3a) or continuants (3b), combined with still uncertain hierarchies, in which constraints have not yet reached their definitive positions. In tableau (3a) a still outranking *[cont] is made responsible for the incorrect production of *dedo* without a medial spirant; in (3b) spirantization is overdone (in initial position), because of a wrong input and a relatively dominating faithfulness constraint.

Tableau (3a) for Spanish *dedo* ['dedo] 'finger' in child language: *[cont] » AGREE$_{[cont]}$

/'dedo/	*[cont]	AGREE$_{[cont]}$	*[stop]	IDENT$_{[cont]}$
['deðo]	*!		*	*
☞ ['dedo]		*	* *	
['ðeðo]	* *!			* *
['ðedo]	*!	*	*	*

Tableau (3b) for Spanish *dedo* ['ðeðo] 'finger' in child language: AGREE$_{[cont]}$ » IDENT$_{[cont]}$ » *[cont]

/'ðeðo/	AGREE$_{[cont]}$	IDENT$_{[cont]}$	*[cont]	*[stop]
['deðo]		*!	*	*
['dedo]	*	*!*		* *
☞ ['ðeðo]			* *	
['ðedo]	*!	*	*	*

One could be tempted to attribute the reduction in the rate of both spirants and stops to the spreading rule (1). That is, we might suppose that the grammar of Spanish contains a rule of spirantization, and that it takes some time for children to learn it correctly. Children might apply it incorrectly at first, e.g. to the inadequate contexts, and this would explain the regression shown in the data. We do not see the need to posit such a rule, though. As we have seen above, the two markedness constraints (2) and (3) in combination with faithfulness can account for the target as well as child data, without the need of a hybrid system containing both constraints and rules. Although there are some proposals in the literature in favor of keeping rules along with constraints (see particularly some of the contributions in Roca 1997), the adduced necessity for rules refers to very idiosyncratic processses, as in Blevins (1997). This is not the case of the spirantization process in Spanish, resulting from the interaction of markedness constraints.

Turning now to bilinguals, we have seen that in Spanish the percentages of spirantization are similar to those of the monolinguals up to 2;4-2;6, albeit a bit lower. It can be proposed that the bilinguals in Spanish begin with a grammar that is very similar to the grammar of the monolinguals, with constraint AGREE[cont] soon in a dominant position, since spirants are correctly produced to a large extent. The percentages of voiced stops are about the same as those of the monolinguals in both languages; additionally, in German the rate of spirantization is as negligible as it was for the German monolinguals. This means that the sole difference between monolinguals and bilinguals appears in the slightly lower rate of spirantization in Spanish, that is, at the point at which the two markedness constraints conflict. In relation to those phenomena corresponding to unmarked segments, i.e. the appearance of stops, there is no difficulty for the bilinguals, thus no difference between bilinguals and monolinguals. But the appearance of spirants in Spanish involves markedness, because the least general markedness constraint AGREE[cont] must dominate the most general *[cont]. Here, we observe some delay in the case of the bilinguals. We have argued that the demotion of the general constraint *[cont] involves a high frequency of spirants; this is the case for monolinguals. But in the case of bilinguals, their input adds the stops of both languages, Spanish and German, whereas spirants are only present in one of the languages. This brings about a dilution of spirants in the data of the bilinguals, and thus provides less cases of violation of the general constraint *[cont]. Accordingly, its demotion

is delayed. The data on bilingual acquisition of spirants until 2;4-2;6 makes clear that in the early periods of acquisition, the two languages of the bilingual child interact. Similar results evidencing interaction have also been shown in other domains of bilingual acquisition: VOT (see Kehoe, Lleó & Rakow 2004), metrical structure (Lleó 2002), consonantal codas (Lleó, Kuchenbrandt, Kehoe & Trujillo 2003), German vowels including schwa (Kehoe 2002, Kehoe & Lleó 2003), intonation (Lleó, Rakow & Kehoe 2004). All these cases of interaction seem to involve markedness. If markedness is not relevant, as in the case of Spanish vowels, bilingual production is indistinguishable from that of monolinguals (Kehoe 2002). Clearly, the determining factor for this strong influence is markedness: the constraint banning spirants, *[cont], universally dominates the one sharing features, AGREE[cont].

In the time points following 2;4-2;6 the spirantization values of the bilinguals substantially decrease. As we have seen, only one of the bilingual children, Simon, begins to regain his spirantization rate again at 3;4-3;6, and there is a slight growing tendency after that, until the end of the study at 3;10-4;0, although his value at this point still hardly reaches 40%. Jens manifests a decreasing curve up to the end of the study, and Nils shows a clear decrease, too, but his data stop at 2;7-2;9. The only possible explanation for this drastic reduction of the rate of spirants is transfer from German into Spanish. In the literature there are hardly any cases of transfer reported at this early age, but it is one of the theoretical possibilities posited by Paradis & Genesee (1996), when arguing for possible cases of interaction between the two languages of the bilingual: acceleration, delay and transfer. Given that the bilingual children had reached over 60% of spirantization at 2;4-2;6, after a period of reorganization, the striking decrease can only be caused by a factor external to Spanish, i.e. by the presence of the other language, German. This hypothesis opens many questions, as for instance, a) why should transfer precisely appear after 2;6, and b) what is really meant by transfer.

As for the question relating to the point of appearance of transfer, it is clear that transfer can make its appearance after the system has been established and the hierarchy of constraints is in its way to fixation. This happens at 2;4-2;6, with a percentage of 60% of correct spirant production and over, but the development towards values similar to the monolingual ones gets interrupted by the influence of the other language. The weight of German may be explained by reasons of input. Bilingual children developing in a monolingual society are more intensively exposed to the language of the large society, especially if the weaker language is only represented by the mother, as is the case for our bilingual children. The input of the mother's language looses weight once children begin visiting the Kindergarten and having a greater interaction with German speaking children and adults. In such a situation, they hear many more stops than spirants, and their process of acquisition of spirants is disturbed by the reduction of exposure to Spanish.

What does it mean that German influences Spanish or that there is transfer of German into Spanish? We have argued that in Spanish the demotion of the general constraint banning spirants is effected by the frequent violation of this constraint, when confronted with the numerous spirants of Spanish. Once the exposure to German intensifies, the rate of violations of this constraint decreases, and the child does not have a clear reason to keep on demoting it, he/she rather tends to place it again to the outranking position it has in German. This is what transfer means in OT: The German constraint hierarchy *[cont] » AGREE[cont] is considered valid in Spanish by the bilingual child, to a greater extent than it should, and thus the child substitutes many stops for spirants in his Spanish words. Notice that in case we contemplated a mixed system with constraints and some language-specific rules, transfer might also mean that the spreading rule (1) is suspended in Spanish given the strong evidence of German in favor of stops.

Our findings have shown two different periods of spirant reduction for bilinguals, the first one almost coinciding with a slight decrease among the monolinguals and the second one emerging exclusively among bilinguals. What we are implying in our interpretation of the results is that these two periods are very different. The first one has as its cause a

restructuring of the system, whereas the second one takes place once the system has already been established and its cause emerges from the influence of another linguistic system.

4. Conclusions

This study has examined the production of voiced stops and spirants by a group of Spanish-German bilingual children and has compared it to two groups of monolingual children, one Spanish and another one German. In spite of the alleged markedness of spirants, they are produced from the very beginning by Spanish speaking children. However, Spanish-German bilinguals show less spirants in their productions and what is more important, percentages of spirants are drastically reduced from 2;7 on. These findings shed light on the interaction between different markedness constraints and at the same time exemplify the interaction between the two languages of the bilingual child on the basis of markedness. All grammars must contain two markedness constraints in relation to the feature [cont], one banning spirants in general and the other one, a contextual one, requiring agreement of the feature [cont] between two contiguous segments, favoring [+cont] in postvocalic position. In the grammar of Spanish, the constraint favoring contextual [+cont] outranks the general constraint favoring stops. After many productions of spirants, children experience a slight reduction in the rate of spirants, which is explained by a restructuring of the system. Additionally, bilingual children experience a dramatic reduction of spirants, and this is explained by transfer from German into Spanish, in the sense that given a largely reduced input, children revert to the most general hierarchy, by which the general constraint banning spirants is the most dominant one.

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