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FIRST LANGUAGE ACQUISITION OF ONSET CLUSTERS IN CHILEAN SPANISH: ANALYSIS FROM OPTIMALITY THEORY AND SONORITY PRINCIPLE

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Abstract: This article examines the development of complex onsets (CO) during the L1 acquisition of Spanish (Chilean variety) by nine children (ages 1;6 to 2;8). The participants were interviewed at their homes (in Concepción, Chile) twice a month half a year long. Data were obtained by semi-guided conversation and picture-naming. The analysis of the data was done within Optimality Theory (OT), with a hierarchical configuration of constraints for each stage of CO development. Three stages could be identified. 1st stage: reduction of CO to one position, usually filled by the less sonorous segment; 2nd stage: gliding of the second consonant of CC; and 3rd stage: faithful production of CC. These data provide evidence in favour of certain phonological theories: The first stage favours the Sonority Principle of the syllable. The second stage shows that the skeleton develops earlier than the segments. And the third stage slightly favours laterals over rhotics.

Keywords**:** consonant clusters, complex onsets, L1 phonological acquisition, Optimality Theory, constraint demotion.

Adquisición de la estructura silábica de ataque complejo en el español de Chile un análisis desde la teoría de la optimidad y el principio de sonancia

Resumen: En el siguiente artículo se analiza el desarrollo de la estructura silábica de ataque complejo (AC) durante la adquisición de la primera lengua, el español de Chile. Los participantes, nueve niños entre 1;6 y 2;8 años quienes fueron entrevistados en sus hogares (Concepción, Chile) con una frecuencia de dos veces al mes durante un año y medio. El instrumental analítico utilizado fue el de la Teoría de la Optimidad, mediante la configuración de jerarquías de restricciones para cada estadio de desarrollo de los ACs. Se identificaron tres estadios de adquisición: 1.ª Etapa: reducción del AC a una sola posición prosódica, que suele corresponder al segmento menos sonoro; 2.ª Etapa: semiconsonantización de la segunda posición

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del AC; y 3.ª Etapa: producción fiel del AC. Los datos proporcionan evidencia en favor de ciertas teorías fonológicas: en la primera etapa de adquisición se privilegia el principio de sonancia. El segundo estadio pone de manifiesto que el esqueleto silábico se desarrolla antes que los segmentos. Finalmente, en el tercer estadio se observa una leve preferencia de las laterales sobre las vibrantes.

Palabras clave: ataques complejos, grupos consonánticos, adquisición fonológica de la lengua materna, teoría de la optimidad, rejerarquización de restricciones.

1. Introduction

In the acquisition of a first language, consonant clusters constitute difficult phonological structures for the child, as exemplified by simplifications like suppression, reduction and substitution of these structures or parts of them. Although there are universal acquisition patterns (conditioned by markedness) common to different languages, the phonotactic characteristics and the frequency of appearance of segments and syllable types in each language play a crucial role in the type of simplification applied by the child. In the present study consonant clusters are of the obstruent plus liquid type, which is the only existing type in Spanish.

Kirk (2008: 36) points out that research on the specific non-targetlike productions by children in relation to consonant clusters (CCs) provides important evidence about the constraints operating in grammatical development. She also notes that "much of the previous research on error patterns in cluster production has focused on the reduction of consonant clusters to a single consonant (e.g. Gnanadesikan 1994, Goad and Rose 2004, Jongstra 2003; Lleó and Prinz 1996, Ohala 1999, Pater and Barlow 2003, Wyllie-Smith, McLeod and Ball 2006)". The reduction of CCs to a single consonant only constitutes an initial stage of language development, and should thus be studied within a larger developmental perspective. Not many descriptions of CC acquisition have focused on stages, and the existing ones are not very detailed. Templin (1957) was the first study trying to describe these stages, and it defines acquisition norms of singleton consonants and of CCs for the English language. The author concludes that at the age of 4;0 75% of the participants correctly produce CCs comprised of /s+stop/, /s+nasal/, /obstruent+liquid/ (except /gɾ/) and /obstruent+w/. However, at that same age, few CCs have been acquired in final position.

In a similar vein, Greenlee (1974) compared the CO production, comprised of obstruent+liquid in six different languages (Czech, English, Estonian, French, Serbian and Slavonic) by ten children. In this study, three stages were identified. During the first stage the liquid is deleted, while in the second stage it is substituted by a different segment. In the third stage of acquisition Greenlee observed that both positions of the CO are maintained in the output, although one of them or both are still substituted by a different consonant, for example *frog* [fwag]. Finally, children reach the correct production of the COs.

Bosma Smit (1993) investigated the error patterns in singleton consonants and CCs by 1,048 native speakers of English, who were between two and nine years of

age. She delivers the specific percentages of error for each age and type of complex onset. For example, the author points out that between the ages of two and three 30% of the children produce the CC /bl/ in *block* in an adult way, 15-50% produce [b] and less than 3% produce [l]. Typical errors in the production of clusters are the reduction of CC to obstruent plus glide, and the reduction to the second element of those CCs comprised of /s/+consonant. Especially at the stage at which the reduction of consonant clusters takes place, children usually reduce them to the less sonorous segment, regardless of the target language. This means that although children acquire different languages, they tend to reduce the same types of clusters to the same single consonant (Chin, 1996; Ohala, 1999; Barlow, 2005; Pater and Barlow, 2003; Gierut, 1999), argueably abiding by some linguistic universal.

From the perspective of *phonological simplification processes*, CCs are targets of phonological reduction processes. Bosch (2004) observes that syllable reduction from CCV to CV happens in 80% of the utterances produced by 3-year-olds. This percentage decreases progressively as the subjects get older (at 4 years: 43%, at 5 years: 34,3%, at 6 years: 24%, and at 7 years: 9,1%).

From a *prosodic perspective* Fikkert (1994) analyses the prosodic acquisition of the syllable by twelve Dutch monolingual children. Results concerning complex onsets show that the first utterances of these structures are characterised by a maximal sonority distance between their two members. Furthermore, in the acquisition of complex onsets comprised of an obstruent and a lateral, several stages can be distinguished[1]: in stage 1 the complex onset is simplified to one single obstruent; in stage 2 the onset is simplified to a single sonorant consonant; in stage 3 the correct CC is produced.

Since the early 1990s, a new theory has been introduced in all fields of phonological description, Optimality Theory (Prince and Smolensky, 1993). The central notion is a system of interacting constraints of two main types: markedness and faithfulness. All constraints, even low-ranked ones, may influence the phonology of a language. At the earliest stages of phonological acquisition, markedness constraints outrank faithfulness constraints (Gnanadesikan, 1994). Development involves the demotion of markedness constraints below faithfulness ones. Markedness is fundamental to understand the acquisition process from an OT perspective. (For a detailed introduction to acquisition and OT, the reader should refer to Boersma & Levelt, 2003).

OT incorporates developments of non-linear phonology, which make it possible to describe segmental and prosodic aspects simultaneously. However, despite the large array of existing descriptions of child phonological acquisition couched in OT terms, there has hardly been any research on the phonological acquisition of the Chilean variety of Spanish by children younger than three years of age. This constitutes an important deficit in this research field, given that the most important phonological progress is made in those young years. Children older than 3;0 have already acquired

[1] Note that not all children follow the same stages. And as Fikkert (1994, p. 103) says, “stages for each cluster type are not stages in real time”.

about 80% of their phonetic repertoire, and this is also the case for the Chilean variety of Spanish (Vivar and León 2009).

The studies and theoretical views mentioned have applied production error analysis to explain the different solutions children apply to the double complexity problem, relative to the prosodic positions and to the segments that must fill them. If the child is not yet able to produce CCs or does not master COs, a mismatch between these two levels emerges. Hence, an adequate description of the CCs should consider all these aspects.

1.1. The structure of onset clusters in Spanish

The syllable is generally defined as a group of segments around a nucleus, which in Spanish must be a vowel. The onset in Spanish is optional and can have one or two [+consonant] segments. If the onset contains a consonant, this can have any value from the sonority scale. But if there are two consonants in the onset, these cannot be contiguous in the sonority scale, and the first one must have less sonority than the second one. Therefore, the only possible complex onset in Spanish is comprised of an obstruent followed by a liquid (D'Introno, Del Teso and Weston 1995).

All descriptions of Spanish agree that independently of being in word-initial or word-medial position, Spanish onsets admit clusters of two consonantal segments: /pɾ/, /bɾ/, /fɾ/, /tɾ/, /dɾ/, /kɾ/, /gɾ/, /pl/, /bl/, /fl/, /kl/, /gl/. These clusters consist of a stop or the fricative /f/ in the first position, and a liquid /l/ or /ɾ/ in the second position, with the proviso that /t/ and /d/ can only combine with /ɾ/ and never with /l/ (except in loanwords, such as *tlaxcalteca*, where /tl/ only represents a lateral occlusion in Náhuatl; see Alarcos Llorach 1965). A further aspect to be noted is that in Chilean Spanish, the variety here considered, the cluster built by a coronal followed by the rhotic, /tɾ/, is generally pronounced "with alveolar closure followed by a voiceless frication that is close to that of [tʃ]" (Lapesa 1992).

1.2. Hypotheses and research questions

As mentioned in the Introduction, there have been many studies of phonological development focused on the acquisition of consonant clusters. Although clusters may in principle appear in onset and coda position, Spanish hardly has any clusters in the coda. In word final position there are only a few words like *biceps* ['bi.θeps] 'biceps' or *torax* ['to.ɾaks] 'thorax' ending with clusters, which in Peninsular Spanish are generally reduced to the fricative [s]. In word medial position, coda clusters in words like *instruir* [ins.tɾu.'iɾ] or *perspicaz* [peɾs.pi.'kaθ] are also reduced to the fricative [s] in an informal register of that same variety. In Chilean Spanish, unlike in Peninsular Spanish, such clusters are reduced in favour of the sonorant: the nasal [n] in the case of *instruir* [in.tɾu.'iɾ] and the simple vibrant [ɾ] in *perspicaz* [peɾ.pi.'kas]. Coda clusters appear only in a few words that do not belong to child speech.

Thus, the present study only considers clusters in *onset position*, where the evolution of clusters has been generally interpreted as conditioned by the *Sonority Principle of the syllable,* predicting that onsets have a minimum of sonority (Chin, 1996; Ohala, 1999; Barlow, 2005; Pater y Barlow, 2003; Gierut, 1999). Consequently, we also set out to finding out whether the initial reduction of clusters in Chilean Spanish follows that principle. How the evolution takes place from the initial reduction to the mastery of both members of a cluster is not clear in the literature, and we thus define it as our second aim. Because our participants were acquiring the Chilean variety of Spanish, we also wanted to find out when and how specific Chilean phenomena, like the retroflexion and assibilation of /tɾ/ are acquired, given that this phenomenon involves variation.

We hypothesise an initial stage in which only one of the segments of the cluster is produced, and we pose the following five research questions. Q1) Is the reduction of CC to C led by the *Sonority Principle,* and if there are cases of reduction contradicting the Sonority Principle, how can they be explained? This first question was guided by the results of a previous study on cluster acquisition in Peninsular Spanish, where Lleó and Prinz (1996) found many cases that contradicted the Sonority Principle. Q2) What is the following stage after consonant reduction, and what is the prosodic structure of such a stage? Q3) Are clusters with the lateral /l/ acquired before those with the rhotic /ɾ/, as found in Kehoe, Hilaire-Debove, Demuth, and Lleó (2008)? Q4) When and how appear the Chilean specific properties of the /tɾ/ cluster production? Q5) To what extent does Optimality Theory contribute an explanation of the data?

2. The present study

2.1. Participants

The sample is comprised of nine children, divided into four age groups. Each group contains two or three participants. Children were recorded for about four months each, with a frequency of two or three times per month. The distribution of the children and the various age groups can be seen in table (1).

Groups	**Age**	**N° of participants**	**N° of recordings**
Group 1	1;6 – 1;8	3	34
Group 2	1;9 –1;11	2	26
Group 3	2;0 – 2;3	2	20
Group 4	2;4 – 2;8	2	14
Total	1;6 – 2;8	9	94

Table 1. *Distribution of the sample*

2.2.Data recordings

Most of the children were recorded at their homes and in the presence of their parents or close relatives to facilitate their social and communicative interaction. Only in three specific cases the participants were interviewed at day care centers, with previous authorization of these institutions. Each session was stored in WAV format in a general database for all the participants. In the database participant's age at the moment of recording, and recording date were coded. Utterances in each session were phonetically transcribed (by means of the International Phonetic Alphabet) and exported to the EXMARaLDA[2] data-base. For each transcribed session EXMARaLDA specifies several pieces of information, e.g. whether the utterance is spontaneous or a repetition of the adult word and the phonetic and orthographic transcription of the adult word (see Wörner 2012 for a more detailed description of the interface and properties of the programme).

2.3. Data analysis

For each child a total of 354 words with complex onsets were elicited and transcribed, out of which 147 are /C+l/ and 207 are /C+ɾ/. It is important to point out that the young age of the subjects made it impossible to apply the test with the same nouns to all children. The word list managed was a reduced version of the list previously prepared, to which the researcher added some words adapted to children's life experience and stored vocabulary. To elicit them some improvised questions were spontaneously posed.

To analyse the data, the various non-target-like productions by the participants were classified according to the following criteria:

a) Maintenance of the first consonant (C_1): The child faithfully retains the first element in the output, for example in [ʻbaŋ.ko] for *blanco.* The utterance is also included in case the obstruent is reduced in sonority, as for example in [ʻpan.ko] for *blanco.* b) Maintenance of the second consonant (C_2): The child faithfully produces the second element in the output, for example in [ʻlaŋ.ko] for *blanco.* The utterance is also included if the second consonant is substituted by a different sonorant, as for example [ʻraŋ.ko] for *blanco*. c) Maintenance of both positions with gliding of the second one (C_1C_G): for example in [ʻbjaŋ.ko] for *blanco.* d) Absence of onset (ØV): for example in [ʻaŋ.ko] for *blanco*. e) Absence of the syllable in which the onset is located (Ø): deletion of the whole syllable, in which the complex onset is located, for example in [ʻti.ja] for *frutilla*. In these last two cases the complex onset could not be analysed.

[2] This so-called "partiture editor" was developed by Thomas Schmidt and Kai Wörner within the Research Center on Multilingualism of the University of Hamburg.

3. Description of results

3.1. Initial stage

3.1.1. Major pattern (C_1): Maintenance of the first consonant (C_1) of the cluster

In the sample analysed there is an obvious tendency in favour of maintaining the first element, given that from a total of 357 COs evaluated, the first element has been maintained 191 times, which corresponds to 53,5% of the whole sample. The second element is maintained 23 times, which corresponds to only 6,4%. Some examples of child utterances, in which the first element of the CO is maintained are shown in table 2; they are ordered according to place of articulation and CC type.

Target form		**child form**	**child (age)**
/'pla.to/	'plate'	['pa.to]	Sofía (1;8, 27)
/'glo.bo/	'balloon'	['go.lo]	Emilia (1;9,11)
/bi.si.'kle.ta/	'bike'	['ke.ta]	Seba P. (2;6,22)
/'bra.bo/	'bravo!'	['ba.βo]	Pascual(1;6,25)
/'fru.ta/	'fruit'	['fu.ta]	Agustina (2;3,29)
/'tren/	'train'	[te:]	Pascual(1;6,25)

Table 2. *Faithful maintenance of the first (obstruent) consonant*

For /C+1/ most of the children in the first stage maintain the first consonant of the CC (C_1). This suggests that at this stage of their development two markedness constraints are operating in their grammar. One of the constraints bans complex onsets: *ComplexOns, and the other one bans onsets filled with a liquid: *L-Onset.

/'pla.to/	***ComplexOns**	***L-Onset**	**Max**
a. ['pla.to]	*!	*	
√ b. ['pa.to]			*
c. [la.to]		*!	*

Table 3. *Tableau for input /'pla.to/ and output ['pa.to]*

*ComplexOnset is a constraint that does not allow branching onsets in the output. It is violated in (3a), whereas in (3c) *L-Onset is violated. The latter constraint does not allow the occurrence of liquids in the onset. Therefore, the best candidate at this stage of acquisition is (3b). It only violates Max, which disallows deletions. According to optimality conventions, the winner is signaled with the √ symbol.

In the case of /C+ɾ/, as well as in /C+1/, most of the children maintain C_1 during this first stage. This suggests that at this point of their development, beside the structural

constraint *ComplexOns, the markedness constraint banning /l/ should be extended to also ban liquids in general, /l/ and /ɾ/. In fact, these data show preference for less sonorous segments in onset position, i.e. compliance with the Onset Principle (see table 4).

/'bra.bo/[3]	*ComplexOns	*L-Onset	Ident-IO	Max
a. ['bra.βo]	*!	*	*	
√ b. ['ba.βo]			*	*
c. ['ɾa.βo]		*!	*	*

Table 4. *Tableau for input /'bra.bo/ and output ['ba.βo]*

The markedness constraints operating here are: *ComplexOnset and *Liquid-Onset, and the faithfulness constraints are Ident-IO and Max. The former precludes modifying features from input to output and is violated by the approximant [β]; the latter is violated by deletion. Thus, in tableau 4 the ideal candidate will have a non-branching onset in the initial syllable, filled by a bilabial obstruent. The second onset is filled by the approximant [β], which is target-like, given Spanish Spirantization. However, we will ignore this phenomenon, as it is beyond the focus of the article (see Lleo sumitted).

3.1.2 Minor pattern (C_2): Maintenance of the second consonant (C_2) of the cluster

Although in the sample analysed the maintenance of C_1 is much more frequent than the maintenance of C_2 (recall 53,6% vs. 6,4%), the maintenance of the second consonant of CCs has been observed with a certain systematicity, specifically in: /gl/, /dɾ/ and /gɾ/ (see examples in table 5).

cluster	target form		child form	child (age)
/gl/:	/glo.bo/	'balloon'	['lo.βo]	Agustina (2;4,9)
/gl/:	/glo.bo/	'balloon'	['lo.βo]	Sebastián P. (2;6,22)
/gɾ/:	/'gɾan.de/	'big'	['lan.de]	Sebastián P. (2;6, 22)
/dɾ/:	/ko.ko.dɾi.lo/	'crocodile'	[go.go.ʝi.jo]	Emilia (2;1,1)

Table 5. *Maintenance of C_2 from CC*

The second consonant of the onset cluster /gl/ of the word *globo* is kept systematically. To explain this it is necessary to introduce two constraints into the analysis: *Dorsal-Onset, which is a markedness constraint against dorsal obstruents,

[3]

and Onset, a markedness constraint operating in favour of the obligatory nature of onsets, which leads to the canonical CV syllable. In table 6, the *Dorsal-Onset constraint would account for the fact that some children avoid the production of dorsal obstruents. Moreover, the markedness constraint Onset outranks *Liquid-Onset, which accounts for the fact that, being forced to produce an onset, children prefer to violate *Liquid-Onset. Note that candidates (6c) and (6d) make clear that the motivation to violate *Liquid-Onset is to satisfy Onset.

/'glo.bo/	*Complex	Onset	*Dorsal-Onset	*L-Onset	Ident-IO	Max
a. ['glo.βo]	*!		*	*	*	
b. ['go.βo]			*!		*	*
√ c. ['lo.βo]				*	*	*
d. ['o.βo]		*!			*	**

Table 6. *Tableau for input /'glo.bo/ and output ['lo.βo]*

Within simple onsets, these children produce /g/ to avoid the production of syllables without onset (see examples in table 7). If there are two consonants in an adult onset, they produce the liquid and avoid the dorsal; however, when there is no other option, they do produce the dorsal, in order not to leave the syllable without an onset.

Child	Target form		Child form	|(age)
Agustina	/se.gu.ra/	'sure'	[de.'ɣu.ɾa]	(2;0,27)
	/re.ga.'lo/	'gave me'	[de.ɣa.'lo:]	(2;0,27)
	/re.'ga.lo/	'a present'	[de.'ga.lo]	(2;0,27)
Sebastián P.	/un.re.'ga.lo/	'a present'	[u:.'ga.lo]	(2;5,19)
	/'ga.to/	'cat'	[ga.to]	(2;6,22)

Table 7. *Singleton /g/ in simple onsets*

As mentioned above, in the output of /C+ɾ/ onsets, the second consonant is produced basically in the CCs /dɾ/ and /gɾ/. The following constraints operate for words like *grande*, produced as ['lan.de] by Sebastián P. Obviously, beside *Dorsal-Onset, that is, the prohibition of the consonant /g/ in the output initial onset, the child Sebastian P. (see table 8) also abides by the constraint *Coronal-Onset. Otherwise, he could have chosen to produce e.g. ['dan.de] (8d).[4] At this stage of acquisition the child maintains the second consonant of the cluster, i.e. the sonorant, which means that the candidate

[4] Note that the two liquid consonants that fill the second position of complex onsets are coronal, too. However, it can be argued that the feature coronal is not distinctive for liquids, as there is no contrast with other

[‘lan.de] is the winner. Note that this candidate contains /d/ in the onset of the second syllable. The reason for violating *Coronal-Onset is that there is no other alternative to /d/ in this second syllable, and producing /d/ avoids a violation of Onset. This is shown by means of candidate (8e), which looses because of the violation of Onset. Liquid sonorants in Spanish do not need to be specified as coronals, given that liquids do not contrast with non-coronals. Since here the focus is on clusters, the violations of *Coronal-Onset corresponding to the onset of the second syllable have been put in parenthesis. The winner candidate finally is (8c) due to Onset, which outranks *Liquid-Onset, as at this point of acquisition it is better to violate a constraint that bans the occurrence of sonorants and complies with the obligatory nature of onset.

/’ɡran.de/	*Dorsal-Ons	*Coronal-Ons	Onset	*L-Onset	Max
a. [‘ɡran.de]	*	(*)		*	
b. [‘ɡan.de]	*!	(*)			*
√ c. [‘lan.de]		(*)		*	*
d. [‘dan.de]		*(*)			*
e. [‘an.de]		(*)	*!		* *

Table 8. *Tableau for input /’ɡran.de/ and output [‘lan.de]*

3.2. Intermediate stage: glide instead of liquid

After the first stage, characterised by the reduction of the two consonantal segments to one, most participants go into a stage in which both positions of the CO are filled, the second one by a glide, though, instead of the liquid of the target, either /l/ or /ɾ/. Some other children continue to produce one single consonant of the cluster (stage 1) up to the end of the recordings. Within the group of children producing an obstruent followed by a glide (C_1C_G) some show the presence of the glide as a second and last stage, whereas others show this behaviour as a (second) stage before producing both elements in the output. The following tables exemplify some target words containing a diphthong (table 9), and show the evolution of the clusters /C+l/ (table 10) and /C+ɾ/ (table 11) produced by the children.

child	age	target form		child form
Sofia	1;6,12	/’a.ɡwa/	‘water’	[‘a.ɣwa]
Agustina	2;0,16	/san.’tja.ɡo/	‘name’	[tʃan.’tja.ɣo]

places of articulation, since the etymological palatal liquid /ʎ/ is pronounced as the approximant /j/ in Chilean Spanish (as in most other varieties of Spanish), through the phenomenon called *yeísmo*.

Table 9. *Examples of output diphthongs (C_1C_GV) resulting from target diphthongs*

child	**cluster**	**target form**		**child form**	**age**
Selva	/bl/	/'blan.ko/	'white'	['bjaŋ.ko]	2;4,6
Emilia	/bl/	/'a.bla/	'speak'	['am.bja]	1;11,17
Selva	/pl/	/'plan.ta/	'plant'	['pjan.ta]	2;5,16
Selva	/fl/	/'flo.ɾes/	'flowers'	['fjo.letʃ]	2;5,16
Sofia	/gl/	/'glo.bo/	'balloon'	['gwa.ɣwa]	1;8,1
Manuela	/gl/	/'glo.bo/	'balloon'	['gwo.βo]	2;4,27
Emilia	/gl/	/'glo.bos/	'balloons'	['gwo.βoʃ]	1;10,17
Agustina	/kl/	/bi.si.'kle.ta/	'bicycle'	[si.'kje.ta]	2;2,11

Table 10. *Examples of output diphthongs (C_1C_GV) resulting from target / C+l / clusters*

child	**cluster**	**target form**		**child form**	**age**
Selva	/bɾ/	/'li.bɾo/	'book'	['li.ljo]	(2;7,3)
Iko	/tɾ/	/'tɾen/	'train'	['tjen]	(1;9,25)
Pascual	/tɾ/	/'tɾen/	'train'	['tjen]	(1;6,25)
Emilia	/gɾ/	/'gɾa.sjas/	'thank you'	['gja.sja]	(1;11,17)

Table 11. *Examples of output diphthongs (C_1C_GV) resulting from target / C+ɾ / clusters*

3.3. Final stage: Production of both consonants (C_1C_2)

The third stage is characterised by the production of both elements of the clusters. From an optimality-theoretical perspective this suggests that the faithfulness constraint MAX outranks the markedness constraint *COMPLEXONSET. Nevertheless, during the acquisition process of faithful forms not all the participants go through the same stages. Children reach the faithful forms at different rhythms and in different ways. These differences are caused by particular or individual characteristics of the phonological systems of each child as well as by the articulatory characteristics of the different CCs. The third stage is characterised by the violation of the *COMPLEX constraint, as both elements of the CC are produced, filling both positions of COs. The production of both consonantal elements in the output is shown in (12) for Agustina, and in (13) for Emilia. In some cases, Agustina clearly goes through the three stages, and reaches the final stage (producing the CC, in fact C+l) a bit later than Emilia, namely after 2;6.

cluster	**target form**		**Stage 1**	**Stage 2**	**Stage 3**	**age**
/pl/	/'pla.ta.no/	'banana'	['pa.ta.no]			(2;0.27)
	/kum.ple.'a.ɲos/	'birthday'		[kum.'pja.ɲo]		(2;3,29)
	/'pla.ja/	'beach'			['pla.ja]	(2;6,5)
/kl/	/bi.si.'kle.ta/	'bicycle'	[i.ʃi.'ke.ta]			(2;0,27)
	/bi.si.'kle.ta/	'bicycle'		[si.'kje.ta]		(2;3,11)
	/bi.si.'kle.ta/ ' 'bicycle'				[bi.si.'kle.ta]	(2;8,12)

Table 12. *Agustina's stages C1 → C1Cg → C1C2*

Emilia treats the consonant clusters, /fl/ and /pl/ differently. The CC /fl/ (see table 13) goes through the three stages: initial stage, with reduction to the obstruent (the less sonorous segment [t]; intermediate or gliding stage, and finally, the stage with the two consonants, that is, the CC. Emilia's initial and intermediate stages are very short-lived, as the child produces the CC very soon (at 1;10,22). However, the CCs /pl/ and /kl/ first show the preservation of one segment for quite a while; in the case of the /pl/ CC there is a certain preference for the sonorant. The intermediate stage is skipped, and both segments are produced in the output.

cluster	target form	stage 1	(age)	Stage 2 (age)	Stage 3 (age)
/fl/	/floɾ/ 'flower'	[toʃ]	(1;10,7)	[fjo] (1;10,7)	[ploʃ] (1;10,22)
/pl/	/'pla.to/ 'plate'	['la.lo]	(1;9,23)		
/pl/	/'pla.ta. no/				['pla.ta] (1;11,17)

Table 13. *Emilia's stages C --> C_1C_g --> C_1C_2*

3.4. Comparison of CC obstruent + lateral and CC obstruent + rhotic

All along this article we have seen target clusters comprised of an obstruent in the first position and a sonorant in the second position. Sonorants filling the second position of a tautosyllabic Spanish cluster can be of two types: the lateral /l/ or the rhotic or vibrant /ɾ/. Some researchers - Kehoe et al. (2008), as well as Nuñez-Cedeño (2016) - have argued that the cluster comprised of obstruent+liquid is acquired before the one comprised of obstruent+rhotic. A comparison of the percentages of target-like production of both types of cluster is illustrated in Table 14. The resulting mean percentages of correct cluster production are very similar for the two types of clusters: 13.84 % of cluster with lateral and 9.4 % of cluster with rhotic. A t-test resulted in no statistical differences, one-tailed (p-level = .07711) or two-tailed (p-level = .15423). Summarizing, although a tendency was observed in favour of the clusters with a

lateral over the clusters with a rhotic, these data hardly contribute to differentiate the two types of clusters. Their behaviour in relation to percentages of correct production was very similar in both cases.

Obstr + l	**N correct**	**% correct**	**Obstr + ɾ**	**N correct**	**% correct**
/pl/	8	20 %	/pɾ/	2	15.4 %
/bl/	3	15 %	/bɾ/	4	17.4 %
/fl/	3	9.1 %	/fɾ/	0	0 %
/kl/	3	15 %	/gɾ/	3	7.5 %
/gl/	6	10.1 %	/tɾ/	8	5 %
			/dɾ/	1	11.1 %
	mean: 13.84 %			mean: 9.4 %	

Table 14. *Comparison of correct percentages of obstruent+lateral and obstruent+rhotic*

4. Discussion

We have identified three main stages children went through:
Stage 1: preservation of one consonant in the output
Stage 2: substitution of a glide for the second onset consonant
Stage 3: retention of both complex onset consonants in the output

Although not all children went through all three stages, most children did. Thus, these stages can be considered developmental corner stones of phonological acquisition. Note that the first stage had two variants occurring simultaneously: either the obstruent or the sonorant was preserved.

In the introduction we proposed five research questions related to the acquisition of consonant clusters that fill syllabic onset positions. Once the production data has been presented and analysed we are able to answer those questions with the results obtained.

Q1) Is the reduction of CC to C led by the *Sonority Principle,* and if there are cases of reduction contradicting the Sonority Principle, how can they be explained? The tendency to maintain the first segment is obvious, given that out of a total of 357 complex onsets evaluated the first segment is maintained 191 times, which constitutes 53,5% of the whole sample; the second segment is maintained 23 times, which corresponds to 6,4%. This overwhelming difference between the production of C1 and C2 in Spanish is not reported for the first time. For example, Goldstein and Cintrón (2001) showed that in Puerto Rican Spanish, the second element of the cluster was deleted in 59 out of 64 reductions (ex. /'pla.ja/ → ['pa.ja]). The sonority theory seems to be the most adequate hypothesis to explain the preference for the first element in complex onsets. It implies that $C_1C_2V \rightarrow C_1V$ structures optimise the structure of the syllable with regard to the number of segments or onset structure,

and with regard to sonority requirements: the ideal output syllable in the reduction of onset CC clusters is therefore one that begins with an onset of low sonority followed by a vowel. Q1 also asks for the explanation of cases contradicting sonority. Although in the sample analysed, maintaining C_1 is much more frequent than maintaining C_2, the second consonant of an onset consonant cluster is maintained in a relatively systematic way in the case of some COs, especially in /dɾ/, /gɾ/ and /gl/. In the case of /dɾ/ some subjects prefer to produce the sonorant consonant, especially if the next onset of the word is also a sonorant, as e.g. in *flores* or *cocodrilo*. This leads onsets to having identical place and manner features. However, in case the vibrant /ɾ/ is not yet acquired, it is substituted by the lateral /l/. In the case of /gl/, the preference for the sonorant seems to be conditioned by a tendency against /g/ in some children's phonological inventories.

The question still remains open as to why in these cases --/dɾ/, /gɾ/ and /gl/-- children do not prefer the first consonant as they do in most of the other complex onsets. The special status of /dɾ/ in articulatory terms has already been described for Chilean Spanish in former research. For example, Vivar (2009) observed that the CC /dɾ/ had the lowest percentage of correct production (51%) although the children of that study were older than the ones in the present sample. Bosch (2004) points out that the difficulty of this CO is related to the articulatory proximity of the consonants to one another, given that both are coronals. However, this argument does not hold, taking into consideration that in the CC /tɾ/ the two consonants building the onset are also close in their articulation, but there is not a single case, in which the second element has been maintained.

Another reason for the different performance between /dɾ/ and /tɾ/ is related to the words with /tɾ/ being much more frequents than those with /dɾ/, which entails that words containing the cluster /tɾ/ are more familiar to the children than words containing /dɾ/ (ex. *tres* 'three'*, cuatro* 'four'*, tren* 'train'*, estrella* 'star'*, otro/a* 'another').

The CO /gɾ/, built by a voiced dorsal stop and a simple vibrant, also showed a strong tendency to maintain the second consonant in the output. To explain this behaviour we may assume that those children who do not maintain the consonant /g/ in the CO output do not have it in their phonological repertoire. Nevertheless, the evidence obtained from simple onsets shows that this consonant may indeed occur in childen's phonological repertoire. This type of result does not agree with the claim made by Bosma Smit (1993) that the typical mistakes found in a CC are also present in the production of isolated consonants. In fact, here, Optimality Theory offers an insightful solution: consonant clusters including a dorsal /g/ are generally reduced to the sonorant, but singleton dorsals are often preserved. Both situations abide by an outranking Onset constraint. That is, if there is a choice, as in the case of consonant clusters, the liquid is preferred. But if the input onset only has one position, this must be filled with whatever consonant is available, also a dorsal.

About the CO /gl/, Vivar (2009) also observed a preference to maintain the second element in the output, given that in 11 out of 13 cases of omission (of one of the consonants), the first consonant was deleted, producing the lateral in the output.

Just as in the case of /tɾ/ vs. /dɾ/ the opposition /kl/ vs. /gl/ is given probably by the sonority of the first element of the CO; and just as in /tɾ/ onsets, the first element was maintained without exception, the same is true for /kl/. It is also important to consider that voiced stops in Spanish undergo weakening processes in certain prosodic positions, which could make the perception of these sounds more difficult in complex structures, such as the COs. The fact that in the CCs involving bilabial voiced stops, all children maintain the first element could be related to the additional visual information available for the production of bilabial consonants, which is not the case for coronals or especially for dorsals.

Q2) What is the following stage after consonant reduction, and what is the prosodic structure of such a stage? After the first stage, characterised by the reduction of the two consonant segments to one, most of the participants show the appearance of a glide in the second position of the output CO. To explain the obstruent+glide output type, it is necessary to take into consideration the particular phonotactic characteristics of the Spanish syllable, where rising diphthongs have a considerable frequency of appearance (Gili Gaya 1966). Consequently, Spanish speaking children should have much early experience in dealing with diphthongs, which is also projected in their treatment of the CO in the second stage.

The utterances in (9) and (10) indicate that the child grammar admits the production of rising diphthongs, which are independent from the production of CCs, as in most cases their production precedes that of the diphthongs that substitute for CC. From an optimality-theoretical perspective, just as we have a constraint *ComplexOnset, which is justified by the existence of languages which do not tolerate consonant clusters in the onset, we have also a constraint against complex syllable nuclei, justifiable by the existence of languages which do not tolerate diphthongs.

(15) *ComplexNucleus: (complexity of the nucleus) penalises complex syllable nuclei.

Thus, these children prefer to violate *ComplexNucleus than *ComplexOnset, as evidenced by their rendering of two consonantal sequences as an obstruent followed by a glide [j] or [w]. The output [tjen] for the word /tɾen/ can be accounted for in OT by the hierarchy of constraints (16).

(16) *ComplexOnset >> MaxIO >> *ComplexNucleus

According to this analysis, rising diphthongs fill the syllable nucleus, whereas the consonant cluster fills the onset. Both configurations, rising diphthongs and consonant clusters match those of the adult language. Kehoe, Hilaire-Debove, Demuth & Lleó (2008) conclude that in the early acquisition stages some children treat rising diphthongs as belonging to the onset, that is, as consonant clusters. However, here we claim that some children follow the opposite path, turning consonant clusters into diphthongs. This aspect of language presents much variation both between different languages and much individual variation, as well (see, for example, Barlow 2005).

Q3) Are clusters with the lateral /l/ acquired before those with the rhotic /ɾ/, as found in Kehoe *et al.* (2008)? Table 14 shows that there are some differences between the percentages of correct production of CCs with a lateral and those with a rhotic,

in general being a bit higher in the former clusters, although the percentages do not show significance when both types of clusters are submitted to t-tests. Thus, there is a certain tendency in favour of clusters with a lateral over those with a rhotic.

Q4) When and how appear the Chilean specific properties of cluster production? One of the main characteristics of Chilean pronunciation involves the cluster /tr/, which is produced with retroflexion and assibilation. However, this "typical" Chilean feature is stigmatized, and avoided nowadays by educated speakers. Although several cases of target /tr/ were included in the words used to elicit child production of clusters, we did not find any special feature that would differentiate this cluster from the rest of clusters in the words produced by the children. We then inspected the adult productions that we had recorded, and realized that the few cases of /tr/ produced by adults in our records were always produced with standard pronunciation, without retroflexion or assibilation. It should be noted that the parents of all children interviewed have some higher education, and that Concepción is one of the most important Chilean universities. This is thus an open question yet, which should be focused in future research.

Q5) To what extent does Optimality Theory contribute an explanation of the data? Optimality Theory suggests basically that the outputs in the first acquisition stages are structurally and segmentally unmarked and therefore not faithful to the input, in case the latter involves some markedness. This is related to the proposal that in the initial stage of acquisition markedness constraints outrank faithfulness constraints (Gnanadesikan 1994). From an optimality-theoretic perspective we say that the responsible constraints for the appearance of CV instead of other syllable types -CCV or V- in the output are Onset and *ComplexOnset. As already pointed out, these constraints have a phonetic as well as a typological base. Both constraints are of the markedness type. They are violated by those languages that belong to the type allowing onsetless syllables and/or complex onsets, i.e. branching onsets with two consonantal positions. The case of the obligatory nature of the onset is related to phonetic aspects, given that the transition pattern between consonant and vowel (CV) maximises perception of the syllabic nucleus (see Wright 2004), as according to Warner, Smits, McQueen and Cutler (2005: 60) "at least in some diphones, the preceding sound carries information about height and backness of an upcoming vowel." With regard to the constraint *ComplexOnset, it takes quite a long time until children are able to violate it, that is, to fill both onset positions. During the process of language acquisition the productions progressively become more marked if the target language demands it. Finally, the structural reordering of constraints stops when the language learner does not detect differences between his/her output and the target language anymore (Levelt, Schiller & Levelt, 1999/2000). That means that the acquisition process consists in a gradual hierarchical restructuring between the markedness and the faithfulness constraints (Gnanadesikan, 1994; Boersma & Levelt, 2003; Levelt, Schiller & Levelt, 1999/2000).

To account for the hierarchical structuring process, following stages have been identified (see (3.5) above):

Stage 1: phase 1) Children violate Max and abide by the constraints banning the production of complex onsets. IDENT-IO is often violated by the consonant retained.

Stage 1: phase 2). The child grammar is similar to the previous one, except that the first element of the cluster appears faithfully unmodified in the output.

A further type of hierarchy has to do with the preservation of the second element, i.e. the liquid, observed only in some COs: /dɾ/, /gl/ and /gɾ/

Stage 2) The gliding of the 2nd consonant of CC implies a violation of *COMPLEXNUCLEUS and the outranking of *COMPLEXONSET over *COMPLEXNUCLEUS Stage 3) Child grammar moves forward from the gliding of the second element to the retention of both elements in the complex onset.

The second stage shows that the prosodic skeleton develops before the segments, since a new prosodic position is developed, which is filled by a different segment as the target one, namely a glide instead of a liquid consonant. Thus, the skeleton is faithfully fulfilled --in the sense that it reproduces a complex or double position-- whereas segments are not faithful, since the liquid is replaced by a glide.

5. CONCLUSIONS

The purpose of this study was to investigate the L1 acquisition of Complex Onsets by Chilean Spanish children. One of the conclusions we obtain from this study is that during the first stages of acquisition, speakers of Chilean Spanish have a clear tendency to reduce the syllable CCV to CV, and to preserve the first and less sonorous element of the complex onset. In consequence, this study supports the claim that the reduction of consonant clusters (and complex onsets) can be accounted for by the sonority pattern (Chin 1996; Ohala 1999; Barlow 2005; Pater & Barlow 2003; Gierut 1999).

The preservation of the second consonant in the output was only found with a certain regularity in the complex onsets /gl/, /dɾ/ and /gɾ/. It is not clear why these COs have a different behaviour compared to all the other COs analysed in this sample. The difference between /dɾ/ and /tɾ/ can be related to the frequency of appearance of these onsets in (child) Spanish. Furthermore, it is well-known that voiced stops are more marked than voiceless stops.

One of the most interesting aspects of the studies related to the acquisition of consonant clusters is the relationship between the articulatory behaviour of the consonants in isolated position and within consonantal groups. In this study the conclusion is that the asymmetry existing between the groups /C+l/ and the groups / C+ɾ/ in keeping the first element or the second, respectively, is due to the articulatory difficulty that vibrants present to Spanish speaking children (Bosch, 2004; Serra and Raventós, 1984; González, 1989; Miras Martínez, 1991; Vivar & León, 2009). Nevertheless, this relationship between an isolated consonant and a consonantal group does not work as an explanation for the case of the CO /gl/, where in a few occasions the subjects maintain the second element. This solution (the production of a sonorant instead of an obstruent) could indicate that the child is not yet able to produce the dorsal obstruent /g/. Nevertheless, in cases where the onset only consists

of the singleton /g/, children prefer to produce the simple onset, independently of the articulation point, instead of producing an empty onset.

About the behaviour of the hierarchy of constraints, it can be concluded that both types of complex onsets (with lateral and with vibrant) show a great similarity. The only differences found in the data are related to the fact that complex /C+l/ onsets show more cases of maintenance of the second element. About the second stage, where we observe the production of a glide in the second position of the complex onset, we conclude that the constraint *ComplexNucleus is the most adequate markedness constraint to account for the process of gliding in Spanish speaking children, because rising diphthongs have a considerable frequency of appearance in this language, which leads the child to soon demote this constraint, given its numerous violations.

Finally, it can be concluded that the dominance of markedness over faithfulness is valid for all participants in the first acquisition stage, until demotion of markedness takes place.

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