The behavior of secondary consonant clusters in Swiss French child language

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Abstract

This paper aims to determine the behavior of secondary clusters in Swiss French child language and, in doing so, provide a first step towards the identification of the order of acquisition of primary and secondary clusters. The data first of all reveal that the variant with schwa is in a global fashion preferred to the variant without schwa, and this regardless of the child's mastery of primary clusters. The data further reveal that the occasional production of the non-preferred variant without schwa entails modifications of the secondary cluster in conformity with the child's relative mastery of consonant sequencing. While secondary clusters pattern with primary clusters when it comes to repair strategies such as gliding and realization of an interconsonantal reduced vowel, they diverge from the latter when it comes to cluster reduction: there is a general preference for the preservation of C2, irrespective of the sonority profile of the cluster.

1. Introduction

Phonetically similar to the front rounded vowel /œ/, but unlike /œ/ subject to optional deletion, the literature contains a large number of analyses of French schwa.[1] While scholars disagree as to whether schwa is represented underlyingly in word-medial and word-final positions and in monosyllabic function words, the postulation of an underlying schwa in the initial syllable of lexical polysyllables is uncontroversial, e.g. *renard* 'fox' [ʁœnaʁ] ~ [ʁnaʁ]. As for the alternative insertion account of schwa, it has long been argued against because "[a] wide range of forms show similar behavior [to *place* [plas] vs. *pelouse* 'lawn' [pœluːz] ~ [pluːz]]" (Anderson 1982:338), which would make it "necessary to mark most clusters in most words for whether or not they were subject to epenthesis" (1982:338).[2] We will briefly return to this issue during the discussion of the child language data in Section 5. Thus, argued to be psychologically real according to psycholinguistic research (Spinelli and Gros-Balthazard 2007), schwa in this position serves to avoid consonantal sequences not found word-initially in the native vocabulary, e.g. [ʃv] in *cheveux* 'hair:PL' [ʃœvø] ~ [ʃvø] (vs. the Germanism *schwyzerdütsch* 'Swiss German variety' [ʃvitsəʀdytʃ], cf. Knecht and Thibault 2004). There are thus two types of word-initial consonant sequences in French (cf. the table in (1) for a detailed presentation): "primary clusters" whose members are adjacent in the underlying form (Obstruent+Liquid-clusters, henceforth ObsLiq-clusters, and [s]+C-clusters), and "secondary clusters" whose members are at least underlyingly separated by schwa (terminology borrowed from Bazylko 1976). Although many of the secondary clusters show level or decreasing sonority towards the syllable nucleus, and thereby form less optimal complex onsets than the primary ObsLiq-clusters (cf. the Sonority Dispersion Principle by Clements 1990, 2009), they are in many cases equally frequent as or more frequent than the alternative variant with schwa (*petit* 'small:M' [pti] preferred to [pœti], *reçu* 'receipt' [ʁsy] equally frequent as [ʁœsy], *degré* 'degree' [dgʁe] slightly less preferred than [dœgʁe], cf. Racine 2008:372-378). Further, the secondary clusters show no sign of

[1] We would like to thank two anonymous reviewers and Chantal Lyche for their constructive comments.

[2] The discussion on the explanatory power of the insertion analysis is beyond the scope of our paper, and we refer to Andreassen (to appear), where this analytical alternative is reconsidered and finally discarded through a detailed examination of the primary and secondary clusters in adult and child language.

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reduction or modification, e.g. *venir* 'come:INF' [vœniʁ] ~ [vniʁ], *[viʁ], *[niʁ] with cluster reduction, and *[sniʁ], *[vʁiʁ] with substitution making the secondary cluster identical to a primary cluster, cf. [sn] in *snob* and [vʁ] in *vrai* 'true:M'.

In a sonority-based approach, the non-optimal combination of segments that constitutes many of the secondary onset clusters in French is *a priori* a challenge to the child, in particular when we take into account that already primary (and near-optimal, when sonority-defined) ObsLiq-clusters are subject to heavy modification in child language. While primary ObsLiq-clusters have received much attention in the literature, no study thus far, to the best of our knowledge, has looked at the acquisition of secondary clusters. This paper aims to determine the behavior of secondary clusters in Swiss French child language and, in doing so, provide a first step towards the identification of the order of acquisition of primary and secondary clusters. With earlier works on primary cluster formation as our starting point, we argue that secondary clusters are prevented from surfacing altogether until primary clusters are in place. First, if primary ObsLiq-clusters with rising sonority are not authorized, neither are secondary ObsLiq-clusters or secondary ObsNas-clusters. Also, clusters of level or decreasing sonority, i.e. primary [s]+C-clusters and secondary ObsObs-, NasObs- and LiqC-clusters are prevented from surfacing. In contrast to primary clusters, however, the two segments in a secondary cluster can be saved without violating faithfulness, i.e. by virtue of realizing the underlying schwa. Empirical support to our analysis is drawn from a corpus containing semi-directed and naturalistic speech (Andreassen to appear).

Section 2.1 provides the distribution of the two types of clusters attested in adult Swiss French. Section 2.2 presents some earlier findings on the acquisition of word-initial clusters, with particular emphasis on children acquiring L1 French. Section 3 lays out our methodological approach. Section 4 presents the results obtained in this study and Section 5 provides a discussion of these results.

2. Consonant clusters

2.1 Primary vs. secondary clusters in French

As already observed by Bazylko (1976) and Spinelli and Gros-Balthazard (2007), among others, there is a near-complementary distribution of primary and secondary clusters in French: for instance, Spinelli and Gros-Balthazard (2007), on the basis of a count made in the Brulex database (Content, Mousty and Radeau 1990), conclude that the deletion of schwa leads to the production of secondary clusters also attested as primary clusters in less than 15% of the cases.

A manual search in *Lexique.org* (New, Pallier, Ferrand and Matos 2001), *le Petit Robert* (Rey-Debove and Rey 2004) and *le Dictionnaire Suisse romand* (Knecht and Thibault 2004), crossed with the secondary clusters attested by Racine (2008) for Swiss French, reveals the distribution of the two cluster types presented in (1).[3]

[3] Note that glides are included in (1) since glide substitution (e.g. /bl/ → [bj]) constitutes a viable modification of clusters in child language, see for instance Fikkert (1994) and Goad (2006) for examples.

(1) *Segmental combinations observed as primary (= P) vs. secondary (= S) clusters. Primary clusters in parentheses are judged "deviant" by Dell (1995).*[4] *Clusters shaded in dark grey are attested as both primary and secondary clusters. Question marks refer to the lack of judgment data indicating whether or not [œ] in the segmental context in question is alternating, e.g.* [db] *in* debout *'standing'* [dœbu] ~ ?[dbu].[5]

C1 \ C2			Plosive	Fricative	Nasal		Liquid	Glide
Plo.	P		(pt kt)	(pf ps pʃ ts tz tʃ dʒ ks gz)	(pn kn km gn)	pl	pʁ bʁ bl tʁ dʁ kʁ kl gʁ gl	pj/ɥ/w bj/ɥ/w tj/ɥ/w dj/ɥ/w kj/ɥ/w gw
	S		pt dp db? dd dg	pz bz ds dv	tn dm			
Fri.	P	sk	ft sp st (sb ʃp ʃt)	(sf sv ʃv)	(sm sn ʃm ʃn)	fʁ	fl vʁ (vl sl zl ʃʁ ʃl)	fj/ɥ/w vj/w sj/ɥ/w zj ʃj/ɥ/w ʒɥ/w
	S		sp? sg ʒt	fz ss? ʃv	fm fn vn sm ʃm ʃn ʒn		vl sʁ sl? ʒl	
Nas.	P				(mn)			mj/ɥ/w nj/ɥ/w
	S			ms mz nv	mn		mʁ ml	
Liq.	P							lj/ɥ/w ʁj/ɥ/w
	S		ʁp ʁb ʁt ʁd ʁk ʁg lk?	ʁf ʁv ʁs ʁʃ ʁʒ lv ls	ʁm ʁn		ʁl	
Gli.	P							
	S							

The table in (1) shows that secondary clusters with a liquid C1 do not overlap with any primary clusters. Concerning secondary clusters with a nasal C1, the sole overlap is found with [mn], which is considered a deviant primary cluster. In fact, if all deviant clusters are left aside, the distribution of primary and secondary clusters turns out near-complementary: the sole combinations found in both cases are [pl] (*plus* 'more' [plys] vs. *peluche* 'teddy bear' [pœlyʃ] ~ [plyʃ]), [sk] (*ski* [ski] vs. *secoue* 'shake:PRS.3SG' [sœku] ~ [sku]), and [fʁ] (*frais* 'fresh:M' [fʁɛ] vs. *fera* 'do:FUT.3SG' [fœʁa] ~ [fʁa]).

At this point, let us mention that Bürki et al. (2009) discuss whether primary and secondary clusters that are identical with regard to segmental content are articulated differently. In contrast to Lebel (1968) and Rialland (1986), Bürki et al. (2009) first show that schwa absence does not entail complementary lengthening in the secondary cluster. Second, they observe that other acoustic cues separating the two types of clusters are few and unsystematic. Further, in light of the observation of gradual reduction of schwa, Bürki et al. (2011) state that the discussion on the categorization of schwa

[4] Dell (1995) judges a cluster deviant when "it occurs in few morphemes, or when it occurs mostly in unfrequent words, in foreign-sounding words [this does not mean all loan-words, cf. Dell (1995:11, Footnote 15)], or in specialized strata of the lexicon" (Dell 1995:11). According to Bazylko (1976) and Dell (1995), the degree of pronunciation difficulties varies from one cluster to another, which suggests that some – but not all – deviant clusters are fully integrated into the French native phonotactic system. The implications of the latter suggestion for the relation between primary and secondary clusters are subject to future research.

[5] For the procedure of determining the threshold between schwa and stable /œ/, cf. Andreassen (to appear).

needs to go beyond the classification of a full vowel vs. zero vowel (for more details, cf. Andreassen to appear).

2.2 Primary clusters in acquisition

If we concentrate on syllable-initial complexity, development seems to be guided by the nature of the consonants (Fikkert 1994, Gnanadesikan 2004) and the relative prominence of the syllable (Rose 2000). As concerns the segmental makeup of the sequence, it has been shown that ObsLiq-clusters first reduce to the least sonorous segment (/bl/ → [b]). At a later stage, the clusters are optionally subject to different kinds of modifications (/bl/ → [l] [bj] [bʊ] [bəl], cf. Fikkert 1994, 2010), before they are produced in a target-like manner. As for [s]+C-clusters, Fikkert (1994) observes for Dutch that they also reduce to the least sonorous segment in a first stage: while [s]+Obs-clusters typically reduce to Obs, [s]+Son-clusters typically reduce to [s][6] (cf. also the English examples *star* [dɑ] vs. *sleep* [sip], taken from Gnanadesikan 2004:78). According to Fikkert (2010), the most common pattern seems to be acquisition of ObsLiq-clusters prior to acquisition of [s]+C-clusters, although both paths are attested.

An effect of relative syllable prominence is observed by Rose (2000) for Québec French: while complex onsets in a first stage are reduced in both prominent and non-prominent syllables (*train* [tʁɛ̃] → [kɛ], *brisé* 'break:PST;PTCP' [bʁize] → [pɪˈz̥e]), they are in a second stage faithfully produced only in prominent syllables (*glisse* 'slip:PRS.3SG' [glɪs] → [klɪs], *brûlé* 'burn:PST;PTCP' [bʁyle] → [byˈle]). In a third stage are complex onsets licensed in both positions (*plancher* 'floor' [plɑ̃ˈʃe]). According to Rose, who considers underlying representations to contain prosodic structure, relative prominence does not play any role when it comes to clusters of a consonant followed by the glide component of a following rising diphthong (henceforth C+Glide-clusters, e.g. *poisson* 'fish' [pwaˈsɔ̃]): these are fully mastered in non-prominent syllables far earlier than branching onsets in this position.[7]

Rose (2000) does not discuss other types of modifications besides segment deletion. Kehoe et al. (2008), on the other hand, in their study of 14 children acquiring European French, show that ObsLiq-clusters behave somewhat differently from C+Glide-clusters: ObsLiq and C+[w] typically reduce to C1 (*bras* 'arm' [bʁa] → [ba], *pois* 'pea' [pwa] → [pa]) while C+[j] typically reduces to the glide (*camion* 'truck' [kaˈmjõ] → [kaˈjõ]). Further, within the ObsLiq-group, only Obs+[l] is observed with epenthetic vowel. Kehoe et al. also observe an occasional substitution of glides by liquids and vice versa, with Obs+[l] being the preferred output structure (*viande* 'meat' [vjɑ̃d] → [plɑ̃], *trompette* 'trumpet' [tʁɔ̃pɛt] → [tlɔ̃pɛt]). Finally, deletion of the entire onset is attested (*brosse* 'brush' [bʁɔs] → [ɔs]), although less frequently.

What do the above-mentioned findings imply with regard to schwa and secondary clusters in French child language? First let us reflect on schwa and its segmental context in light of Rose's (2000) observation of prosodic faithfulness. When schwa is absent in the output, the two consonants (C1 and C2) are adjacent and form a cluster in the prominent syllable (*semaine* 'week' [sœ.ˈmɛn] ~ [ˈsmɛn]). In contrast to primary clusters, however, only the second consonant in the secondary cluster would in Rose's analysis be prosodified in the prominent cluster underlyingly. If we interpret Rose correctly, faithfulness to the consonant(s) part of the prominent syllable (=C2) in the underlying form is stronger than faithfulness to the consonant(s) part of the non-prominent syllable (=C1), which would imply that in the case of schwa absence and cluster simplification, C2 would be maintained at the expense of C1. Let us now reflect on schwa and secondary clusters in light of the findings in Fikkert (1994, 2010) and Kehoe et al. (2008): clusters have proven subject to various modifications all depending on the nature of the

[6] Note that the nasal is preserved at the expense of [s] as long as the sibilant is not part of the child's system (*snoep* 'candy' [snu:p] → [mu:n], cf. Fikkert, 1994:93). When [s] is in place, [s]+Nas is reduced to the sibilant.

[7] The low number of examples provided of C+Glide-clusters in non-prominent positions makes us question the strength of this claim.

different segments. In the case of schwa absence, we would expect various modifications of C1 and C2 to occur as a means to circumvent the creation of a cluster not authorized in the child's current grammar: reduction to C1 or C2, and modification of C1 or C2. Further, a possible modification constitutes the realization of an interconsonantal vowel, which can either bear on the phonological (epenthesis, e.g. Fikkert 1994) or the phonetic (excrescence, e.g. Levin 1987, Hall 2006) level of analysis.[8] To the best of our knowledge, there has been no discussion in the literature on the distinction between epenthetic and excrescent vowels in child language. On the other hand, Goetry et al. (2001, referenced in Hall 2006), in a perception study on Dutch children, reported that 50% did not perceive the excrescent schwa as syllabic, in contrast to the underlying one. Although the nature of the reduced interconsonantal vowel is beyond the scope of this paper (for a detailed discussion, cf. Andreassen to appear), we briefly return this issue in Section 4.1.1

The modification of a secondary cluster in the output seems however to be an unnecessarily costly procedure if we take into account the alternative output for a schwa-item: the realization of the schwa vowel. This argument is based on the examination of the totality of schwa items in our child language data (cf. Section 3), which has revealed that the variant with schwa is in a global fashion largely preferred to the variant without schwa. The preference of the variant with schwa is in fact the case across the corpus, even in some of the items that are judged with a highly frequently absent schwa in the target language. This observation first of all suggests that the schwa item has one single underlying representation (contra Bürki et al. 2010), in which schwa is present.[9] Second, the high level of schwa presence indicates that the alternative variant, without schwa, comes at a higher cost.

Two hypotheses emerge from this discussion and will guide the remainder of our study, cf. (2)

(2) *Hypotheses*

A If primary clusters are not mastered, secondary clusters are not mastered.

B If secondary clusters are not mastered, schwa alternation is blocked.

The first hypothesis holds on the different nature of the two types of clusters. Primary clusters are mainly ObsLiq-clusters, which in light of the sonority scale and the principle of Sonority Dispersion form optimal complex onsets, with a maximally increasing sonority profile (Clements 1990, 2009).[10] Secondary clusters compete with schwa presence and do in the majority of cases not occur outside the set of schwa items. Further, they come in many configurations with regard to sonority profile and manner combinations. When we finally take into account that primary [s]+C-clusters are in general acquired later than ObsLiq-clusters, and also that the secondary clusters in many cases contain a sibilant C1, the facts lead to the *a priori* conclusion that the secondary clusters should emerge later than the primary ones. The second hypothesis concerns the relation between the two phonological variables available for each schwa item: the selection of the variant with schwa (*cheval* 'horse' [ʃœval]) over the variant without schwa (target [ʃval]) is preferred if secondary clusters are not authorized. This hypothesis predicts that the variant with schwa also should be preferred to a variant in which schwa is absent alongside one of the consonants (hypothetical [ʃal] or [val]).

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[8] Excrescence has been reported for French varieties with apical [r] (Klingler and Lyche in press): phonetically reduced, with a phonetic schwa quality and not attested a docking site for prominence, the schwa vowel occurring between the two elements of a primary clusters is considered a matter of gestural timing and thus a phonetic, not a phonological, phenomenon.

[9] Schwa in child language thereby contrasts with liaison in child language by the fact that children for the latter phenomenon use several variants from early on, which in turn has been analyzed as the reflection of multiple lexical variants (Chevrot et al. 2009).

[10] Glides are highest on the sonority scale for non-syllabic elements defended by Clements (1990).

3. Methodology

In this paper we make use of data from thirteen monolingual children residing in the Nyon district in francophone Switzerland, aged 2;2.15 – 3;2.14 at the outset of the recording period, cf. (3) for details.

(3) *Information on children and recording settings*

Name	Gender	First session	Last session	Density	Sessions spontaneous	Sessions semi-directed
Fabienne	F	2;2.15	2;5.21	1/week	6	5
Henri	M	2;4.1	2;7.8	1/week	7	5
Lucas	M	2;7.1	2;10.25	1/week	16	5
Adèle	F	2;7.8	2;10.13	1/week	12	5
Janice	F	2;7.28	3;0.14	1/week	16	6
Kim	M	2;8.27	3;0.5	1/month	-	5
Théa	F	2;9.27	3;1.12	1/month	-	5
Armand	M	2;11.13	3;4.0	1/week	16	6
Lambert	M	2;11.13	3;2.12	1/month	-	5
Eric	M	2;11.16	3;2.15	1/month	-	5
Albert	M	3;1.0	3;4.17	1/month	-	6
Tom	M	3;1.17	3;6,5	1/week	19	6
Guy	M	3;2.14	3;7.4	1/week	16	6

All children were recorded monthly on the premises of the kindergarten. The recording situation was semi-directed in order to obtain comparable data across informants: the child "interacted" with a PowerPoint-presentation containing pictures and pre-recorded utterances by a male Swiss French speaker: for each picture aimed to trigger the child's production of a schwa item, two sound files were available, i.e. one sound file with schwa present (*"Oui, c'est un cheval"* 'Yes, it is a horse' [wisɛtœ̃ʃœval]) and one sound file with schwa absent ([wisɛtœ̃ʃval]). This way, we obtained a semi-directed "dialogue" between the child and the adult.[11] Further, in order to indirectly provoke the production of the non-preferred – but possibly available – variant (with or without schwa), we manually selected the sound file (= utterance by the male speaker) with the variant opposite to the one previously selected by the child.

Natural speech for comparison and completion was obtained via a weekly recording of eight children, with an average duration of 30-40 minutes. Six of the children were recorded at home with the mother taking part in the play. The naturalistic speech of Fabienne and Henri was obtained during play on the premises of the kindergarten.

This paper will primarily make use of the semi-directed speech data, cf. (4) for some recurring items across informants and sessions.

(4) *Recurring items across informants and sessions (kindergarten recordings)*

a. Items with primary clusters: *bleu* 'blue:M' [blø], *blanc* 'white:M' [blɑ̃], *fleur* 'flower' [flœʁ], *grenouille* 'frog' [gʁœnuj], *grand* 'big:M' [gʁɑ̃], *Claudine* (proper name) [klodin]

b. Items with secondary clusters: *cheval* 'horse' [ʃœval] ~ [ʃval], *chevir* (invented) [ʃœviʁ] ~ [ʃviʁ], *fenêtre* 'window' [fœnɛtʁ] ~ [fnɛtʁ], *fenasse* (invented) [fœnas] ~ [fnas]

The data were treated in Phon (Rose and Hedlund 2006-2012), a software designed to facilitate the treatment of data used in phonological analyses (in particular first and second language acquisition and phonological disorders): the signal was first manually segmented and orthographically transcribed. The target (adult) pronunciation and the actual (child) pronunciation were then automatically transcribed by Phon on the basis of the orthographic transcription. A manual adjustment of the actual pronunciation by

[11] See Andreassen (to appear) for further details.

the child was subsequently performed after auditory inspection. When necessary, the signal was exported to Praat (Boersma and Weenink 1992-2012) and subjected to visual inspection of the spectrogram. The target and actual pronunciations were then automatically aligned (at the level of the segment) in Phon. All alignments were checked and adjusted if necessary. Target primary and secondary clusters and their actual correspondents were extracted and exported to Excel for further examination.

The number of occurrences of the four schwa items and the rates of schwa presence vs. absence are displayed in (5).

(5) *Four schwa items in kindergarten sessions: number of occurrences and rates of schwa presence vs. absence (numbers and percentages, global results)*

	Total	**Presence**		**Absence**	
Cheval	573	79%	454	21%	119
Chevir	282	83%	233	17%	49
Fenêtre	241	83%	199	17%	42
Fenasse	261	82%	214	18%	47

Target primary clusters were extracted from both the semi-controlled and the naturalistic settings.[12] Attention will however mostly be paid to the semi-controlled data (all 13 children) as these might shed some light on the rates of schwa alternation in (5).[13] Let us recall that we only focus on target clusters in the word-initial position.[14]

4. Results

4.1 Primary clusters: level of mastery and types of modification

4.1.1 ObsLiq-clusters

The table in (6) displays the results for ObsLiq-clusters extracted from the kindergarten sessions. Note that we in most cases follow the methodology of Kehoe et al. (2008) in the presentation of the data, which was developed as a means to reveal the structure of target branching onsets and C+glide-clusters in French and Spanish child language: Consonant deletion and insertion of an interconsonantal vowel are classified as errors. We have also counted as errors any substitution of a liquid by a glide or vice versa. Modifications in place of articulation (*tracteur* 'tractor' [tʁaktœʁ] → [kʁaktœʁ]), modifications in manner within the class of obstruents (*fleur* 'flower' [flœʁ] → [klɔ]) and differences in voicing (*bleu* 'blue:M' [blø] → [plø]) are not counted as errors. For the sake of consistency, however in contrast to Kehoe et al. (2008), we do not consider within-class substitutions in the second element to be errors (*crayon* 'pencil' [kʁɛjɔ̃] → [klea]).

12 The primary ObsLiq-clusters produced by Janice, Tom and Guy were not extracted from the naturalistic setting. The transcription of their productions in the semi-controlled setting revealed that they produce the primary clusters with ~ 90% accuracy. Based on this result, we found it unnecessary to further examine the ObsLiq-clusters in their naturalistic speech.

13 The clusters were extracted from the entirety of the recording session, i.e. the play with the PowerPoint-presentation, a second semi-directed play with pictures and other productions made by the child relevant or not to the play in question.

14 The data from the semi-controlled setting are unfortunately too scarce to reveal any difference between target word-initial clusters in non-prominent vs. prominent syllables at the individual level (cf. Rose 2000). The spontaneous data from Adèle do however indicate that she is on the verge of mastering Obs+[l]-clusters in monosyllabic words.

(6) *Target production of ObsLiq-clusters (kindergarten sessions), faithfulness with respect to number of segments and obstruency (numbers and percentages, individual results). Children with less than 75% accuracy (cf. Fikkert 2010) are shaded in dark grey.*

Name	**First session**	**Last session**	**Target production of ObsLiq-cluster (numbers and percentages)**	
Fabienne	2;2.15	2;5.21	10%	4/41
Henri	2;4.1	2;7.8	59%	41/70
Lucas	2;7.1	2;10.25	67%	40/60
Adèle	2;7.8	2;10.13	27%	32/120
Janice	2;7.28	3;0.14	89%	106/119
Kim	2;8.27	3;0.5	10%	6/61
Théa	2;9.27	3;1.12	54%	39/72
Armand	2;11.13	3;4.0	91%	69/76
Lambert	2;11.13	3;2.12	84%	68/81
Eric	2;11.16	3;2.15	81%	78/96
Albert	3;1.0	3;4.17	96%	64/67
Tom	3;1.17	3;6.5	92%	112/122
Guy	3;2.14	3;7.4	95%	161/169

A detailed examination shows that about half the children (Janice, Armand, Lambert, Eric, Albert, Tom, Guy) demonstrate mastery of these clusters both with respect to the number, manner and place of articulation of segments, cf. (7a). Note that Armand is singled out from this group as he alone replaces the alveolar plosive by a velar one in front of [ʁ]. At an intermediate level we find Lucas, Henri and Théa, ranging between 50-70% rate of accuracy, cf. (7b).[15] The remaining children (Fabienne, Kim and Adèle) display less than 30% faithful cluster production, cf. (7c).

[15] Inspection of the target clusters attempted by Henri in both recording settings reveals that he only masters Obs+[ʁ] (the alveolar C1 is replaced by [k] in *train*, *trop* 'too much', *trou* 'hole' etc). As for the few instances of words with target Obs+[l], the cluster is reduced to the plosive.

(7) *Faithful production of ObsLiq-clusters*

a. *Children with 75% accuracy or higher*

prends	[pʁɑ̃]	→ [pʁɑ̃]	‘take:PRS.2SG’	Guy 3;2.22
pleure	[plœʁ]	→ [plœ̜ʁ]	‘cry:PRS.3SG’	Guy 3;2.22
brun	[bʁœ̃]	→ [bxœ̃]	‘brown:M’	Eric 2;11.16
bleu	[blø]	→ [bly]	‘blue:M’	Eric 2;11.16
fraises	[fʁɛz]	→ [fʀ̥ɛθ]	‘strawberry:PL’	Tom 3;1.22
fleurs	[flœʁ]	→ [flœʀ]	‘flower:PL’	Tom 3;1.22
train	[tʁɛ̃]	→ [tʀ̥ɛ̃]	‘train’	Lambert 2;11.13
tracteur	[tʁaktœʁ]	→ [kʀ̥atœ]	‘tractor’	Armand 3;2.13
drôle	[dʁol]	→ [dʕol]	‘funny’	Janice 2;11.2
dragon	[dʁagɔ̃]	→ [gʁɛ̃gɔ̃]	‘dragon’	Armand 3;0.20
crache	[kʁaʃ]	→ [kχaʃ]	‘spit:PRS.3SG’	Albert 3;1.11
Claudine	[klodin]	→ [klɔdin]	proper name	Albert 3;3.6

b. *Children with 50-70% accuracy*

près	[pʁɛ]	→ [pʁɛ]	‘near’	Lucas 2;9.10
pleure	[plœʁ]	→ [plɐʁ]	‘cry:PRS.3SG’	Théa 3;0.22
brun	[bʁœ̃]	→ [bʁœ̃]	‘brown:M’	Théa 2;9.29
blanc	[blɑ̃]	→ [blɑ̃]	‘white:M’	Théa 2;9.29
fleurs	[flœʁ]	→ [flʌʀ]	‘flower:PL’	Lucas 2;7.13
fraises	[fʁɛz]	→ [fʀ̥ɛð]	‘strawberry:PL’	Lucas 2;10.19
train	[tʁɛ̃]	→ [tʀ̥æ]	‘train’	Lucas 2;10.19
trompe	[tʁɔ̃p]	→ [kxɔ̃p]	‘trunc’	Henri 2;7.1
drapeaux	[dʁapo]	→ [kʁapo]	‘flag:PL’	Henri 2;6.4
crayons	[kʁɛjɔ̃]	→ [kχɛjɔ̃]	‘pencil:PL’	Théa 3;1.12
Claudine	[klodin]	→ [klɘdi]	proper name	Lucas 2;9.29
grenouille	[gʁœnuj]	→ [kʀ̥ujd]	‘frog’	Henri 2;4.1
glace	[glas]	→ [glas]	‘ice cream’	Lucas 2;7.18

c. *Children with 30% accuracy or lower*

prêt	[pʁɛ]	→ [p^{h}ʁ̥ɛ]	‘ready:M’	Kim 3;0.5
pleure	[plœʁ]	→ [plʌ]	‘pleure:PRS.3SG’	Adèle 2;8.29
bleu	[blø]	→ [plœ]	‘blue:M’	Kim 2;11.15
fleur	[flœʁ]	→ [klɜ][flɔ̜][plɔ̜]	‘flower’	Adèle 2;8.29
fraises	[fʁɛz]	→ [klɛθ]	‘strawberry:PL’	Adèle 2;9.15
train	[tʁɛ̃]	→ [kʀ̥ɛ̃]	‘train’	Fabienne 2;5.21
crayon	[kʁɛjɔ̃]	→ [klea]	‘pencil’	Adèle 2;8.9
clown	[klun]	→ [klu]	‘clown’	Adèle 2;10.13
grenouille	[gʁœnuj]	→ [gʁɔlud]	‘frog’	Adèle 2;9.24
glace	[glas]	→ [glas]	‘ice cream’	Adèle 2;10.4

In the case of unfaithful production of target ObsLiq, the three main modifications expected from the literature are observed: reduction, substitution and realization of an interconsonantal vowel. Deletion of the entire cluster is sporadically observed across the corpus, however only in cases of Obs+[ʁ], and most notably in the productions of Fabienne, Adèle and Armand: *bracelet* [bʁaslɛ] → [atle] (Adèle 2;9.15), *tracteur* ‘tractor’ [tʁaktœʁ] → [atœ̜ʁ] (Fabienne 2;3.19), *trouver* ‘find:INF’ [tʁuve] → [ue] (Fabienne 2;3.19), *drapeau* ‘flag’ [dʁapo] → [apo] (Adèle 2;10.4), *Grosminet* ‘Sylvester the Cat’ [ominɛ] (Adèle 2;10.7), *Grégoire* (proper name) [gʁegwaʁ] → [egʁuwa] (Armand 2;11.13). Note that cluster deletion is only attested in non-prominent syllables, which patterns with Rose's (2000) claim of reduced faithfulness to non-prominent syllables compared to prominent syllables.

As predicted, in the case of cluster reduction, liquid deletion is more frequent than obstruent deletion. However, some variation emerges when we concentrate on the younger children Fabienne, Henri, Kim and Adèle: whereas Kim invariably deletes the liquid, e.g. *grand* 'big:M' [gʁɑ̃] → [gɔ] (2;9.26), Adèle and Henri display several occurrences of obstruent deletion. The latter finding is however restricted to the target combination of a velar plosive and a uvular [ʁ] (or phonetic variants thereof), where the latter competes with the obstruent and the full cluster, e.g. *grand* [gʁɑ̃] → [ʀɔ̃] ~ [kʀ̥ɔ̃] (Henri 2;4.1) ~ [ku̥] (Henri 2;4.29). Fabienne also has several variants for target Obs+[ʁ]: deletion of the plosive, deletion of the entire cluster (see above), faithful production, e.g. *grand* [gʁɑ̃] → [gʀɔ] (2;4.3), and harmony (cf. *grenouille* in 8c).

In (8) we present examples of reduction of ObsLiq-clusters. Note that we only include reductions observed in the children with a level of accuracy lower than 30% – in addition to Henri (cf. Footnote 15).

(8) *Reduction of ObsLiq-clusters*

a. *Liquid deletion*

pris	[pʁi]	→ [pi]	'take:PST;PTCP'	Kim 3;0.5
prends	[pʁɑ̃]	→ [kɔ]	'take:PRS.1SG'	Adèle 2;10.7
prend	[pʁɑ̃]	→ [bɔ]	'take:PRS.3SG'	Fabienne 2;5.21
plier	[plije]	→ [pije]	'fold:INF'	Adèle 2;9.29
bras	[bʁa]	→ [ba]	'arm:PL'	Adèle 2;8.9
bleu	[blø]	→ [bɵ]	'blue:M'	Henri 2;6.18
fleur	[flœʁ]	→ [fœχ]	'flower'	Henri 2;4.1
fleur	[flœʁ]	→ [fɛ]	'flower'	Fabienne 2;4.3
fraises	[fʁɛz]	→ [fɛt]	'strawberry:PL'	Kim 3;0.5
fraises	[fʁɛz]	→ [kɛθ]	'strawberry:PL'	Adèle 2;9.16
train	[tʁɛ̃]	→ [tæ]	'train'	Kim 3;0.5
trouvé	[tʁuve]	→ [puve]	'find:PST;PTCP'	Adèle 2;9.24
drôle	[dʁol]	→ [kɔj]	'funny'	Adèle 2;9.15
Claudine	[klodin]	→ [kɔjdi]	proper name	Adèle 2;7.8
crayon	[kʁɛjɔ̃]	→ [gejɔ̃]	'pencil'	Kim 3;0.5
grenouille	[gʁœnuj]	→ [gənyj]	'frog'	Kim 2;8.27
griffer	[gʁife]	→ [gife]	'scratch:INF'	Adèle 2;9.24
glace	[glas]	→ [gaç]	'ice cream'	Henri 2;6.4

b. *Obstruent deletion*

blanc	[blɑ̃]	→ [la]	'white:M'	Adèle 2;8.5
train	[tʁɛ̃]	→ [xa]	'train'	Fabienne 2;3.19
drôle	[dʁol]	→ [ʕɔj]	'funny'	Adèle 2;9.29
grand	[gʁɑ̃]	→ [ʀ̥ɔ̃]	'big:M'	Henri 2;6.18
clown	[klun]	→ [χunə]	'clown'	Fabienne 2;4.17

c. *Other*

grenouille	[gʁœnuj]	→ [nœnɔj]	'frog'	Fabienne 2;3.12

As regards substitutions, we have already presented in (7c) some examples of the replacement of liquid [ʁ] by [l]. The most common, however, is the replacement of liquids by glides, which leads to the production of an ObsGli-cluster where the degree of increase in sonority is maximal (cf. Clements 1990, 2009). Most children exhibiting a certain degree of cluster reduction also adopt this second strategy, the sole exception being Henri. Note that gliding is also observed for Théa, which explains her rather low 54% rate of ObsLiq-cluster accuracy, cf. (6).

(9) *Substitution in ObsLiq-clusters*

a. *Substitution of [ʁ]*

près	[pʁɛ]	→ [kwɛ]	'near'	Adèle 2;10.7
prépare	[pʁepaʁ]	→ [pjepa]	'prepare:PRS.3SG'	Kim 3;0.5
pris	[pʁi]	→ [pwi]	'take:PST.PTCP'	Théa 3;0.22
fraise	[fʁɛz]	→ [kweθ]	'strawberry'	Adèle 2;10.7
train	[tʁɛ̃]	→ [tjæn]	'train'	Kim 3;0.5

b. *Substitution of [l]*

pleure	[plœʁ]	→ [pjœx]	'cry:PRS.3SG'	Kim 2;11.15
bleu	[blø]	→ [βjẹ]	'blue:M'	Fabienne 2;5.0
blanc	[blɑ̃]	→ [djɑ̃]	'white:M'	Fabienne 2;5.0
blanc	[blɑ̃]	→ [bjʌ]	'white:M'	Adèle 2:9.24
blanc	[blɑ̃]	→ [βjɑ̃]	'white:M'	Théa 2;11.3
fleur	[flœʁ]	→ [fɥɛ]	'flower'	Fabienne 2;3.12
fleur	[flœʁ]	→ [fɥɛx]	'flower'	Fabienne 2;5.0
fleur	[flœʁ]	→ [fjɛʁ]	'flower'	Fabienne 2;4.0
fleur	[flœʁ]	→ [ɸjœʀ̥]	'flower'	Fabienne 2;4.0
fleur	[flœʁ]	→ [pjɔχ]	'flower'	Fabienne 2;5.21
fleur	[flœʁ]	→ [kja]	'flower'	Adèle 2;7.8
fleur	[flœʁ]	→ [pjɑ]	'flower'	Adèle 2;8.29
fleur	[flœʁ]	→ [fɥəʁ̥]	'flower'	Kim 2;9.27
fleur	[flœʁ]	→ [fjœ̞x]	'flower'	Kim 2;11.15
fleur	[flœʁ]	→ [fjɜʁ]	'flower'	Théa 2;9.27
clown	[klun]	→ [kjun][djuj]	'clown'	Fabienne 2;4.17

The final type of modification observed in the data, i.e. realization of an interconsonantal vowel (in an overall fashion shorter in duration than stable vowels in non-prominent positions, and thereby transcribed with a breve), is observed as sporadically applied throughout the corpus. Never observed in the data from Tom and Guy, who have some of the highest scores on ObsLiq-accuracy, the short interconsonantal vowel is neither observed in the data from Fabienne or Kim, with the lowest scores on ObsLiq-cluster accuracy. This strategy is in particular found in the data from Adèle, Lucas, Janice and Armand, whose scores on ObsLiq-cluster accuracy are highly variable. It is interesting to notice that for Adèle and Lucas, who have not acquired ObsLiq-clusters (below 75%), the interconsonantal vowel occurs most frequently in front of [l], whilst for Janice and Armand, who have acquired ObsLiq-clusters (above 75%), it occurs more frequently in front of [ʁ]. The asymmetrical distribution of the interconsonantal vowel in Lucas and Adèle patterns with the fact that Obs+[ʁ]-clusters are more frequently than Obs+[l]-clusters subject to other modifications in their production, i.e. liquid deletion or gliding. The asymmetrical distribution of the interconsonantal vowel in Janice and Armand, on the other hand, is more difficult to explain as a phonological operation aiming to avoid ObsLiq-clusters, since the two children master these latter. Taking the level of accuracy on ObsLiq-clusters of the two pairs of children into account, it might be the case that we witness the realization of an interconsonantal vowel, which in the case of Janice and Armand is merely an excrescent vowel and thus a matter of gestural timing. Regarding Adèle and Lucas, however, it might be the case that the excrescent vowel is phonologized and serves to break up the ObsLiq-cluster. Only a finer acoustic study of these data will allow us to confirm this claim.

(10) *Repair strategy: Interconsonantal vowel*

a. *In front of [ʁ]*

brosse	[bʁɔs]	→ [bʌ̆ʁɔs]	'brush:PRS.3SG'	Armand 3;2.16
truc	[tʁyk]	→ [tʏ̆ʁʏk]	'thing'	Janice 2;11.15
crayons	[kʁɛjɔ̃]	→ [kɛ̆ʁɛjɔ̃]	'pencil:PL'	Lucas 2;10.19
graines	[gʁɛn]	→ [gɛ̆ʁɛn]	'grain:PL'	Armand 3;3.4
griffes	[gʁif]	→ [gə̆ʁif]	'claw:PL'	Janice 2;10.8

b. *In front of [l]*

plus	[plys]	→ [pʏ̆lys]	'more'	Lucas 2;9.21
blanc	[blɑ̃]	→ [pə̆la]	'white:M'	Adèle 2;7.8
bleu	[blø]	→ [pə̆le]	'blue:M'	Adèle 2;7.8
blanc	[blɑ̃]	→ [bɪ̆la]	'white:M'	Adèle 2;8.29
fleurs	[flœːʁ]	→ [fɛ̆lʌʁ̥]	'flower:PL'	Lucas 2;7.13
clown	[klun]	→ [kʏ̆lut]	'clown'	Adèle 2;8.29
glace	[glas]	→ [gălaθ]	'ice cream'	Adèle 2;8.22
glace	[glas]	→ [gɛ̆las]	'ice cream'	Lucas 2;9.21

4.1.2 [s]+C-clusters

Let us now turn to the second type of primary clusters in French, i.e. [s]+C-clusters. The number of occurrences of this second cluster type is unfortunately too low across both recording settings to reveal any patterns. The few examples that are found are nevertheless in line with previous research: in most cases, [s] is deleted in favor of the following plosive. Two exceptions are however found in the data from Lucas: the deletion of the plosive in *Scoubidou* and the preservation of the nasal in *Smarties*. In the data from Lucas we further observe that the one occurrence of a well-formed [s]+C-cluster is found in monosyllabic *stop*, which might indicate that his grammar authorizes these clusters in the prominent syllable only.

(11) *[s]+C-clusters*

a. *[s]+Obstruent*

sparadrap	[spaʁadʁa]	→ [badəʁa]	'adhesive plaster'	Théa 2;9.27
spectacle	[spɛktakl]	→ [pθpɛtɛtaklœ̥]	'spectacle'	Janice 2;10.8
stylo	[stilo]	→ [tilo]	'pen'	Adèle 2;7.11
stop	[stɔp]	→ [stɔp]	'stop'	Lucas 2;9.21
Scoubidou	[skubidu]	→ [s̪ubidu]	'Scooby-Doo'	Lucas 2;9.14
scotch	[skɔtʃ]	→ [gɔθ]	'self-adhesive tape'	Adèle 2;9.30
ski	[ski]	→ [ki]	'ski'	Armand 2;11.13
ski	[ski]	→ [θ.ti]	'ski'	Guy 3;5.23
skier	[skije]	→ [θkije]	'go skiing:INF'	Janice 2;8.28
scarabée	[skaʁabe]	→ [kaʁabe]	'beetle'	Tom 3;2.17
squelette	[skœlɛt]	→ [skœlɛt]	'skeleton'	Tom 3;4.05

b. *[s]+Sonorant*

Smarties	[smaʁtiz]	→ [matiz]	'Smarties'	Lucas 2;10.21
Smarties	[smaʁtiz]	→ [smaʁtiz]	'Smarties'	Eric 3;2.1

While the reductions observed in the children with a low score on ObsLiq-cluster accuracy are unsurprising, we notice with interest the occasional errors by Janice, Armand, Guy and Tom, all with a high score on ObsLiq-cluster accuracy: they all reveal some articulatory difficulty when it comes to this second primary, albeit rare, cluster type.

4.2 Secondary clusters: level of mastery and types of modification

Let us recall from Section 2.2 that the variant with schwa (*fenêtre* 'window' [fœnɛtʁ]) is in a global fashion largely preferred to the variant without schwa (*fenêtre* [fnɛtʁ]), also in cases where schwa is highly frequently absent in the adult language: while *ser-* 'be:FUT' is invariably produced without schwa by the children, *peluche* 'teddy bear', with a secondary cluster identical to the primary cluster [pl], is produced with schwa: [pølyθ] (Kim 2;8.27), [pe̹lyʃə] (Janice 2;8.4) and [pølyʃ] (Tom 3;5.17).

Although there is a large amount of variation across children, there is nevertheless a clear tendency in the data whereby each child prefers one of the variants, i.e. we witness little target-like alternation compared to what is observed in the judgment data from adult Swiss French speakers (Racine 2008):[16] For instance, Adèle, who does not master ObsLiq-clusters, realizes schwa in *cheval* 'horse' [ʃ(œ)val] → [tʌvat] but omits it in *cheveux* 'hair:PL' [sjø] [θje] [tjæ] [çu] [θʏ] – both items equally unstable in the target language. Note that the segmental makeup of the secondary cluster she produces varies across the two items, and that the secondary cluster in *cheveux* is realized via gliding – a repair strategy attested in her production of primary ObsLiq-clusters. Other examples come from Guy, who – unlike Adèle – masters ObsLiq-clusters: while he consequently selects the schwa-less variant of the verbal stem *ser-*, e.g. *sera* 'be:FUT.3SG' [sʀ̥a] (3;7.4), he never deletes schwa in *requin* 'shark' [ʀ̥ɔ̹kɛ̃] (3;6.13). In the expression *avoir besoin de* 'need:INF', on the other hand, he displays true schwa alternation: [bœ̧zwɛ̃] ~ [bzwɛ̃] (3;2.19).

Let us return to two of the recurrent items in the semi-controlled setting, i.e. *fenêtre* 'window' and *cheval* 'horse', in which schwa is surrounded by a fricative and a sonorant (≈ ObsLiq-cluster) and a sibilant and a fricative (≈ [s]+C-cluster), respectively. Note that the numbers of schwa-less variants are low across the corpus. Also note that there is much variation when it comes to segmental makeup in the variant with schwa, labeled "CœC-shape" in (12-13), and that we only focus on some of the recurring structures.[17]

(12) *"Fenêtre": segmental makeup of secondary cluster with (=CœC) and without (=CC) schwa (tendencies, individual results). The quality of schwa varies at the intra- and inter-speaker level, and for the ease of presentation, all vowels are transcribed [œ].*

Score on ObsLiq	**Child**	**CœC shape (tendency)**	**CC shape (tendency)**	
	Fabienne	[hœn] [tœ∅] [∅œj]	Reduction	[j] ∅
	Kim	[fœn]	*none*	
< 30%	Adèle	[tœn]	= CœC shape	[tn]
			Assimilation with C2	[ñ̥nː]
			Substitution C1 + C2	[kl̥͡l]
	Lucas	[fœn]	= CœC shape	[fn]
			Interconsonantal vowel	
50-70%	Henri	[fœn] [fœʋ] [fœj] [fœ∅]	Reduction to C1	[f]
		[vœv]	Gliding	[fɥ]
	Théa	[fœn]	= CœC shape	[fn]

16 Note that although the adult speakers as a group in Racine (2008) judge the variants with and without schwa as equally frequent in their own speech, this result does not automatically transfer to the actual production pattern of the individual speaker: it is possible that speakers differ as to whether they use both or just one of the variants.

17 Note that Fabienne shows no clear tendencies with regard to the consonants produced alongside schwa.

> 75%	Janice	[fœn]	= CœC shape	[fn] [fn̥͡n]
	Armand	[fœj] [fœ∅] [vœ∅] [ʋœ∅]	Reduction to C1	[v]
			Reduction to C2	[n]
	Lambert	[fœn]	= CœC-shape	[f.ñ̥͡n]
	Eric	[fœn]	Interconsonantal vowel	
	Albert	[fœn]	= CœC shape	[fn]
	Tom	[fœn] [fœñ̈]	= CœC shape	[fñ̥͡n]
			Assimilation with C2	[n̥̈.n] [h.n]
			Interconsonantal vowel	
	Guy	[fœn]	= CœC shape	[fn] [fñ̥͡n]

Let us start with the children having acquired the ObsLiq-clusters (> 75%): Although they largely prefer the variant with schwa, when they select the other variant, they do produce the secondary cluster largely accurately. There are some instances of short interconsonantal vowels and assimilations, however, which perhaps show the difficulty of implementing the cluster phonetically. For instance Tom produces nasal assimilation when schwa absence is indirectly provoked. This is a strategy found elsewhere in the lexicon: when repeating *Genève* without schwa in another semi-directed play, he assimilates once again: [ʒnɛv] → [ñ̥nɛv] (3;6.1). The same solution is found in the data from Guy in the naturalistic setting: *semaine* 'week' is produced [m̥̃mɛn] (3;3.13). The one child in the group of older children that shows a distinct behavior is Armand: producing a non target-like combination of C1 and C2 in the case of schwa presence, alongside several instances of deletion of C2, e.g. [fãɛt] (3;0.21), the target cluster is reduced to C1 ([f] → [v]) or the nasal C2 when he omits schwa. Interesting results emerge in the group of children with a ObsLiq-cluster accuracy of less than 30%: Fabienne freely employs the schwa-less variant in the recording session, however with one or both consonants deleted: [jæ̜t] [ɛt] (2;3.12). In fact, she is one of the few who do not depend on schwa absence in the male speaker's speech to produce schwa absence herself: in contrast to all other children (except Armand, cf. discussion on *cheval* below), the schwa-less variant is the "default" variant produced in the beginning of the recording session, before any schwa-less variant is heard in the male speaker's productions. Fabienne further establishes that it is not the potential consonant clustering that triggers schwa presence in her speech: the vowel might well be present even if one of the consonants is modified: [tɛɛk] (2;5.0). Like Fabienne, Adèle modifies C1 in the CœC-shape of *fenêtre* ([f] → [t]). Further, when schwa absence is indirectly provoked by the schwa-less variant produced by the male speaker, the secondary cluster is subject to modification, either nasal assimilation or substitution by a consonant cluster that she is on the verge of mastering, e.g. [kl] found in *clés* 'key:PL' [kle] (2;7.11). In the middle group, while Lucas and Janice behave more or less like the older children, Henri does not master the segmental makeup in the variant with schwa. The difficulty of the cluster is further illustrated in the one case of a secondary cluster construction: C2 is replaced by a glide. Let us recall that gliding was not applied by Henri in order to modify target ObsLiq, which in turn is not unsurprising when items with target C + Glide-clusters are included: these are obligatorily reduced by Henri, typically to the least sonorous segment: *pièce* 'piece' [pjɛs] → [peç], *chien* [ʃjɛ̃] → [ɕɛ̃] (2;5.6).

We now turn to the results for the second schwa item.

(13) *"Cheval": segmental makeup of secondary cluster with (=CœC) and without (=CC) schwa (tendencies, individual results). The quality of schwa varies at the intra- and inter-speaker level, and for the ease of presentation, all vowels are transcribed [œ].*

Score on ObsLiq	Child	CœC shape (tendency)	CC shape (tendency)	
<30%	Fabienne	[∅œ∅] [θœ∅] [ɹœ∅]	Reduction Gliding	[j] [s] [∅] [θj]
	Kim	[sœv] [θœv]	Reduction to C2	[f] [p]
	Adèle	[tœv]	Reduction Gliding	[s] [fw]
50-70%	Lucas	[ʃœv]	= CœC shape Interconsonantal vowel	[ʃv]
	Henri	[fœv] [vœv]	Reduction to C2	[f]
	Théa	[ʃœv] [ɕœv] [sœv]	= CœC shape	[ʃv]
>75%	Janice	[ʃœv] [ɕœv]	= CœC shape Assimilation to C1/C2 Reduction	[ʃv] [fv] [θv] [θf] [ʃ] [v]
	Armand	[fœ∅] [ɕœv] [ɕœh] [vœj]	Assimilation Reduction to C2 Gliding	[fʋ], [fv] [f] [fw]
	Lambert	[θœv]	= CœC shape Gliding Substitution Interconsonantal vowel	[θv] [θw] [fw] [θt]
	Eric	[ʃœv]	Interconsonantal vowel	
	Albert	[ʃœv]	= CœC shape	[ʃv]
	Tom	[sœv]	= CœC shape Interconsonantal vowel	[sv]
	Guy	[ʃœv]	= CœC shape	[ʃv]

Again let us start with the children having acquired ObsLiq-clusters. Both Janice and Lambert encounter some difficulties and display several occurrences of reduction, gliding, assimilation and short interconsonantal vowels. Eric and Tom as well produce short interconsontantal vowels, while Albert and Guy show target-like behavior. Again Armand is singled out from the group: the preferred form of *cheval* throughout the recording period is [fal], the sole examples of a disyllabic output in the early part of the period being a doubling of the final vowel, deletion of C1 and the positioning of C2 word-initially: [faal]. Only towards the end of the recording period does a target-like disyllable emerge in Armand's data, however in fierce competition with the preferred [fal]: starting off the recording session by producing [çyval] (3;3.10), he rapidly falls back to the monosyllabic form when hearing the schwa-less variant uttered by the male speaker. Turning now to the children with less than 30% accuracy on ObsLiq-clusters, Fabienne once again freely produces monosyllabic forms, most frequently without target C1 and C2: her preferred form is [jan]. Like Armand, a second variant emerges towards the end of the recording period, with gliding: [θjan] (2;5.0). Also at this point emerges a disyllabic form for the plural form: *chevaux* 'horse:PL' [ʃ(œ)vo] → [zavo]. As for Kim and Adèle, they modify the shape of the secondary cluster only when this is indirectly provoked in the recording session: for instance, Adèle goes from a stable [tœn] cluster in the variant with schwa to a variant without schwa plus gliding: [fwat] (2;8.29). This is a cluster found elsewhere in her output: *toi* '2SG;DISJ' [twa] is invariably produced [fwa]. Kim displays another strategy: in the variant with shwa, he produces two fricatives: [θœvaj] (2;10.17). The sole productions of a schwa-less variant come within the same utterance: *un cheval noir,* *un cheval blanc* 'a black horse, a white horse' [a fã nwaʁ a pa mjã] (2;11.14), where C2 is preserved but devoiced (and in addition turned in to a plosive in the second case). Finally, the middle group is once again quite heterogeneous: while Théa and Lucas produce target-like clusters, Henri alters the segmental makeup by reduction to C2: [faj] (2;5.20).

5. Discussion

Let us start this section by recalling the objective of our paper, which was to determine the shape of secondary clusters in Swiss French child language and, in doing so, provide a first step towards the identification of the order of acquisition of primary and secondary clusters. Two hypotheses were put forward: a) if primary clusters are not mastered, secondary clusters are not mastered, and b) if secondary clusters are not mastered, schwa alternation is blocked.

First, we have seen that the variant with schwa is the preferred form for the majority of words, and this across children. Faced with two alternative forms in the input, one with a cluster and another without, we expected the latter to be the variant selected by the child by default. This holds true, also in children mastering primary clusters. In a global fashion, secondary clusters are only occasionally produced, and – at least as regards the items elicited in the kindergarten sessions – the cluster construction is never spontaneous: it is in most cases triggered by the absence of schwa in the immediate input (the male speaker in the PowerPoint-presentation). The occasional absence of schwa combined with secondary cluster construction found in some of the older children indicates that schwa alternation is unblocked in their grammar. However, even these children do have problems implementing the secondary cluster phonetically (as they do at least to some extent with the primary [s]+C-clusters, as well), which might constitute one of the reasons for avoiding these clusters altogether.

The most interesting cases are the children who do not master primary clusters. Not only do they not master primary clusters and turn to repair strategies such as reduction and gliding; several of them also modify single onsets, e.g. *cheval* 'horse' [ʃ(œ)val] → [vɵvaj] (Henri 2;4.29), *remorque* 'trailer' [ʁ(œ)mɔʁk] → [mamak] (Henri 2;6.5), *renard* 'fox' [ʁ(œ)naʁ] → [gɔna] (Adèle 2;7.26). From this it is clear that the construction of more complex secondary clusters comes at a high cost: the underlying schwa vowel must be deleted and the secondary cluster must be modified in order to be authorized by the child's current grammar. Several solutions to this problem are observed. The most frequently selected solution is to preserve the underlying schwa alongside the two consonants, and this irrespective of the rate of schwa deletion in the input. In some rare instances, a second variant without schwa seems to be available in the grammar, although not preferred. This second variant is subject to heavy modifications: either C2 is substituted by a glide, one of the consonants is deleted, or the entire cluster is modified: in most cases, the modification of the cluster is in conformity with the child's relative mastery of phonotactic sequencing observed for the primary clusters.

Until this point we have not discussed the cases of "unprovoked" deletion, i.e. the few cases where the schwa-less variant is preferred. There is a slight tendency in the data to delete C1, even when it happens to be the least sonorous element of the cluster: for instance, in the case of schwa absence in *demander* 'ask:INF' [d(œ)mãde] and *demi* [d(œ)mi] 'half:M', with a target secondary [dm]-cluster, it is invariably the most sonorous [m] that is retained: [mɑde] (Adèle 2;8.22) and [mi] (Adèle 2;8.9) vs. [dœmãde] (Guy 3;6.14) ~ [dmãde] (Guy 3;7.6) and [dm̩i] ~ [dmi] (Janice 2;8.26).[18] In the case of segment modification, it is the plosive that undergoes gliding or assimilation: [jmi] (Kim 2;8.27) and [nmi] (Lucas 2;9.10). The same holds for *venir* 'come:INF' with target [vn]: the nasal is preserved at the expense of the fricative: *venu* 'come:PST;PTCP' [ni] (Adèle 2;10.13) vs. [viny] (Armand 3;3.20) vs. [vny] (Guy 3;5.30). Some exceptions to deletion of C1 are of course observed, e.g. *remonte* 'lift up:PRS.3SG' realized by Guy (3;5.30) as [ʁɔ̃t].

[18] One occurrence of [d]-deletion in *demander* is attested in the data from Guy (3;6.6): *demande* 'ask:PRS.3SG' [mãdə].

Finally we must mention the group of schwa items with a liquid C1. Besides a few occurrences in the older children (Janice, Eric, Tom, Guy), the variant with schwa is by far the preferred one in our corpus. [ʁ]-initial schwa words are however special in that the liquid is subject to omission, e.g. *refais* 'do again:PRS.1SG' [ʁ(œ)fɛ] → [ɔfɛ] (Adèle 2;9.24), *renard* 'fox' [ʁ(œ)naʁ] → [eaʁ] (Armand 2;11.26), to substitution by C2 or another consonant, e.g. *reviens* 'come back:PRS.1SG' [ʁ(œ)vjɛ̃] → [vœjɛ̃] (Lukas 2;9.3), *renard* 'fox' [ʁ(œ)naʁ] → [gɔna] (Adèle 2;7.26), to assimilation, e.g. *remorque* 'trailer' [ʁ(œ)mɔʁk] → [mamak] (Henri 2;5.6), and to one occurrence of metathesis, i.e. *ressemble* 'resemble:PRS.3SG' [ʁ(œ)sɑ̃bl] → [θʁɑ̃b] (Janice 2;10.29). All these examples taken together show that consonant modifications are necessary even in the variant with schwa. It goes without saying that the creation of a secondary cluster with a target initial [ʁ] constitutes a challenge.

Let us now review our findings in light of the literature presented in Section 2.2. Our data pattern with Rose (2000) in that C2 is in a global fashion preserved when one of the consonants is deleted. In fact, this also holds for some of the cases in which one of the consonants is deleted but schwa is retained: for instance, [v] moves to the word-initial position both in *cheval* [ʃ(œ)val] → [faal] (Armand 2;11.21) and in *reviens* 'come back:PRS.1SG' [ʁ(œ)vjɛ̃] → [vœjɛ̃] (Lucas 2;9.3). Some occurrences with schwa deletion go against Rose: *fenêtre* [f(œ)nɛtʁ] → [fɛt] (Henri 2;4.29), where the least sonorous C1 is retained. This is expected on the basis of the findings on the primary clusters presented in Fikkert (1994, 2010) and Kehoe et al. (2008). In fact, we attest in our corpus several modifications of secondary clusters that are in conformity with the modifications found with primary clusters, i.e. reduction, gliding and short interconsonantal vowels. But, as already mentioned, it is not always the case that the least sonorous segment is preserved in the case of cluster reduction: *fenêtre* [f(œ)nɛtʁ] → [nɛt] (Armand 3;1.10).

In sum, secondary clusters – once they are attempted by the child – seem to be both dissimilar and similar to primary clusters: dissimilar in that segment reduction frequently affects the least sonorous segment, and similar in that other types of modifications follow the general development of consonant sequencing.

Let us conclude our paper by a brief mention of Armand, the "mystery child" of our corpus. Although with a high score on ObsLiq-clusters, his production of schwa items singles him out by the high amount of monosyllabic forms with cluster reduction. Further, he differs from the rest of his "group" by several deletions of C1 and/or C2. He is also the only child (alongside Fabienne) to produce vowel doubling plus consonant deletion. At this point, let us suggest that the many cases of deletion of C1 and/or C2 indicate that the insertion account mentioned in Section 1 does not hold: schwa surfaces independently of the consonants. Also, the many qualities taken on by schwa in the output suggest that that the vowel is underlyingly empty (Eychenne 2006). Although additional parts of the corpus need to be looked at more closely before we can analyze Armand's production patterns, he nevertheless provides many examples suitable for the testing of our hypotheses: while it seems to be the case that primary clusters are acquired before secondary clusters (Hypothesis A confirmed), modifications of the schwa items are available even if secondary clusters are not in place (Hypothesis B not confirmed). This does not correspond to target schwa alternation, however, whereby the two underlying consonants faithfully surface in the output: our data reveal a multitude of constructions modified in various ways, and only future research can provide a extensive phonological analysis of the behavior of schwa in child language.

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