On the Place of Rhotics: A case study on the acquisition of French /ʁ/

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Abstract

In this paper, we discuss the acquisition of /ʁ/ for two children acquiring French, for one of whom, /ʁ/ triggers within-cluster assimilation of coronal obstruents. This is conspicuous, as French has a placeless rhotic. Accordingly, the rhotic of the other child is the target of place assimilation. Rose (2000, 2003) attributes the difference to the fact that the French rhotic is phonetically fricative-like, whereas it behaves – phonotactically – like a liquid. Hence, two possible sources of information for the acquiring child contradict each other. We discuss cross-linguistic evidence for and against place-bearing rhotics, concluding that both possibilities exist. To see to what degree the /ʁ/ is the same in the two children, we present an acoustic study, after which we demonstrate a reconstruction of the possible path of acquisition of Théo. Finally, we discuss the relevance of phonetic measurement for phonological patterns.

1. Introduction

In deciding which features to use when storing words and their segments, children must reconcile multiple sources of evidence. For one thing, phonetic similarity and distributional properties play an important role (Maye & Gerken 2000; Maye Werker & Gerken 2002; Maye & Weiss 2003). On the other hand, we know that children are sensitive to the phonotactic patterns of their surrounding language from the age of nine months (Saffran & Thiessen 2003). In some instances, these two sources provide contradictory cues.

One such case is French /ʁ/. Phonetically a fricative, or at least very fricative-like (see, for example, Rose 2000:8), phonotactically it patterns with the other liquid in the language, /l/. Thus, learners of French must find some way to weigh these two conflicting sources of evidence in such a way as to arrive at an adult-like grammar.

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Spreafico, L. & Vietti, A. (Eds.). (2013). *Rhotics. New Data and Perspectives*. bu,press. https://doi.org/10.13124/9788860461025

It is not surprising that children have difficulty with this. Rose (2000) describes two learners of French, Clara and Théo, who have differing acquisition patterns when it comes to /ʁ/. What is especially striking is that Théo's /CʁC/ onset clusters display a very robust pattern of cluster-internal dorsal assimilation, where the /ʁ/ is the trigger and coronal obstruents are targets. This is a highly remarkable pattern, because cross-linguistically, there are very few cases where rhotics are specified for place of articulation, let alone where they trigger assimilation. In his analysis of these data, Rose (2000: chapter 5) proposes that the differences between the development of /ʁ/ observed in the two children stem from different underlying representations: Clara's rhotic is placeless, whereas Théo has posited an underlying feature [dorsal] for his /ʁ/[1]. Rose (2000) attributes this difference to the phonetics of French /ʁ/, namely that it is a uvular across the board (Rose 2000:244-5, 261), and uvular consonants can be analyzed as [dorsal] (Rice 2011). This idea is further expanded upon in Rose (2003), where the author points to the fact that in adult (Québec) French, the rhotic often surfaces as a uvular fricative in branching onsets (where the head is a voiceless obstruent).

Based on the data observed and the analyses proposed in Rose (2000, 2003), it would appear a viable option that Clara's initial hypothesis is that /ʁ/ is a liquid, whereas Théo's initial hypothesis might be that it is an obstruent. This would imply that Clara places more emphasis on the phonotactic evidence, and Théo more on the phonetic evidence (see also Rose 2003:428). In this paper, we will attempt to see if we can find evidence for different representations in the acoustic signature of the rhotics of both children. We will follow Rose's hypothesis that the phonetics of French /ʁ/ contradict its phonotactic distribution, and that this is the reason for the difference. Whereas Rose (2000, 2003) focuses mainly on the phonetics of Place of Articulation, we will also consider the manner specification of /ʁ/ in the respective grammars of both children.

In the next section, we will briefly go over some typological data to see whether we can find cross-linguistic evidence for either placeless or place-bearing rhotics. In section 3, we will show the acquisition pattern of the two children's rhotics in more detail. Section 4 presents a tentative acoustic study, and section 5 concludes.

[1] It should be noted that there are more differences between the two children regarding their /ʁ/; reasons of space prevent us to go into much more detail, but see section 3 below, and Rose (2000) for a full description.

2. A typology of rhotics and Place of Articulation

Liquids are among the most elusive and difficult-to-understand of all phonemes. With regard to rhotics, phonological discussion focuses mainly on the feature specification. One area of disagreement is whether rhotics have a Place of Articulation (henceforth: PoA) specification. The most radical proponent of rhotic PoA is Walsh Dickey (1997), who goes so far as to say that rhotics are universally defined by a specific PoA specification (that is, all rhotics have a secondary laminal node). The other position has less radical proponents, but deserves consideration nonetheless. In the following sections, we will review some evidence for and against both positions. If not indicated otherwise, the examples are from synchronic phonology.

2.1 Placeless rhotics

Despite Walsh Dickey's proposal, rhotic placelessness appears to be the default position in the literature. In this section, we will review some of the reasons why this is so.

A general indicator of the presence of a feature in an underlying representation is that the segment it belongs to displays some phonological behavior (the 'natural class' argument). Hence, we will look at the phonological behavior of rhotics. In general, rhotics do not trigger any alternations involving PoA (but see section 2.2 for some counter examples). In addition, they often escape rules that otherwise trigger PoA, such as coda place assimilation:

(1) Place assimilation in Italian

a. Diachronic obstruent-obstruent assimilation: cognates

English	*Italian*	<	*from Latin*
fact	fatto	<	factum
abdomen	addome	<	abdomen

b. Nasal assimilation: morpheme boundaries

in+portante > importante

c. Liquids in codas

Italian	*English*
aperto	open
arco	arch
salto	jump
alcol	alcohol

As 1c illustrates, both laterals and rhotics escape the coda condition on place. Something similar arises if we consider the distributional properties of the word-final consonant in Italian; in general, Italian has no word-final codas. However, in some function words, such as *per* 'for, to, through', consonants appear word-finally. Most of these cases involve liquids. We can attribute both patterns to a general ban on independent PoA in codas; the ban does not apply to rhotics because they are placeless.

Another indicator for placelessness is found in Backley (2011), who notes that the rhotic in (British) English stands in a similar relation to /a/ as /i/ to /j/ and /u/ to /w/, in that they group together in glide/liquid alternations. Backley proposes that the rhotic in English is a glide, and its vocalic counterpart is /a/. This low vowel is usually thought of to be underspecified for place (Hall 2011), and by analogy, the same would hold for the rhotic.

In a study of onset cluster phonotactics in Germanic languages, Goad & Rose (2004) note an asymmetry in the distribution of clusters where the obstruent is coronal. Consider the onset cluster inventory of Dutch, for example, in Table 1. Laterals can cluster with coronal fricatives, but not stops, and rhotics can cluster with coronal stops, but not fricatives. The analysis that Goad & Rose (2004) propose rests on two points: laterals are [coronal], whereas rhotics are placeless. Second, there is a difference between 'real' onset clusters and 'apparent' onset clusters: whereas most obstruents in onset clusters are actually in the onset constituent, this does not apply to /s/, which is syllabified as an appendix[2]. The absence of /tl/ in this inventory, Goad & Rose (2004) argue, is due to a restriction on identical places of articulation in a cluster (/pʊ/ onset clusters are also banned in Dutch, as are /kx/ clusters; the same constraint holds in German and English). If so, the reason /tr/ is licit must be that the rhotic is not coronal. The ungrammaticality of /sr/ clusters is due to the fact that an appendix must be licensed, and can only be licensed by a 'strong' onset. The rhotic is not strong enough, because it lacks a place specification.

stop + liquid	/pr/	/tr/	/kr/
	/pl/	*/tl/	/kl/
fricative + liquid	/fr/	*/sr/	/Xr/
	/fl/	/sl/	/Xl/

Table 1 – Onset cluster inventory of Dutch.

[2] The strange behavior of sC clusters is one of the most famous problems in phonology. See Goad (2011) for an overview.

A similar situation holds for English (which also bans /θl–/) and German (the German case is slightly different as the language allows for /ʃr/ onset clusters. See Goad & Rose (2004: section 4.3) for details – which however do not change the analysis of the rhotic as placeless.

Rose & Demuth (2006) show that in English and Afrikaans loan word adaptation in Sesotho, epenthetic vowels breaking up illegal onset clusters obtain their place of articulation from their leftward environment. In word-initial context, the left environment is constituted by the first member of the cluster – in other words, a consonant. Word-medially, where there is a vowel to the left of the cluster, it is the vowel that supplies the feature. A number of exceptions to this pattern exist, however. First, dorsal consonants do not supply a place of articulation to the vowel. Secondly, the vowel /ɑ/ is only copied if no other source is available (Rose & Demuth 2006: section 3.3). What is most important for our present purposes is that neither /l/ nor /r/ ever supply a place of articulation feature to an epenthetic vowel. In (2) there are some examples[3].

(2) Epenthetic vowels in Sesotho loanword adaptation

a. Word-initial clusters: left-to right from consonant

Lab+Liq	blik	[blɪk]	[bɷleke]	'tin can/dish'
Cor+Liq	troon	[tʀuwn]	[tɪronɪ]	'thrown'

b. Word-initial dorsal-initial clusters: right-to-left from vowel

Dor+Liq	kroon	[kʀuwn]	[kɷronɪ]	'crown'
	krip	[kʀɪp]	[kɪrɪpɪ]	'crib/manger'

c. Word-medial clusters: left-to-right from vowel

Lab+C	hops	[hɔps]	[hɔpɔse]	'drink made from hops'
Cor+C	football	[fʊtbɔl]	[fʊtubɔlɔ]	'football'
Dor+C	box	[bɔks]	[bɔkɔse]	'box/case'

d. Word-medial cluster preceded by /ɑ/: left-to-right from consonant

Lab+C	sɑmbreel	[sɑmbʀeːl]	[sɑmpørelɪ]	'umbrella'
Cor+C	address	[ædʀɛs]	[ɑtɪrɛsɛ]	'address'

e. Word-medial Lic+C clusters, preceded by /ɑ/ followed by non-ɑ-vowels: right-to-left from vowel

Liq+Cor	kartjie	[kɑʀtʃi]	[kɑriki]	'cart'

[3] The examples are all taken from Rose & Demuth (2006). I have adopted their transcriptions.

It would be going too far at this point to reproduce the entire analysis developed in Rose & Demuth (2006). What is important, however, is that the rhotic in Sesotho (and the lateral) behaves as a placeless segment in loan word adaptation, as we can see in example (2e).

A final example of an argument comes from van Oostendorp (2001). Discussing two dialects of Dutch, van Oostendorp (2001) argues that /r/ is not only placeless, but actually featurally empty. In the brabantic dialect of Tilburg, /r/ patterns with fricatives word-finally, and with sonorants elsewhere. More directly related to place, in Maasbracht Dutch (Limburg), a contrast exists between falling and 'dragging' tone. Tone is realized on the main stressed vowel of the word, but minimal pairs exist only for rimes consisting of long vowels and vowels followed by sonorants:

(3) Tonal minimal pairs in Maasbracht Dutch

a. Long vowels and sonorants

falling tone		*dragging tone*	
biː	'bee'	biː	'at'
mɪn	'minus'	mɪn	'vile'

b. Obstruent-final rimes

falling tone		*dragging tone*
pɪt	'kernel'	–
zɔk	'sock'	–

This contrast exists because sonorants can be moraic, whereas obstruents cannot, and falling tone is represented by a single high tone on the nucleus, whereas dragging tone consists of two high tone features. Rhotics display a dual behavior. Word-internally they pattern with sonorants, in that rhotic-final rimes can have falling as well as dragging tone, but word-finally, they behave as obstruents: no tonal contrast exists.

(4) Dual tonal patterning of rhotics in Maasbracht Dutch

a. Word-internal rhotic final rimes

falling tone		*dragging tone*	
spɛrma	'sperm'	fɪrma	'firm'
'ɛrɣər	'worse'	'ɛrɣər	'annoy'

b. Word-final rhotic-final rimes

falling tone		*dragging tone*
kɛr	'car'	–
vɛr	'far'	–

In this respect, rhotics pattern exactly like /ŋ/, the placeless nasal (see van Oostendorp 2001 for references, and Rice 1996 for arguments for the placelessness of /ŋ/).

2.2 Rhotics with PoA

Our first example in which rhotics display evidence of a place of articulation feature comes from Selayarese (Mithun & Basri 1986). In morphological reduplication, word-final velar nasals assimilate to the adjacent onset. Consider the examples in (5)[4]:

(5) Reduplication in Selayarese

pekaŋ	–	pekampekaŋ
soroŋ	–	soronsoroŋ
jaŋaŋ	–	jaŋaŋjaŋaŋ
keloŋ	–	keloŋkeloŋ
roŋgaŋ	–	roŋganroŋgaŋ

The telling example here is the final one, in which the nasal surfaces as a coronal if followed by the rhotic. The pattern holds over word boundaries, as can be seen in the following examples involving the numeral *annaŋ* 'six'.

(6) annam poke
annan tau
annaŋjaraŋ
annaŋ golo
annan rupa

Thus, Selayarese exemplifies the possibility for rhotics not only to have a PoA, but an active one, too.

Selararese is not alone in this respect; Chukchee (Lewis 2009) also has a pattern wherein a velar nasal assimilates to the following onset. Blevins (1994) gives the following examples:

[4] Apart from the role of the rhotics, this process is also interesting in connection to van Oostendorp (2001)'s argument for phonological placelessness of ŋ. See also Rice (1996) on the relation between coronals and velars, and why they are both often seen as 'unmarked' or 'default'; one possible alternative analysis to the one proposed here is that the patterns in 5, 6 and 7 are the result of two interpretations of the same underlying, placeless consonant. However, this would leave unexplained the fact that the rhotic patterns with the other coronals.

(7) Nasal assimilation in Chukchee

teŋ-əl̥ʔ-ən	–	'good'
tam-pera-k	–	'to look good'
tan-tʃottʃot	–	'good pillow'
tan-l̥əmŋəl̥	–	'good story'
tan-rʔarqe	–	'good breastband'

Again, we see that the rhotic triggers the phonologically placeless nasal to surface as a coronal, whereas its default surface form (as can be seen in the first example, teŋ-əl̥ʔ-ən) is velar.

The examples from Selayarese and Chukchee involve a primary coronal place of articulation for the rhotic in these languages, but Sanskrit presents us with an example of a language in which the rhotic has an active secondary PoA feature, namely through the process of retroflexion (see 8):

(8) n → ɳ / {ʂ, r}[...]

That is, the rhotic patterns with the retroflex fricative in triggering retroflexion on coronal nasals. Some examples are given in 9 (from Avery & Rice 1989):

(9) Retroflex harmony in Sanskrit

a. pur - āṇa
   iṣ - ṇa
b. kṣubh – āṇa
   krpa – māṇa
c. marj – āna
   kṣved – āna

The examples in 9a and 9b show that vowels and consonants respectively are transparent to retroflex harmony (perhaps unsurprisingly). The examples in 9c, however, show that not all consonants are transparent: coronals block harmony. Hence, a straightforward hypothesis is that the triggers are coronals with a secondary feature [retroflex]. This entails that the rhotic in Sanskrit is a coronal. Finally, let us investigate an example where the PoA feature is not coronal, but something else (possibly [back]), and where the evidence is diachronic rather than synchronic. In Old English Breaking, front vowels underwent a diachronic process of diphthongization when followed by [back] consonants (Baker 2007; Barber 1997, among many others):

(10) Old-English Breaking description

$$\begin{array}{l} [a] \text{ or } [ɑ] \rightarrow [æɑ] \text{ or } [ɛɔ] \\ [e] \text{ or } [ɛ] \rightarrow [eo] \text{ or } [eʊ] \\ [i] \text{ or } [ɪ] \rightarrow [ɪʊ] \end{array} \quad / \quad \left\{ \begin{array}{l} \text{+ consonant} \\ \text{+ continuous} \\ \text{+ back} \end{array} \right\} \quad \text{+ C}$$

Example 11 lists a number of Proto-Germanic words, and their Old English counterparts. The pattern should by now be clear: the rhotic participates in a process that is best characterized by crucial reference to a PoA feature (as in 10 above).

(11) Proto-Germanic and Old English cognates

Proto-Germanic	*Old English*	*Contemporary English*
ahta	eahta	eight
hertō	heorte	heart
hirdijaz	hiorde	herder

2.3 Summary

In this section, we have looked at a number of languages and a number of reasons why rhotics should be either placeless or place-bearing phonologically. In the end, evidence can be found for either position. However, placelessness seems to be the default, as cases in which rhotics are active in place-related phonological processes (either diachronic or synchronic) are rare (see also Rose 2000, 2003). In the next section, we will examine the acquisition patterns of two learners of French, who show remarkably different patterns when it comes to the rhotic. The case at hand, in which the child exhibits evidence of a place-bearing rhotic when the surrounding language does not, raises the question of whether the child acquired the sound as a rhotic in the first place. These questions are especially relevant with respect to French, with its fricative-like rhotic.

3. The acquisition patterns of Clara and Théo

In this paper, we investigate the phonetic contours of the rhotics of two learners of Québec French: Clara and Théo (Rose 2000)[5], who, for all intents and purposes of the present study, are acquiring the same (Eastern) dialect of Québécois. The segmental inventory of Québécois French is, as far as consonants are concerned, identical to the segment inventory of European French (Rose 2000). The primary data consist of spontaneous speech, recorded roughly bi-weekly from

[5] The data and software used in this study are freely available from PhonBank, see http://childes.psy.cmu.edu/phon/.

age 1;00.27 to 2;08.19 for Clara, and from age 1;10.26 to age 4;00.00 for Théo. They were first published in Rose (2000), and the observations and examples given in this section rely heavily on that work.

Cross-linguistically, as we have seen, rhotics may either bear a place feature, or they may not, where the latter is the unmarked situation. In the Goad/Rose corpus of Québec French, we see this variation exemplified. Clara appears to represent her /ʁ/ as a placeless liquid from the beginning. She does not show any behavior that would indicate otherwise. On the other hand, Théo seems to go for the dorsal option. This, as shown by Rose (2000, 2003), we see is evidenced in a pattern of dorsal assimilation in branching onsets where /ʁ/ combines with a coronal, throughout the entire period for which Théo was recorded.

(12) Constituent-limited dorsal assimilation in Théo's onsets

a. Session 1998-11-26 record 149
orthography: Je suis trop fatigué encore
target: [ʒə] [sɥi] [tʁo] [fatige] [ãkɔʁ]
actual: [ʃy] [sy] [kʁo] [fasige] [ãkʰɔʁ]

b. Session 1998-11-26 record 47
orthography: faudrait qu'on ait une patte
target: [fodʁɛ] [kõ] [nɛ] [ʏn] [pat]
actual: [fokʁɛ] [kõ] [nɛ] [ʏn] ['paʁtla]

c. Session 1998-11-26 record 30
orthography: y'avais en train de sauter
target: [javɛ] [ã] [tʁɛ˜] [d] [sote]
actual: [javɛ] [kʁã] [kʁɛ˜] [d] [sote]

As becomes clear from these examples, Théo's rhotic has a dorsal place feature that triggers assimilation of coronal obstruents in the same onset constituent. There is, however, no phonological evidence (e.g. from spreading, blocking, or other phonological phenomena) for any place feature in rhotics in the surrounding language. Either his /ʁ/ is phonologically a rhotic with a [dorsal] feature, or it is a dorsal fricative with peculiar phonotactic properties. In the first case, Théo overspecifies his /ʁ/[6], in the second case, he violates a phonotactic rule of French: there are no stop-fricative onset clusters[7].

[6] But see Hale & Reiss (2003) for an argument why this could be expected.

[7] Save for some learned exceptions such as *psaume* 'psalm', *psychologie* 'psychology', which are very small in number.

One clue comes from looking at the timeline of development of Théo's /ʁ/. The first instance of /ʁ/ *per se* occurs relatively late, but the segment surfaces target-like from its inception. It occurs in word-final position during the same period when other consonants do so. In contrast to Théo's rhotics, which trigger assimilation in clusters, Clara's rhotic undergoes place assimilation in singleton onsets in early sessions:

(13) Non-adjacent place assimilation

Word	*Target*	*Actual*
carotte	kaʁɔt	kagɛ
robe	ʁɔb	wɔb

Although superficially this is very similar to patterns of Consonant Harmony she displays, the timeline is not identical, and furthermore, in the case of /ʁ/, there is no directionality restriction (that is, /ʁ/ can receive its PoA from either the left or the right). This, Rose (2000) proposes, is because Clara's rhotic is devoid of any PoA of independently, reflecting the cross-linguistically unmarked case. Clara's /ʁ/ behaves in all respects like a rhotic, whereas Théo's represents the dual identity of the segment in the environment language. This begs the question of what underlying representation Théo has, other than the obvious [dorsal] feature, particularly in terms of Manner features.

4. A tentative acoustic study

The different acquisition patterns of Clara and Théo closely resemble the dual nature of the French rhotic: it is both liquid-like and fricative-like. It is especially interesting why Théo would posit a place-bearing rhotic, since there is no phonological evidence (e.g. from spreading) for this in his input, even though the acoustic evidence is potentially misleading – although we have seen that place – bearing rhotics are cross-linguistically not ruled out. Thus, the question arises whether Théo is acquiring a rhotic in the phonological sense, or whether he is hypothesizing a fricative with highly marked phonotactic properties. Hence, we set out to investigate the acoustic characteristics of both children's rhotics.

4.1 Items

From both Clara and Théo, 40 tokens of faithfully produced prevocalic[8] rhotics were selected, from both singleton and cluster onsets. Since the recordings are all of spontaneous speech, and made in a living room situation, not all tokens were suitable. Unsuitable tokens were those in which, during the period in which the rhotic was uttered, another voice was audible, background noise was present, someone present at the session apparently touched or breathed into the microphone, or where microphone hum was unacceptable. In order to avoid an uneven representation of rhotics produced in single words, the number of tokens from the same lexical item was limited to three. All tokens were studied in Praat (Boersma & Weenink 2012).

4.2 Criteria

Six criteria were used, from general to more rhotic-specific. These are listed below, along with a brief description of how they were applied. Some of the measures involve the degree to which the segment is 'sonorant-like', mostly with respect to voicing (voice and harmonics-to-noise ratio HNR). Measuring trillness, of course, is specific to rhotics. Two measures of PoA were also taken, as we might assume that a phonological specification of [dorsal] in Théo's case might lead to a smaller standard deviation (because a phonological target is present).

Length. The delimitations of each item was measured by exclusion; that is, the end of the section before the rhotic was determined, as was the start of the section after the rhotic. The remaining section was designated as 'rhotic'. It was expected that this exclusive criterion would provide more objective results than any inclusive criterion.

Voice. Whether a given token is voiced was determined on the basis of the presence or absence of voice bar throughout the duration of the rhotic. For the purposes of the present study, voicing is treated as a binary variable.

Trillness. Even in a language like French, with its fricative-like rhotic, some tokens involve a Bernoulli effect induced pulse stemming from the uvula hitting the tongue root. In the current study, each token was inspected both impressionalistically and spectographically to see whether such pulses are present. 'Trillness' is treated as a binary variable.

HNR. The harmonics-to-noise ratio is a measure of the amount of energy in the signal that is present in harmonics relative to the amount of energy in the signal that is not; in other words, it measures the 'fricativity' of a given auditory segment.

[8] For the purposes of the present study, pre-glide rhotics were also included.

F3. A characteristic of both apical and uvular trills is that they induce lowering of the third formant (Ladefoged & Maddieson 1996). As children's voices are different from adult voices, filters in Praat were adjusted to the following settings prior to performing measurements: the number of formants to look for was limited to three, and in the spectral filter the window length was set to 0.0025.

Center of Gravity. For those items for which no F3 could be measured, because there was not enough formant structure, the Center of Gravity (henceforth: COG) was measured instead. The COG takes into account the energy distribution of noise and determines where it is centered. Hence, it is a measure of relative backness and frontness, whereby a higher COG corresponds to a more forward PoA.

4.3 Results

The power to extrapolate conclusions from any kind of statistical test on data from two subjects is extremely limited. The results derived from the current study should therefore be treated as indications rather than conclusions. Having said that, the most apt test for these data is the Mann-Whitney U-test, an alternative to the t-test that is non-parametric and allows for unequal samples. For the criteria for which binary measures were performed, a χ^2-test was applied.

Length. On the whole, Clara's rhotics are somewhat longer than Théo's: 17.37 ms vs. 14.42 ms. On the other hand, she also has a larger standard deviation: 8.32 ms vs. 5.17 ms. A Mann-Whitney U-test yielded no significant result ($z=1.49$, $p>.5$).

Voice. The number of voiced tokens in Clara's sample is much higher (26) than in Théo's (12). This translates to a proportion of .33 for Théo and .66 for Clara. A χ^2-test was significant: $\chi^2=7.0413$, $p<.01$.

Trillness. Although the French rhotic is not necessarily known as a trill, trilled tokens do occur. There were 11 in Théo's example (proportion: .31), and 15 in Clara's (proportion: .39). This does not translate to a significant result in the χ^2-test: $\chi^2=.2265$, $p>.5$.

HNR. The mean HNR for Clara's rhotics in this study is 6.7601 dB (SD: 3.9355), whereas Théo's mean is 3.3593 dB (SD: 4.1776). This corresponds to a significant difference in the Mann-Whitney U-test: $Z=1.7$, $p<.05$.

F3. Théo's sample rhotics are produced with a mean F3 of 4213.86 Hz (SD: 243.38), and Clara's sample has a mean of 4304.28 Hz (SD: 350.91). The Mann-Whitney U-test yielded no significance: $Z=1.25$, $P>.1$.

COG. The center of gravity in Clara's sample has a mean of 1272.29 Hz (SD: 565.88). For Théo's sample, the center of gravity is somewhat higher: 1644.14 Hz

(SD: 817.99). This is a non-significant difference in the Mann-Whitney U-test: Z=-1.1, p>.1.

In this section, we looked at the acoustic characteristics of the rhotic productions of Clara and Théo, two children acquiring Québecois French. The two children display markedly different acquisition patterns, which correlate with either the phonotactic (Clara) or phonetic (Théo) identities of /ʁ/. For the six criteria we applied, significant differences were found only for voicing and HNR. The findings are summarized in Table 2. The results are not unequivocal. I take this to mean that the children are aware of, and struggling with, the dual identity of /ʁ/. In the next section, we will discuss some of the implications of this study.

Criterion	Significant
length	no
voice	yes
trill	no
HNR	yes
F3	no
COG	no

Table 2 – Summary of the results.

5. Discussion

The multitude of ways in which rhotics manifest themselves, both phonetically and phonologically, have puzzled many linguists. As we have seen, children also struggle with rhotics during the course of phonological acquisition: Théo's /ʁ/ triggers dorsal assimilation when it combines with coronal obstruents in onset clusters. On the other hand, the French rhotic is remarkably fricative-like in its acoustic signature, which could have caused the child to parse it as an obstruent. A dorsal fricative is, of course, much less remarkable. Thus, the dual nature of the French rhotic appears to be a cause for confusion.

Another case of dual nature is Positional Lateral Gliding as described in Inkelas & Rose (2008). Inkelas & Rose describe a pattern in the phonology of E., a child acquiring (American) English, who during a certain period does not produce faithful tokens of /l/. Instead, E. substitutes the glides /j/ and /w/, but not in a random way: in 'strong' positions (onsets of words and stressed syllables), E. substitutes /j/, whereas in 'weak' positions (onsets of unstressed syllables, codas), /w/ is inserted. This is interesting for our present case, because

/l/, like /ʁ/, has a dual nature – albeit in a different way. Whereas in the case of rhotic, there is a conflict between its phonetic contour and its distributional properties, the duality in the lateral lies in the fact that it involves both a coronal and a dorsal gesture[9]. In the case of E., the dual nature of /l/ manifests itself in the grammaticalized patterns of a single child, whereas what we see here is that two children each opt for a different route – albeit not with full confidence. It would be interesting to investigate the data from more children acquiring Québécois French, to see where Clara and Théo fit into general picture.

Théo's grammar undoubtedly is not in the adult stage. Although he knows the features of his language, some fine tuning must ensue. If it is true that Théo's /ʁ/ is indeed a dorsal fricative, he has two options: either he must live with the fact that one of the fricatives of his language has phonotactic properties different from the others, or he must revise the featural make-up of the segment. If indeed he knows the sound is a liquid, no such revision is necessary. However, in all cases, he must stop assimilating onset clusters. Again, two possibilities exist: either he must drop the dorsal specification, or 'unlearn' the rule that enforces the assimilation. We do not have data from the moment at which assimilation ceased, but we know it did so shortly after the final recording (Rose 2000:238, footnote 3).

We set out to investigate whether Théo and Clara had different phonetic rhotics, because Théo's acquisition pattern of the segment is markedly un-rhotic-like. We were unable to find conclusive evidence, and so we cannot know with certainty what the right answer is. We can, however, attempt an informed speculation as to the scenario: given the hypothesis that children appear to adhere to supra-segmental structures to the extent that these form the basis of their substitution patterns, not only exemplified by E. as described above, but by many others as well (Chiat 1989; Pater 1997; Rvachew & Andrews 2002; Marshall & Chiat 2003), and given the fact that children are sensitive to their native language's phonotactics from a very early age (Saffran & Thiessen 2003), given that cross-linguistically, the option exists, and given that the acoustic study, with all its limits and caveats in mind, gives no conclusive evidence to the contrary, I propose that Théo's /ʁ/ is, in fact, a rhotic – even if it is a place-bearing one.

In this study, we examined the place of articulation specification of rhotics in a number of ways; we considered typological and diachronic evidence and corpus evidence from acquisition (as presented in Rose 2000). Finally, we set out to perform acoustic tests over the production data from two children who appear to have different underlying representations for their rhotics, presumably

[9] Incidentally, the substitution pattern of E. closely follows the distribution of /l/ in his surrounding language (English): light /l/ in onsets, dark /l/ in codas. E. generalizes this pattern to strong and weak positions.

stemming from the segment's dualistic nature in their surrounding language. No conclusive evidence could be found in the acoustic measurements; only some criteria reached significance, and in the case of the PoA-criteria, the asymmetry goes in opposite directions in the two tests. Of course, it is possible that with a larger sample of children, and a larger sample of items, a more unequivocal picture would arise. On the other hand, it is very possible that the fact that no conclusive acoustic difference could be found between two subjects - who show phonological evidence of having different underlying representations - is simply a reflection of the fact that the acoustic input is the same for both children. In this sense, the current results are an illustration of the observation that phonetic measuring cannot always probe into phonological representation.

The non-idiosyncratic relation between phonetics and phonology has been pointed out in many previous publications, perhaps most strongly in Substance-Free phonology (see Hale & Reiss 2008, for example). Furthermore, in their large-scale overview of studies on the acquisition of artificial phonological grammars, Moreton & Pater (to appear) find very little evidence for phonetic complexity as a factor in determining learnability. Rather, they show that structural (featural) complexity is a much better predictor of the relative difficulty of a learning task. In the current study and the works on which it builds (Rose 2000, 2003), the learners' systems are accredited with a certain degree of abstraction. That is, learners construct their representations not based on acoustic information only – which is in line with the conclusions in Moreton & Pater (to appear). The current finding that different underlying representations do not necessarily lead to different acoustic signatures may actually reinforce the idea that phonological learning is abstract to a fairly high degree. In fact, when a child such as Théo apparently has difficulty integrating acoustic and phonotactic/distributional evidence, the effects are seen in the phonological behavior rather than in the corresponding phonetics.

Acknowledgements

Much of the work reported here was done in collaboration with the students attending the 2010 *sound and sound structure* class at the Department of Linguistics of Leiden University: Matthias Franken, Saskia Lensink, Renée Middelburg, Nina Ouddeken and Marijn Verschuure. I am also indebted to advice from Jessie Nixon, Kathrin Linke and Allison Kirk, and feedback from the audiences of the *'r-atics-3* conference in Bozen-Bolzano, 2011, and the ninth *Old World Conference in Phonology*, 2012, Berlin, and from Marc van Oostendorp and Yvan Rose. Of course, all errors are my own.

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