French Language Studies **17** (2007), 159–186, © Cambridge University Press
doi:10.1017/S0959269507002827

The nature of the schwa/zero alternation in French clitics: experimental and non-experimental evidence[1]

MARIE-HÉLÈNE CÔTÉ
GEOFFREY STEWART MORRISON*

Université d'Ottawa

(Received September 2005; revised August 2006)

ABSTRACT

This article examines the phonological status of schwa in clitics, in particular whether or not schwa should be included in their lexical representation. Several distributional and experimental arguments pointing to the lexical status of clitic schwas are reviewed and are shown to be inconclusive, due to the existence of additional data that suggest a different interpretation not involving underlying schwas. The discussion includes experimental results that fail to show residual lip rounding in the vicinity of an omitted schwa at clitic boundaries, contra Barnes and Kavitskaya's (2002) previous claim. In the absence of evidence to the contrary, the non-contrastive nature of clitic schwas militates against their underlying status.

INTRODUCTION

Just about every aspect of the alternation between schwa and zero in French has been intensely debated, starting with its very nature. Does it result from a process of vowel deletion or vowel epenthesis? Or is it a case of allomorphy, or even allophony? If we are dealing with deletion, as has generally been assumed, what exactly is deleted: the whole vowel, only its segmental content (as opposed to its prosodic position), or its acoustic output (as opposed to its articulatory target)? One key question in this debate concerns the underlying status of schwa, which may or may not be present in the lexical representations. The issue is complicated by the fact that the alternation is found in many different contexts that need not be analysed in a uniform fashion. If schwas are generally taken to be underlying inside morphemes, their lexical status word-finally is more disputable. Claims have been

[1] We would like to thank three anonymous reviewers for their helpful and constructive comments. This research was supported by a grant to the first author from the Social Sciences and Humanities Research Council of Canada (# 410-2002-0793).
* Now at Boston University.

based essentially on distributional arguments, in particular whether schwa can serve to establish lexical contrasts.

Schwas in clitics, such as the definite article *le* or the reflexive pronoun *se*, deserve particular attention. Clitic schwas are not contrastive, in the sense that they do not give rise to lexical contrasts between words like *le* or *se*, variably pronounced with or without a vowel [l(œ), s(œ)], and other items that would always surface as [s] or [l], without schwa. The presence of schwa depends on the context, and this can be taken to argue against their being lexically present. But a few other arguments have been adduced which can be interpreted as supporting their underlying status. Most notable is recent experimental evidence that suggests the presence at clitic boundaries of articulatory remnants of schwa even in the absence of any audible vowel (Fougeron and Steriade, 1997, 1998; Smorodinsky, 1998; Barnes and Kavitskaya, 2002). Such a conclusion entails the presence of lexical schwas.

We review here the various arguments, distributional and experimental, in favour of the underlying nature of clitic schwas. We conclude that these arguments fail to support the existence of lexical schwas in clitics, as all are weakened by additional data which point to a different conclusion and the existence of alternative interpretations not involving underlying schwas. The arguments are presented and discussed in section 2, after the necessary preliminaries on the French schwa in section 1. One experimental result, however, deserves a more elaborate treatment. Barnes and Kavitskaya (2002) find that some lip rounding can be observed in the vicinity of an omitted schwa at clitic boundaries. This result clearly suggests the presence of underlying schwas (corresponding to front rounded vowels), from which the rounding originates. This conclusion being based on very limited and partly inadequate data, section 3 presents additional experimental results that fail to show any residual rounding in the vicinity of omitted schwas and suggest an alternative source for the rounding observed by Barnes and Kavitskaya.

1 PRELIMINARIES

Schwa is defined here as a vowel that alternates with zero in the context of the same morpheme. When pronounced, the vowel corresponds to a mid front rounded vowel. In Standard French it appears to vary between [œ], [ø] and a vowel intermediate between the two, depending on the context (Martinet, 1945; Deyhime, 1967; Dauses, 1973; Malécot and Chollet, 1977). In Québec French, schwa is pronounced invariably [œ] (Martin, 1998).[2] Following Jetchev (1999), we represent schwa with the symbol Œ (which should not be confused with the IPA

[2] The phonetic realization of schwa has been debated. The only element that matters here is its rounded quality, which is crucial to Barnes and Kavitskaya's (2002) conclusion and the experimental results presented here. This fact is accepted for modern Standard French (e.g. Tranel, 1987; Dell, 1985), and confirmed for the subjects used in Barnes and Kavitsaya's and our experiment. We do not exclude that other varieties have unrounded schwas, in particular those spoken in Southern France, in which schwa also displays patterns of

symbol [œ]), in both phonemic and phonetic transcriptions. At the phonemic level this symbol avoids the confusion with the stable vowels /ø/ and /œ/; at the surface level it indicates its underspecified phonetic quality.

For example, the word/morpheme *semaine* 'week' is pronounced [sŒmɛn] or [smɛn]. A less straightforward example is the verb stem *gard-* 'keep', which appears without a schwa in the infinitive *garder* [gard+e], with an obligatory schwa in the conditional (2nd plural) *garderiez* [gardŒ+rje], and with an optional schwa in the future *garderai* [gard(Œ)+re].

Defining the French schwa is a thorny issue. The definition provided here is strictly phonological, based on vowel alternation. It contrasts with the more traditional one, based on orthography, which associates schwa with a subset of the occurrences of the unaccented letter <e>. This orthographic definition may be useful in some contexts (e.g. Tranel, 1987) but it is not phonologically adequate (see e.g. Ayres-Bennett and Carruthers, 2001, chap. 3). Schwa may correspond to letters other than <e> (e.g. <ai> in *faisait* 'did' [fŒzɛ]/[fzɛ]) and, more importantly, to no orthographic sign (e.g. *film russe* 'Russian movie' [filmŒrys]/[filmrys]).

This phonological definition excludes from the domain of schwa all morpheme-internal vowels that surface invariably in contemporary French, including those that derive from historic schwas. Representative examples include *squelette* 'skeleton' and *guenon* 'she-monkey', always pronounced [skœlɛt] and [gœnɔ̃].[3] Also excluded from the domain of schwa are the orthographic <e>'s that correspond to no vowel in the oral form, as in *samedi* 'Saturday', systematically pronounced [samdi] in spontaneous speech.[4]

behaviour distinct from those addressed in this paper (e.g. Walter, 1982; Durand, Slater and Wise, 1987). For varieties that have rounded schwas, it has been debated whether schwa is distinct from both [œ] and [ø]. A classic study like Pleasants (1956) argues that it is, but Valdman (1970), with additional data, concludes otherwise. Unfortunately, methodological problems often arise when comparing schwa with [œ] and [ø], including experimental procedures that presuppose the existence of three distinct vowels, a possible influence of spelling, and inadequate control of stress (schwa is normally unstressed but [œ]'s and [ø]'s are often stressed).

[3] In both *squelette* [skœlɛt] and *garderiez* [gardŒrje], the vowel is obligatorily pronounced. The reason why the latter is considered a schwa and the former a stable /œ/ is related to the morphological structure of these two words. The vowel in *garderiez* is variable with respect to the two morphemes that compose the word. As noticed above, the stem *gard-* surfaces with or without a vowel. The same applies to the conditional suffix *–riez*, which occurs with [Œ] in *garderiez* but not in *prieriez* 'you.PL would pray' [pri+rje]. *Squelette*, however, corresponds to a unique morpheme that invariably surfaces with [œ].

[4] We also exclude from the domain of schwa the so-called schwa-[ɛ] alternation. Three cases arise in modern French: [ɛ] alternates with zero (i), a stable [œ] (ii), or a deletable [œ] (iii).

(i) *appelle* 'call.PRESENT' [apɛl] vs. *appeler* 'to call' [aple]
(iii) *pèse* 'weigh.PRESENT' [pɛz] vs. *peser* 'to weigh' [pœze]
(iii) *mène* 'lead.PRESENT' [mɛn] vs. *mener* 'to lead' [m(Œ)ne]

We follow Morin (1978, 1988), who convincingly argues that these alternations are not phonological in contemporary French but are to be derived by allomorphy. Only the

The alternation between schwa and zero appears in a variety of contexts, exemplified in (1) with cases of optional schwas. These contexts can be grouped into two categories: morpheme-internally, more precisely in the initial syllable of polysyllabic morphemes (1a), and at different types of morphological junctures (1b–e). In the examples below '=' and '+' indicate a clitic boundary and any word-internal boundary, respectively.

(1)	a. morpheme-internally:	*cerise*	'cherry'	[s(Œ)riz]
	b. at word boundaries:	*valse rapide*	'fast waltz'	[vals(Œ)rapid]
	c. at clitic boundaries:	*ce bateau*	'this boat'	[s(Œ)=bato]
	d. at affix boundaries:	*garderai*	'I will keep'	[gard(Œ)+re]
		repartir	'leave again'	[r(Œ)+partir]
	e. in compounds:	*garde-malade*	'nurse'	[gard(Œ)+malad]

These contexts of alternation between schwa-less and schwa-full variants have been generally analysed as involving vowel deletion. But deletion accounts have taken different twists, and several non-deletion options have emerged: epenthesis, allomorphy, and allophony.

The traditional view considers deletion to be a complete process in the sense that underlying sequences /CC/ and /CŒC/ both result in identical [CC] surface forms when schwa deletion applies in the second sequence. Some, however, have supported an incomplete omission process that deletes the melodic material of the schwa but retains some other properties of the schwa-full underlying representation. Rialland (1986) finds evidence for the maintenance of the syllabic position of deleted schwas morpheme-internally and in clitics, while Fougeron and Steriade (1997, 1998) argue that the consonant in clitics such as *de* 'of' retains the articulatory properties of a prevocalic consonant even when the schwa is omitted, by analogy with the underlying form /dŒ/. Others have gone one step further and argued that schwa deletion is in fact only apparent: even when the schwa is not audible, its articulatory target is maintained. Schwa 'omission' corresponds to an increase in gestural overlap in fast speech, which masks the acoustic effect of the vowel (Smorodinsky, 1998; Barnes and Kavitskaya, 2002).[5]

Accounts based on deletion (complete, partial or apparent) have been challenged by a variety of different options. The most prevalent alternative views the schwa-zero alternation as resulting from vowel epenthesis, as assumed for at least some categories of schwa by Tranel (1981), Lyche and Durand (1996), and Côté (2000),

variable vowel in *mener* [m(Œ)ne] is considered a schwa according to the definition adopted here.

[5] Accounts of the schwa-zero alternation in Government Phonology (e.g. Charette, 1991) also consider that schwa omission does not involve complete deletion but simply non-realization of the melodic material with maintenance of the nucleus position. This analysis, however, is not motivated by any phonetic property of schwa, unlike the proposals cited in this paragraph.

among others. Avoiding the deletion vs. epenthesis debate altogether, the schwa-less and schwa-full variants have also been analysed as cases of allomorphy, with both variants being specified in the lexicon. For example, Walker (1993) and Jetchev (1999) consider schwas before derivational suffixes like *-ment* to be derived from two allomorphs of the suffix: /mə̃/ as in *sûrement* 'surely' [syr+mə̃] and /Œmə̃/ as in *lourdement* 'heavily' [lurd+Œmə̃].[6] More marginally, allophony has been proposed to be the source of C-CŒ alternations (Martinet, 1962, 1969, 1972; Hammarström, 1965, cited in Bazylko, 1981: 93; Cornulier, 1975): underlying consonants /C/ have two surface allophones, [C] and [CŒ], and are realized [CŒ] in the relevant phonological context.[7]

It is now common to advocate a non-uniform treatment of schwa and adopt different approaches among those described above for the different contexts in (1) (e.g. Spence, 1976; Rialland, 1986; Lyche and Durand, 1996; Jetchev, 1999; Côté, 2000). At one end, morpheme-internal schwas are those that are most strongly associated with a deletion account; at the other end schwas at word boundaries are most compatible with epenthesis. Opinions on other categories of schwa have not been as clear. We focus here on schwas at clitic boundaries (lc), which involve the following forms:

- object pronouns: *me* (1st pers), *te* (2nd pers), *le* (3rd pers), *se* (3rd pers reflexive)
- subject pronoun: *je* (1st pers)
- determiners: *le* (definite masculine), *ce* (demonstrative masculine)
- conjunctions: *que* 'that', *de* 'to'
- preposition: *de* 'of'
- negation particle: *ne* 'not'

These schwas have often been assimilated to schwas in morpheme-initial syllables (1a), on the basis of parallel distributional patterns (see for instance Dell's (1985) VCE_1 rule). As far as we know, all those who adopt underlying schwas in morpheme-initial syllables also do in clitics, with the exception of Déchaine (1990, 1991) and Côté (2000). It remains to be seen, however, whether the parallels established between these two types of schwa result from a common underlying status or from something else.

2 ARGUMENTS FOR UNDERLYING SCHWAS IN CLITICS

2.1 *Lexical contrastiveness*

Lexical contrastiveness has played a decisive role in determining the underlying status of schwa. Morpheme-internally, there is no doubt that schwas are potentially

[6] Declarative Phonology (e.g. Scobbie, Coleman and Bird, 1996) analyses all segment-zero alternations as deriving from lexical representations that are underspecified for the presence or absence of this segment, an account akin to allomorphy.

[7] Allophony and epenthesis are not always easily distinguished. Muljačić (1978), for instance, considers that alternating schwas have no phonological status, but this is compatible with both allophony and epenthesis.

lexically contrastive. The presence vs. absence of schwa gives rise to lexical contrasts; schwa is therefore unpredictable. A word such as *pelouse* 'lawn' admits two pronunciations [pluz] [pœluz] while *blouse* 'blouse' or *place* 'place' admit only one: [bluz] *[bœluz], [plas] *[pœlas]. The possibility of a schwa in *pelouse* but not in *blouse* or *place* can naturally be accounted for by positing a schwa in the underlying representation of *pelouse*, but not by an epenthetic approach.[8] (The schwa-less output [pluz] could be derived by vowel deletion or allomorphy, lexical contrastiveness being compatible with both options.)

The contrastive or unpredictable nature of schwa in the initial syllable of polysyllabic morphemes has sometimes been extended to schwa in general (Verluyten, 1988; Noske, 1993, 1996) or to clitic schwas in particular (Jetchev, 1999: 235, 2003a: 104). This move is unmotivated, as the contrastive nature of junctural schwas, in clitics, at word boundaries or word-internally, has not been established. The presence of schwa at boundaries is predictable from the segmental, morphological and prosodic context. It is triggered in particular in CC-C sequences (where '-' indicates any boundary), obligatorily or variably, depending on the type of boundary, the nature and number of surrounding consonants, the number of syllables, and the prosodic structure. At word boundaries, for instance, any word ending in two consonants may trigger the appearance of schwa before another consonant-initial word, as in *film russe* 'Russian film' [film(Œ)rys] and *parle trop* 'speaks too much' [parl(Œ)tro]. There is no possible contrast between the word *parle* [parl(Œ)] and another word identical to *parle* but incompatible with a schwa *[parlŒ]. This has been used to justify the epenthetic nature of all schwas at word boundaries, which is gaining wider acceptance.

Two empirical arguments for the contrastive nature of junctural schwas have been put forward, but neither is conclusive. The first one involves the distribution of schwa at word boundaries before words beginning with 'h aspiré'. Dell (1985: 186) cites the contrast between *quelle housse* 'what cover' [kɛlŒus], with a schwa, and *quel hêtre* 'what beech' [kɛl(ʔ)ɛtr] *[kɛlŒɛtr], where schwa cannot surface. This is taken as evidence that the feminine form *quelle* contains an underlying final schwa, which is absent from the masculine *quel*. Similarly, Selkirk (1972) opposes *cette haie* 'this hurdle' and *sept haies* 'seven hurdles', the latter being unacceptable with an intervening schwa. Tranel (1981: 287–288) convincingly denies the phonological status of such contrasts. The pronunciation [sɛtŒɛ] is less likely for *sept haies* than *cette haie*, but it is easily attested. The contrast is just one of frequency, which Tranel attributes to the influence of spelling.

The second argument involves the behaviour of schwa before the verbal suffix *-rions/-riez* (1st/2nd person plural forms of the conditional present tense). When this suffix appears after verb stems ending in a consonant, in the context /C+rjɔ̃/

[8] An epenthetic approach to the schwa in *pelouse* could be maintained if we adopt the idea that inseparable consonants like [pl] in *place* form unique complex segments, while separable ones like [pl] in *pelouse* are two distinct consonants (Hirst, 1985; Angoujard, 1997).

and /C+rje/, either a schwa appears at the boundary [CŒrjɔ̃] [CŒrje], or the glide surfaces with the corresponding high vowel [Crijɔ̃] [Crije]. Prescriptive grammars teach us that the two strategies to avoid [Crj] sequences are mutually exclusive: schwa appears with verbs of the first conjugation (verbs in *-er*), while glide vocalization is used with verbs of the third group. The verbs *fonder* 'to found' and *fondre* 'to melt' form in this respect a minimal pair: their (prescriptive) second plural conditional forms are, respectively, *fonderiez* [fɔ̃dŒrje] and *fondriez* [fɔ̃drije]. This distinction has led to the postulation of an underlying thematic schwa after stems of the first group (e.g. Dell, 1985). But this contrast has largely disappeared in the spoken language, both strategies being generally available for all verbs, e.g. *aimeriez* 'you-PL would like' [ɛmŒrje]/[ɛmrije] (first group) and *prendriez* 'you-PL would take' [prɑ̃drije]/[prɑ̃dŒrje]; see Martinet (1969), Morin (1978), Bazylko (1981), Spence (1982). Bazylko in particular designed tests that show that speakers do not distinguish between [fɔ̃dŒrje] and [fɔ̃drije], both forms being available for the conditional of both *fonder* and *fondre*. The role of schwa as a thematic vowel is therefore questionable.

Lexical contrastiveness, then, does not support underlying schwas at boundaries. Like other junctural schwas, those at clitic boundaries cannot be argued to be lexically contrastive: there is no possible contrast between a clitic *te*, which may be pronounced [t] or [tŒ], and another clitic that could only be pronounced [t]. Claims that clitic schwas are underlying must be based on other evidence. Two types of arguments have been suggested: distributional and experimental.

2.2 *Distributional arguments*

First, Tranel (1981: 294) retains underlying schwas in clitics for the reason that a schwa is pronounced in the citation form of these words. The citation form does not provide unambiguous evidence for underlying schwas, as the presence of schwa in the citation form could simply follow from a minimal word requirement. In French all prosodic words contain a vowel, so an output such as [d] for *de* does not form an acceptable prosodic word, hence schwa epenthesis.

More subtle arguments come from distributional parallels between morpheme-internal and clitic schwas, which are interpreted as stemming from their identical phonological status. As morpheme-internal schwas are taken to be underlying, as opposed to word-final ones in particular, this conclusion is extended to clitic schwas. Generally, clitic and morpheme-internal schwas are pronounced more readily than word-final schwas in similar environments. Rather than attributing this common behaviour to the underlying status of schwa, we argue that it follows from the prosodic position occupied by different categories of schwa.

In the context VC_CV, clitic and morpheme-internal schwas are pronounced much more often than schwas at word boundaries. In the same [id_mV] segmental environment, a schwa is natural in (2a-b), but normally omitted in (2c). This distinction is reflected, for example, in Dell's (1985) schwa deletion rules, which are optional in contexts like (2a-b), but obligatory in contexts like (2c). The frequent

pronunciation of clitic and internal schwas in C_C following a vowel or a pause is confirmed statistically in Hansen's (1994) recent corpus of spoken Parisian French: 32% of schwas in monosyllables and 37% of schwas in morpheme-initial syllables are pronounced.

(2) a. *la souris de Marie* 'M.'s mouse' [lasurid(Œ)mari]
b. *la souris demande* 'the mouse asks' [lasurid(Œ)mãd]
c. *la candide Marie* 'the candid M.' [lakãdidmari]

A more specific parallel between clitic and morpheme-internal schwas, which concerns the behaviour of schwas in two consecutive syllables, has been put forward by Lyche and Durand (1996: 466), and developed by Jetchev (1999, 2003a, b) (see also Dell, 1985: 254–256). Schwas in adjacent syllables obey four possible patterns: clitic + clitic (3), clitic + morpheme-internal (4), word-final + clitic (5), and word-final + morpheme-internal (6).[9] The first schwa may be preceded by one consonant (context VC_C_CV, (a) examples) or two consonants (VCC_C_CV, (b) examples). Recall that schwas at word boundaries are considered epenthetic. Schwa is potentially inserted at the end of any word ending in at least one consonant (for example, a schwa may intervene between any word ending in a consonant and 'h aspiré', as in [sɛtŒɛ] for *sept haies* mentioned in 2.1). The consonants surrounding the two schwas in (3)-(6) are kept identical: [tlv] in (a) and [ltlv] in (b). Each schwa may or may not be omitted, which yields four possible outputs; only the two where one of the schwas is pronounced will be considered. The omitted schwa is indicated by '-'. Possible but marginal pronunciations are preceded by '??'.

(3) Clitic + clitic

a. *Élie te le vante*
'É. praises it to you'
i. [elit-lŒvãt]
ii. [elitŒl-vãt]

b. *Ursule te le vante*
'U. praises it to you'
i. ??[yrsylt-lŒvãt]
ii. [yrsyltŒl-vãt]

(4) Clitic + morpheme-internal

a. *Élie te levait*
'É. lifted you'
i. [elit-lŒvɛ]
ii. [elitŒl-vɛ]

b. *Ursule te levait*
'U. lifted you'
i. ??[yrsylt-lŒvɛ]
ii. [yrsyltŒl-vɛ]

(5) Word-final + clitic

a. *Lafitte le vante*
'L. praises it'
i. [lafit-lŒvãt]
ii. *[lafitŒl-vãt]

b. *L'adulte le vante*
'The adult praises it'
i. [ladylt-lŒvãt]
ii. *[ladyltŒl-vãt]

[9] Two adjacent schwas can also be found word-internally, as in *devenir* 'to become'. We are only concerned here with adjacent schwas in different words.

(6) Word-final + morpheme-internal

a. *Lafitte levait*	b. *L'adulte levait*
'L. lifted'	'The adult lifted'
i. [lafit-lŒvɛ]	i. [ladylt-lŒvɛ]
ii. *[lafitŒl-vɛ]	ii. ??[ladyltŒl-vɛ]

When a clitic schwa competes against another clitic schwa (3) or a morpheme-internal one (4), either schwa can be omitted after one consonant (a), but it is normally the first schwa that is pronounced after two consonants (b). This output is motivated by the consonantal environment: the omission of the first schwa (i) creates a cluster of three consonants, which is avoided in the alternative pronunciation in (ii).

We observe a different pattern when the first schwa is word-final rather than in a clitic (5)–(6). If one schwa is omitted, it is normally the word-final one, whether preceded by one or two consonants. In other words, morpheme-internal and clitic schwas have priority over those at word boundaries, which are normally pronounced only when the following schwa is also present, as in [ladyltŒlŒvɑ̃t] (5b) or [ladyltŒlŒvɛ] (6b). By contrast, no priority emerges between internal and clitic schwas in (3) and (4).

The priority enjoyed by internal and clitic schwas over final ones has been interpreted as an indication of their different phonological status: underlying vowels morpheme-internally and in clitics are more likely to be pronounced than epenthetic schwas at word boundaries. A closer look at the data, however, suggests a different explanation, which is based on prosodic structure. Dell (1985) and Jetchev (1999, 2003a) mention that not all words ending in two consonants pattern like those in (5–6b). Words like *contre* 'against', *quelques* 'some', *presque* 'almost', *entre* 'between' can be pronounced with a final schwa even if a following internal or clitic schwa is omitted (7).

(7) a. *contre le mur* 'against the wall' [kɔ̃tr-lŒmyr] [kɔ̃trŒl-myr]
b. *quelques repas* 'some meals' [kɛlk-rŒpa] [kɛlkŒr-pa]

Such words have been considered lexical exceptions to the general pattern exemplified in (5) and (6), and Jetchev takes their final schwa to be underlying. In fact, it seems that the possibility for words to behave as in (7) depends on prosodic factors: all monosyllabic words which are prosodically (and syntactically) closely associated with the following word allow the pattern in (7). Such words include prepositions, determiners, and prenominal adjectives. The fact that the main factor is prosodic rather than lexical is supported by the data in (8), where the same word *triste* more easily comes with a final schwa in the sequence adjective+noun (8a) than in a subject+verb structure (8b), where *triste* is prosodically more distant from the following word. The relevance of monosyllabicity is shown by the contrast between (8a) and (8c), which contains a disyllabic prenominal adjective.

https://doi.org/10.1017/S0959269507002827 Published online by Cambridge University Press

(8)	a. *une triste semaine*	'a sad week'	[yntristŒs-mɛn]
	b. *l'homme triste semait*	'the sad man sowed'	??[lɔmtristŒs-mɛ]
	c. *un infecte repas*	'a filthy meal'	??[œ̃nɛ̃fɛktŒr-pa]

The relevant generalization is that schwa preferentially surfaces inside prosodic words (PW) rather than at their edges. Clitic and internal schwas are necessarily PW-internal. In *la souris demande* (2b), if the internal schwa is included, the sentence is pronounced [(lasuri)$_{PW}$ (dŒmɑ̃d)$_{PW}$], with the schwa trapped inside the second PW. Likewise, in *la souris de Marie* (2a); the sentence with the clitic schwa is parsed in two PWs: [(lasuri)$_{PW}$ (dŒmari)$_{PW}$], with the clitic attaching to the following word. Clitic and morpheme-internal schwas being PW-internal, their appearance is not constrained prosodically. Schwas at word boundaries, however, normally surface in PW-final position. For example, *l'artiste réussit* 'the artist succeedes' surfaces as [(lartistŒ)$_{PW}$ (reysi)$_{PW}$], with a PW-final inserted schwa. When a clitic or morpheme-internal schwa competes with a word-final one, as in (6b) *l'adulte levait*, the output with a PW-internal schwa (i) wins over the alternative with a PW-final one (ii).

The 'exceptions' in (7) and (8a) are expected if we accept the natural assumption that monosyllabic words that are prosodically and syntactically closely associated with the following material may form a single PW with it. *Une triste semaine* (8a) may be parsed into a single PW. This is not possible in (8c), which contains a polysyllabic prenominal adjective.[10] In (8b), *triste* may not form a single PW with the following verb because the two words are syntactically too distant. (See Côté (forth-coming) for analyses of the interaction between the number of syllables, the syntactic configuration and the behaviour of schwa.)

This account appears more explanatory and it makes no reference to lexical representation. The parallel behaviour of clitic and internal schwas follows from their common prosodic position, not underlying status. Prosody explains both the general fact that clitic and internal schwas are more readily pronounced than word-final schwas (2), and the specific priority they enjoy in a competition with word-final schwas (5–6).

A final distributional argument for underlying clitic schwas also comes from Jetchev (1999: 245–247), who suggests that internal and clitic schwas have in common that their distribution may or may not be sensitive to rhythm, while the distribution of word boundary schwas always depends on rhythm. This conclusion seems to be based on a misinterpretation of the data. In the context CC_C, both clitic and word boundary schwas are sensitive to rhythm, since schwa is more likely to appear if followed by only one syllable (9) than if followed by more than one (10).

[10] This explains why *quatorze* 'fourteen' behaves as in (8c), as mentioned by Dell (1985: 255), who suggests that the nature of the final cluster influences the behaviour of the word. Prosodic structure probably interacts with segmental content, but a full account of the behaviour of contiguous schwas is beyond the scope of this paper.

(9)	a. clitic:	*la terre se vend* 'the land sells'	[latɛrsŒvɑ̃] ??[latɛrsvɑ̃]
	b. word-final:	*il parle peu* 'he speaks little'	[ilparlŒpø] ?[ilparlpø]
(10)	a. clitic:	*la terre se vend bien* 'the land sells well'	[latɛrs(Œ)vɑ̃bjɛ̃]
	b. word-final:	*il parle beaucoup* 'he speaks a lot'	[ilparl(Œ)boku]

If schwa is preceded by only one consonant (context VC_C), clitic schwa omission is variable but not sensitive to rhythm (11), while word boundary schwas are generally excluded (12). Therefore, rhythm is never relevant in the context VC_C,[11] and there is no reason to argue that rhythm affects differently the distribution of clitic, internal and final schwas.

(11)	a. *l'eau se vend*	'water sells'	[los(Œ)vɑ̃]
	b. *l'eau se vend bien*	'water sells well'	[los(Œ)vɑ̃bjɛ̃]
(12)	a. *il donne peu*	'he gives little'	[ildɔnpø] *[ildɔnŒpø]
	b. *il donne beaucoup*	'he gives a lot'	[ildɔnboku] *[ildɔnŒboku]

2.3 Experimental evidence

While distributional arguments fail to provide clear evidence for the underlying status of clitic schwas, recent experimental results have shown that schwa omission in clitics does not lead to a complete neutralization between /CŒC/ forms and corresponding /CC/ ones. This is taken to indicate an incomplete deletion process, which entails the presence of schwa in the lexical representation of clitics. Upon closer examination of the data, this conclusion does not appear to be a necessary one, or even the most plausible one.

First, Fougeron and Steriade (1997, 1998) find that clitic consonants before an omitted schwa tend to be longer and more strongly articulated than identical consonants not preceding an omitted schwa (see also Lebel, 1968; Rialland, 1986). Two native speakers of French each produced 20 repetitions of the sequences in (13) (as well as another similar set involving the clitic *que* 'that', not reported here).

[11] This is true in Standard and Québec French, but not in Midi French, as mentioned by an anonymous reviewer. Watbled (1991) offers the contrast between *la princesse Anne* 'Princess A.', with schwa retained at the word juncture, and *la reine Amélie* 'Queen A.', with schwa omitted. Even after a single consonant, the behaviour of schwa depends on the number of following syllables.

https://doi.org/10.1017/S0959269507002827 Published online by Cambridge University Press

(13)	a. full schwa in clitic:	*pas de rôle*	'no role'	[pa dŒ=rol]
	b. omitted schwa in clitic:	*pas d' rôle*	'no role'	[pa d=rol]
	c. initial cluster with no schwa:	*pas drôle*	'not funny'	[pa drol]

The following measures were taken: amount of linguopalatal contact for the [d], closure duration for the [d], and frequency of lenition of the [d] (absence of full closure). The results indicate that the [d] before a schwa, present or omitted (13a-b), has significantly greater linguopalatal contact, longer lingual occlusion, and is less subject to lenition than the [d] with no schwa (13c). This is interpreted in analogical terms: the clitic in (13b) has the articulatory properties of a prevocalic [d] by phonetic analogy with the underlying form /dŒ/.

The relative strength of the clitic [d] in (13b), however, is amenable to an alternative explanation, which appeals to its morphemic status rather than to a lexical schwa. Consonants with a morphemic status have been shown to be regularly longer than corresponding nonmorphemic consonants (Walsh and Parker, 1983). For example, the inflectional [s] in *wrecks* is longer than the non-morphemic [s] in *Rex*. Sociolinguistic studies have also shown that past tense [t d] (e.g. *passed, banned*) delete less often than non past tense [t d] (e.g. *past, band*) in final clusters, presumably because of their 'functional' character (e.g. Guy, 1996).

A similar situation for French clitics is plausible. We suggest that consonants are stronger when they are the sole exponent of a morpheme, as in *d'rôle* (13b), than when they are part of a larger morpheme, as in *drole* (13c).[12] As suggested by Fougeron and Steriade, the relative strength of the [d] in *de rôle* (13a), compared to that in *drôle*, may be related to its prevocalicness. This alternative proposal is in fact supported by one of Fougeron and Steriade's results: The [d] is clearly longer before an omitted schwa (13b) than before a full schwa (13a) for one of the two speakers. This difference is not predicted by the underlying prevocalicness of the [d] in (13b), but it is expected under an analysis based on the morphemic status of consonants, since the [d] in (13a) does not surface as the unique expression of the clitic.[13]

Smorodinsky (1998) looks at tongue body position during the production of consonants in different contexts and claims that this position reflects the

[12] Walsh and Parker (1983) find that the durational difference between morphemic and non-morphemic /s/ is not perceived and that listeners tend to label ambiguous /s/ as non-morphemic. Viau (2004) obtains similar results for French: the contrast between (13b) and (13c) is not reliably perceived and *pas d'rôle* is generally identified as *pas drôle*.

[13] In comparing minimal pairs such as *pas d'rôle* (13b) and *pas drôle* (13c), Rialland (1986) finds that word-initial [r] (as in *rôle*) tends to be longer and stronger than [r] in clusters (as in *drôle*). This is interpreted as an indication that the clitic consonant [d] fails to resyllabify with the following word-initial [r], due to the maintenance of the nucleus position of the underlying clitic schwa. This conclusion has no character of necessity. The different realizations of [r] can be explained by their different position in the word, without reference to syllabic affiliation.

maintenance of an articulatory target for schwa even when it is omitted. One native speaker of French produced five repetitions of 8 $V_1C_1C_2V_2$ sequences appearing in four different contexts, described and exemplified in (14). The sequences were embedded in sentences, V_1/V_2 are high vowels and C_1/C_2 are labial or coronal stops.

(14) a. C1 and C2 separated by a clitic boundary (1 sentence)

$[V_1\ C_1{=}C_2V_2]$	*Mamie te nie...*	[i t=ni]
	'Mommy denies to you'	

b. C1 and C2 separated by an omitted internal schwa (3 sentences)

$[V_1\ C_1\_C_2V_2]$	... *Tu dois t'y tenir*	[i t_ni]
	'you have to stick to it'	

c. C1 and C2 separated by a word boundary (3 sentences)

$[V_1C_1\ C_2V_2]$	... *deux types tissent*	[ip ti]
	'two men weave'	

d. C1 and C2 strictly adjacent morpheme-internally (1 sentence)

$[V_1C_1C_2V_2]$	... *deux diptyques*	[ipti]
	'two diptichs'	

The lowest vertical displacement of the tongue body (TB) during the closures of the consonants was measured. Since high vowels involve a high TB position, the TB is expected to remain high during the production of the consonants in the absence of a distinct tongue body target. TB position was observed to be lowest at clitic boundaries and across an omitted internal schwa (14a-b), intermediate across word boundaries (14c), and highest word-internally (14d). These results are interpreted in Articulatory Phonology terms (e.g. Browman and Goldstein, 1992). The low TB position in (14a-b) is claimed to be due to the maintenance of the articulatory target of an underlying schwa (a mid vowel). The schwa is hypothesized not to be heard in fast speech because its acoustic effect is obscured by an increase in gestural overlap between the surrounding consonants.

This interpretation is surprising given the direct association it establishes between schwa deletion and fast speech. Although some studies have suggested a correlation between speech rate and the frequency of schwa omission (Malécot, 1976; Lyche, 1978), schwa can be easily omitted even in very slow speech, which prevents defining schwa deletion strictly as a fast speech process. Also, associating the low TB position in (14a-b) with the articulatory target of a lexical schwa leaves unexplained the relatively low position at word boundaries as well (14c). Smorodinsky suggests that the TB goes back to its neutral position in this case. But if the low position in (14c) is explained by a return to a neutral position, there is no reason why the same process could not also be involved in the low position in (14a-b). In other words, why is the TB position associated with a lexical schwa in one context and with a neutral position in another?

Again, an alternative explanation is available, which solves the issue just mentioned and avoids a definition strictly based on speech rate. We suggest that

https://doi.org/10.1017/S0959269507002827 Published online by Cambridge University Press

it may be that low TB is always the result of a return to a neutral position (this may be a rebound effect, since explicit gestural instructions may be needed to hold the tongue in the high vowel position), and that this is correlated to the degree of overlap between C_1 and C_2: the less overlap, the more the TB can move back to its neutral position (and the lower the TB). Wright (1996) shows that two adjacent stops are less overlapped in word-initial position than word-internally, because more overlap initially would compromise the perceptibility of the initial stop. Byrd (1994) also finds that a consonant is less overlapped by a following one in initial (onset) clusters than in final or heterosyllabic clusters. Likewise, the sequence [tn] in *tenir* (14b) is expected to show less overlap than [pt] in *diptyques* (14d), which accounts for the lower tongue position in *tenir*. It is also expected that sequences that cross a word boundary are less overlapped than word-internal ones, which accounts for the lower TB position in (14c) than in (14d).

What remains to be explained is the similar TB position in *tenir* (14b) and *te nie* (14a). We suggest that the C_1C_2 sequences in both (14a) and (14b) are PW-initial, as clitics attach to the following word. The identical patterning of clitic and morpheme-initial consonants is therefore again attributed to their common position rather than to the lexical vs. epenthetic status of schwa. Note that the fact that the [t] in *tenir* is word-initial does not preclude a possible surface syllabic affiliation with the preceding vowel, for example with the preceding [i] in (14b). Likewise for the [t] of *te nie* (14a). But we maintain that [t] remains phonologically attached to the following word in both *tenir* and *te nie*. This forward attachment is uncontroversial when schwa is pronounced, as in *Mamie te nie* [mami tœni]. One argument in favor of the maintenance of this attachment even when schwa is omitted comes from the behaviour of high vowels in Québec French. High vowels become lax in word-final closed syllables. In *Mamie te nie* [mami tni], the final [i] of *Mamie* is always tense, which would not be the case if [t] attached to the preceding word. Note that laxing is not simply a lexical property; a word like *piston* 'piston' has a tense [i] in normal speech, but may get a lax [ɪ] in very slow speech [pɪs - tɔ̃], in which each syllable behaves as final. Likewise, *bulle* 'bubble' [bʏl] has a lax [ʏ] in normal speech, but may get a tense [y] in a spelling pronunciation [by - lœ].

In sum, the two pieces of articulatory evidence for the underlying nature of clitic schwas are not compelling. Alternative explanations not involving schwa are possible and appear more plausible, although additional experiments are needed to confirm their validity.

A third experimental result, that of Barnes and Kavitskaya (2002), appears to more strongly support the presence of lexical schwas and an Articulatory Phonology account of their omission. Barnes and Kavitskaya (BK) find that some lip rounding can be observed in the vicinity of an omitted schwa after a clitic consonant. This rounding is interpreted as originating from an underlying rounded schwa. One native speaker of French produced five repetitions of each of the sequences in (15) and was videotaped.

(15) a. full schwa in clitic
plus p'tit que Lannes [ply pti kŒ=lan]
'smaller than Lannes'
b. omitted schwa in clitic
plus p'tit qu'la femelle [ply pti k=la=fœmɛl]
'smaller than the female'
c. word-initial cluster with no intervening schwa
tout p'tit clavecin [tu pti klavsɛ̃]
'really small harpsichord'

The degree of lip rounding during the [kla] or [kŒla] portion of the utterances was measured by looking at side contact of the lips (the amount of contact between the upper and lower lips as seen from the front). Results indicate that, as expected, the most lip rounding was observed in the vicinity of a full schwa (15a) and no rounding was present in sequences that do not involve a schwa at any level (15c). The interesting result lies in the intermediate degree of lip rounding observed in the context of an omitted schwa (15b). Partial rounding is interpreted as an articulatory remnant of an underlying vowel. The schwa is not really deleted, insofar as some of its gestures remain articulated, and schwa 'deletion' is, as in Smorodinsky (1998), analysed as a fast-speech process.

The problem raised by a fast-speech interpretation of schwa omission is still present. This result is also based on very limited data: one speaker, only one set of stimulus sentences, and, more importantly, the sequences in (15a-c) do not form minimal pairs, which leaves open the possibility that the rounding observed be due to an element independent of schwa. Given that BK's results are crucial to our understanding of the schwa-zero alternation, they need to be confirmed by additional data. To this end, BK's experiment was replicated using more and carefully designed test stimuli, and more repetitions.

3 LIP ROUNDING EXPERIMENT

3.1 Methodology

Four pairs of sentences were used; each pair includes one sequence involving an omitted schwa in a clitic, and another similar or identical sequence without a schwa. One of the pairs is similar to the one used by BK (16a), to allow a comparison between our and BK's results. Another pair (16b) is also similar but with identical segmental sequences after the target clitic [k], which is not the case in (16a). The remaining two sets (16c–d) form true minimal pairs that differ only in the presence or absence of a clitic boundary, indicated by '='; the segmental material is strictly identical. Rounded segments (rounded vowels and [ʃ ʒ]) in (16c–d) were systematically avoided in order to eliminate all potential sources of rounding other than a possible lexical schwa.

https://doi.org/10.1017/S0959269507002827 Published online by Cambridge University Press

In an attempt to elicit natural and colloquial speech, the sentences were not presented in standard written French, rather use was made of orthographic devices that reflect a spontaneous pronunciation (apostrophes indicate omitted segments). The transcriptions given in (16) include features typical of Québec French, the variety spoken by our subject: lax high vowels in closed syllables, [ɑ] rather than [a] word-finally, [ɛ̃] instead of [ɛ̃], affrication of [t d] before high front vowels.

(16)	a.	i.	*I' était ben plus p'tit qu'la femelle*	[ply pt^{s}i k=la=fœmɛl]
			'He was much smaller than the female'	
		ii.	*C'était rien qu'un tout p'tit clavecin*	[tu pt^{s}i klafsɛ̃]
			'It was only a really small harpsichord'	
	b.	i.	*C'est plus p'tit qu'Lima*	[ply pt^{s}i k=limɑ]
			'It's smaller than Lima'	
		ii.	*C'est l' tout p'tit climat*	[tu pt^{s}i klimɑ]
			'It's the really small climate'	
	c.	i.	*Élie t' rame ben ça*	[eli t=ram bɛ̃ sɑ]
			'É. rows that well for you'	
		ii.	*Élie trame ben ça*	[eli tram bɛ̃ sɑ]
			'É. plots that well'	
	d.	i.	*Éric t' rame ben ça*	[erɪk t=ram bɛ̃ sɑ]
			'É. rows that well for you'	
		ii.	*Éric trame ben ça*	[erɪk tram bɛ̃ sɑ]
			'É. plots that well'	

One male native speaker of Québec French participated in the experiment and was videotaped reading 21 repetitions of each of the stimulus sentences. The sentences were presented to the speaker in written form via a computer screen placed immediately below the video camera. He sat with his head in an open-fronted box which fixed the distance between the camera and his lips. A reference scale was drawn on the front edge of the box so that distances measured in video-image pixels could be converted into millimetres. A mirror was attached to the box at 45° so as to provide a side view of the speaker's lips.

All the sentences were presented once in random order within a block, and there were 21 blocks, each with a different randomisation. The first block was intended to familiarise the participant with the procedure and the results from this block were not analysed. Two extra sentences were added at the end of the experiment to prevent list-end effects. The speaker pressed a button to advance from one stimulus sentence to the next. He was asked to speak in an informal manner and to keep his speaking rate consistent throughout the experiment.

The video recording of the experiment was transferred to computer, and the sequences of frames of interest were isolated and the lips were measured using ImageJ 1.29 (a Java application based on NIH Image). The scale of the images was calibrated using the scale on the front edge of the box and found to be 2.14 pixels per mm.

Figure 1. *Lip measurements obtained.*

The lip measurements obtained for each video frame were: the internal vertical aperture between the lips, the internal width (horizontal aperture between the inside corners), and the side contact. These measurements are illustrated in Figure 1. Small distances were difficult to measure reliably, and the lips were deemed closed if the measured vertical aperture was less than 4 pixels.

Side contact was the only measure reported by BK based on Goldstein's (1991) proposal that this was the most reliable correlate of degree of lip rounding. Goldstein (1991: 98) defines side contact as the 'upper and lower lips touch[ing] along their sides', and measured as the '[d]istance form the corner of the mouth to the most forward point of contact'. Reference to Linker (1982), the source of Goldstein's data, and personal communication with Goldstein (25 June 2004) confirmed that this measurement was made from a side view of the lips. However, difficulties with image quality made it impossible to obtain reliable side-view measurements from our video recordings. Side contact was therefore measured from the front-view image instead by measuring the external width of the lips (to the corners of the vermilion border) and subtracting the internal width. This appears to be the same measure of side contact used by BK.

3.2 Results

BK found that differences between contexts were apparent from visual inspection, and reported results for side contact in the frames which had maximum lip rounding. In contrast, no differences in lip rounding were immediately apparent in our data. Therefore, in order to identify potential points for statistical comparison, we plotted the trajectories through time of the vertical aperture, horizontal width, and side contact. Since not every sample of a particular sentence was of the same duration, samples had to be normalised for duration. Lip-measurements were interpolated between anchor-points in time. The anchor points were the first and last frame measured in the sample (for each sentence pair, details of these anchor points are given below) and an additional intermediate anchor point such as the point corresponding to the maximum vertical aperture (the mean time for the maximum aperture over all samples for a given sentence). For each sample, time was interpolated in linear time-steps from the first anchor to the intermediate anchor, and in linear time-steps from the intermediate anchor to the last anchor. Aperture values were interpolated using a piecewise cubic Hermite interpolating polynomial (an interpolation which passes through all measured values).

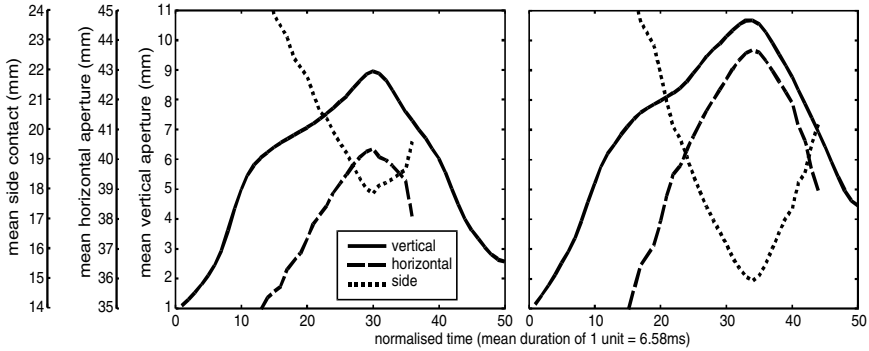

Figure 2. *Trajectories of lip measurements for (16a)* [pt^{s}i k=la=f] *(left) and* [pt^{s}i klaf] *(right).*

I' était ben plus p'tit qu' la femelle–C'était rien qu'un tout p'tit clavecin (16a)
Figure 2 shows the mean trajectories for measurements of the lips in [ply pt^{s}i k=la=fœmɛl] (16ai) and [tu pt^{s}i klafsɛ̃)] (16aii). The initial anchor point was the last frame with closed lips in the [p] in *p'tit*. The final anchor point was the first frame showing contact between the lower lip and upper teeth in the [f] of *femelle* and *clavecin*. The frame of maximum vertical aperture was used as the intermediate anchor point for plotting purposes. The maximum peak in vertical aperture occurred immediately after the [l] in *qu'la* and *clavecin*. Mean width trajectories become somewhat erratic as the vertical aperture approaches zero because of the lack of reliable width measurements at small vertical aperture. Side contact of the lips was essentially a mirror image of the internal-width trajectory.

Points of comparison selected for statistical analysis were: the maximum vertical aperture (at the last peak or end of the last plateau in the vertical aperture trajectory), the vertical aperture at the shoulder visible in Figure 2 to the left of the maximum peak (the frame before the acceleration became negative in each sample),[14] the maximum width (the last peak or end of the last plateau in the width trajectory), and the minimum side contact of the lips (the last trough or end of the last plateau in the side-contact trajectory). The times of each of these points of measurement relative to the first and last anchor points were also subjected to statistical analysis. The results of t-tests conducted on each comparison are shown in Table 1.

Except for the relative time of the shoulder in the vertical aperture, all comparisons were significantly different at an alpha level of 0.05 and remained significant after the application of a Bonferroni correction to compensate for the fact that 8 comparisons had been made. Based on the resolution of the video images and the authors' estimate of how reliably they were able to measure the

[14] Acceleration was measured by subtracting the distance measurement at the present frame from the distance measurement for the subsequent frame to obtain the velocity, then subtracting the velocity at the present frame from the velocity at the subsequent frame.

https://doi.org/10.1017/S0959269507002827 Published online by Cambridge University Press

Table 1. *Results of t-tests conducted on lip measurements for (16a)* I' était ben plus p'tit qu'la femelle *and* C'était rien qu'un tout p'tit clavecin.

Measurement		Means [i k=la]	Means [i kla]	difference	*t*	df	Sig. (2-tailed)
maximum vertical aperture	mm	8.95	10.68	−1.73†	−6.556	34.687	0.000**
	time units	29.79	33.43	−3.65	−3.268	37.823	0.002**
vertical aperture shoulder	mm	6.13	7.32	−1.19	−3.287	36.892	0.002**
	time units	11.80	13.83	−2.03	−1.646	34.224	0.109
maximum width	mm	40.72	44.02	−3.30†	−6.289	27.390	0.000**
	time units	30.36	35.61	−5.25†	−4.355	37.862	0.000**
minimum side contact	mm	17.37	14.58	2.77†	4.956	31.135	0.000**
	time units	30.10	34.52	−4.42	−3.987	36.075	0.000**

*significant at 0.05.
**significant at 0.05 after Bonferroni correction (0.05/8=0.00625).
†substantial difference (>3 pixels = 1.40 mm, or > 5.06 normalised time units = mean of 1 video frame = 1/30 second).

video images, distance differences were only considered substantial if they were greater than 3 pixels (1.40 mm), and time differences only if they were greater than 1 video frame (1/30 second = 5.06 normalised time units). The distance difference between maximum vertical apertures, maximum internal widths, and side contact were substantial. For the statistically significant time differences, only the time difference between maximum internal widths was substantial.

C'est plus p'tit qu' Lima – C'est l'tout p'tit climat (16b)

Figure 3 shows the mean trajectories for lip measurements in [ply pt^{s}i k=limɑ] (16bi) and [tu pt^{s}i klimɑ] (16bii). The initial anchor point was the last frame with closed lips in the [p] in *p'tit*, and the final anchor point was the first frame with closed lips in the [m] in *Lima* and *climat*. In vertical aperture, individual samples had either a single peak, a plateau, or a double peak in which the first peak was either of equal or lesser magnitude than the second. Several intermediate anchor points were considered, and the second peak/end of the plateau was chosen. The maximum aperture peak occurred immediately after the [l] in *Lima* and *climat*. Points identified for statistical comparison were the same as those for the sentences in (16a).

The results of t-tests conducted on each comparison are shown in Table 2. The differences in distances for vertical aperture at the shoulder, maximum internal width and minimum side contact were significant at the 0.05 alpha level; however, once a Bonferroni correction was applied to compensate for the fact that 8 comparisons had been made, none of the differences remained significant. Of

https://doi.org/10.1017/S0959269507002827 Published online by Cambridge University Press

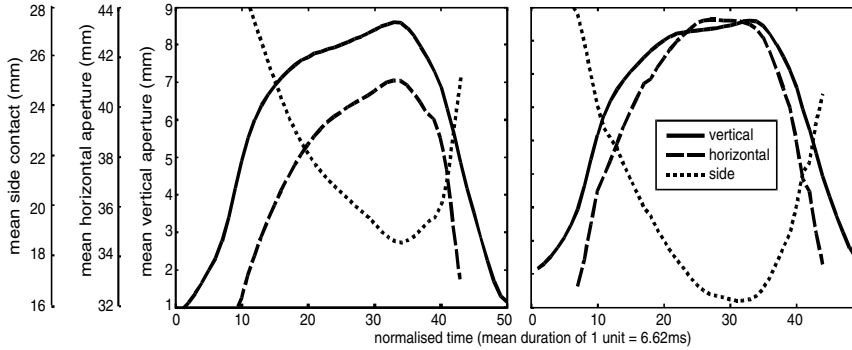

Figure 3. *Trajectories of lip measurements for (16b)* [pt^{s}i k=lim] *(left) and* [pt^{s}i klim] *(right).*

Table 2. *Results of t-tests conducted on lip measurements for (16b)* C'est plus p'tit qu'Lima *and* C'est l'tout p'tit climat.

Measurement		Means [i k=li]	Means [i kli]	difference	*t*	df	Sig. (2-tailed)
maximum vertical aperture	mm	8.60	8.60	0.00	0.000	37.374	1.000
	time units	33.10	33.08	0.02	0.018	37.722	0.985
vertical aperture	mm	6.97	7.65	−0.68	−2.674	28.208	0.012*
	time units	29.03	28.07	0.07	−0.888	36.051	0.380
shoulder maximum width	mm	41.50	44.39	−2.89†	−2.581	25.045	0.016*
	time units	33.79	31.79	2.00	1.276	37.671	0.210
minimum side contact	mm	17.95	15.25	2.70†	2.930	25.742	0.007*
	time units	35.20	32.30	2.90	1.598	36.698	0.119

*significant at 0.05.
**significant at 0.05 after Bonferroni correction (0.05/8=0.00625).
†substantial difference (> 3 pixels = 1.40 mm, or > 5.04 normalised time units = mean of 1 video frame = 1/30 second).

the three differences significant at the nominal 0.05 level, only maximum internal width and side contact were substantial.

Élie t' rame ben ça – Élie trame ben ça (16c)

Figure 4 shows the mean trajectories for measurements of the lips in [eli t=ram bẽ sɑ] (16ci) and [eli tram bẽ sɑ] (16cii). The initial anchor point was the last frame containing the maximum aperture corresponding to [el] in *Élie*, and the final anchor point was the central frame with the maximum amplitude corresponding to the

https://doi.org/10.1017/S0959269507002827 Published online by Cambridge University Press

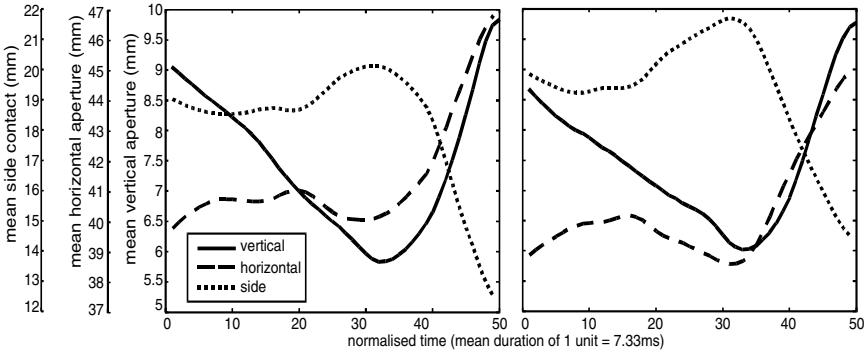

Figure 4. *Trajectories of lip measurements for (16c)* [eli t=ram] *(left) and* [eli tram] *(right).*

[a] in *t'rame* and *trame*. Minimum vertical aperture was an obvious potential point for comparison, but choosing appropriate points on the width and side-contact trajectories was more problematic: although a peak and trough are visible in the mean trajectories, some samples had monotonic trajectories sloping downwards to the trough without the first peak or sloping upwards to the [a]-maximum without a clear first peak or trough. Fluctuations from the general trends of the trajectories for individual samples also made it impossible to devise an algorithm to pick peaks and troughs based on raw data values. Compromise points for comparison were chosen as the interpolated width values for each sample at the time of the mean minimum (calculated across all samples) and preceding mean maximum. This choice necessarily precludes the possibility of making a statistical comparison of differences in time between the peaks and troughs. Table 3 contains results of t-tests for the points of comparison. None of the differences were statistically significant.

Éric t'rame ben ça – Éric trame ben ça (16d)

Figure 5 shows the mean trajectories for measurements of the lips [erɪk t=ram bẽ sɑ] (16di) and [erɪk tram bẽ sɑ] (16dii).[15] The trajectories had the same general shape as for the sentences in (15c) and were plotted according to the same criteria except that the initial anchor point was the last frame containing the maximum aperture corresponding to [er] in *Éric*. Points identified for comparison were the same as those as for the preceding pair with the addition of the shoulder point visible in the internal width trajectories in Figure 5. Table 4 contains results of t-tests for the points of comparison. None of the differences was statistically significant.

[15] Note that schwa omission is less likely in (16d, i), where the clitic consonant is preceded by another consonant, than in (16a-c, i), where the clitic consonant is preceded by a vowel. Our subject, however, produced (16d, i) without schwa in all cases.

https://doi.org/10.1017/S0959269507002827 Published online by Cambridge University Press

Table 3. *Results of t-tests conducted on lip measurements for (16c)* Élie t'rame ben ça *and* Élie trame ben ça.

Measurement		Means [i t=ra]	Means [i tra]	difference	*t*	df	Sig. (2-tailed)
minimum vertical aperture	mm	5.81	6.01	−0.21	−0.739	37.984	0.464
	time units	32.39	32.93	−0.54	−0.583	37.643	0.563
internal width	max. mm	40.98	40.11	0.86	0.858	37.639	0.396
	min. mm	40.00	38.52	1.48	1.211	37.106	0.234
side contact	min. mm	18.49	19.18	−0.69	−1.031	37.861	0.309
	max. mm	20.07	21.61	−1.54	−1.414	36.567	0.166

*significant at 0.05.
**significant at 0.05 after Bonferroni correction (0.05/8=0.00625).
†substantial difference (> 3 pixels = 1.40 mm, or > 4.55 normalised time units = mean of 1 video frame = 1/30 second).

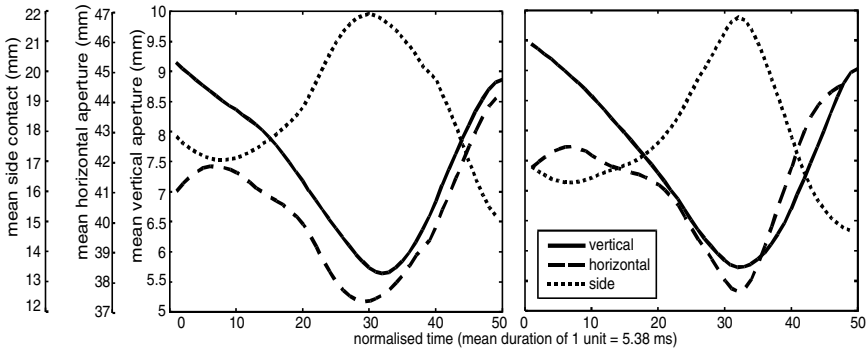

Figure 5. *Trajectories of lip measurements for (16d)* [erɪk t=ram] *(left) and* [erɪk tram] *(right).*

3.3 Discussion

Significant differences in lip measurements were found for the sentences that were similar to those of BK (16a-b). However, the differences appear to be due to differences in the articulation of other segments in the sentences rather than the omission of a clitic schwa versus no-schwa word-internally. In stimulus set (a), the target segments in the (i) sentence were followed by the sequence [fœ], whereas in the (ii) sentence the following segments were [fs], and the vertical lip aperture was greater for the [f] in [fs] than in [fœ]. In stimulus sets (a) and (b), one of the segments prior to the target segments in (i) was the front rounded vowel [y], whereas in the (ii) sentence the parallel segment was the back rounded vowel [u], and lip rounding is greater for [y] than [u]. Set (a) displays both the preceding and

https://doi.org/10.1017/S0959269507002827 Published online by Cambridge University Press

Table 4. *Results of t-tests conducted on lip measurements for (16d)* Éric t'rame ben ça *and* Éric trame ben ça.

Measurement		Means [ɪk t=ra]	Means [ɪk tra]	difference	*t*	df	Sig. (2-tailed)
vertical	min. mm	5.62	5.71	−0.09	−0.377	36.806	0.708
aperture	time units	32.09	32.14	−0.05	−0.051	36.529	0.960
internal width	max. mm	41.85	41.73	0.12	0.142	36.968	0.888
shoulder	min. mm	37.35	37.73	−3.79	−0.287	36.477	0.775
	mm	39.56	40.78	−1.22	−1.236	35.571	0.224
side	min. mm	17.04	16.26	0.78	1.199	37.091	0.238
contact	max. mm	21.84	21.66	0.18	0.141	37.997	0.889

*significant at 0.05.
**significant at 0.05 after Bonferroni correction (0.05/8=0.00625).
†substantial difference (> 3 pixels = 1.40 mm, or > 6.19 normalised time units = mean of 1 video frame = 1/30 second).

following segmental differences, while set (b) has only the prior one. This possibly explains the greater lip measurement differences for the target segments in set (a) than in set (b), for which the differences are only marginally significant.

Significant lip measurement differences were not found in the stimulus sentences sets (c) and (d), which lack such differences in prior and following segments. This supports our hypothesis that the observed differences in lip position are due to factors independent of schwa.[16] Therefore the results of BK and of the experiment reported here do not establish the existence of underlying schwas in clitics, contra BK, although further experimental data with additional minimal-pair sentences and more speakers are needed to ascertain the generalisability of this finding.

4 GENERAL CONCLUSION

This discussion does not allow us to determine with certainty the nature of the schwa-zero alternation in French. But several partial conclusions can be drawn, which clarify some of the issues involved and help reduce the range of possible alternatives.

The main result concerns the evidence for lexical schwas in clitics, which has been shown to be inconclusive. Three of the main arguments are reinterpreted

[16] Our subject is a speaker of Québec French. BK do not specify the variety spoken by their subject, but we can presume it is a European one. There is no indication that this difference is relevant in the present discussion, given the similarity of the results of both experiments for the sentences in (16a). The behaviour of clitic schwas is essentially the same in Standard and Québec French (see Picard, 1974 for Québec French), and there is no a priori reason to think that conclusions on the underlying status of schwa in one variety would not extend to the other variety.

in the light of two independent properties of clitics; in all cases the alternative explanation integrates additional facts that are not covered by an analysis that appeals to lexical schwas. On the one hand, clitic consonants are the only exponent of their morpheme when schwa is omitted, which may explain their stronger articulation. On the other hand, clitics appear PW-initially, a position also shared by morpheme-internal schwas. This prosodic position, rather than a common underlying vowel, accounts for distributional parallels between clitic and internal schwas. First, the apparent priority of clitic and internal schwas over word-final ones is explained by the greater likelihood for schwa to be pronounced inside phonological words than at edges. Second, the different tongue position in consonant clusters containing an omitted internal schwa or a clitic boundary, compared to adjacent consonants morpheme-internally or across a word boundary, is interpreted as a result of reduced overlap in PW-initial consonant sequences.

The strongest argument in support of lexical schwas, however, has been the existence of residual lip rounding in the vicinity of omitted schwas at clitic boundaries. This finding is contradicted by further experimental results, which also suggest a different source for the lip movement observed in some of the stimulus sentences.

Questioning the underlying status of clitic schwas reopens a debate that had been largely taken to be settled. The facts remain compatible with both an epenthetic and a deletion account. In this situation, lexical contrastiveness could be used as the decisive argument. Clitic schwas cannot be contrastive, in the sense that their appearance depends on the context and does not give rise to an opposition between clitic consonants that are variably pronounced with schwa and other consonants that exclude schwa. Consequently, it can be argued that schwa should not be present in phonological representations, following the principle of lexical economy that has served to exclude predictable information from lexical forms. This conclusion leads to the generalization that all morpheme-internal schwas are underlying and all schwas at boundaries are epenthetic, which appears to be a quite natural distribution.

Our discussion also bears on the issue of whether schwa deletion, when it applies, is a complete process or a partial one, which leaves articulatory and/or temporal traces of the underlying vowel. If the experimental results used to support an incomplete deletion process in clitics should indeed be reinterpreted without reference to underlying schwas, does the same conclusion hold morpheme-internally, the only context where lexical schwas are clearly motivated? If so, this supports the traditional view of a total schwa deletion process. (Alternatively, both the schwa-full and schwa-less variants could be listed in the lexicon.) Indeed, there is little evidence for traces of deleted morpheme-internal schwas. Such evidence may be found in comparisons between [CCV] sequences deriving from /CCV/ and /CŒCV/ (but minimal pairs such as *ferais* 'I would do' [f(Œ)rɛ] and *frais* 'fresh' [frɛ] are rare and cover only a small subset of the possible C_1C_2 combinations in /C_1ŒC_2/ words). Rialland (1986: 203) claims that *ferais* and *frais* '*peuvent* être réalisés

différemment, du moins par *certains* locuteurs' (emphasis added), but this needs to be confirmed by additional experimental results. Rialland presents only one pair of spectrograms and it is unclear whether the observed durational differences are statistically significant. Interestingly, the differences observed in similar minimal pairs involving clitics, such as *te renversait* 'struck you down' [t=rɑ̃vɛrsɛ] and *traversait* 'crossed' [travɛrsɛ], are clearly more salient than those between *ferais* and *frais*. If deleted schwas really have an effect on the acoustic output, it is weaker than that of morphological structure.

Address for correspondence:
Marie-Hélène Côté
Département de linguistique/Department of Linguistics
Université d'Ottawa/University of Ottawa
C.P. 450, Succursale A/P.O. Box 450, Station A
Ottawa, Ontario, K1N 6N5
Canada
e-mail: mhcote@uottawa.ca

REFERENCES

Angoujard, J.-P. (1997). *Théorie de la syllabe: rythme et qualité*. Paris: CNRS Éditions.
Ayres-Bennett, W. and Carruthers, J., with Temple, R. (2001). *Problems and perspectives: studies in the modern French language*. Harlow: Pearson Ed.
Barnes, J. and Kavitskaya, D. (2002). Phonetic analogy and schwa deletion in French. *Berkeley Linguistics Society*, 28: 39–50.
Bazylko, S. (1981). Le statut de [ə] dans le système phonématique du français contemporain et quelques questions connexes. *La linguistique*, 17.1: 91–101.
Byrd, D. (1994). *Articulatory timing in English consonant sequences*. Ph.D. dissertation, UCLA.
Browman, C. P. and Goldstein, L. (1992). Articulatory phonology: an overview. *Phonetica*, 49: 155–180.
Charette, M. (1991). *Conditions on phonological government*. Cambridge: Cambridge University Press.
Cornulier, B. de (1975). Le droit d'e: e et la syllabicité. *Cahiers de linguistique, d'orientalisme et de slavistique*, 5–6: 101–117.
Côté, M.-H. (2000). *Consonant cluster phonotactics: a perceptual approach*. Ph.D. dissertation, MIT.
Côté, M.-H. (forthcoming) Rhythmic constraints on the distribution of schwa in French. In: J. Camacho, V. Deprez, N. Flores and L. Sanchez (eds), *Selected Papers of the 36th Linguistic Symposium on Romance Languages*. Amsterdam: John Benjamins.
Côté, M.-H. (2006b) Segmental constraints on prosodic phrasing. Paper presented at the GLOW workshop on prosodic phrasing, Universitat Autònoma de Barcelona.
Dauses, A. (1973). *Études sur l'e instable dans le français familier*. Tübingen: Max Niemeyer.
Déchaine, R.-M. (1990). Stress and weight gain. Ms. University of Massachusetts, Amherst.

Déchaine, R.-M. (1991). On schwa in Québécois. Paper presented at the annual meeting of the Canadian Linguistic Association.
Dell, F. (1985). *Les règles et les sons*, 2nd edition. Paris: Hermann.
Deyhime, G. (1967). Enquête sur la phonologie du français contemporain. *La linguistique*, 3.1: 97–108 and 3.2: 57–84.
Durand, J., Slater, C. and Wise, H. (1987). Observations on schwa in Southern French. *Linguistics*, 25.5 (291): 983–1004.
Fougeron, C. and Steriade, D. (1997). Does the deletion of French schwa lead to the neutralization of lexical distinctions? In: *Proceedings of the Eurospeech conference*, Rhodes, pp. 943–946.
Fougeron, C. and Steriade, D. (1998). Au-delà de la syllabe: le rôle des informations articulatoires stockées dans le lexique pour l'analyse de la chute de schwa. In: S. Wauquier-Gravelines (ed.), *Journées d'études linguistiques: la syllabe sous tous ses aspects*, Université de Nantes, pp. 122–127.
Goldstein, L. (1991). Lip rounding as side contact. In: *Proceedings of the XIIth International Congress of Phonetic Sciences*. Université de Provence, vol. 1, pp. 97–101.
Guy, G. R. (1996). Form and function in linguistic variation. In: G. R. Guy, C. Feagin, D. Schiffrin and J. Baugh (eds), *Towards a social science of language*. Amsterdam: John Benjamins, vol. I, pp. 221–252.
Hammarström, G. (1965). Sur l'inventaire des phonèmes français. In: I. Iordan et al. (eds), *Omagiu lui Alexandru Rosetti la 70 de ani*. Bucarest: Editura Academiei Republicii Socialiste Romania [cited in Bazylko, 1981].
Hansen, A. B. (1994). Étude du E caduc—stabilisation en cours et variations lexicales. *Journal of French language studies*, 4: 25–54.
Hirst, D. (1985). Linearisation and the single segment hypothesis. In: J. Guéron, H.-G. Obenauer and J.-Y. Pollock (eds), *Grammatical representation*. Dordrecht: Foris, pp. 87–99.
Jetchev, G. (1999). Schwa or 'ghost' vowels in French: a Harmonic Phonology account. *Rivista di linguistica*, 11: 231–271.
Jetchev, G. (2003a). Le schwa français au miroir de la variation. In: J. Durand, B. Laks and C. Lyche (eds), *La prononciation du français = Tribune internationale des langues vivantes*, 33: 102–107.
Jetchev, G. (2003b). La variabilité du schwa français vue à travers une approche syllabique. In: É. Delais-Roussarie and J. Durand (eds), *Corpus et variation en phonologie du français: méthodes et analyses*. Toulouse: Presses Universitaires du Mirail, pp. 301–320.
Lebel, J.-G. (1968). Allongement compensatoire de quelques consonnes par suite du 'e' caduc. *Revue de phonétique appliquée*, 7: 53–78.
Linker, W. (1982). Articulatory and acoustic correlates of labial activity in vowels: a cross-linguistic study. *UCLA working papers in phonetics*, 56: i-ii and 1–134.
Lyche, C. (1978). On the optionality of French schwa deletion in natural generative phonology. In: K. Gregersen, H. Basbøll and J. Mey (eds), *Papers from the 4th Scandinavian conference of linguistics*. Odense: Odense University Press, pp. 441–446.
Lyche, C. and Durand, J. (1996). Testing government phonology ou pourquoi le choix du schwa. In: J. Durand and B. Laks (eds), *Current trends in phonology: models and methods*. Salford/Paris: CNRS/ESRI/Paris X, vol. 2, pp. 443–471.
Malécot, A. (1976). The effect of linguistic and paralinguistic variables on the elision of the French mute-e. *Phonetica*, 33: 93–112.

Malécot, A. and Chollet, G. (1977). The acoustic status of the mute-e in French. *Phonetica*, 34: 19–30.
Martin, P. (1998). À Québec, a-t-on l'schwa?. In: Y. Duhoux (ed.), *Langue et langues: hommage à Albert Maniet*. Leuven: Peeters, pp. 163–180.
Martinet, A. (1945). *La prononciation du français contemporain: témoignages recueillis en 1941 dans un camp d'officiers prisonniers*. Paris: Droz.
Martinet, A. (1962). *A functional view of language*. Oxford: Clarendon Press.
Martinet, A. (1969). Qu'est-ce que le «e muet»?. In: *Le français sans fard*. Paris: Presses universitaires de France, pp. 168–190.
Martinet, A. (1972). La nature phonologique d'e caduc. In: A. Valdman (ed.), *Papers in linguistics and phonetics to the memory of Pierre Delattre*. The Hague: Mouton, pp. 393–399.
Morin, Y.-C. (1978). The status of mute 'e'. *Studies in French linguistics*, 1.2: 79–140.
Morin, Y.-C. (1988). De l'ajustement du schwa en syllabe fermée dans la phonologie du français. In: S. P. Verluyten (ed.), *La phonologie du schwa français*. Amsterdam: John Benjamins, pp. 133–189.
Muljačić, Ž. (1978). Sur la valeur de l'*e* 'instable' en français moderne. *Via domitia*, 14.2: 231–238.
Noske, R. G. (1993). *A theory of syllabification and segmental alternation: with studies on the phonology of French, German, Tonkawa*. Tübingen: Niemeyer.
Noske, R. G. (1996). Is French optimal: a question concerning phonological process order. In: J. Durand and B. Laks (eds), *Current trends in phonology: models and methods*. Paris/Salford: CNRS/ESRI/Université Paris X, vol. 2, pp. 485–507.
Picard, M. (1974). L'effacement du cheva dans les monosyllabes en québécois. *Cahiers de linguistique*, 4: 1–12.
Pleasants, J. V. (1956). *Études sur l'e muet: timbre, durée, intensité, hauteur musicale*. Paris: Klincksieck.
Rialland, A. (1986). Schwa et syllabes en français. In: E. Sezer and L. Wetzels (eds), *Studies in compensatory lengthening*. Dordrecht: Foris, pp. 187–226.
Scobbie, J. M., Coleman, J. S. and Bird, S. (1996). Key aspects of declarative phonology. In: J. Durand and B. Laks (eds), *Current trends in phonology: models and methods*. Salford/Paris: CNRS/ESRI/Paris X, vol. 2, pp. 685–710.
Selkirk, E. O. (1972). *The phrase phonology of English and French*. Ph.D. dissertation, MIT.
Smorodinsky, I. (1998) The phonology and phonetics of schwas in Parisian French: an articulatory analysis. *Texas linguistic forum*, 41: 161–171.
Spence, N. C. W. (1976). French 'mute e': the basic difficulties. *Lingua*, 39: 27–51.
Spence, N. C.W. (1982). Another look at the Loi des trois consonnes. *French studies*, 36.1: 1–11.
Tranel, B. (1981). *Concreteness in generative phonology: evidence from French*. Berkeley, CA: University of California Press.
Tranel, B. (1987). *The sounds of French*. Cambridge: Cambridge University Press.
Valdman, A. (1970). Le *E* muet et la hiérarchie structurale du français. In: A. Graur (ed.), *Actes du Xe congrès international des linguistes*, Bucarest, août-septembre 1967. Bucarest: Éditions de l'Académie de la République socialiste de Roumanie, vol. 4, pp. 71–78.
Verluyten, S. P. (1988). Introduction. In: S. P. Verluyten (ed.), *La phonologie du schwa français*. Amsterdam: John Benjamins, pp. 1–13.

Viau, J. (2004). On the production and perception of derived French clusters following schwa deletion. Paper presented at the annual meeting of the Linguistic Society of America, Boston.
Walker, D. C. (1993). Schwa and /œ/ in French. *Canadian journal of linguistics*, 38: 43–64.
Walsh, T. and Parker, F. (1983). The duration of morphemic and nonmorphemic /s/ in English. *Journal of phonetics*, 11: 201–206.
Walter, H. (1982). *Enquête phonologique et variétés régionales du français*. Paris: Presses universitaires de France.
Watbled, J.-P. (1991). Les processus de sandhi externe en français de Marseille. *Journal of French language studies*, 1: 71–91.
Wright, R. A. (1996). *Consonant clusters and cue preservation in Tsou*. Ph.D. dissertation, UCLA.