REPRESENTATION AND PHONOLOGICAL LICENSING IN THE L2 ACQUISITION OF PROSODIC STRUCTURE

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Abstract

It is widely recognized that differences in both prosodic complexity and position-sensitive contrasts exist both within and across languages. In contemporary phonological theory, these differences are often attributed to differences between heads and non-heads and the asymmetries in licensing potential that exist between such positions.

In this thesis, the consequences of such differences for the second language (L2) acquisition of prosodic complexity and position-sensitive contrasts are explored. It is argued that an explanatorily adequate account of L2 syllabification must include highly-structured representations as well as a theory of licensing, which distinguishes between the licensing of a given position and the licensing of featural content in such a position. Using data drawn primarily from a number of studies that investigate the acquisition of French by native speakers of English and Mandarin, it is demonstrated that the widely-attested interlanguage (IL) syllable-structure-modification processes of deletion, epenthesis, and feature change have a common source. Specifically, all three processes result from the IL grammar's inability to license a syllable position or (some of) the featural content present in such a position in the target representation. Within Optimality theory, the framework adopted, this is formalized through the competition between Faithfulness constraints and Markedness constraints, which evaluate the wellformedness of the licensing relationships. Finally, it is argued that Prosodic Licensing and the principle of Licensing Inheritance from Harris (1997) work together to encode prosodic markedness in representation, as they create a series of head-dependent asymmetries in which heads are strong licensors vis-à-vis their dependents.

Résumé

En phonologie, il existe des différences de complexité prosodique et de pouvoir contrastif des positions prosodiques entre les langues ainsi qu'à l'intérieur d'une même langue. En phonologie générative, on attribue ces différences aux asymétries de pouvoir d'autorisation qui existent entre les têtes et les non-têtes.

Dans la présente thèse, j'explore les conséquences de ces différences de complexité prosodique et de pouvoir contrastif des positions pour l'acquisition des langues secondes (L2). Je propose que, pour avoir un pouvoir explicatif adéquat, une analyse de la syllabation en L2 doit comprendre des représentations hautement articulées aussi bien qu'une théorie d'autorisation (angl. *licensing*), qui distingue l'autorisation d'une position de l'autorisation du contenu mélodique de cette position. À l'aide de données tirées surtout d'études sur l'acquisition du français par des locuteurs natifs de l'anglais et du mandarin, je démontre que les processus d'effacement, d'épenthèse et de changement de traits qui caractérisent les interlangues ont une source commune : ils résultent tous de l'incapacité de la grammaire de l'interlangue à autoriser une position syllabique ou le contenu mélodique (ou une partie de ce contenu) d'une telle position présente dans la représentation cible. Dans le cadre de la Théorie de l'optimalité, qui est adoptée ici, il s'agit d'une concurrence entre des contraintes sur la fidélité et des contraintes de marquage, qui évaluent les relations d'autorisation. Enfin, je propose que l'autorisation phonologique et le principe de «Licensing Inheritance» de Harris (1997) travaillent de concert pour encoder le marquage prosodique dans les représentations, car ils créent une série d'asymétries entre les têtes et les non-têtes, dans lesquelles les têtes sont des autorisateurs plus puissants que les non-têtes.

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1 *Introduction*

1.0 Introduction

Previous research on second language (L2) syllabification has demonstrated an important role for transfer and has highlighted the productivity of epenthesis, deletion, and feature change (e.g. devoicing) in the earlier stages of acquisition. Studies investigating the role of transfer have shown that L2 learners' syllabifications are initially strongly influenced by the syllable structure of the first language (L1), both in terms of the syllable positions available to the learner (see e.g. Broselow & Finer 1991, Eckman & Iverson 1993 on branching onsets) and in terms of the L1 restrictions on the types of segmental content syllabifiable in a given position (see e.g. Eckman & Iverson 1994, Cichocki et al. 1999 on coda consonants).

To illustrate, consider the data in (1) taken from two studies that will feature prominently in Chapter 3. In both of these studies, beginner Mandarin learners were tested on their syllabification of French consonant clusters. In contrast to French, Mandarin disallows clusters across the board. As such, when early Mandarin learners of French are faced with the consonant sequences in (1), they begin by simplifying them.

(1) *Mandarin learners' realization of French consonant clusters*

Target Form	Learner Form	Process
a. *tableau* [tablo] 'painting'	[dabu]	*Deletion*
b. *drap* [dʁa] 'sheet'	[dəʁa]	*Epenthesis*
c. *corde* [kɔʁd] 'rope'	[kɔt]	*Deletion+* *Feature Change (Devoicing)*

In (1a), the medial [bl] onset cluster of target *tableau* is reduced to a singleton onset via deletion of the stop. The realization of the initial stop-liquid cluster of *drap* in (1b) is more faithful: rather than deleting the liquid, an epenthetic [ə] is inserted to break up the two members of the cluster. Finally, in (1c), the word-final cluster of target *corde* is simplified through deletion of the liquid (and devoicing of the final stop; see below).

As concerns interlanguage (IL) development, the majority of research has investigated the role of markedness, where markedness has been defined almost exclusively in terms of cross-linguistic typology and implicational universals (e.g. Eckman 1977, Anderson 1983, Eckman & Iverson 1994, Carlisle 1997). Such studies have clearly demonstrated that markedness guides IL development, with typologically unmarked structures being acquired earlier than their marked counterparts (e.g. voiceless before voiced final consonants (e.g. Heyer 1986, Wang 1995); see also (1c)).

Several recent works (Hancin-Bhatt & Bhatt 1997, Broselow, Chen & Wang 1998, Hancin-Bhatt 2000) have examined transfer and the role of markedness within the constraint-based framework of Optimality Theory (OT; Prince & Smolensky 1993, McCarthy & Prince 1993a). In OT, transfer is understood as the adoption of the L1 constraint ranking as the initial IL grammar. Epenthesis, deletion and feature change result from the grammar-internal conflict between Markedness constraints, which prohibit marked structures (e.g. branching onsets, codas) in the output, and Faithfulness constraints, which seek to maximize identity between the input, generally assumed to be equivalent to the target form, and the IL grammar's output. As all constraints in OT are universally present in every language, markedness is encoded *within* the grammar in this theory. This is a clear advantage over previous typological approaches that rely on cross-linguistic distributions. While grammar-internal, OT markedness constraints are, however, for the most part still typologically-defined, and typological accounts have been argued to lack explanatory power (e.g. Cairns & Feinstein 1982, Archibald 1998). Arguably, typological approaches fail to provide principled, formal mechanisms responsible for epenthesis, deletion, and feature change. Moreover, they do not fully recognize the unity of such processes. The question arises as to whether it is not possible to encode markedness in some other way so that the theory of markedness adopted would have greater explanatory adequacy.

In this thesis, I will argue that a theory of L2 syllabification that attributes a central role to structure allows for a more explanatorily adequate approach to markedness than typological approaches.[1] This includes a theory of highly-articulated representations as well as a theory of phonological licensing, which distinguishes between the licensing of a given position and the licensing of featural content in such a position (e.g. Harris 1997, Piggott 1999). I argue that Prosodic Licensing and the principle of Licensing Inheritance (Harris 1997) work together to encode prosodic markedness in representation as they create a series of head-dependent asymmetries in which heads are strong licensors vis-à-vis their dependents. In such a theory, a syllabification is marked if it requires licensing of a position or featural content by a weak licensor, i.e. a non-head. Using data drawn primarily from a number of studies that investigate the acquisition of French consonant clusters by native speakers of English and Mandarin, I demonstrate that the IL syllable-structure-modification processes of deletion, epenthesis, and feature change

[1] By 'explanatory' and 'explanatorily adequate', I mean that a theory should not only offer an explanation of surface patterns and the acquisition of such patterns, but critically offer a principled motivation for constraints on output wellformedness and determine what are possible versus impossible grammars.

illustrated in (1) have a common source. Specifically, all three processes result from the IL grammar's inability to license a syllable position or (some of) the featural content present in such a position in the target representation. In short, a representational, licensing-based account allows for a more explanatorily adequate theory of markedness and L2 syllable structure development than theories that accord little or no importance to structure.

In the remainder of this chapter, I will contextualize and outline the research to be undertaken in this thesis. In §1.1, the focus will be on the role of transfer. As will be the case in Chapters 3 and 4, the discussion will be organized with reference to the acquisition of new syllable positions and the acquisition of segmental contrast in such positions. Such a division is not arbitrary. Rather it falls out naturally from the conception of phonological licensing to be adopted in this thesis, where a distinction is made between the licensing of a prosodic/syllable position and the licensing of melodic content in such a position. In §1.2, discussion will turn to the role of markedness in the L2 acquisition of prosodic structure, both as concerns new positions and new position-sensitive contrasts. In §1.3, we will briefly examine the interaction of transfer and markedness in those cases where they place competing demands on learners' outputs. Finally, in §1.4, I will outline the content and organization of the remainder of this thesis. Let us now turn to the role of transfer in the L2 acquisition of syllable structure.

1.1 The influence of transfer on L2 syllable structure

As alluded to above, research on L2 syllable structure has consistently shown a central role for transfer. It is important to note that there are two ways in which transfer is normally discussed, the first as concerns the initial state, the second as concerns later stages in development. The strictest interpretation of transfer involves the extent to which properties of the L1 phonology shape the initial state, that is the L2 learner's first IL grammar. The most common and strongest proposal concerning this aspect of transfer is that of the Full Transfer hypothesis (Schwartz & Sprouse 1994). Proponents of Full Transfer for phonology (e.g. Broselow & Finer 1991, Archibald 1998, Brown 1998, Broselow, Chen & Wang 1998, Hancin-Bhatt 2000) assume that a learner's endstate L1 grammar serves as the initial IL grammar. It is this position that will be adopted in the present thesis. The second and more common way in which transfer is discussed concerns the extent to which properties of the L1 grammar continue to manifest themselves throughout IL development. In Chapters 3 and 4, we will examine data that demonstrate the important role played by transfer in shaping IL syllable structure in non-initial-state grammars.

In the rest of this section, we will first look at the role of transfer in the acquisition of syllable structure positions (§1.1.1), and then turn to its role in the acquisition of position-sensitive contrasts (§1.1.2).

1.1.1 Transfer and syllable structure positions

Unlike L1 acquisition, where children's earliest outputs typically consist of CV-strings regardless of the target language syllable structure (e.g. Jakobson 1941/68, Ingram 1978), research on the L2 acquisition of syllable structure has demonstrated that learners' initial IL grammars possess those syllable structure positions present in the L1.[2] As discussed in the introduction to this chapter with reference to the data in (1), the transfer of syllable

2 Tarone (1980) argues for the creation of open syllables as an IL process that would parallel early child phonology. However, see Sato (1984), Benson (1988) and Steele (2000) for data and discussion that refute this claim.

structure positions from the L1 into the IL is typically attested to by the fact that L2 learners regularly modify target syllable structures via deletion and epenthesis in order to bring the target string into conformity with the L1 syllable structure.

Evidence for transfer of syllable positions also comes from asymmetries in syllable structure modification, including location of the deletion site. Greenberg's (1983) study of Greek and Turkish learners of English provides an example of this phenomenon. In this study, 75% of the Greek learners' modifications involved word-final clusters while 77% of the Turkish learners' modifications involved initial clusters. This asymmetry reflects differences between the learners' L1s: whereas Greek allows initial but not final clusters, the reverse situation holds in Turkish.

In Chapter 3, we will see data from L2 learners of English and French consistent with the transfer of the syllable positions present in the learners' respective L1 grammars. I will argue that transfer is best understood formally not as the transfer of the positions per se but rather as the transfer of the ability to license such positions. Under such a view, the acquisition of new positions involves the acquisition of the licensing of the dependent position of a branching onset, rhyme, or nucleus when such licensing possibilities are absent in the L1. We now turn to the role of transfer in the acquisition of new position-sensitive contrasts.

1.1.2 Transfer and position-sensitive contrasts

As we will see in §2.1.3.1, languages differ not only in terms of the syllable structure positions that they allow, but also as concerns the types of segmental contrasts that may occur in a given position. Perhaps the most widely attested position-sensitive contrasts involve codas. To illustrate, consider Mandarin and English. While the syllable structure of both of these languages is more complex than that of CV languages such as Hawaiian, one way in which Mandarin and English differ concerns the types of segments that may be licensed in coda position. In English, a coda may consist of virtually any consonant from the language's inventory. In contrast, Mandarin codas are restricted to a small subset of its inventory, namely the nasals /n,ŋ/ and, in inflected forms, the liquid /ɹ/ (e.g. Wiese 1988). There exists strong evidence that L2 learners transfer such differences in position-sensitive contrasts from the L1. For example, Altenberg & Vago (1983), in their study of two Hungarian learners of English, provide convincing evidence that the outputs of the less proficient learner show the effect of an L1 regressive (onset-to-coda) voicing assimilation process.

In Chapter 4, we will focus on data from a series of studies relevant to the acquisition of place in the dependent of a branching onset and codas, as well as voice in word-final consonants. In a number of the analyses proposed, we will see that the contrasts available to early L2 learners are those available in the L1 grammar. Moreover, in parallel to the analyses proposed for the acquisition of new syllable structure positions in Chapter 3, I will argue that the acquisition of new position-sensitive contrasts involves restructuring of the IL grammar so as to allow for the licensing of new featural configurations. This restructuring reflects markedness, as discussed in the next section.

1.2 The role of markedness in L2 syllable structure development

Research on phonological development has posited an important role for markedness, both in L1 (e.g. Jakobson 1941/68, Stampe 1969, Fikkert 1994, Gnanadesikan 1995) and in L2 acquisition (e.g. Eckman 1977, 1991, Broselow & Finer 1991, Broselow, Chen & Wang 1998). Within L2 phonological research, markedness has been argued to play a particularly important role in the acquisition of syllabification. The common theme of such studies, one shared with L1 studies, is that markedness guides interlanguage development: acquisition is characterized by stages of progressively more target-like, and more marked syllabifications. It is of interest that, whereas all such studies agree on the role of markedness in L2 phonological acquisition, there is certainly no consensus as to its actual formalization.

1.2.1 The formalization of markedness in L2 research

As mentioned earlier, the most common formalization of markedness in L2 research is that of implicational markedness. Such research, based on typological universals (e.g. Greenberg 1966), argues that markedness should be defined in terms of the implicational relationships that exist between related structures cross-linguistically. Such relationships include, for instance, voicing in stops, where the presence of voiced stops in a language implies the presence of their voiceless counterparts (i.e. voiced stops ⊃ voiceless stops).

Within OT, markedness is encoded through a family of markedness constraints that ban complex structures.[3] To illustrate, let us briefly examine Broselow, Chen & Wang's (1998) analysis of IL coda devoicing. The data examined in this study come from Wang (1995), who investigates the syllabification of word-final consonants by Mandarin and Taiwanese learners of English. In the original study, Wang's Mandarin-speaking learners modified word-final obstruents via epenthesis, deletion, or devoicing of voiced stops in 81% of cases. Broselow, Chen & Wang propose that all three processes involve high ranking markedness constraints in these learners' grammars. In the case of epenthesis and deletion, the relevant constraint is NOOBSCODA, which bans the syllabification of obstruents in coda position. Depending upon the relative ranking of the segmental faithfulness constraints MAX(C) and DEP(V), which militate against consonant deletion and vowel epenthesis respectively, learners will either delete the final obstruent, or epenthesize a final vowel to which the target word-final obstruent can be syllabified as an onset. Both processes allow the learner to avoid syllabifying the obstruent as a coda. In the case of word-final devoicing, Broselow, Chen & Wang argue that the relevant markedness constraint is NOVOICEDOBSCODA. The Mandarin learners' devoicing of English word-final voiced obstruents (e.g. target [vɪg], learner form [vɪk]) allows for satisfaction of such a highly ranked constraint.

OT analyses such as that of Broselow, Chen & Wang undoubtedly have certain advantages over previous accounts. First, constraint violability and the possibility of equally ranked constraints allow for variation, an important characteristic of IL grammars. Second, the nature of OT allows us to express the reality of constraint interaction, where constraints on markedness are not the sole consideration in determining output wellformedness. Third, in contrast to traditional typological accounts, OT accounts bring markedness into the grammar. However, these advantages are counterbalanced by certain weaknesses. First and most importantly, as I will argue in Chapter 2, many OT markedness constraints (e.g. NOCODA) reduce to notational variants of implicational/typological universals. While it is true that codas are marked vis-à-vis onsets, OT markedness constraints fail to achieve greater explanatory adequacy than typological descriptions: they do not explain why, for a given pair of features or structures, one is marked over the other. Second, given the lack of a formal theory of

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[3] For a discussion of the mechanics of OT, including the nature of constraints and ranking, see §2.4.

constraints, there is the very real danger of a proliferation of markedness constraints, or any family of constraints for that matter. Consider the processes examined by Broselow, Chen & Wang – deletion, epenthesis, final obstruent devoicing. In order to explain these three phenomena, they appeal to two constraints, NoObsCoda and NoVoicedObsCoda, whose unity may not extend beyond their labelling. In contrast, as will be argued in Chapters 3 and 4, a theory of representation and licensing allows for a constrained and explanatory account of IL deletion, epenthesis, and devoicing. All three processes have a common source. Specifically, they result from the inability of a learner's L1 grammar to license codas and/or the featural content syllabified in such positions.

We now turn to the role of markedness in shaping IL development, beginning with its role in the acquisition of new syllable structure positions.

1.2.2 Markedness and the acquisition of syllable structure positions

Research on markedness has consistently shown its role in the acquisition of syllable structure positions, with marked positions being acquired later and with greater difficulty than their unmarked counterparts. The most common finding among such studies is that, in the acquisition of consonant sequences not permitted in the L1, shorter sequences (i.e. C vs CC/CCC) are acquired more quickly and with greater accuracy when other factors, including cluster position, are held constant (e.g. Anderson 1983, Carlisle 1997, Sekiya & Jo 1997). Such facts are consistent with the implicational markedness relationship that languages which allow complex consonant sequences also allow for less complex sequences (i.e., CCC $\supset$ CC $\supset$ C; e.g. Kaye & Lowenstamm 1981). As concerns the relative markedness of onset clusters based on sonority, particularly the relative typological markedness of fricative-liquid onset clusters vis-à-vis stop-liquid clusters, in

Eckman & Iverson's (1993) study of 11 Cantonese, Japanese and Korean learners, these typological universals held in 50 of 54 cases with the less marked onset clusters (i.e. stop+liquid) being acquired first. Hancin-Bhatt & Bhatt (1997) report similar results for Japanese and Spanish learners of English.

In Chapter 3, we will examine two studies on the acquisition of French consonant clusters by native speakers of Mandarin. Data from these two studies will support the view that markedness guides IL development: syllable structure complexity will emerge in strong licensing (i.e. unmarked) positions first. Moreover, when faced with two possible representations for a given output, learners will adopt the less marked of the two.

1.2.3 Markedness and the acquisition of position-sensitive contrasts

Less research has investigated the role of markedness in the L2 acquisition of position-sensitive contrasts. The most common evidence put forward in support of the role of markedness in the acquisition of position-sensitive contrasts involves the acquisition of voicing in coda position. A commonly attested IL phenomenon is the devoicing of target voiced obstruents by learners whose L1 does not permit obstruent codas at all (e.g. Eckman 1981, Flege & Davidian 1984, Wang 1995). Coda devoicing shows that learners do not move directly from a transferred L1 grammar which bans all obstruent codas to the target grammar which allows both voiceless and voiced coda obstruents. Rather, they pass through an intermediate stage in which both voiceless and voiced target obstruents are realized as voiceless. At such a stage, the IL grammar is more marked than the learners' L1 grammar in that it allows voiceless obstruent codas, yet less marked than the target grammar in not allowing voiced obstruents.

In Chapter 4, I will propose that intermediate stages of development, including stages where only the unmarked member of a contrast is present in learners' outputs, are best understood under a structure building approach in which progressively more melodic structure (i.e. contrast) is licensed over time. For example, under the theory of segmental representation to be proposed in Chapter 2, the voiced member of a voiceless-voiced pair includes more laryngeal structure than its voiceless counterpart. As such, at an intermediate stage where only part of the laryngeal structure necessary for the representation of the voiced member of the pair can be licensed, all final stops will surface as voiceless.

In the following section, we conclude our discussion of transfer and markedness by briefly examining how these two shaping forces interact when they make competing demands on L2 learners' outputs.

1.3 Competition and interaction between transfer and markedness

While our discussion of transfer and markedness to this point has focused on their individual roles, one naturally might wonder how transfer and markedness interact and, when interaction occurs, whether one of the two typically dominates. For example, as all grammars are marked in some ways, it will often be the case that, following transfer, a learner's initial IL grammar will contain marked structures (e.g. complex onsets, some subset of codas). One might wonder whether, under pressure from markedness, the learners' outputs might be less marked than predicted by transfer alone. In the extreme case, one might predict that L2 learners will revert to the type of unmarked grammar proposed for the L1 initial state (cf. §1.1.1).

Data from previous studies of the L2 acquisition of syllable structure offer a mixed answer as to the relative roles of transfer and markedness in the acquisition of syllable structure. Both possible interactions, that is transfer over markedness (e.g. Baptista & da Silva 1997) and markedness over transfer (e.g. Altenberg & Vago 1983), have been proposed. However, it is arguably more often the case that there is evidence for markedness over transfer. Data from Eckman & Iverson's (1994) study of six learners, two native speakers each of Cantonese, Korean and Japanese, and their syllabification of English word-final codas are consistent with this. For all three groups of learners, voiceless obstruent codas involved more errors than nasal codas, which were virtually error free. While such an asymmetry is understandable for the Japanese learners whose L1 does not permit obstruent codas, voiceless obstruent codas are licit in both Cantonese and Korean as are nasals. As nasals are less marked than obstruents in coda position, the Cantonese and Korean data would appear to be consistent with markedness overriding transfer. Within OT, the competition between transfer and markedness is readily formalized through constraint ranking.[4] In Chapters 3 and 4, we will see that L2 learners' outputs show both evidence of the constraint ranking of the L1 as well as the effect of structurally-encoded markedness.

Having examined the general findings of previous L2 research as concerns transfer, markedness and their interaction, in the following section, I will outline the structure of the remainder of the thesis.

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4 While OT allows for the competition between transfer and markedness to be formalized through constraint interaction, it does not provide an explanation as to which of the two forces dominates and in which contexts. Such an issue remains a topic for future research.

1.4 Thesis structure

The remainder of this thesis consists of three core chapters as well as a brief conclusion. In Chapter 2, we will focus on the theories of syllable structure and phonological licensing that will underpin the analyses to be proposed in Chapters 3 and 4. As concerns prosodic representation, I will propose that a learner's competence includes highly-structured representations built from a finite set of constituents including the Syllable, Foot and Prosodic Word, as well as the Onset, Rhyme and Nucleus. A central role will be proposed for heads, whose presence serves to set the lower bound on constituent size. While many theories of representation accord an important role to heads, I will adopt the less widely held view that heads may be phonetically unrealized under certain conditions. This allows for the presence of onsets of empty-headed syllables. As we will see, such onsets play a particularly important role in the organization of word-final consonants.

Once constituency has been discussed, we will turn to an investigation of the types of dependency or licensing relations that serve to organize prosodic structure. Much of the discussion will focus on asymmetries between heads and non-heads, where the former are imbued with a greater stock of licensing power and thus the ability to host a wider range of contrasts, both prosodic and melodic. Discussion of representation will also focus on segmental structure, albeit to a lesser extent. Particular attention will be paid to the representation of place, laryngeal contrasts, and sonorant consonants.

Once the issues of prosodic and segmental representation have been discussed, we will turn to markedness. I begin by presenting a brief overview of the ways in which markedness has been formalized in previous research. This will include typological markedness of the type discussed in §1.2.1 as well as the type of grammar-internal proposals that figure in most generative accounts. The approach to be adopted in this thesis builds on the latter view of markedness in attributing a central role to structure. Following Harris' (1997) principle of Licensing Inheritance, I assume that the head-non-head licensing relationships that exist throughout prosodic structure are inherently asymmetrical, with the result that heads possess a greater stock of licensing potential than their dependents. I will propose that an explanatorily adequate theory of syllable structure markedness can be derived from such asymmetries: a syllabification is relatively marked if its representation involves the licensing of a position or feature in a weak position, where non-heads constitute such positions. Chapter 2 concludes with a presentation of the fundamentals of OT, including the nature and basic families of constraints, as well as constraint ranking and output candidate evaluation.

In Chapters 3 and 4, we will investigate the implications of the theory of representation and licensing outlined in Chapter 2 for the acquisition of prosodic complexity and position-sensitive contrasts respectively. I begin Chapter 3 with a discussion of three basic assumptions made by L1 researchers working within OT; these include the nature of the initial state and grammatical development, as well as the role of markedness in guiding acquisition. Under the assumption that L1 and L2 acquisition are fundamentally similar, this discussion will serve to outline the framework adopted for the L2 analyses in the rest of the chapter and on into Chapter 4.

The data discussed in Chapter 3 come from two separate studies on the acquisition of French by native speakers of Mandarin. In both studies, the learners were tested on their syllabification of consonant clusters involving stops and liquids. In the case of the first study, I will argue that the data provide evidence for the central role of heads in L2 prosodic organization. When simplifying a target word-final stop-liquid or liquid-stop cluster through deletion, the Mandarin learners preserve the stop almost without exception. Under the representations proposed, the stop of both types of clusters is syllabified as the head of the onset of an empty-headed syllable. As such, the learners' reduction pattern provides evidence for head preservation. Another aspect of the same data, specifically the learners' phonetic realization of final stops, will be relevant to the discussion of markedness. In this study, the learners (heavily) aspirated virtually all final stops. I will propose that the aspiration is the phonetic interpretation of a final consonant syllabified as an onset. As will be argued in Chapter 2, onset syllabification of final consonants is unmarked. Thus, the learners' aspiration is consistent with their adopting the unmarked option where possible.

The second study to be investigated tests Mandarin learners on their syllabification of French stop-liquid onset clusters. While the learners' outputs provide evidence for the role of Markedness constraints on heads and positional prominence as well as Foot Binarity in assuring wellformedness, I will propose that the data also allow for insights into the role of phonetic cues in the construction of inputs. The French targets in question contained both stop-/l/ and stop-/ʁ/ clusters. I will argue that the phonetic properties of French /ʁ/, namely its frication and low sonority, misled many of the learners to assign a phonological input representation in which /ʁ/ is an obstruent; this is consistent with the learners' realizations of target /ʁ/ as [χ], [x] and/or [h]. As a consequence, even when branching onsets begin to emerge in the learners' grammars, as attested to by their target-like syllabification of stop-/l/ targets, stop-/ʁ/ forms are syllabified via epenthesis or reduction of the cluster.

In Chapter 4, we turn to an investigation of the acquisition of new position-sensitive contrasts involving place in the dependent of branching onsets and codas, as well as voice in word-final consonants. As concerns place in the dependent of a branching onset, we will examine data from two separate studies that investigated the acquisition of word-final stop-liquid clusters (e.g. *table* [ta.bl] 'table', *lettre* [lɛ.tʁ] 'letter') by English- and Mandarin-speaking learners of French. In both studies, the learners acquired the stop-/ʁ/ targets first. I will argue that this asymmetry is related to differences in the representation of /l/ and /ʁ/ discussed in Chapter 2. Specifically, given that the representation of /ʁ/ involves less place structure than /l/, the rhotic can be more readily licensed in the dependent position of the onset, a weak licensor. In the case of codas, we will examine asymmetries involving nasal codas. In all of the analyses, I will argue that coda place is acquired easily when the place features of the coda can be licensed by the following onset.

Chapter 4 concludes with a discussion of the acquisition of voice in word-final stops. The data will be drawn primarily from a study on the acquisition of English by native speakers of Japanese. I will argue that learners acquire the voiceless member of the pair first given that its representation is less complex and thus more easily licensed in a weak position such as the coda. The relatively higher cost of licensing the greater featural content of the voiced member of the pair results in epenthesis being triggered significantly more often following voiced as opposed to voiceless stops, as epenthesis allows for the syllabification of the voiced member in an onset, a strong licensing position.

In Chapter 5, we will briefly summarize the primary findings of Chapters 3 and 4.

1.5 Chapter Summary

In this chapter, discussion has focussed primarily on the role of transfer and markedness in shaping L2 learners' syllabification. As concerns transfer, we have seen that early IL grammars possess both the positions and position-sensitive contrasts available in the L1. As concerns markedness, I have discussed data from a number of studies that are consistent with markedness guiding IL development.

We will now proceed to Chapter 2 where discussion will centre on the theoretical assumptions that will serve to frame the analyses proposed in the rest of the thesis.

2 *Theoretical assumptions*

2.0 Introduction

In the examination of the L2 acquisition of prosodic complexity and position-sensitive contrasts to be undertaken in Chapters 3 and 4 respectively, I will argue for a central role for highly structured representations. As theories of representation may vary greatly concerning their basic assumptions, the goal of the present chapter will be to present the theory of syllable structure and phonological licensing adopted in this thesis.

The present chapter consists of four principal subsections. In §2.1, I discuss prosodic representation. The focus will be on the nature of constituency and headedness, including the possibility of prosodic positions lacking segmental content, and the principle of Phonological Licensing. In the discussion of the latter, considerable attention will be paid to the types of asymmetries in licensing potential that exist between different prosodic positions. I will propose that such asymmetries are the consequence of the principle of Licensing Inheritance (Harris 1997). Phonological Licensing will be central to the analyses presented in Chapters 3 and 4 in two different respects. First, I will argue that L2 learners' deletion, epenthesis and feature change result from the IL grammar's inability to license phonological material present in the target representation. Second, in Chapters 3 and 4 respectively, I will demonstrate that the asymmetries attested in the acquisition of new prosodic positions (e.g. branching in head before non-head syllables) and positional contrasts, including place and voice, mirror the asymmetries in licensing potential between different prosodic positions that follow from Licensing Inheritance. In

§2.2, I turn to segment structure, presenting those components of a theory of representation necessary for the examination of the acquisition of position-sensitive contrasts to be undertaken in Chapter 4. These include the manner in which features involved in the representation of place, laryngeal contrasts and sonorant consonants are organized. In §2.3, I present the licensing-based theory of markedness adopted in this thesis. I begin with a discussion of previous approaches to markedness, including typological accounts, SPE, and more recent structure-based analyses which share the idea that markedness is defined in terms of relative structural complexity (e.g. Rice 1992, 1999, Causley 1999); it is this latter conception of markedness that will be espoused in Chapters 3 and 4. I will argue that an explanatory theory of markedness must involve highly structured representations and elaborate a theory of syllable structure markedness derived from the principles of Prosodic Licensing and Licensing Inheritance discussed in §2.1. Finally, in §2.4, we will examine the basic mechanics of Optimality Theory, including constraints and their interaction. We begin with an examination of the fundamentals of prosodic representation.

2.1 Prosodic representation

As stated in Chapter 1, I assume that a learner's competence includes highly articulated representations. In the present section, we will focus on the nature of prosodic representation. Discussion will centre particularly on the manner in which phonological representations are built from a finite set of features and prosodic constituents, all of which are interrelated through a series of dependency relations formally known as Phonological Licensing.

2.1.1 Constituency and headedness

It is widely accepted that languages draw from a universal set of prosodic constituents (e.g. Selkirk 1980a,b, Nespor & Vogel 1986, McCarthy & Prince 1986) in the construction of phonological representations. This set minimally includes the Syllable (σ), Foot (Ft), Prosodic Word (PWd), and Prosodic (PPhr) and Intonational Phrases (IntPhr).[1] Prosodic organization consists of a series of embedding relationships in which prosodic constituents, from the level of the syllable up, are grouped into progressively larger constituents as per the Prosodic Hierarchy (e.g. Hockett 1955, Fudge 1969, Selkirk 1980a,b, Booij 1983) given in (1). Note that, while the entire Prosodic Hierarchy is shown below for the sake of completeness (modulo note 1), given that the focus of the present research is syllable structure, in this thesis, I will only discuss prosodic structure at and below the level of the Prosodic Word.

(1) *Prosodic hierarchy*

IntPhr
|
PPhr
|
PWd
|
Ft
|
σ

All prosodic constituents are organized internally via a series of head-non-head relationships. As stated in (2), I adopt the view that the minimal wellformed structure consists of a *head* (e.g. Fudge 1969, Halle & Vergnaud 1987, Kaye, Lowenstamm & Vergnaud 1990, Hayes 1995, Dresher & van der Hulst 1998, Piggott 1999).

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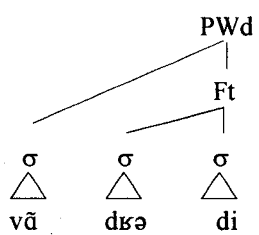
1 Other members of the prosodic hierarchy, including the mora (e.g. Hyman 1985, Hayes 1989) and the clitic group (e.g. Nespor & Vogel 1986), have been proposed. In adopting Onset-Rhyme theory (see (4)), I exclude the mora from (1) above. I remain agnostic as to the status of the clitic group as this constituent is not relevant to the types of structures to be investigated in Chapters 3 and 4.

(2) Headedness

All phonological constituents minimally consist of a head

The head of any constituent is one instance of the constituent that it immediately dominates in the Prosodic Hierarchy. If a language chooses to expand upon the minimal structure required by (2), it does so by adding a non-head. In those cases where the non-head is prosodified within the same immediate constituent as the head, it is called a *dependent*. Thus, in a three syllable word like French *vendredi* (vɑ̃(dʁə.ˈdi)$_{Ft}$)$_{PWd}$ 'Friday',[2] both of the syllables [vɑ̃] and [dʁə] are non-heads. However, [dʁə] alone is a dependent of the head of the foot as only it is prosodified foot-internally. The representation in (3) shows these head-non-head relationships, where a vertical line between the head constituent and the constituent of which it is a head indicates head status. In contrast, an oblique line indicates non-head status.

(3) *Prosodic structure of French vendredi* [vɑ̃drəˈdi]



The prosodic structure of a word like *vendredi* demonstrates the series of head-non-head relations existent in all prosodic structure. As we will see in §2.1.3.1, heads typically distinguish themselves from non-heads in their ability to license a greater range of contrasts, including greater prosodic complexity (e.g. branching constituents) and/or segmental complexity (e.g. larger number of featural contrasts). While the importance of heads in phonological organization is widely recognized in theories of endstate grammars

2 I follow Charette (1991) in assuming that French final stress results from the construction of a non-iterative iamb at the right edge.

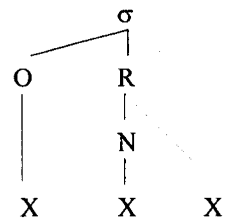
(e.g. Government Phonology: Kaye, Lowenstamm & Vergnaud 1990, Harris 1994; Head-driven Phonology: van der Hulst & Ritter 1999a; Principles and Parameters Phonology: Dresher & van der Hulst 1998, Piggott 1999), a number of recent analyses have proposed an equally important role for heads in language development (e.g. Rose 2000, Goad & Rose to appear for L1; Steele 2002 for L2). Indeed, in Chapters 3 and 4, we will see that the greater licensing ability of prosodic heads is the source of a number of asymmetries in the acquisition of new prosodic positions and position-sensitive contrasts in L2 acquisition.

2.1.2 Syllable-internal constituency

In this thesis, I adopt Onset-Rhyme theory (e.g. Pike & Pike 1947, Fudge 1969, 1987, Kaye & Lowenstamm 1981, Selkirk 1982, Booij 1983). In Onset-Rhyme theory, the Rhyme heads the syllable.[3] Pre-vocalic consonants are organized within the syllable non-head, the Onset. As per (2), the Rhyme and Onset both minimally consist of a head; I follow Government Phonology (GP, Kaye, Lowenstamm & Vergnaud 1990) in assuming that syllable constituents are universally left-headed. In the case of the Rhyme, the head is the leftmost position within the Nucleus. I also follow GP in giving no formal status to the coda. However, I will continue to use this term informally to refer to post-vocalic rhymal consonants. The internal organization of the syllable is given in (4) below where the 'X's represent positions or timing-slots (e.g. Levin 1983, 1985).

[3] In some versions of Onset-Rhyme theory, the head of the syllable is the Nucleus, of which the Rhyme is a projection.

(4) *Onset-rhyme theory*



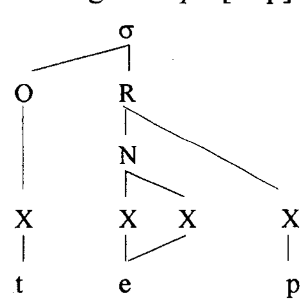
One further assumption concerning syllable constituency is necessary. I assume that the binary head-dependent structure fixes the upper limit on syllable constituent size (e.g. Selkirk 1982, Kaye & Lowenstamm 1990, van der Hulst & Ritter 1999b).[4] This principle is formalized in (5).

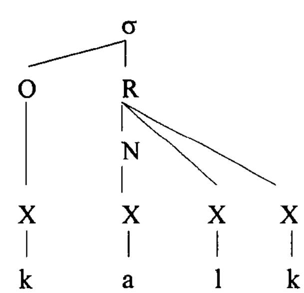
(5) Binarity theorem

Syllable constituents are maximally binary

One important consequence of constituent binarity will be central to the analyses proposed in Chapters 3 and 4. If the rhyme is constrained by binarity, the maximal sequence that may be syllabified rhyme-internally is VV/VC. As such, the syllabification of sequences of greater length will necessarily involve structures more complex than a simple rhyme. For example, in English, words may end in VVC (e.g. *tape* [te:p], *wise* [waiz]) or VCC (e.g. *milk* [mɪlk]) sequences. Word-final VCC sequences are also licit in French (e.g. *calque* [kalk] 'copy', *orgue* [ɔʁg] 'organ'). Consider (6).

(6) a. English *tape* [te:p] b. French *calque* [kalk] 'copy'





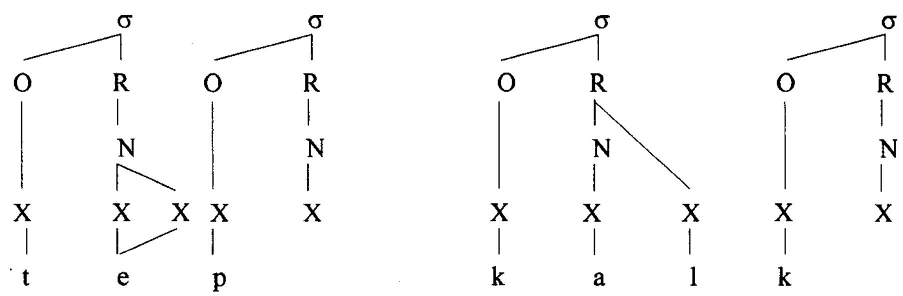
[4] For van der Hulst & Ritter, binarity holds for all prosodic constituents.

Both of these representations involve ternary branching within the rhyme.[5] Consequently, if the Binarity Theorem is a principle of syllable constituent wellformedness,[6] such representations must be ill-formed. In the following section, I adopt an alternative representation consistent with binarity, one in which the final consonant of such forms constitutes the onset of a degenerate or empty-headed syllable.

2.1.2.1 Onsets of empty-headed syllables

Alternative representations for English *tape* and French *calque* are given in (7) below.

(7) a. English *take* [te:p] b. French *calque* [kalk]



The representations in (7) differ from those of (6) in two important respects. First, the forms in (7) are phonologically bisyllabic. Second, such representations involve prosodic positions lacking segmental content. In both (7a) and (7b), the final consonant is syllabified as the onset of an empty-headed syllable (OEHS). The possibility of empty positions argued for here has been posited in a number of phonological frameworks (e.g. Government Phonology (e.g. Kaye, Lowenstamm & Vergnaud 1990, Kaye 1990),

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5 I assume that binarity is evaluated in terms of a single wellformed head-dependent relationship within the constituent(s) in question. Thus, the addition of a coda consonant to a branching nucleus is ill-formed. Consequently, within the rhyme, a simple nucleus, a branching nucleus, or a simple nucleus-simple coda structure are all wellformed as concerns binarity. The cross-linguistic restrictions on rhyme wellformedness discussed in §2.1.2.1 are consistent with such an assumption.

6 Rhyme binarity is explicitly posited for English by e.g. Borowsky (1989), at least for 'Level 1' phonology, and Harris (1994), and for French by Plénat (1987), Charette (1991), and Dell (1995) among others.

Principles and Parameters (e.g. Goldsmith 1990, McCarthy & Prince 1990, Piggott 1991a,b), OT (Féry 2001)).

Several distributional characteristics of English and French final sequences support an OEHS analysis. First, it has been widely observed that, in many languages, sequences such as VXC are typically restricted to word-edge syllables (e.g. Booij 1983, Itô 1986, Goldsmith 1990, Kaye 1990, Harris 1997, van der Hulst & Ritter 1999b). If the representations in (6), which violate binarity, were indeed wellformed, the theory would predict that such clusters should occur word-internally. That is, if [eːp] and [alk] were truly possible English and French rhymes respectively, monomorphemic words like [tʃeːp.tɹ̩] and [falk.tœʁ] would be wellformed, yet such words are virtually unattested (compare with wellformed English *chapter* [tʃæp.tɹ̩] and French *résultat* [ʁe.zyl.ta] 'result', *facteur* [fak.tœʁ] 'mailman').[7,8] Second, if word-final CC clusters were instead coda-onset sequences, one would expect that the phonotactics of such clusters should mirror those of indisputable word-medial coda-onset sequences. As shown in (8) below, this prediction is borne out for the most part.[9]

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7 Such exceptional syllable complexity often involves morphological complexity (e.g. Level-2 derivation (e.g. *statement* [steːt#mənt]), compounding (e.g. *mailman* [meːl##mæn])). As such forms also involve greater prosodic complexity, for example conjoined prosodic words in the case of compounds, it is essential to consider only monomorphemic forms when determining a language's core syllable structure (Harris 1997:366, van der Hulst & Ritter 1999b:18).

8 See Goldsmith (1990:340, Note 35) for a list of words including *mountain* that contravene this observation in English. However, the exceptions are extremely few in number. Moreover, in all of the cases given by the author, the onset of the sequence must be coronal (e.g. *shoulder* [ʃoːldəɹ], **shoulper*, **shoulker*). Were such sequences truly representative of what English permits, the theory would predict that no such phonotactic restriction should hold.

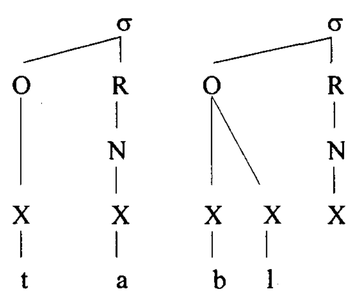
9 Exceptions include nasal+nasal (e.g. *amnesty*, **amn*) and nasal+voiced non-coronal obstruent sequences (e.g. *amber*, **amb*)

(8) *English and French nasal- and liquid-stop sequences*

	English		*French*	
	Word-Medial	Word-Final	Word-Medial	Word-Final
Nasal-Stop	*ample* [æm.pl̩]	*amp* [æm.p]	n/a[10]	
	centre [sɛn.tɹ̩]	*cent* [sɛn.t]		
	inkling [ɪŋ.klɪŋ]	*ink* [ɪŋ.k]		
Liquid-Stop	*filter* [fɪl.tɹ̩]	*silt* [sɪl.t]	*soldat* [sɔl.da] 'soldier'	*solde* sɔl.d] 'sale'
	cordon [kɔɹ.dn̩]	*cord* [kɔɹ.d]	*carpette* [kaʁ.pɛt] 'rug'	*carpe* [kaʁ.p] 'carp'

The phonotactics of French word-final obstruent-liquid clusters give further weight to the onset analysis adopted here. In Continental French, words may end in obstruent-liquid clusters (e.g. *table* [tabl] 'table', *lettre* [lɛtʁ] 'letter', *gifle* [ʒifl] 'slap'). The representation of such clusters, using the example *table*, is given in (9).

(9) *Representation of French table* /tabl/ *'table'*



Several phonologists have posited an OEHS syllabification of such clusters (e.g. Charette 1991, Dell 1995, Piggott 1999, Rose 1999, Féry 2001). Such an analysis is supported by three characteristics of these clusters. Consider the data in (10).

10 In French, underlying /VNC/ sequences are realized as [VC] outputs. See §4.1.2.1 for discussion of the representation of such sequences.

(10) *French obstruent-liquid clusters*

	Initial	*Medial*	*Final*
Licit	*pli* 'fold' [pl̠i]	*réplique* 'replique' [ʁe.pl̠i.k][11]	*couple* 'couple' [kupl̠]
	trop 'too' [tʁ̠o]	*attrait* 'appeal' [a.tʁ̠e]	*quatre* 'four' [ka.tʁ̠]
	fléau 'curse' [fl̠e.o]	*ronfler* 'to snore' [ʁɔ̃.fl̠e]	*gifle* 'slap' [ʒi.fl̠]
Illicit	**tlot* *[tl̠o]	**cartlot* *[kaʁ.tl̠o]	**matle* *[ma.tl̠]

First, in French, any possible word-final obstruent-liquid cluster is also a possible word-initial and word-medial branching onset (Dell 1995).[12] Second, like English, French does not allow onsets consisting of a coronal stop followed by /l/. The absence of word-final /tl/ and /dl/ is in line with such a restriction on branching onsets. Third, the rising sonority profile of such clusters is the typical profile of branching onsets cross-linguistically.[13] In summary, the phonotactics and sonority profile of French word-final obstruent-liquid clusters perfectly mirror those of indisputable word-initial/-medial onsets as should be expected following the representation in (9).

2.1.3 Licensing

In the preceding section, we saw that prosodic representations are built from a series of universal constituents that are organized through a series of dependency relationships instantiated in the Prosodic Hierarchy. In most theories, such dependency relationships

11 Word-final consonants are syllabified as OEHS in French (e.g. Dell 1995, Piggott 1999).

12 It is not the case that the set of contrasts licensed in OEHS are always identical to those contrasts licensed in onsets of melodically-filled syllables. Indeed, in some languages, OEHS fail to license all of the contrasts of word-initial and word-medial onsets. For example, in English, any consonant save /ŋ/ may appear in an onset preceding an overt nucleus. However, it is not only /ŋ/ but also /h/ that is prohibited from being licensed by an OEHS. The prohibition on /h/ also holds for Yapese (see Goad & Brannen in press, among others).

13 The role of sonority in determining syllable wellformedness will be discussed in §2.2.1.4.

are formalized via the principle of Phonological Licensing (e.g. Itô 1986, Goldsmith 1990), one version of which is given in (11).

(11) Phonological licensing

All phonological units must be phonologically licensed, i.e., belong to higher prosodic structure.

Phonological Licensing requires that all phonological structure be organized into progressively larger units from the level of the feature up, with the presence of any prosodic constituent being dependent upon some higher constituent in the Prosodic Hierarchy. As such, licensing is the formal mechanism that authorizes the presence of all phonological material in output representations. In this thesis, I will distinguish between two sub-types of phonological licensing, namely Prosodic or P-Licensing versus Autosegmental or A-Licensing (Goldsmith1990, Harris 1997) as defined in (12) and (13) respectively.[14]

(12) Prosodic licensing (P-licensing)

A prosodic constituent (e.g. Syllable, Foot) or syllable structure position (i.e. Onset, Rhyme, Nucleus) is prosodically licensed if it is dominated by some superordinate constituent in the Prosodic Hierarchy

For example, in the first syllable in the representation in (9) above, the syllable P-licenses the onset and rhyme, with the rhyme in turn P-licensing the nucleus. In contrast, Autosegmental licensing refers to the licensing of features as stated below.

(13) Autosegmental licensing (A-licensing)

A phonological feature (e.g. place, manner, laryngeal feature) is autosegmentally licensed if it is dominated by some superordinate feature or prosodic constituent

[14] For a discussion of licensing applied to syntagmatic relations, see §2.1.3.1.

In (9), the first onset A-licenses the root node which dominates all other nodes and features in the representation of [t] (see §2.2).[15] The root node in turn A-licenses the segment's place node, which licenses the place feature [coronal]. In summary, phonological licensing requires that both prosodic and segmental material be anchored into progressively larger phonological structure. Whereas P-licensing is responsible for the licensing of prosodic constituents at all levels of the Prosodic Hierarchy, A-licensing ensures that featural material present in representation is anchored into prosodic structure.

2.1.3.1 Asymmetries in licensing potential

While the principle of Phonological Licensing must be respected to ensure representational wellformedness, languages differ as concerns the types of positions that may be P-licensed as well as the featural contrasts that may be A-licensed in a given position. These differences typically manifest themselves as asymmetries in both the P- and A-licensing potential of heads versus non-heads. The most widely recognized licensing asymmetry of this type is that between onsets and codas (e.g. Itô 1986, Goldsmith 1990, Kaye, Lowenstamm & Vergnaud 1990, Harris 1997, Piggott 1998). As concerns P-Licensing, while all languages license the presence of onsets, rhymes, and nuclei (Blevins 1995), in many languages codas are illicit; that is, such languages do not P-license post-rhymal consonants (e.g. CV languages like Senufo). Furthermore, in languages that do licence codas, it is generally the case that the set of segmental contrasts possible in coda position constitutes a smaller set than the set of possible onsets.

[15] X-slots are not imbued with any licensing power. It is consequently the onset that licenses the presence of the featural material in question. A-licensing and the theory of segmental representation adopted here will be examined in greater detail in §2.2.

To illustrate, consider the case of Mandarin, the native language of two of the groups of L2 learners to be studied in Chapters 3 and 4. The language's inventory of consonants is given in (14) below.

(14) *Mandarin consonant* inventory (Based on Duanmu 2000:26)

	Labial	Coronal	Retroflex	Dorsal
Stop	p pʰ	t tʰ		k kʰ
Fricative	f	s	ʂ	x
Affricate		ts tsʰ	tʂ tʂʰ	
Nasal	m	n		ŋ
Liquid		l	ɹ	
Glide	w	j		

With the exception of /ŋ/, all of the above consonants can appear in onset position. In stark contrast, Mandarin codas are restricted to the nasals /n,ŋ/ (e.g. Wiese 1988) as well as well as the liquid /ɹ/.[16,17] In the theory of prosodic licensing adopted here, such an asymmetry results from the relatively weak A-licensing potential of codas, as illustrated here with Mandarin.[18]

[16] /ɹ/-final words result from affixation only (e.g. Cheng 1966, Wiese 1986, Yip 1992). See §4.1.2.2 for discussion.

[17] Some researchers argue that the glides /j,w/ may also appear in coda (e.g. Cheng 1966, Duanmu 2000). While Mandarin words may indeed end in glides (e.g. [laj] 'come', [paw] 'run'), I assume that they are syllabified within the nucleus as the second part of a heavy diphthong (i.e. [lai], [pau]). Two facts support such an analysis. First, /j/ and /w/ are restricted to following /a,ə/. This contrasts with the nasal codas /n,ŋ/ which may follow a wider range of vowels (e.g. /n/: [pan] 'half', [tʂʰən] 'sink', [ɕin] 'cloud', [ɕʷyn] 'fast'; /ŋ/: [waŋ] 'forget', [tɕəŋ] 'quiet', [tʂʰʷuŋ]). Were glides also syllabified as codas, one would expect the same freedom of distribution as nasal codas. Second, as I will argue in §4.1.2.1, the Mandarin coda cannot license place features. While the coronal place of [j] could result from default phonetic interpretation (see §2.2.2), the representation of [w] involves the articulator [labial], which must be licensed.

[18] In §2.1.3.2, I will argue that such asymmetries are the consequence of the principle of Licensing Inheritance (Harris 1997), which results in non-heads having weakened licensing potential vis-à-vis the heads from which such potential is inherited. Consequently, an onset, as a head, has greater licensing potential than a coda, a rhymal dependent.

Licensing asymmetries between heads and non-heads also exist at the level of the Foot. In a number of languages, contrasts that are possible in the head of the foot are not possible in the non-head. For example, Harris (1997:363) provides relevant data from southeastern Brazilian Portuguese. In this variety, an onset in the head of the foot may P-license a dependent (i.e. may branch) as shown in (15a), whereas branching is illicit in non-heads (15b).[19]

(15) *Southeastern Brazilian Portuguese: positional asymmetry in branching onsets* (Harris 1997)

a. *prato* [ˈpra.tu] 'plate'
   livreto [li.ˈvre.tu] 'small book'

b. *pratinho* [pa.ˈtʃi.ɲu], *[pra.ˈtʃi.ɲu] 'small plate'
   livro [ˈli.vu], *[ˈli.vru] 'book'

A further example involving licensing potential asymmetries at the level of the Foot comes from Quebec French. Recall from (10) that in Continental French, obstruent-liquid clusters may occur in all positions in the word (e.g. *bleu* [blø] 'blue', *tableau* [tablo] 'painting', *table* [tabl] 'table'). Under the assumption that the French foot is a non-iterative iamb constructed at the right edge (Charette 1991; e.g. *table* 'table' $[(\text{ta})_{\text{Ft}}\text{bl}\varnothing]_{\text{PWd}}$), word-final obstruent-liquid clusters must be unfooted and P-licensed by the PWd. The non-head status of such syllables has consequences for their realization in Quebec French. While obstruent-liquid clusters are possible word-initially and word-medially (see examples in (10) for Continental French), in word-final position, only the

[19] Interestingly, Rose (2000) observes the same asymmetry in L1 acquisition. Data from his two child learners of Quebec French show that, at the first stage in development where branching is permitted in onsets, it is restricted to the head of the foot. Such data attest to the role of prosodic licensing, including licensing asymmetries, in phonological development.

head of the obstruent-liquid cluster can be licensed. As a result, the underlying cluster is realized as a singleton obstruent (e.g. *table* [tab]).

Asymmetries within the foot may also involve position-sensitive contrasts, that is A-licensing. Van der Torre (2001) presents relevant data concerning the contrasts possible in the non-head of the onset in Dutch. As shown in (16), while branching onsets are possible both in the head and dependent of the foot, the number of possible segmental contrasts that can be A-licensed is greatly reduced in non-head positions.[20]

(16) *Dutch: asymmetry in positional contrasts in branching onsets* (Van der Torre 2001)

Stressed σ	Unstressed σ
knV	*knV
stV	*stV
plV	*plV
prV	prV

The types of A-licensing asymmetries discussed here do not only involve consonants. Indeed, differences in the contrastive potential of head and non-head syllables within the Foot manifest themselves more typically with vowels. Dresher & van der Hulst (1998) provide the example of certain dialects of Modern Greek. In these dialects, the set of possible contrasts in syllables in the head of the foot is that of (17a) whereas non-head syllables are restricted to licensing the reduced set of contrasts in (17b).

(17) *Modern Greek: asymmetry in vowel contrasts*

a. Vowel contrasts in head

i		u
e		o
	a	

b. Vowel contrasts in non-head

i		u
	a	

---

[20] It is likely that /sC/, and possibly /kn/, involve initial appendices. Regardless of whether such sequences are licensed as branching onsets or appendix-onset sequences, the licensing relations necessary for the syllabification of these two types of clusters are permitted in head syllables only.

In summary, the difference between positions of maximum and reduced complexity, both as concerns P- and A-licensing, reflects the head versus non-head status of such positions. As such, these contrasts constitute examples of head-dependent asymmetries (Dresher & van der Hulst 1998), or head-non-head asymmetries more generally.[21] When such asymmetries exist, it is always the case that the head will allow more complexity vis-à-vis non-heads. Stated in terms of licensing, in cases of asymmetry, prosodic heads are always stronger licensers than non-heads.

As we will see in Chapters 3 and 4, such asymmetries have important implications for the acquisition of prosodic complexity. Indeed, Dresher & van der Hulst propose that the origin of head-non-head asymmetries is the acquisition process itself. Specifically, they argue that children begin with relatively impoverished representations and, under pressure from the data, increase the complexity of such representations beginning with heads. L1 studies such as Rose (2000) and Goad & Rose (to appear) make similar proposals and provide empirical support; we will examine relevant data from Rose (2000) in §3.3.3.3. While agreeing with the general thrust of such a proposal, I will argue in this thesis that it is not only that learners pay attention to heads, but that the universally greater P- and A-licensing capacity of heads results in complexity emerging first in head positions other things being equal.

While head-non-head asymmetries can be stated in terms of licensing, a principled explanation for the relatively stronger licensing power of heads has yet to be offered here. In the following section, we will examine another type of licensing that

[21] While Dresher & van der Hulst speak of head-dependent asymmetries, the examples discussed above demonstrate that 'dependent' must be extended to all non-heads. For example, in southeastern Brazilian Portuguese, branching onsets are banned in non-head syllables regardless of whether they are foot-internal or not.

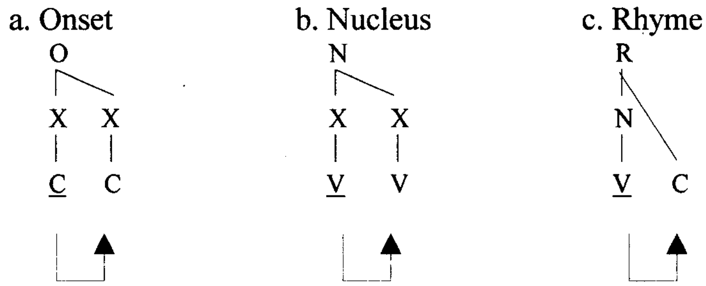
exists between constituents embedded within the same prosodic constituent. It is this type of intra- and interconstituent licensing, in conjunction with the principle of Licensing Inheritance (Harris 1997), that is the source of the types of head-non-head asymmetries we have just seen.

2.1.3.2 Intra- and interconstituent licensing

To this point, the phonological licensing relationships that we have examined have involved dependency relationships between prosodic units where the licensee is embedded within the licensor (e.g. $[\text{Ons}]_\sigma$). I assume, following GP, that there also exist dependency relations across syllable constituents. Moreover, I will demonstrate that these relations, in conjunction with the principle of Licensing Inheritance to be discussed in §2.1.3.3, serve to determine the A-licensing properties of different syllable structure positions. Before discussing these licensing relationships, one general note should be made. In contrast to the assumptions outlined in §2.1.1, GP does not recognize the syllable as a prosodic unit. Consequently, in the discussion that follows, I depart from GP and adapt its theory of licensing to representations in which syllables are prosodic constituents.

We begin with intraconstituent licensing. The principle of Headedness in (2) necessitates that the presence of a dependent co-occur with the presence of a head. Stated otherwise, a constituent head licenses the presence of its dependent. At the level of the syllable constituent, this means that there are three such possible relationships as shown in (18) below where heads are underlined.

(18) Intraconstituent licensing



In each of the representations above, the arrow-headed line indicates the head-dependent licensing relationship that exists within the constituent.

The licensing relationship shown in (18c) merits special comment. In GP, such a relationship is insufficient to A-license a coda. Indeed, following the principle of Coda Licensing (Kaye 1990), a coda must be licensed by a following onset. While such a principle creates the effect of maximizing onsets, a cross-linguistic principle of syllable wellformedness (e.g. Selkirk 1982, Goldsmith 1990), this effectively requires an OEHS syllabification of all final consonants. Were a word-final consonant to be syllabified as a coda, it would violate Coda Licensing as such a coda would not be in a licensing relationship with a following onset. However, Piggott (1999), using data from a number of languages, provides several arguments that support the view that such a principle is too strong. He argues that, in the case of word-final consonants, there are two possible ways in which such consonants may be syllabified and licensed, either as codas or as OEHS.[22] The thrust of Piggott's argument is that in many languages the phonotactics of word-final consonants exactly mirror those of word-internal codas and, as such, final consonants in such languages must be syllabified as codas, not OEHS. An example of a language that clearly syllabifies word-final consonants as codas is the Indonesian language Selayarese

[22] Piggott's analysis, in allowing two options for the syllabification of final consonants, follows in the spirit of earlier views of the syllabification of final consonants as codas and through extraprosodicity (e.g. Itô 1986).

(Mithun and Basri 1986, Goldsmith 1990). In Selayarese, word-medial codas are restricted to the first half of a partial or full geminate, or to glottal stop as shown in (19a-c) respectively.

(19) *Selayarese word-internal coda*s (Piggott 1999; data originally from Mithun & Basri 1986)

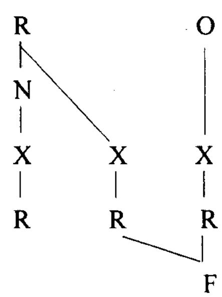
a. [sam.baŋ] 'to trip'
   [laŋ.ka.sa] 'tall'

b. [bat.tu] 'come'
   [tuk.kaŋ] 'walking stick'

c. [taʔ.mu.ri] 'smile'
   [taʔ.doʔ.doʔ] 'be sleepy'

Piggott attributes this restriction to a coda condition in Selayarese that prohibits the licensing of place and laryngeal features (see earlier Goldsmith 1990). Under the assumption that the licenser of a given feature may differ from the position into which a feature is parsed, in (19a,b) the place features of the coda are licensed by the following homorganic stop. Such a licensing relationship is known as parasitic licensing, as shown in (20).

(20) <u>Parasitic licensing</u>



The glottal stop codas in (19c) also fail to violate the language's coda condition as /ʔ/ lacks both place and laryngeal specification. Now compare the internal codas in (19) with the possible word-final consonants in (21).

(21) *Selayarese word-final consonants*

a.	[toboʔ]	'stab'
	[barroʔ]	'eagle'
b.	[bataŋ]	'driftwood'
	[sokoŋ]	'to support'

The forms above show that word-final consonants are restricted to /ʔ,ŋ/. Piggott argues, following Trigo (1988), Humbert (1995) and Rice (1996), that /ŋ/, like /ʔ/, is unspecified for place. Moreover, neither segment bears any laryngeal features. As such, the prohibition on final consonants bearing place and laryngeal features mirrors the restriction on word-internal codas. Were final consonants syllabified as onsets, one would expect that no such place restrictions would hold. Consequently, one must conclude that Selayarese final consonants are syllabified as codas and that the licensing relationship in (18c) is wellformed.

The contrasting type of language is one that syllabifies final consonants as onsets. While French, where the set of word-final consonants and word-internal onsets is identical (Dell 1995), is one such language, a more convincing case comes from languages where internal codas are subject to strong restrictions yet word-final segments enjoy the contrastive freedom of onsets. Piggott provides data from the West Atlantic language Diola Fogny, which typifies this latter type (original source Sapir 1965). In Diola Fogny, word-internal codas are restricted to homorganic nasals (22a) or liquids (22b). Such restrictions closely mirror the coda restrictions of languages like Selayarese.

(22) *Diola Fogny word-internal codas*

a.	[ni.mam.maŋ]	'I want'
	[kun.don]	'large rat'
b.	[sal.te]	'be dirty'

In stark contrast to Selayarese-type languages, any obstruent or sonorant may appear word-finally in Diola Fogny as shown in (23) below.

(23) *Diola Fogny word-final consonants*

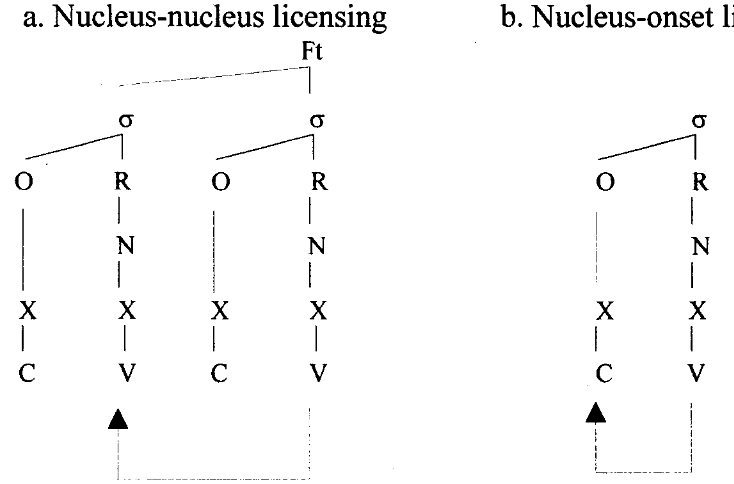
[nikɔkɔb]	'I waited'
[ijaut]	'I did not come'
[kuɲilak]	'children'
[nalanlan]	'he returned'

A coda analysis of these word-final consonants is incompatible with the contrast between the strong restrictions on word-internal codas and the relative freedom of word-final consonants. Rather, the lack of restrictions on word-final consonants is highly consistent with the strong licensing power of onsets attested cross-linguistically; clearly word-final consonants in Diola Fogny are syllabified as OEHS, not as codas. We will consider the relative markedness of coda versus final onset syllabification in §2.1.3.3.

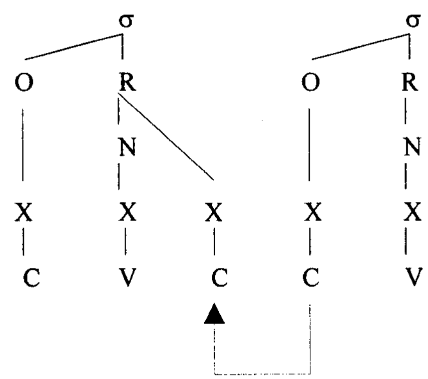
Let us return to the discussion of head-non-head licensing. The second type of licensing relationship is termed interconstituent licensing, of which there are three kinds as illustrated in (24a-c).

(24) Interconstituent licensing

a. Nucleus-nucleus licensing b. Nucleus-onset licensing



c. Onset-coda licensing



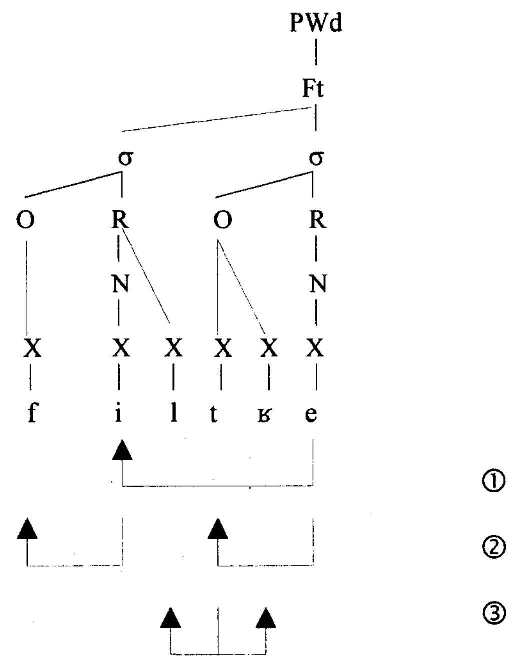
In GP, government is a relationship between two skeletal points. In this theory, inter-nucleus government (24a) is uniquely right-headed as is the case with interconstituent government in general. As Charette (1991:25) states, nucleus-nucleus government is principally designed to account for constraints on vowel sequences in some languages. In this thesis, I will argue that the consequences of inter-nucleus government are more general and extend to all levels of prosodic complexity. For example, the fact that branching onsets are restricted to the head syllable of the foot in languages like southeastern Brazilian Portuguese is a direct consequence of the governor status of the nuclei of such syllables (cf. Harris 1994). Consequently, I argue that nucleus-nucleus government is a head-non-head relationship with the directionality in a given language being determined by foot shape (i.e. left-headed in trochaic languages, right-headed with iambs). Indeed, if nucleus-nucleus government is strictly right-headed, one cannot account for the types of licensing asymmetries between head and non-head syllables in trochaic languages.

(24a) illustrates nucleus-nucleus licensing in which the nucleus of the head of the foot licenses the presence of the head of the dependent syllable. (24b) illustrates nucleus-onset licensing. I assume, as in most theories of syllable structure, that the nucleus is the central element of the syllable (see §2.1.2). Thus, for a syllable to P-license an onset, it must also license a nuclear position. The licensing relation in (24b) expresses this property of syllable structure. Finally, the licensing relationship in (24c) between an onset and preceding coda reflects the observation that, in most languages, codas bear certain features only when they are followed by an onset that may license such features (cf. Itô 1986). Selayarese (19,21) and Diola Fogny (22,23) are languages of this type. Such a restriction finds an explanation if the licensing relation in (24c) holds, with a coda being dependent upon the following onset for the licensing of (some) of its featural content. Indeed, I argue that, in the unmarked case, codas are interconstituent licensed as per (24c). The sole exception to coda-onset licensing occurs in languages like Selayarese in which final codas alone are licensed by the preceding nucleus as per (18c). With these head-dependent licensing relations in mind, let us now consider one final principle, that of Licensing Inheritance.

2.1.3.3 Licensing Inheritance

Harris (1997) proposes that the types of intra- and interconstituent licensing relations discussed in §2.1.3.1 exist throughout prosodic structure and define a series of licensing paths through which A-licensing potential is distributed. To illustrate, consider French *filtrer* [filtʁe] 'to filter'.

(25) *Licensing inheritance paths in French filtrer* [filtʁe]



The first of the five paths, labelled ① in (25) above, is a nucleus-nucleus licensing relationship of the type in (24a) that exists between the head and dependent syllables of the foot. In an iambic language like French, this path is right-headed; in trochaic languages like English, such a relation is left-headed. As the head of the foot, the second syllable [tʁe] is also the head of the PWd. Consequently, it is from the nucleus dominating [e] that all licensing potential within the word originates. Level ② shows two nucleus-onset licensing paths of the type in (24b). The final level ③ shows the last network of paths which flow from the head of the onset of the head syllable [t], both to its dependent [ʁ] (intraconstituent licensing as per (18a)) and to the preceding coda [l] (interconstituent licensing as per (24c)).[23]

[23] The illustration of these two types of licensing relations at the same level should not be understood to imply that they are of the same type. Indeed, languages may allow for only one such type of licensing (codas but not branching onsets).

This distribution of featural (i.e. autosegmental or A-) licensing power is formalized in the principle of Licensing Inheritance in (26).

(26) Licensing inheritance (Harris 1997:340)
A licensed position inherits its A-licensing potential from its licensor.

While the nucleus of the dependent syllable of the foot is P-licensed by the rhyme that dominates it, its A-licensing potential comes from the head nucleus of the foot, which interconstituent licenses it. Harris proposes that, within any prosodic word, the stock of A-licensing potential is limited and depleted as it is discharged along any given licensing path. To use Harris's metaphor, an intra- or interconstituent licensed position serves as a type of licensing resistor. The consequence of the depletion inherent to licensing inheritance is that the further a given position is from the origin of the licensing network, i.e. the head nucleus of the PWd, the weaker the charge of licensing potential it will possess. Licensing Inheritance thus provides a principled explanation for the differences in segmental contrasts that may appear in different prosodic positions within the word. Having non-head status in some licensing relation reduces a position's ability to A-license featural contrasts as its licensing potential is diminished relative to the head that licenses it.

If we reconsider the cases discussed in §2.1.3.1, we now have a principled explanation for the observed asymmetries. For example, the differences in licensing potential between the onset of a head syllable and the onset of a non-head noted in both southeastern Brazilian Portuguese (15) and Dutch (16) is related to the fact that the licensing paths which imbue these two positions with licensing potential are different. In the case of the onset of the head syllable, it is but one path removed from the head nucleus as per (24b). In contrast, the onset of the dependent syllable of the foot is at two removes or paths, namely the first nucleus-nucleus path at level ① in (25) above, then a nucleus-onset path at level ②. In both languages, this results in the reduced set of contrasts possible in the onset of the dependent syllable. In southeastern Brazilian Portuguese, the difference between head and non-head syllables manifests itself in the inability of non-head syllables to P-license the dependent position of a branching onset. In Dutch, the difference is not one of P-licensing and positions, but rather A-licensing and segmental contrasts: the dependent position of a branching onset A-licenses a smaller set of segmental contrasts in this language.

To this point in the chapter, we have seen that prosodic representation is highly structured, being built from a universal set of constituents which include the syllable, foot and prosodic word. Two sorts of dependency relationships serve to organize these constituents. First, constituents are organized in the Prosodic Hierarchy via phonological licensing. Second, constituents also have internal organization; this organization minimally takes the form of a head and maximally of a head and its dependent. Finally, we have seen that licensing asymmetries exist in representation. Following Harris (1997), I assume that such asymmetries result from the principle of Licensing Inheritance. We will see in §2.3.2 that Licensing Inheritance also provides the basis for an explanatory theory of syllable structure markedness.

With these central concepts in mind, in the following section we will turn to segmental representation. We will see that the A-licensing relations that exist between the composite features of a segment parallel the P-licensing relations present at the level of prosodic organization.

2.2 Segmental representation

In this section, I articulate the basics of the theory of segmental representation adopted in this thesis. While I assume that all segmental structure is constrained by Feature Geometry, I will only discuss those parts of the geometry necessary for the analyses proposed in Chapters 3 and 4. Specifically, in the following sections, I focus on the representation of place and laryngeal contrasts in consonants, as well as on the representation of sonorants. Particular attention will be paid to differences in representation between /l/ and /r/ as these differences will be crucial to a number of hypotheses to be tested in Chapter 4.

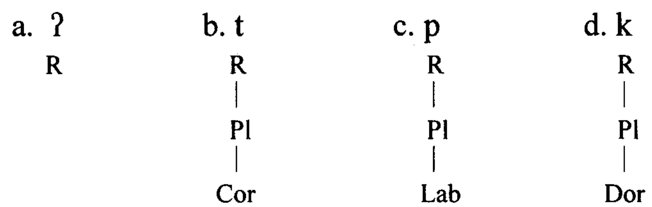
2.2.1 Features

I assume that features are organized via a universal Feature Geometry (e.g. Clements 1985, Sagey 1986, McCarthy 1988). Furthermore, I assume that all phonological features are monovalent (e.g. Anderson & Ewen 1987, Avery & Rice 1989, van der Hulst 1989, Rice 1992b). As such, any phonemic contrast is represented via the presence versus absence of the relevant feature. For example, in languages that contrast voiced and voiceless obstruents, the representation of the voiceless member of the pair will contain no specification for voicing (i.e. a bare Laryngeal node only) whereas the representation of the voiced member will include the feature [voice]. In the following sections, we will discuss the representation of place, laryngeal contrasts, and sonorants in turn.

2.2.1.1 Place

Place features are organized under the Place node, which is a dependent of the Root node (R). These features include [coronal], [labial] and [dorsal]. The representations for voiceless obstruents showing a four-way contrast in place (i.e. laryngeal vs. oral, oral contrasting between labial, coronal and dorsal) are given in (27) below.

(27) *Representation of place in consonants*

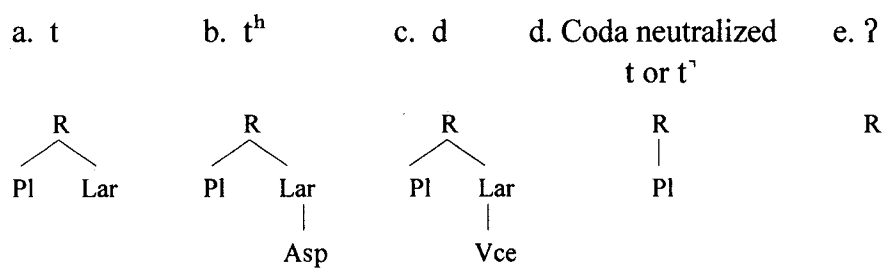


As shown in (27), a glottal stop is represented as a bare Root node (e.g. Steriade 1987, McCarthy 1988). In contrast, the representation of labial, coronal, and dorsal stops includes a Place node under which the relevant articulator is licensed.

2.2.1.2 Laryngeal contrasts

I assume that the UG-permitted laryngeal contrasts minimally include voicing and aspiration (e.g. Lombardi 1991, 1995). The phonological features which express these contrasts (i.e. [vce] and [asp]) are organized under the Laryngeal node, itself a dependent of the Root node. The three-way contrast between voiceless plain, voiceless aspirated and voiced stops is represented as in (28a-c).

(28) *Representation of laryngeal contrasts*

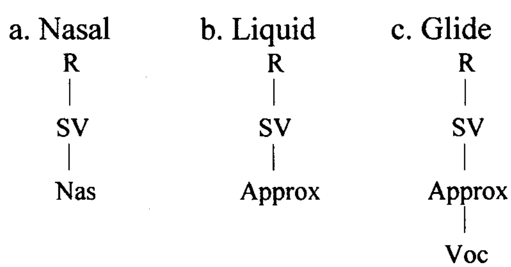


A bare Laryngeal node is interpreted as a voiceless plain segment (28a). The features necessary to contrast voiceless plain segments from their aspirated and/or voiced counterparts are licensed as dependents of the Laryngeal node as shown in (28b,c). Finally, in those languages in which laryngeal contrasts are neutralized in coda position, the Laryngeal node and its dependents are not A-licensed syllable-finally. While in such languages, the output representation of [t] in onset position is that in (28a), in coda position, [t] (or [t˺]) has no Laryngeal specification (28d), like glottal stop (28e), but bears place structure.

2.2.1.3 The representation of sonorants

The representation of all sonorants involves an SV-node (Sonorant Voice (Rice & Avery 1989) or Spontaneous Voice (Piggott 1992)). Following Piggott (1993) and Kawasaki (1998), I assume that the SV-node has two immediate dependents, [nasal] and [approximant]. Whereas the representation of nasals includes the feature [nasal] under the SV-node (29a), the representation of liquids involves the feature [approximant] (29b). Glides involve a further level of complexity with the feature [vocalic] being licensed as a dependent of [approximant].

(29) *Representation of sonorants*

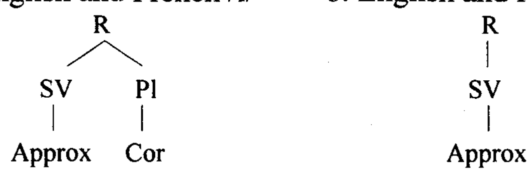


I assume that, in languages with two phonemic liquids (one lateral and one rhotic), the relevant difference in representation involves Place and not SV structure (e.g. Rice

1992a, Brown 1997, Walsh Dickey 1997, Smith 2000, van der Torre 2001, Goad & Rose to appear).[24] /r/ has less place structure than /l/ in both English (Rice 1992a, Harris 1994, Goad & Rose to appear) and French (Béland, Paradis & Bois 1993). Specifically, /l/ has the same amount of place structure as other coronals (i.e. Place-[coronal] as in (27b)). In contrast, I follow Goad & Rose (to appear) in assuming that /r/ is inherently placeless (i.e. bears no Place node).[25] The relevant representations are given in (30).[26]

(30) *Representation of English and French liquids*

a. English and French /l/ b. English and French /r/



Evidence in support of such a representational difference comes from two phonotactic properties of clusters involving /l/ and /r/ already discussed with reference to the data in (10). The first concerns restrictions on obstruent-liquid onset clusters in both languages. Consider the data in the table in (31). As shown below, both English and French allow for any combination of stop-liquid clusters with the exception of coronal-/l/ sequences. Following Rice (1992a) and others, I assume that the absence of such sequences is related to a ban on identical place structure in branching onsets. If the representation of /l/ includes the feature [coronal] as in (30), the absence of [tl] onsets falls out straightforwardly.

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24. It has also been argued that laterals and rhotics may contrast in terms of their sonority structure/features (e.g. Venneman (1972) for Icelandic, Kahn (1976) for English, Piggott (1993:25) for English and French, Zec (1995:125) for Serbo-Croatian). See further below for why this position is not adopted here.

25 It may be the case that English and French /r/ has a bare place node. Whether or not /r/ has a place node will not affect the analyses to be proposed in Chapter 4.

26 I use the symbols /r/ and /l/ to represent both languages' rhotic-lateral contrast in spite of differences in the phonetic interpretation of these segments (i.e. English [l]-[ɹ]; French [l̪]-[ʁ]).

(31) *English and French stop-liquid onsets*[27]

	English		French	
	[l]	[ɹ]	[l]	[ʁ]
Labial	*plea* [pli:] *blue* [blu:]	*pray* [pɹe:] *brew* [bɹu:]	*pli* [pli] 'fold' *bleu* [blø] 'blue'	*pré* [pʁe] 'meadow' *brou* [bʁu] 'husk'
Coronal	**tlo* **dlo*	*tree* [tɹi:] *Drew* [dɹu:]	**tlo* **dlo*	*tri* [tʁi] 'sorting' *dru* [dʁy] 'thick'
Dorsal	*clue* [klu:] *glue* [glu:]	*crow* [kɹo:] *grew* [gɹu:]	*clou* [klu] 'nail' *glu* [gly] 'leech'	*croc* [kʁo] 'fang' *grue* [gʁy] 'crane'

Additional support for the role of such a constraint in English comes from the absence of labial-/w/ clusters (e.g. **bw*, **pw*, **fw*).[28] Consequently, the absence of /tl,dl/ onset clusters in English and French argues in favour of a representation of /l/ which contains the same place structure as /t,d/ (i.e. Place-[coronal]). This representation contrasts with that of /r/, which is placeless.

The second phonotactic restriction which supports an analysis in which /r/ has less place structure than /l/ involves clusters containing both liquids. Such clusters show a strong asymmetry: while /rl/ is possible both word-medially and word-finally, /lr/ is not (e.g. English: *darling* [dɑɹ.lɪŋ], *curl* [kɜɹl] but *[dɑl.ɹɪŋ], **culr* [kɜlɹ]; French *parler* [paʁ.le] 'to speak', *perle* [pɛʁl] 'pearl', but *[pal.ʁe], *[pɛlʁ]).[29,30] Under the view that

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27 I provide examples of stop-liquid clusters here. The restrictions given also hold for most fricative-liquid clusters. Two gaps in the distribution are /v/- and /ð/-initial sequences in English. I offer no explanation for this here.

28 A few exceptions do exist (e.g. *poil* [pwɑl], *pueblo* [pwɛblo], *pwe* [pwe]), all of which are borrowings. Note that labial-/w/ clusters are licit in French (e.g. *poing* [pwɛ̃] 'fist', *bois* [bwa] 'wood', *foi* [fwa] 'faith') where the glide is syllabified in the nucleus (e.g. Kaye & Lowenstamm 1984, Rose 1999).

29 This generalization is not completely accurate. In both English and French, /lr/ sequences are possible but important restrictions govern their wellformedness. In English, with the exception of *walrus*, such words fall into a series of well-defined classes, including proper names (e.g. *Elroy*, *Milroy*), (historical) compounds (e.g. *already*, *railroad*), or words involving syllabic /r/ (e.g. *boiler*). In French, many of the equivalent forms are also morphologically complex (e.g. *animalerie* [animalʁi] 'pet shop' = *animal* [animal] 'animal' + /ʁi/ 'place where one has Xs'). There are a limited number of monomorphemic forms (e.g. *céleri* [selʁi] 'celery', *galerie* [galʁi] 'gallery'). Note, however, that the pronunciation of

these clusters are syllabified as coda-onset sequences (see (7b) for the representation of such word-final clusters), this asymmetry can be explained with reference to the weak A-licensing potential of codas. In the case of /rl/ clusters, the coda needs only to license the limited structure of the /r/, an SV node-[approximant] structure. In contrast, in /lr/ clusters, the coda must license the featural content of /l/, which includes the same amount of SV structure but also place structure, namely Place-[coronal] (see (30a)). If, following (24c), a coda inherits its A-licensing potential from a following onset and if, as we will assume in §2.3.1.3.2, the licensing potential of a head is dependent in some way upon its featural content, it follows that in [l.r] the minimally specified representation of /r/ impedes it from imbuing the preceding coda with sufficient A-licensing potential to license the melodic content of /l/ (Goad & Rose to appear).

It must be noted that the difference between /rl/ and /lr/ clusters as concerns their wellformedness could be explained in terms of sonority (see note 21). Cross-linguistically, codas prefer to be equally or more sonorous than the following onset (see (32) below). If /l/ were less sonorous than /r/, then [lr] coda-onset sequences would be ruled out on sonority grounds. Nonetheless, I argue that the best explanation for the asymmetry is related to place structure. Indeed, while sonority might explain the illicitness of [lr] clusters, differences in place structure alone can account for both this phonotactic restriction as well as the ban on [tl] onsets.

If Goad & Rose's (to appear) proposal that /r/ is universally placeless is correct, we should predict that asymmetries in the phonological patterning of /r/ and /l/ parallel to

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these monomorphemic forms can include an excrescent schwa between the two members of the cluster (i.e. *céleri* [selᵊʁi], [galᵊʁi]) indicating the presence of an empty nucleus (e.g. [se.l∅.ʁi]) that can be optionally realized.

30 Greenberg (1965:18) proposes that, word-finally, /lr/ sequences are illicit in all languages.

those discussed immediately above for English and French should be observed in other languages. Goad & Rose provide several examples, which I cite here: /r/ is the only consonant that cannot undergo (partial) germination in Japanese (Mester & Itô 1989:275), the only non-labial consonant that cannot host palatalization in Muher (Rose 1997), and it behaves asymmetrically in the L1 consonant harmony patterns observed in Québec French (Rose 2000). Such asymmetries, as well as those discussed for English and French, are consistent with /r/ being minimally placeless.

2.2.1.4 The role of SV structure in syllable wellformedness

Before moving on to a discussion of the phonetic interpretation of phonological representations in §2.2.2, I wish to conclude the discussion of segmental representation by briefly examining the role of SV structure in determining syllable structure wellformedness. As has been widely observed, UG requires that segments syllabified within the onset have a rising sonority profile while coda-onset sequences must have a flat or falling sonority profile. Sonority constraints on syllabification are commonly known as the Sonority Sequencing Generalization (e.g. Selkirk 1984) and the Syllable Contact Law (Hooper 1972, Vennemann 1972, Murray and Vennemann 1983). A formal version of these sonority constraints is given in (32) below.

(32) Sonority sequencing

A string CVC_1C_2V will be syllabified as $CV.C_1C_2V$ where sonority $C_1<C_2$ and as $CVC_1.C_2V$ where sonority $C_1 \geq C_2$ (modulo language-specific constraints)[31]

While relative sonority may be encoded through sonority hierarchies in which values are assigned based on manner classes, I assume that a segment's sonority is formally encoded

[31] Such constraints include a prohibition on branching onsets or on place identity within branching onsets, among other things.

via SV-structure (e.g. Rice & Avery 1991, Rice 1992a; see Clements 1990, Harris 1994 for alternative proposals). Specifically, the greater the amount of SV-structure, the more sonorous a segment. With these aspects of segmental representation in mind, let us now examine how the representations discussed to this point are interpreted by the phonetics.

2.2.2 Underspecification and phonetic interpretation of phonological outputs

In the pre-OT underspecification literature,[32] it was standardly assumed that redundant features were omitted from underlying representation, only to be filled in by a series of redundancy rules before or during phonetic interpretation. For example, it has been widely observed that coronals behave as unmarked vis-à-vis labials and velars in phonological patterning (e.g. papers in Paradis & Prunet 1991).[33] Within a theory of representation that assumed underspecification, the unmarked patterning of coronals was argued to result from their lack of an underlying specification for place: in Feature Geometry, whereas the representation of labials and velars included the relevant articulator under the Place node, coronals were underspecified either for [coronal] or for Place.

In contrast, in standard OT, underspecification of inputs is not allowed following the Richness of the Base hypothesis (Prince & Smolensky 1993) given in (33) below.

(33) Richness of the base hypothesis (ROB)
No constraints hold at the level of underlying forms.

Underspecification, as a restriction on the presence of unmarked features in *input* representations, is incompatible with the theory. As I adopt OT as the framework for the

[32] See Steriade (1995) for a review of this literature.
[33] See, however, Rice (1996) for a discussion of languages where velars pattern as unmarked.

present research, I do not assume underspecification of inputs; outputs, however, can be underspecified under certain conditions.

In much OT research, the once clear distinction between phonology and phonetics has been broken down. I will nonetheless assume that the output of the phonology is interpreted by a separate phonetic component, as was commonly assumed in prior frameworks.[34] In the introduction to the discussion of segmental representation in §2.1.1, we saw that, in a theory of segmental representation that adopts unary features, the absence of a given feature has a specific phonetic interpretation. For example, the lack of the specification for the feature [voice] is interpreted by the phonetics as a voiceless obstruent. This type of phonetic interpretation applies to all organizing nodes, including Place, Laryngeal, and SV as shown in (34) below.

(34) *Phonetic interpretation of bare Place, Laryngeal, and SV* nodes

a. Place	b. Laryngeal	c. SV
R	R	R
|	|	|
Pl	Lar	SV
Phonetics: Coronal	Phonetics: Voiceless Plain	Phonetics: Nasal

A bare Place node is interpreted as coronal (e.g. Avery & Rice 1989, Rice 1992a), a bare Laryngeal node as voiceless plain (e.g. Lombardi 1991, 1995) and a bare SV node as nasal (e.g. Rice 1992a).[35] It follows, thus, that the presence of a phonetic property such as nasality does not require the presence of the corresponding feature in a segment's output representation. Note that the representations in (34a,c) differ in one important respect from that of (34b): as there is no phonological feature [voiceless], voiceless plain stops will have the representation in (34b) in onset position (see (28a)), whereas coronal and

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34 See Kiparsky (1985) for one view of the phonology-phonetics relationship along these lines.

35 In Chapter 4, we will investigate the option of nasals having no Place node in the discussion of Mandarin learners' acquisition of coda place contrasts.

nasal obstruents will have the representations in (34a) and (34c) in coda only; in onset position, their representations will contain a coronal articulator (27b) or nasal feature (29a) respectively.

The types of representations in (34) allow for a straightforward account of the position-sensitive markedness asymmetries attested cross-linguistically. Within OT, (un)markedness phenomena such as the asymmetrical patterning of coronals vis-à-vis labials and dorsals result from constraint ranking, specifically the ranking of markedness constraints over faithfulness constraints. Consider a language such as Lardil (e.g. Wilkinson 1988) in which articulators are licensed in onset but not in coda, where place contrasts are neutralized to a subset of coronals. Given the approach adopted here, a position-sensitive markedness constraint like NoCoda(Articulator), which rules out the licensing of articulator nodes in coda position, must dominate the corresponding faithfulness constraint, Faith(Articulator), in such a grammar. Indeed, this ranking will cause segments whose input representation is specified for an articulator to lose such a feature in its output representation (i.e. to surface with a bare Place node), when the segment is syllabified in coda position. Thus, in such a language, the place structure of an output segment like [t] will differ depending upon the position into which the segment is syllabified: in onset, its representation will contain the structure Place-[coronal] (27b), whereas only a Place node will be licensed in coda (34a). However, both representations will be interpreted as coronal by the phonetics. In Chapter 4, we will see that such a difference offers an interesting account of learners' outputs forms: when the IL grammar fails to license features such as Place, the default interpretations in (34) emerge.

2.3 Markedness

To this point in the chapter, we have investigated the nature of phonological representation and syllable structure, including the principles of Headedness, Binarity, Sonority, and Phonological Licensing that govern representational wellformedness. As concerns licensing, we have seen that it consists not only of dependency relations between an embedded element and the prosodic constituent within which it is embedded (i.e. P-Licensing) or between a feature and the node or constituent that dominates it (i.e. A-licensing), but also within and across constituents (i.e. Intra-/Interconstituent Licensing).

In this section, I will show that the role of Phonological Licensing in ensuring phonological wellformedness extends to encoding markedness in representation. The focus will be on the ways in which markedness manifests itself in terms of prosodic complexity and position-sensitive segmental contrasts (§2.1.3.1). As concerns prosodic complexity, languages may ban prosodic complexity (i.e. branching) across the board or place restrictions on the positions where prosodic complexity is allowed: when licit, branching will be preferred in strong positions (e.g. head of foot) and possibly prohibited in weak positions (e.g. dependent of foot). The restriction against branching onsets in non-head positions in southeastern Brazilian Portuguese discussed in (15) is an example of this type of positional asymmetry. As concerns segmental contrasts, while segments whose representation involves unmarked features may appear in both weak and strong prosodic positions (e.g. both coda and onset), segments involving marked features are often limited to strong positions (e.g. onset position in the case of consonants). The contrast between the larger set of consonants licensed in onsets than codas in languages like Diola Fogny (22,23) is a typical example of a position-sensitive contrast asymmetry. An adequate theory of syllable structure markedness must be able to explain these inventory and position-based markedness facts. As the data to be analyzed in Chapters 3 and 4 involve prosodic markedness alone, both as concerns prosodic complexity and position-sensitive contrasts, in elaborating a theory of licensing-based markedness, I will restrict the focus to these types of prosodic markedness.

In the remainder of the present section, I will argue that the key to an explanatory theory of markedness as concerns syllabification lies in the principles of Phonological Licensing and Licensing Inheritance and in the types of head-non-head licensing asymmetries that result from these principles. The proposal elaborated here takes as its starting point the widely held assumption that markedness is best understood as a measure of relative structural complexity (e.g. Rice 1992a, 1999, Harris 1997, Causley 1999): a segment/structure A is more marked than a segment/structure B if its representation involves more structure (i.e. featural content/prosodic complexity including branching). In some languages, the consequences of differences in representational complexity between two segments/structures will be seen across the board in that no complexity will be tolerated anywhere. However, an adequate explanation must take into account prosodic position. Indeed, in other languages, some markedness asymmetries manifest themselves only in prosodically weak positions like codas, with full contrast being maintained in strong positions like onsets.

It might not be immediately obvious why more structure need be more marked. However, if one considers how phonological structure is organized in representation, a solution becomes apparent. I argue that the markedness of greater structural content, whether segmental or prosodic, is a direct consequence of the cost of licensing more as opposed to less structural material in a weak position. Recall from §2.1.3.2 that, within a given phonological form, the stock of licensing potential is finite and, following Licensing Inheritance, the further a licensing position is from the head of the word in terms of the paths which imbue it with licensing potential, the weaker its licensing power is. As illustrated in (25), weak positions are always further from the head of the word than the strong positions which imbue them with their licensing potential. In the case of prosodic complexity, branching is marked as it requires the licensing of segmental material in a non-head position, a weak licensor vis-à-vis the head that licenses it. As concerns position-sensitive contrasts, if a given prosodic position has a fixed store of licensing potential, it follows that it is more costly to license more as opposed to less featural content in that position. Thus, marked segments, whose output representation involves more featural content than their relatively unmarked counterparts, will be more costly to license. To summarize, relatively marked structures involve the licensing of more versus less structure in the same position (position-sensitive contrast asymmetries) or the licensing of the same amount of structure in a weak versus strong position (head versus non-head).

The structural account proposed here has one potential important advantage over the typology-based theory of markedness espoused in most OT analyses, namely its explanatory adequacy. It is true that both theories allow markedness to be grammar-internal, an important characteristic of any adequate theory of markedness. Indeed, Chomsky & Halle (1968:427) explicitly state this as one of the central goals of linguistic theory.[36] However, only a structural account attempts to begin to *explain* the nature and directionality of markedness asymmetries. To illustrate the difference in explanatory adequacy between these two markedness theories, consider the marked status of codas. Standard OT analyses propose that the constraint set CON contains a markedness constraint, NOCODA, that bans post-rhymal consonants in output representations. Within OT, constraints like NOCODA are motivated based on cross-linguistic typologies: while all languages allow onsets, many languages ban codas. Implicationally, codas are marked vis-à-vis onsets. In those languages where NOCODA is ranked above the relevant constraints enforcing input-output faithfulness (i.e. MAX and DEP), codas will be illicit in outputs.

However, such a typological motivation is circular: the presence of NOCODA in the grammar is motivated based on the cross-linguistic asymmetry between codas and onsets; yet the constraint is then used to explain the very asymmetry that motivates its existence. In contrast, a licensing-based theory of syllable structure markedness seeks to explain markedness asymmetries based on central principles of representation, specifically, the assumption that all phonological structure must be licensed but that licensing comes at a cost. Positional markedness asymmetries result from the weak licensing potential of non-head positions vis-à-vis the heads that license them, for example codas versus onsets, following Licensing Inheritance. The licensing of post-nuclear rhymal consonants comes at a cost as their melodic content must be licensed in a non-head position. As such, a structure-based theory of syllable markedness attempts to derive markedness patterns from independently motivated principles of representational wellformedness, namely Phonological Licensing and Licensing Inheritance. In doing so,

36 This opinion is echoed by Kean (1975).

it seeks to reach a level of explanatory adequacy which typological theories of markedness, including the standard OT approach to markedness, arguably lack.

The remainder of this section is structured as follows. To contextualize the approach taken here, I begin in §2.3.1 by examining the development of markedness theory within phonological research. In doing so, I will contrast two fundamentally different conceptions of markedness. The first is that of typological or implicational markedness in which markedness is a theory-external property. In the second approach, that of generative phonology beginning with Chapter 9 of SPE, markedness is a central component of the theory encoded in structure. In the discussion of markedness in §2.3.2, I elaborate on the theory of prosodic markedness presented above. Let us now situate the current proposal through a brief investigation of the development of markedness theory in phonology.

2.3.1 Approaches to formalizing markedness

In the following sections, I will outline the development of markedness within generative grammar with reference to a number of seminal studies. In doing so, I will not attempt to be exhaustive. Rather, I will seek only to contextualize the licensing-based theory of syllable structure markedness to be proposed in §2.3.2.

2.3.1.1 Grammar-external approaches: typological markedness

The most well known work on typological markedness is that of Joseph Greenberg and colleagues (e.g. Greenberg 1966). As concerns phonology, researchers like Greenberg constructed typologies based on the cross-linguistic distribution of features and prosodic structures. Based on these observations, typologists proposed sets of implicational universals, many of which serve to inform theories of markedness to this day. An implicational universal takes the form given in (35).

(35) Implicational universal

$B \supset A$

The interpretation of such a relationship is that the presence of feature/structure A in a given language implies the presence of feature/structure B in that same language ("If B, then A"). In such a relationship, B is deemed to be marked relative to A. One commonly cited example of an implicational universal in phonology involves voicing in obstruents. Whereas all languages have voiceless obstruents, many languages lack voiced obstruents. Thus, cross-linguistically, the presence of voiced obstruents within a language implies the presence of their voiceless (unmarked) counterparts. This implicational universal is formalized in (36).

(36) *Implicational universal: voicing in obstruents*

[-son, +voice] $\supset$ [-son, -voice]

Implicational universals also exist as concerns possible segmental sequences. For example, Greenberg (1965) proposes that the relative markedness of initial CN and CL sequences is as stated in (37).

(37) *Implicational universal: initial consonant sequences*

CN $\supset$ CL

The implication in (37) is consistent with the cross-linguistically unmarked branching onset being an obstruent-liquid sequence and that, in languages that allow stop-nasal onsets (e.g. German), stop-liquid onsets are also wellformed.

While implicational universals express markedness relations, they do not attempt to explain such relations; that is, as mentioned earlier, they lack explanatory power (see e.g. Kean 1981, Cairns & Feinstein 1982, Baptistella 1990, Rice 1999).[37] That voiced obstruents are marked relative to voiceless obstruents and that stop-nasal onsets are marked vis-à-vis stop-liquid onsets are statements of surface distributional asymmetries. If typological universals were truly explanatorily adequate, they would not only explain why the unmarked feature/structure is what it is, but also why the reverse markedness relationship is unattested. I propose that such an explanation must come from representation. As we will see immediately, a theory of markedness based on structure and representation has been a central goal of generative phonological theory from the very beginning.

2.3.1.2 Grammar-internal approaches: markedness in generative phonology

While the theory of markedness has changed substantially from early generative phonology, one common characteristic of pre-OT theories is that markedness is a structural property derivable from representation. This characteristic contrasts starkly with the previous grammar-external approach of typological universals. It also differs from many recent OT analyses where markedness constraints are typologically motivated. In the following sections, discussion will focus on the role of structure in pre-OT theories of markedness, beginning with the introduction of markedness into generative phonology in SPE (§2.3.1.2.1) and prosodic markedness (§2.3.1.2.2). While the proposal ultimately argued for here also posits a central role for representation, it critically incorporates a theory of licensing including Licensing Inheritance (§2.3.1.3).

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[37] Kean (1981:570) provides a very succinct statement of this fact: "On the matter of implicational universals, [...] there is little reason to believe that they have any systematic status in the theory of grammar; to the extent that any apparently hold, it is, at least in phonology and probably in other domains as well, in virtue of their being derivative from markedness theory."

2.3.1.2.1 Markedness in SPE

In Chapter 9 of SPE, Chomsky and Halle argue that the phonological framework developed in the rest of their tome has a fundamental inadequacy: their theory of features, rules, and evaluations cannot distinguish expected and natural configurations and rules from those that are unexpected and unnatural.[38] To illustrate, consider their example of the evaluation of three possible vowel systems, /i,e,a,o,u/, /i,e,æ,o,u/ and /y,œ,a,ʌ,ɨ/. While it is obvious that the first system is by far the most natural, the SPE measure of evaluation, in which the naturalness of a class or rule is evaluated in terms of the number of features used to define it, makes no distinction between the three inventories. In order to resolve this problem, Chomsky and Halle propose that the Praguian notion of marked and unmarked feature values be incorporated into the theory of representation and that the evaluation measure be revised such that unmarked feature values contribute nothing to complexity. It was here that markedness was first derived from representation. Similar proposals involving marking conventions are proposed in Cairns (1969) and Kean (1975).

2.3.1.2.2 Prosodic markedness

While by far the majority of generative research on markedness has focused on features, there has been some work undertaken on markedness and prosodic structure. Research on prosodic markedness has focused on initial clusters (e.g. Cairns & Feinstein 1982, Morelli 1998, Goad & Rose to apppear), the syllabification of word-final consonants (e.g. Piggott 1991b, 1999, Goad & Brannen 2000) and syllable structure as a whole (Kaye & Lowenstamm 1981, 1984, Steriade 1982, Clements & Keyser 1983, Itô 1986, Blevins

[38] For critiques of the theory of markedness developed in Chapter 9, see Stanley (1967), Cairns (1969) and Stampe (1974).

1995). To this final group, one must also add all work within OT, where, as mentioned earlier, Markedness constraints, many of which make reference to prosodic complexity, constitute one of the two principal families of constraints. In this section, I will review two proposals concerning theories of syllable structure markedness, namely Kaye & Lowenstamm (1981), whose proposal follows on that of Chomsky & Halle (1968) and Kean (1975), and the theory of prosodic markedness adopted in OT (e.g. Prince & Smolensky 1993, McCarthy & Prince 1993). I conclude this section by elaborating the licensing-based theory of syllable structure markedness originally presented in Steele (2000), itself an extension of proposals in Harris (1997), in which markedness is a derived structural property related to licensing potential.

In SPE, the syllable had no formal status. With the introduction of non-linear theories of the syllable, theories of markedness were developed which made critical reference to constituency. One of the first proposals to extend the feature markedness theory of Chomsky and Halle (1967) and Kean (1975) to a non-linear approach to syllable structure was that of Kaye & Lowenstamm (1981). These researchers proposed that syllable structure markedness could be evaluated in terms of constituent complexity, specifically in terms of whether or not a syllable constituent branched. This contrasted starkly with typological statements of markedness which made reference to linear strings of segments (e.g. (37)). A similar proposal was made by Cairns & Feinstein (1982).

As we have seen already, the conception of prosodic markedness in OT differs dramatically from that proposed in theories like that of Kaye & Lowenstamm (1981). OT proposes that prosodic structure is constrained by a series of UG-provided markedness constraints, including NoCoda, which prohibit the presence of codas in outputs, and

*COMPLEX, a constraint banning the syllabification of more than one segment within any syllable constituent (see (38) below).

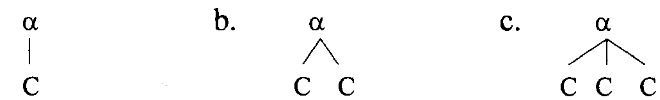
2.3.1.2.3 Summary: the importance of structure and representation

The preceding two sections have briefly outlined the principal types of theories of prosodic markedness proposed in non-linear phonology, all of which make reference to structure. In pre-OT theories such as that of Kaye & Lowenstamm (1981), the markedness of a given syllable structure was evaluated in terms of the complexity of its composite constituents, where 'complexity' was evaluated in terms of branching. In OT, markedness constraints evaluate the relative complexity of output representations; however, complexity does not necessarily equate with hierarchical representations. Consider the definition of *COMPLEX as given in (38).

(38) ***COMPLEX** (Prince & Smolensky 1993)
No more than one C or V may associate to any syllable position node

Of the three representations below, only (39a) fails to violate *COMPLEX. However, there is some intuitive sense in which (39c) is worse than (39b). A constraint such as *COMPLEX does not attempt to formalize this.

(39) a. b. c.



Others have proposed markedness constraints that refer to linear strings only. Consider *CC in (40).

(40) ***CC** (see e.g. Rose 1997, Archangeli & Ohno 1999)
No consonant clusters.

If Markedness constraints can be defined as in (38) and (40), it is possible to adopt OT without adopting a representationally-complex theory of syllable structure such as the one espoused here. In such a case, markedness constraints are not structural constraints as they refer to the wellformedness of strings.

The question arises as to the degree to which OT markedness constraints are truly explanatorily adequate in the absence of non-linear representation. Kager (1999:11) argues that OT phonological markedness constraints should be both typologically and phonetically grounded. While the phonetic grounding of markedness constraints ensures explanatory adequacy, I maintain that typological grounding does not. Indeed, there are at least three potential problems with typological markedness. First, it has little to say about grammatical knowledge (i.e. competence). This characteristic of typological markedness is contrary to the generative research goal of modelling speakers' linguistic knowledge. Second, it is questionable how speakers, including L2 learners, could have access to such universals. Finally, typological markedness arguably lacks explanatory power.

OT does solve two of these three problems. As concerns a speaker's knowledge, markedness constraints, as part of UG, are necessarily part of a learner's innate competence. As such, learners have access to such knowledge. However, it is not clear how markedness constraints such as *COMPLEX and NOCODA achieve any more explanatory adequacy than the descriptive statements "Branching is marked" and "Languages do not like codas". While the presence of markedness constraints within the grammar allows for a formal account of the cross-linguistic pressure against markedness, such constraints offer no explanation for the directionality of asymmetries. For example, a solely constraint-based theory of markedness in itself cannot explain why there is no evidence for constraints such as *SIMPLE or *ONSET.

Thus, I propose that a more explanatorily adequate theory of syllable structure markedness *must* include a theory of highly articulated representation. As concerns prosodic markedness in particular, marked syllabifications involve the licensing of segments and featural material in weak licensing positions, where a weak position's reduced licensing strength is the consequence of Licensing Inheritance. Through a discussion of asymmetries in the L2 acquisition of new positions (e.g. dependent position of branching onset) and new position-sensitive contrasts (e.g. voice and place in coda) in Chapters 3 and 4 respectively, I will seek to demonstrate that a representational, prosodic-licensing-based theory of syllable structure offers a more explanatory account of syllable structure markedness than typological accounts and that such a theory of markedness is completely compatible with OT.

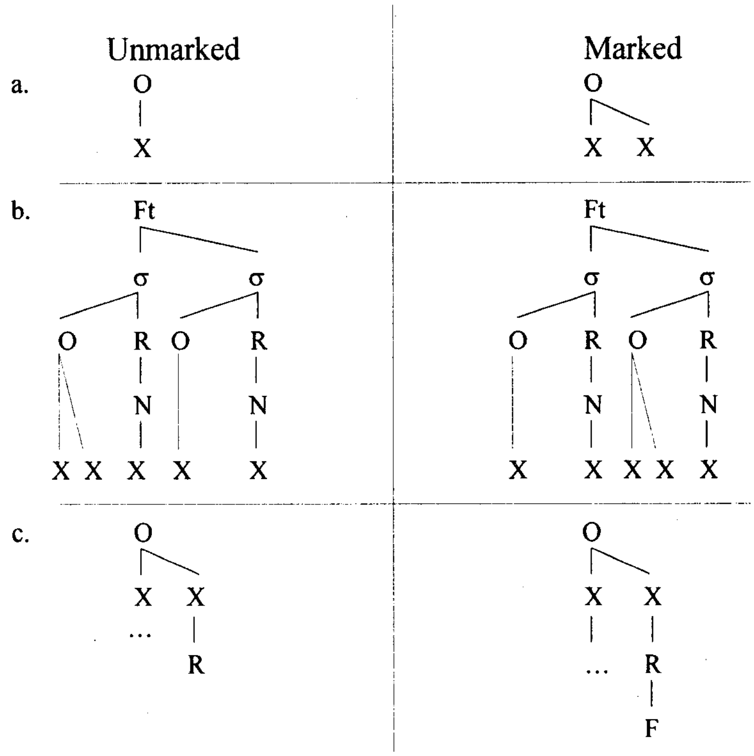
In the following section, we will see that the principles of Phonological Licensing and Licensing Inheritance together serve to encode markedness in representation.

2.3.2 Current proposal: licensing-based markedness

If syllable markedness is related to structure, let us begin by examining the differences in representation between a number of unmarked-marked pairs whose relative markedness will be central to the analyses proposed in Chapters 3 and 4. For the moment, I do not discuss branching rhymes and coda consonants, but leave the discussion of such structures for §2.3.2.3. The relevant onset structures are given in (41).[39]

39 I illustrate with the onset here for sake of simplicity. While the licensing paths that imbue the dependent of the rhyme (i.e. coda) with its licensing potential (cf. (24c)) differ from those for the dependent of the onset illustrated in (42), the markedness asymmetries involving rhymes mirror those in (41). As markedness asymmetries involving complexity within the nuclei are not directly relevant to the analyses of Chapters 3 and 4, I do not discuss them here; see Steele (2000) for discussion.

(41)

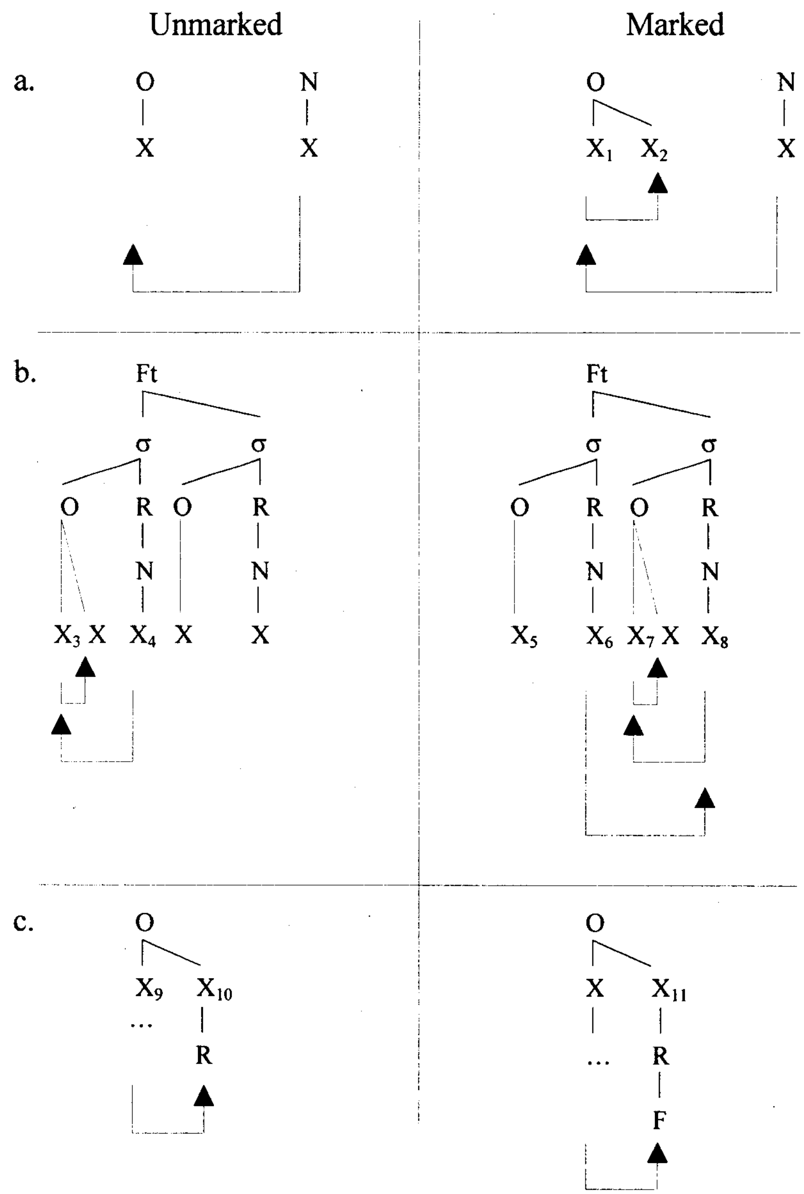


The first two types of markedness relationships (41a,b) involve prosodic complexity, where complexity is defined in terms of branching. Recall from (2) in §2.1.1 that all constituents minimally consist of a head. Thus, a branching syllable constituent obligatorily involves a head-dependent relationship, with the head being the leftmost position within the constituent. As illustrated in (41a), for any syllable constituent, such a head-dependent relationship is marked vis-à-vis a simple head. This representation formalizes the implicational relationships where, in a given language, the presence of branching onsets/rhymes implies the presence of simple onsets/rhymes (e.g. Kaye & Lowenstamm 1981). The representations in (41b) also involve a branching syllable constituent. However, the markedness asymmetry illustrated here does not involve a branching versus non-branching syllable constituent. Rather, it concerns the relative markedness of a branching syllable constituent based on where such a constituent is prosodified within the foot (i.e. head versus dependent). As we saw based on the data from southeastern Brazilian Portuguese in (15), languages may allow branching syllable constituent structures, yet restrict such structures to the head syllable of the foot. As shown in (41b), a branching onset in the head syllable of the foot is relatively unmarked vis-à-vis the same structure in the dependent syllable. Finally, as shown in (41c), in the dependent position of the onset or rhyme (i.e. coda), a segment whose representation involves greater featural (F) complexity is more marked than a segment involving less featural complexity (e.g. voiced versus voiceless obstruents). In the following section, we will see that each of these asymmetries can be explained with reference to the relatively weak licensing potential of a non-head vis-à-vis the head that licenses it.

2.3.2.1 The role of head-dependent licensing asymmetries

In each of the three markedness asymmetries in (42), the marked member of the pair involves either the licensing of a dependent (42a) or the licensing of greater prosodic (42b) or featural (42c) complexity within the dependent. Following Harris (1997), I argue that the markedness of representations involving licensing in a dependent position results from the licensing potential asymmetries between heads and their dependents discussed earlier in §2.1.3.1. Specifically, I contend that a syllabification is marked if it requires the P- or A-licensing of phonological material by a weak as opposed to strong licensor, where non-heads, including the dependent position of any branching onset, nucleus, rhyme, or foot, constitute weak licensors vis-à-vis the heads from which they inherit their licensing potential. To illustrate, the marked representations in (41) are given once again in (42), this time with the relevant licensing paths being indicated.

(42) *Prosodic markedness: licensing paths*



For each of the representations in (42), the marked structure is located in the non-head position of a licensing relationship. In the second structure in (42a), branching requires that the dependent X_2 be licensed within the onset. As a non-head, this dependent must inherent its licensing potential from its head X_1. Following licensing depletion, it is a weak licensor vis-à-vis this head.[40] In (42b), a parallel relationship exists. In the first

[40] Markedness constraints expressing some of these relations will be introduced in Chapter 3.

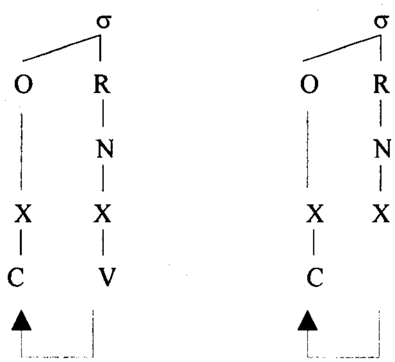
structure, the onset head in the head of the foot X_3 receives its licensing potential from the nucleus of the same syllable X_4 as per (24b). It is thus only one licensing path removed from the head of the PWd, the origin of all licensing potential within the word. In contrast, the second representation in (42b) shows that the onset head of the dependent syllable of the foot X_7 is two paths removed from the head nucleus X_6: the head nucleus first interconstituent licenses the nucleus of the dependent syllable X_8 as per (24a), then this nucleus interconstituent licenses the head of the onset of the dependent syllable X_7 in its syllable as per (24b). Consequently, in contrast to X_7, the head of the onset X_3 is one fewer licensing paths away from the origin of licensing potential within the word given that it is prosodified within the head of the foot. If, following Licensing Inheritance, each position along a chain of licensing paths acts as a licensing resistor, the onset of the head syllable of the foot (X_3 in (42b)) will have more licensing potential than the onset of the dependent syllable X_7. As such, the licensing of a dependent within the onset of the dependent syllable of the foot will require the licensing of a prosodic position by a relatively weaker licensor, i.e. it will be more costly. Finally, in the first representation in (42c), the dependent position X_{10} receives its licensing potential from its head X_9 and is thus a weak licensor vis-à-vis this head. It follows that licensing more versus less featural content in a weak position such as X_{10} – or more specifically, X_{11} in the second representation – is more costly, i.e. relatively marked.

In summary, in an unmarked-marked pair, the representation of the marked member of the pair involves the P-licensing of a dependent position as opposed to the licensing of a head alone (42a), the P-licensing of the dependent position of a syllable constituent within the non-head syllable of the foot (42b), or, within the same position, the A-licensing of more versus less featural content (42c).

2.3.2.2 The importance of featural content to prosodic markedness

In the discussion of licensing inheritance in §2.1.3.3, we examined head-non-head relationships between two melodically-filled positions. However, as we saw in §2.1.1.2, languages may allow empty nuclear positions (i.e. OEHS), at least at the right edge of words. Two important cross-linguistic distributional facts are relevant at this point. First, as previously stated, all languages allow CV syllables; that is, all languages permit consonantal material to be syllabified in onset position when the nuclear position is melodically filled. Second, some languages *only* allow CV syllables; that is, such languages require that nuclear positions be filled and prohibit the presence of OEHS in representation. Furthermore, the number of languages that are like French in allowing branching OEHS is extremely small (Charette 1991:140, Harris 1997:364). The implicational relationship that emerges here is that, if a language allows empty-headed syllables, it also allows syllables in which the nuclear position is melodically-filled. Thus, in the unmarked case, syllable heads are phonetically realized, modulo other wellformedness constraints (see also Goad & Brannen in press). Consequently, of the two representations in (43) below, the representation in (b) is relatively marked. Note that the comparison being made here is restricted to onset syllabification; we will consider the markedness of (b) vis-à-vis coda syllabification in §2.3.2.3.

(43) a. Unmarked b. Marked



While such a claim about markedness might appear intuitively logical, it still requires a structural explanation. In order to put forward such an explanation, I will once again appeal to the principle of Licensing Inheritance. Following Charette (1991) and Harris (1997), I argue that there exists a relationship between the presence of melodic content in a position and the position's ability to discharge licensing potential to a dependent.[41] Recall that all licensing potential ultimately originates from some nuclear head as expressed by the direction of the arrows in (43). It is implicit in such a proposal that it is not the nuclear position per se, but rather the content of such a position from which melodic licensing potential is derived.[42] Were it the case that it were simply the position and not the melodic content from which licensing potential was derived, prosodic theory would predict that interminable strings of OEHS should be possible. Consequently, in the absence of a phonetically realized nucleus, the A-licensing potential

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41 Goad & Rose (to appear) outline the same proposal made here.

42 Arguably, one could extend this to propose that it is not strictly the presence versus absence of segmental material that is relevant, but specifically the amount of SV structure. Languages vary as to what type of segmental material may be syllabified within the nucleus. While all languages allow vowels in such positions, a smaller number of languages allow syllabic liquids and nasals, that is, less sonorous segments (e.g. Zec 1988, Clements 1990). One could argue that languages that prohibit syllabic sonorants do so because such segments lack sufficient SV structure to allow the further discharge of licensing potential within the word and syllable. The near lack of languages with syllabic obstruents such as Berber, segments having no SV structure, is also consistent with this proposal.

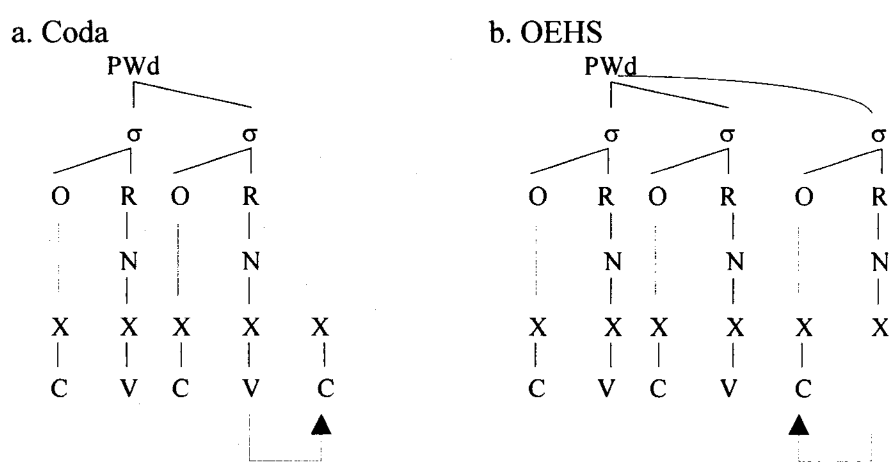
of the syllable is dramatically reduced (Harris 1997:356). It is for this reason that I contend that in the unmarked case syllable heads (i.e. nuclei) are phonetically realized.

To summarize, I have proposed that the absence of melodic material in a given nuclear position reduces the licensing discharge potential of that position. Thus, in the unmarked case, nuclear positions are filled with segmental material. Furthermore, languages will vary as to whether or not the absence of such material impedes further discharge of licensing potential. Such variation will have consequences as concerns the syllabification of word-final consonants.

2.3.2.3 Markedness and the syllabification of final consonants

In §2.1.3.2, I presented arguments from Piggott (1999) that support the view that UG allows for two possible syllabifications of word-final consonants, either as codas or OEHS. The question arises as to which of these two syllabifications is relatively less marked. Both representations of a final consonant are marked in some respect; consider (44) below.

(44) *Syllabification of word-final consonants: coda versus OEHS*



The coda syllabification in (44a) is marked in that codas prefer to be interconstituent licensed as per (24c). Indeed, as we saw in the case of Selayarese in §2.1.3.2 and as is the case cross-linguistically, the unmarked option for licensing featural content syllabified in coda position is via the following onset. In languages that syllabify final singleton consonants as codas, the licensing relation that imbues the coda with its licensing potential is marked in that it does not respect the directionality of the interconstituent licensing relationship that exists between codas and onsets. The OEHS syllabification in (44b) is marked in that the nuclear position that imbues the onset with the licensing potential is melodically empty. The question remains as to which of the two structures in (44) is relatively more marked. While the theory of syllable structure markedness elaborated here allows for the identification of the ways in which final segments are marked vis-à-vis word-internal codas or onsets, it does not allow us to determine the *relative* markedness of the two syllabifications in (44).

Nonetheless, as discussed in §2.1.3.2, I follow Piggott (1991b, 1999) and Goad & Brannen (2000, in press) and assume that it is the onset syllabification in (44b) that is less marked.[43] There are three primary arguments - one theoretical, the other two empirical - that support this position. The first argument is one of learnability. It is generally accepted that children's earliest outputs are unmarked (e.g. Jakobson 1941/68, Stampe 1969, Gnanadesikan 1995) and that children use only positive evidence when restructuring their grammars (e.g. Chomsky 1981, Pinker 1984). Piggott (1991b) and Goad & Brannen (2000) both argue that, if the coda syllabification in (43a) were unmarked and thus a child's initial hypothesis, in some languages in which final

[43] Goad & Brannen differ from Piggott in that they assume that children first begin by syllabifying final consonants as onset-nucleus sequences, not as OEHS. Nevertheless, final consonants are syllabified as onsets, not as codas, in both approaches.

consonants are instead syllabified as onsets, the child would have to be aware of all the restrictions that hold for internal codas to arrive at the onset analysis. Furthermore, in some languages, this could not be determined with positive evidence alone. To illustrate, consider the example provided by Goad & Brannen (2000:13-14) of a child learning a language in which syllables are maximally CVC and word-final consonants are syllabified as onsets. Upon hearing forms such as [tempa] and [dutep], the child would assign a coda representation to the final [p] of the latter form, if coda syllabification (44a) were unmarked. In order to acquire the target representation, i.e., one in which final consonants are syllabified as onsets, the child would have to notice the absence of forms such as *[septo] in order to deduce that codas, in this language, cannot license the place and obstruency of [p] and that, as a consequence, final consonants such as [p] must be syllabified as onsets. That is, the child would have to make use of indirect negative evidence, contrary to the assumption that only positive evidence can trigger reanalysis.

The second argument involves the relative order of the emergence of final obstruents and word-internal codas in L1 acquisition. Both Rose (2000) and Goad & Brannen (in press) draw attention to the fact that final consonants appear before indisputable word-medial codas; we briefly look at Rose's data here. In his study of the acquisition of syllable structure by two child learners of Quebec French, Théo and Clara, Rose proposes two separate stages in the acquisition of word-final stops. Consistent with the initial state hypothesis discussed in §3.1.1, both of the French-learning children's earliest outputs consist of unmarked CV syllables only. At this first stage, final consonants are deleted; see Stage 1 in (45). In contrast, at Stage 2, final consonants present in the target form surface in the child's output.

(45) *L1 acquisition of final consonants in Quebec French: data from Théo* (Rose 2000)

Stage	Word	Target form	Child's output	Gloss
Stage 1	*pique*	[pɪ.k̲]	[pɪ]	'(it) pricks'
	bibitte	[biˈbɪ.t̲]	[pɪˈpɛ]	'bug'
Stage 2	*bus*	[bʏ.s̲]	[pɔ.ç]	'bus'
	mitaine	[miˈtɛ.n̲]	[pəˈtɛ.n]	'mitten'

Importantly, at the point where final consonants emerge (i.e. Stage 2 in (45)), neither child's grammar allows for word-internal codas. Théo's final consonants emerge at 2;04.06, yet internal codas do not appear until 3;07.06. The same asymmetry holds for Clara's outputs: her final consonants first appear at 1;07.06 in contrast to internal codas which are not observed until 2;03.19. Following Goad & Brannen (2000), Rose argues that, across languages, word-final consonants can be syllabified as codas only in languages that tolerate word-internal codas. Given that final obstruents are observed in the children's outputs before word-internal codas, these final consonants must be syllabified as onsets.

The final argument, also empirical in nature, involves the release properties of final obstruents when they first emerge. Data from four recent acquisition studies that investigated the acquisition of final consonants by early learners, including Rose (2000) and Goad & Brannen (in press) for L1 French and English respectively, and Steele (2002) and Goad & Kang (2002) for L2 French and English, are consistent with the unmarked status of the onset syllabification of word-final consonants. In all four of these studies, word-final consonants were (heavily) aspirated.[44] Cross-linguistically, laryngeal properties like aspiration are favoured in onsets and marked in codas. I consider these

[44] Goad & Brannen argue that other phonetic properties, including homorganic nasal release in early outputs, also support an onset analysis of the final stops in question. In §3.3.2.1.1, we will look at both their data and that of Steele (2002) in detail.

three arguments to constitute support for the unmarked status of the onset syllabification of word-final consonants.

2.4 Optimality Theory

In the final section of this chapter, I will present the basic tenets and workings of OT, the framework to be adopted for the analyses in Chapters 3 and 4. While the theories of representation and markedness discussed in this chapter will figure prominently in the analyses of the L2 acquisition of prosodic complexity and position-sensitive contrasts in Chapters 3 and 4 respectively, such theories must exist within a larger theory of grammar. As stated in §2.2.2, I adopt OT as the theoretical framework in this thesis. Given that one of the core components of OT is the constraint set CON that includes Markedness constraints, this theory offers interesting possibilities for the study of the role of markedness in L2 acquisition (see also Hancin-Bhatt & Bhatt 1997, Broselow, Chen & Wang 1998, Hancin-Bhatt 2000). In Chapters 3 and 4, I will demonstrate that OT is an even sharper tool for this end when it is implemented in conjunction with the type of theory of representation discussed to this point in the chapter.

In the following sections, we will briefly examine the basic components of OT: a set of ranked constraints, CON, and two functions, GEN(ERATOR) and EVAL(UATOR), that generate and evaluate the wellformedness of potential output candidates respectively.[45]

2.4.1 Constraints

Four basic properties characterize OT constraints. First, the set of constraints CON is standardly argued to be universal.[46] Second, constraints are rankable; in fact, languages

[45] For a comprehensive discussion of OT, the reader can consult the original manuscripts (Prince & Smolensky 1993, McCarthy & Prince 1993a) as well as general introductions to the theory, including Archangeli & Langendoen (1997), Kager (1999), and McCarthy (2001).

differ principally as concerns the relative ranking of these constraints; we will return to ranking in §2.4.2. Third, OT constraints are (minimally) violable. In this way, OT contrasts starkly with most earlier frameworks. Finally, following ROB (33), constraints evaluate outputs only and are blind to the content, or lack thereof, of inputs.

OT constraints are of two principal types, Faithfulness constraints and Markedness constraints. Faithfulness constraints seek to preserve input-output identity. In doing so, they favour the maintenance of contrasts present in inputs. Two of the most common Faithfulness constraints, MAX-IO and DEP-IO are given in (46) below.

(46) **MAX-IO**
Input segments must have output correspondents.

DEP-IO
Output segments must have input correspondents.

Whereas MAX-IO requires every segment in the input to have a correspondent in the output (i.e. no deletion), DEP-IO requires those segments contained in the output to feature in the input (i.e. no epenthesis). As such, both constraints require that outputs be faithful to the segmental content of their corresponding inputs.

Markedness constraints are the antagonists of Faithfulness constraints in that they are blind to segmental and featural faithfulness. Rather, Markedness constraints ban marked structures in the output. Consider the markedness constraint in (47), repeated from (38).

(47) ***COMPLEX** (Prince & Smolensky 1993)[47]
No more than one C or V may associate to any syllable position node

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[46] However, it has been proposed by some that constraints may emerge (e.g. Hayes 1999).

[47] As argued in §2.3.1.2.3, *COMPLEX as defined in (46) lacks explanatory adequacy. I nonetheless use the definition here for the sake of simplicity. In Chapters 3 and 4, all of the syllable structure markedness constraints will be defined in terms of licensing.

*COMPLEX bans any onset, rhyme or nucleus that contains more than one segment. This reflects the typological universal that, in any language that allows complex syllable constituents, simple syllable constituents are also possible. With these basic constraints in mind, we now turn to the way in which the relative importance of constraints within a given grammar is formalized via ranking.

2.4.2 Constraint ranking and evaluation

Given that Faithfulness and Markedness are antagonistic forces, whenever a language introduces complexity into a lexical form, these two types of constraints will come into conflict. The question arises as to how languages resolve such conflict. The answer is that languages differ in terms of the weighting they give to individual constraints, that is, in how they rank constraints. To illustrate, consider the way in which three different languages might realize inputs involving initial consonant clusters as shown in (48).

(48) *Output realization of input initial consonant clusters*

Language	Input	Output
A	/ple/	[ple]
B	/ple/	[pe]
C	/ple/	[pəle]

In language A, initial consonant clusters present in the input are realized as such in the output. In contrast, languages B and C both prohibit such marked structures but differ in terms of how they simplify the complexity: while language B deletes one member of the cluster, in language C, an epenthetic vowel is inserted to break up the licit sequence. The typology in (48) can be expressed in terms of faithfulness and markedness. Language A tolerates markedness, at least as concerns initial consonant clusters, while prohibiting unfaithfulness to the input. Languages B and C show the reverse pattern: unfaithfulness to the input is tolerated in order to avoid marked initial consonant clusters.

In OT, the relative weighting of constraints on markedness and faithfulness, and the evaluation of individual inputs is shown via tableaux. The tableau in (50) shows the evaluation of potential output candidates for input /ple/ in language A. Constraints are listed horizontally in descending ranking from left to right at the top. A solid line between two constraints indicates dominance, whereas a dotted line indicates that the ranking is indeterminate.

(50) *Language A's evaluation of target*

	Input: /ple/	MAX-IO	DEP-IO	*COMPLEX
☞	a. [ple]			*
	b. [pe]	*!		
	c. [pəle]		*!	

All three candidates violate some constraint as indicated by an asterisk '*'. Whereas candidates (b) and (c) violate the Faithfulness constraints MAX-IO and DEP-IO respectively, candidate (a) violates *COMPLEX. Given language A's ranking of these constraints,violation of *COMPLEX is less serious. Indeed, as indicated by the exclamation marks '!', violations of MAX-IO and DEP-IO are fatal for candidates (b) and (c), leaving candidate (a) as optimal as indicated by the right-turned hand '☞'.

In summary, OT is a theory of constraint interaction where Markedness constraints, which prohibit complexity, compete against Faithfulness constraints, which seek to maintain contrasts present in input representations. Cross-linguistic variation results from differences in the relative ranking of Markedness and Faithfulness constraints.

2.5 Chapter summary

The present chapter has focussed on the theoretical assumptions that will guide the analyses of the acquisition of prosodic complexity and position-sensitive contrasts to be undertaken in the rest of the thesis. A speaker's competence includes highly articulated representations, both for prosodic and segmental structure. As concerns prosodic structure, representations are built from a universal set of constituents respecting the principles of headedness and binarity. In the construction of such representations, Phonological Licensing plays a central role in anchoring all phonological material in representation through a series of dependency relations. Segment structure too involves hierarchical representations in the form of a geometry. In §2.3, both the nature and formalization of markedness in generative phonology were discussed. I have proposed, following others, that typological markedness lacks explanatory adequacy and that, in order to increase the level of explanatory adequacy, a theory of markedness must crucially be derived from structure (i.e. representation). The licensing-based theory of markedness proposed satisfies such a criterion: a syllabification is marked if it requires the P-licensing of a position or A-licensing of featural material by a weak licensor, where non-heads are weak licensors relative to the heads that imbue them with licensing potential. Finally, in §2.4, the basics of OT were presented. These include a universal constraint set CON, which includes both Markedness and Faithfulness constraints, as well as the functions GEN and EVAL which create and evaluate the candidate set respectively.

In the following two chapters, we will see that the theory of syllable structure and licensing argued for here allows for important insights into the L2 acquisition of prosodic complexity and position-sensitive contrasts. We now turn to the acquisition data.

3 *Issues in the L2 acquisition of prosodic complexity*

3.0 Introduction

In the discussion of Phonological Licensing in Chapter 2, a distinction was made between the licensing of a prosodic position (P-licensing) and the licensing of segmental content in a given position (A-licensing). In this chapter and the next, we will investigate how P-licensing and A-licensing interact with other principles of wellformedness, including headedness and binarity, in the L2 acquisition of prosodic complexity and position-sensitive contrasts.

The current chapter consists of three principal sections. In the first section (§3.1), we will briefly review three central assumptions of L1 acquisition theory conducted within OT. These include the nature of the initial state, the elaboration of inputs and constraint reranking, and the role of markedness. Under the assumption that L1 and L2 acquisition are fundamentally similar (e.g. Broselow & Finer 1991, Archibald 1994), the discussion here will serve to introduce the acquisition framework for the L2 analyses to be presented in the rest of the thesis. In §3.2, we return to these assumptions, discussing them as they apply to L2 acquisition. In the remainder of the section and on into §3.3, the investigation will focus on the roles of P-licensing and highly-articulated representation in the acquisition of word-final consonants and branching onsets. The data come from two studies that investigated the acquisition of French by native speakers of Mandarin. In the case of word-final consonants, the data provide strong evidence for the role of heads, particularly head faithfulness, and markedness. As concerns markedness, in the spirit of Goad & Brannen's proposal for L1 acquisition, I will argue that the learners' heavy aspiration of final stops results from their representation as onsets, and not codas, in the IL grammar. Given the hypothesis that onset syllabification of final stops is the cross-linguistically unmarked option (§2.3.2.3), such facts are consistent with the claim that IL development is guided by markedness.

In §3.3, I will provide further evidence for the role of markedness in the acquisition of new positions, particularly as concerns the relatively greater licensing potential of heads and Foot Binarity. The focus in this section will not be on outputs alone; indeed, before undertaking an analysis of the learners' syllabification of onset clusters, we will first pay considerable attention to the learners' construction of inputs. We will focus on two asymmetries. The first involves differences in the learners' accuracy between targets involving /l/ versus /ʁ/. I will argue that the learners' overwhelmingly non-native-like outputs for rhotic targets result from their (mis)analysis of French /ʁ/ as an obstruent. The second asymmetry involves differences in the learners' realization of voiceless and voiced heads in /Cʁ/ clusters. Once again, I will propose that such differences are related to the learners' construction of non-native-like inputs. Specifically, I will argue that the learners misanalyse the /ʁ/ of a voiceless /Cʁ/ cluster not as a separate segment but rather as release of the stop. This leads them to construct inputs in which target /ʁ/ has no independent segmental correspondent. As such, it is perceptual considerations and the shapes of learners' inputs that are the source of 'deletion', not constraints on output representation.

In summary, the current chapter will provide strong evidence for the role of highly articulated representation and structural markedness in the L2 acquisition of prosodic complexity. Before proceeding to the analysis of the L2 data, we begin by discussing a number of core assumptions of acquisition research.

3.1 L1 phonological acquisition

In this section, we examine three general assumptions concerning child language held by acquisition researchers. These include the nature of the initial state, the processes involved in phonological development, and the role of markedness in guiding acquisition. In §3.2, we will turn to the same issues as they concern L2 acquisition.

3.1.1 The initial state

In contrast to L2 acquisition where it is generally assumed that marked properties of the L1 endstate grammar transfer into the L2 initial state (cf. §1.1), a long held assumption in L1 acquisition is that the child's initial grammar is unmarked in all respects (e.g. Jakobson 1941/68, Stampe 1969). Within OT, this is formalized via the ranking in (1) in which Markedness constraints outrank Faithfulness constraints (e.g. Gnanadesikan 1995, Demuth 1995, Smolensky 1996).

(1) *L1 initial state*
Markedness constraints » Faithfulness constraints

As concerns syllable structure, children's earliest outputs consist of CV syllables only. Target structures involving branching at the level of the onset, nucleus or rhyme are reduced to non-branching structures, typically through deletion of the dependent. In structural terms, the L1 initial state is one in which syllable constituent heads (i.e. of onset, nucleus, rhyme) alone are licensed (Goad & Rose to appear). This initial unmarked syllable structure results from the ranking of a Markedness constraint such as *COMPLEX over the Faithfulness constraints MAX-IO and DEP-IO. Only in the presence of positive evidence in the input do children rerank the markedness and faithfulness constraints in order to yield outputs more complex than CV sequences. We now consider ranking and the elaboration of inputs.

3.1.2 Acquisition as constraint reranking and input elaboration

The second central theoretical assumption made by L1 researchers working within OT concerns the manner in which learners restructure their grammar. When a learner encounters a target form that is incompatible with his or her grammar, restructuring takes place.[1] It has been proposed that there are two important aspects to this restructuring. The first aspect is that of constraint reranking. For example, an early child learner of English or French whose grammar allows CV syllables only, when faced with target forms like *train* [treːn]/[trɛ̃] and *please* [pliːz]/*plein* [plɛ̃] 'full', will deduce that the language that s/he is acquiring allows for branching onsets. As a consequence, the markedness constraint prohibiting branching onsets, namely *COMPLEX(ONS), will eventually be demoted below the relevant faithfulness constraints, namely DEP-IO and MAX-IO.[2] The consequence of this reranking is that branching onsets will become licit in the learner's

1 I assume that it is not the presence of a single incompatible form that motivates restructuring, but rather that cues to restructuring must be robust in the ambient input.

2 Within L1 acquisition research in OT, there is some disagreement as to whether reranking involves the demotion of markedness constraints or the promotion of faithfulness constraints. As this issue is tangential to the central research questions of this thesis, I will adopt the more widely held position that acquisition involves constraint demotion (see e.g. Tesar & Smolensky 2000).

productions.[3] A second, less widely discussed restructuring involves inputs. Goad & Rose (to appear) propose that learners not only rerank constraints but also elaborate inputs.[4] Specifically, they argue that, while L1 learners' inputs are prosodified,[5] this prosodification initially only involves heads. Consequently, during the course of acquisition, learners must not only rerank constraints but also determine the input prosodification of non-heads (e.g. dependent of branching onset).

3.1.3 Markedness and grammatical development

The final assumption concerning L1 acquisition to be discussed here concerns the role of markedness in phonological development. As discussed in §3.1.1, the L1 initial state consists of a grammar in which only unmarked options are permitted. As stated in (2) below, it is widely assumed that markedness guides development with learners opting for unmarked structures where a choice exists.

(2) <u>The role of markedness in phonological acquisition</u>

Markedness guides phonological development with learners acquiring progressively more marked structures in the presence of positive evidence.

For example, given the relative unmarkedness of onset versus coda syllabification of final consonants (§2.3.2.3), when a learner whose grammar disallows final consonants is faced

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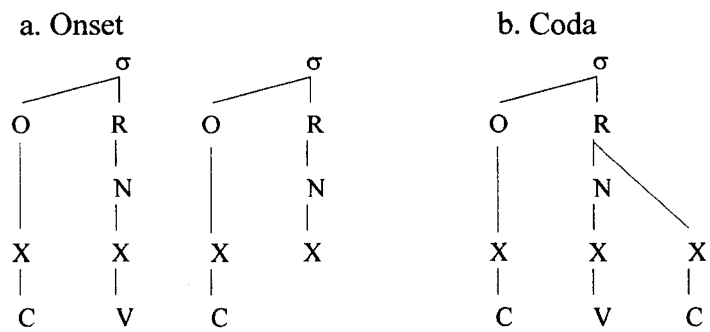
3 This is an oversimplification. Children do not go from an unmarked grammar to one in which complexity is allowed everywhere. Rather, there is evidence that branching constituents appear in the head of the foot (i.e. stressed syllables) first (Rose 2000) as is predicted by the theory of syllable structure markedness argued for in §2.3.2. Consequently, there are a series of rerankings that allow complexity in heads first, followed by complexity in dependent positions when such structures are licit in the language being learned.

4 Structure elaboration has been assumed to play a role by other researchers (e.g. Fikkert 1996, Dresher & van der Hulst 1998). However, in non-OT frameworks, elaboration is assumed to involve surface representation (i.e. outputs).

5 This assumption is also made by Gnanadesikan (1995). However, she differs from Goad & Rose in that she assumes that adult inputs are not prosodified. As such, development does not involve the elaboration but rather paring back of inputs.

with such consonants in the input, s/he begins by syllabifying such consonants as onsets (3a), not as codas (3b).

(3) *Learner's options for the syllabification of final consonants*



Only when there is positive evidence to indicate that final consonants are syllabified as codas (e.g. CVC patterning with CVV as concerns syllable weight, morphological alternations involving place or voice in coda) will a learner opt for the marked coda representation in (3b). Even when final consonants are syllabified as codas in the target language, under the hypothesis that markedness guides acquisition at each stage of acquisition, one should predict that learners will pass through a preliminary stage in which final consonants are syllabified as onsets, before acquiring the target coda representation.[6] With these three theoretical assumptions in mind, we now turn to L2 acquisition.

3.2 L2 phonological acquisition

Beginning in this section and continuing throughout Chapter 4, the data and analyses presented will demonstrate the central role of representation and licensing in the L2 acquisition of syllable structure, both as concerns new positions, specifically the dependent of a branching onset as well as OEHS, and new position-sensitive contrasts

6 Goad & Kang (2002) provide evidence that such is the case in the L2 acquisition of word-final consonants by Korean learners of English.

involving place and voice. In the present chapter, we focus on P-licensing and the acquisition of prosodic complexity. We begin by considering the L1 acquisition assumptions discussed immediately above for L2 acquisition.

3.2.1 Fundamental assumptions: transfer, markedness and development

As discussed in §1.2, previous research on the L2 acquisition of syllable structure has provided strong evidence for transfer. The strongest evidence comes from learners whose L1 and L2 both allow complex syllable structures. Indeed, in the case of learners whose L1 syllable structure is relatively unmarked, evidence for transfer is less clear, as the simplification of relatively complex target structures via epenthesis and deletion can be attributed to two sources, either to transfer or to reversion to an unmarked grammar of the type proposed for the L1 initial state in §3.1.1.[7] Thus, data from studies such as Steele's (2000) study of English-speaking learners of French provide strong evidence for transfer as even the very beginner learners in this study allowed for marked structures, including branching onsets and rhymes as well as the licensing of final consonants, consistent with transfer. Consequently, following Hancin-Bhatt & Bhatt (1997), Broselow, Chen & Wang (1998), and Hancin-Bhatt (2000), I assume that the initial L2 constraint ranking is that of the end state L1 grammar. While markedness may not shape the L2 initial state in the same manner as it does the L1 initial state – i.e. there is little evidence for reversion to an unmarked grammar – I nonetheless assume that structurally-encoded markedness guides phonological development as per (2): when faced with more than one possible representation for a given target form, L2 learners will initially choose the option that is

7 As mentioned in Chapter 1, proposals for reversion to an unmarked grammar include Tarone's (1980) claim that L2 acquisition is characterized by a preference for open syllables, on par with children's early preference for CV outputs.

structurally less marked. Finally, as proposed for L1 acquisition above, I assume that L2 acquisition involves both reranking and the elaboration of inputs.

In the following section, we will examine data from a study of beginner Mandarin-speaking learners of French which demonstrate an important role for markedness in the acquisition of final consonant clusters.

3.2.2 The acquisition of final consonants

Data from Steele's (2002) study of the acquisition of word-final clusters provide evidence both for the importance of heads to L2 syllable organization and for early learners' preference for unmarked syllabifications, specifically for onset syllabification of final consonants. In this study, very early Mandarin-speaking learners of French were tested on their syllabification of word-final liquid-stop (e.g. *carpe* [kaʁ̠p̠] 'carp') and stop-liquid clusters (e.g. *couple* [kyp̠l̠] 'couple') via a word-learning task.[8] As shown in (4) below, in the case of the liquid-stop forms, the learners' outputs were target-like (TL) in only 8% of cases. More often, liquid-stop clusters were syllabified via deletion (56%),

[8] The Mandarin-speaking learners in Steele (2002), as well as the learners in the experiment to be discussed in §3.3, all spoke some English. As such, French was an L3. This raises the question as to the possible influence of their L2 English on their French IL. As I am unaware of any research documenting the influence of the L2 on the L3 phonology, I will adopt the hypothesis that the L3 initial state is also that of the L1 endstate, as per §3.2.1. Even were this assumption erroneous and properties of the L2 did transfer to the L3, the influence of the Mandarin-speaking learners' English would be minimal. Discussion of the experimental procedure as well as of their linguistic background was conducted in English given the learners' low proficiency in French. With a few exceptions, the learners' English was highly accented. Moreover, most learners reported having had little access to native speakers of English during acquisition. Given that English does not have word-final stop-liquid clusters, the learners' knowledge of English should not be relevant. Moreover, the hypotheses to be put forward in (16) and tested in §3.3 concern developmental stages alone. Regardless of the learners' initial state, their development should be consistent with the predictions made based on licensing-based markedness.

overwhelmingly via deletion of the liquid (Del C_1, output [kap]: 32%; Del C_1 + V, output [kapə]: 16%; Total: 48%).[9]

(4) *Beginner Mandarin-speaking learners' syllabification of French word-final liquid-stop clusters* (e.g. *carpe* [kaʁp] 'carp', *bulb* [bylb] 'bulb') (Steele 2002)

			Epenthesis			*Deletion*				*Metathesis*	
Subject	n	TL	C_1C_2V	C_1VC_2	C_1VC_2V	Del C_1	Del C_1 + V	Del C_2	DelC_1C_2	C_2C_1	C_2C_1V
NF7C	9		.11	.11		.33	.33	.11			
NF3C	6		.17			.50	.33				
NF4C	6		.17			.33	.17		.33		
NF6C	9	.11	.11		.33	.22				.11	.11
NF2C	7	.29				.29				.43	
Average		.08	.11	.03	.08	.32	.16	.03	.05	.11	.03

As shown in (5) below, the learners' outputs for stop-liquid targets such as *couple* [kypl] were also target-like in only a small percentage of cases (TL: 15%). However, in contrast to the liquid-stop targets, the learners' preferred syllabification of these clusters involved final epenthesis (C_1C_2V, output [kyplə]: 42%).

(5) *Beginner Mandarin-speaking learners' syllabification of French word-final stop-liquid clusters* (e.g. *lettre* [lɛtʁ] 'letter', *couple* [kypl] 'couple') (Steele 2002)

			Epenthesis			*Deletion*				*Metathesis*	
Subject	n	TL	C_1C_2V	C_1VC_2	C_1VC_2V	Del C_1	Del C_2	Del C_2 + V	Del C_1C_2	C_2C_1	C_2C_1V
NF4C	14		.14				.50	.36			
NF2C	16	.06	.63				.19	.13			
NF7C	15	.07	.27	.20	.13		.20	.13			
NF6C	17	.18	.59				.06			.18	
NF3C	12	.50	.42					.08			
Average		.15	.42	.04	.03		.19	.14		.04	

9 For a key to the syllabification methods in (4) and (5), see the table in (20).

In a smaller percentage of cases, deletion occurred. Once again, deletion was restricted to the liquid (Del C_2, output [kyp]: 19%; Del C_2 + V: 14%, output [kypə]; Total: 33%).

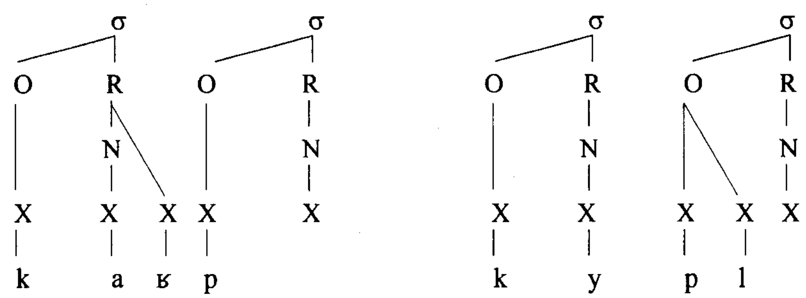
In the following section, we will consider two aspects of the above data. First, we will investigate what motivates the learners' choice to delete the liquid and not the stop for both types of clusters in the majority of cases. Then, in §3.2.2.2, we will examine the learners' phonetic realization of the final stops; I will argue that the (heavy) aspiration of these final consonants is consistent with the learners' representing such segments as onsets, and not codas.

3.2.2.1 Head preservation in cluster reduction

In Chapter 2, heads were shown to have at least two important roles in prosodic organization. First, the lower limit on syllable constituent size is defined in terms of a head (§2.1.1). Second, as concerns licensing, heads are universally stronger licensors than non-heads and thus are positions where maximal contrast will be permitted. Given the importance of heads to representation in natural languages, it would not be surprising to find that they also play an important role in IL development. The Mandarin-French data in (4) and (5) demonstrate that this is indeed the case. It is significant that, in those cases where the cluster was syllabified via deletion, the cluster was reduced to a singleton stop (i.e. liquid-stop output [kap]: 32%; stop-liquid output [kyp]: 19%) and not to a liquid. I argue that the key to understanding this deletion pattern lies in the representation of such clusters. Consider the representations in (6).

(6) *Representation of French word-final liquid-stop and stop-liquid clusters*

a. Liquid-stop (e.g. *carpe* [kaʁp]) b. Stop-liquid (e.g. *couple* [kypl])



In both (6a) and (6b), the stop of a liquid-stop or stop-liquid cluster is prosodified in a head position, namely the head of the onset. In contrast, the liquid is syllabified as a dependent, either the dependent of a branching rhyme (6a) or branching onset (6b). I argue that the preservation of the stop in the learners' outputs is a case of faithfulness to prosodic heads driven by high ranking MAXHEAD(ONSET), a particular instantiation of the general head faithfulness MAXHEAD(PCAT) proposed by Goad & Rose (to appear). The general constraint is given in (7) below.

(7) **MAXHEAD(PCAT)** (Goad & Rose to appear)

Every segment prosodified in the head of some prosodic category in the input has a correspondent in the head of that prosodic category in the output.
PCat ∈ {Onset, Nucleus, Rhyme, Syllable, Foot…}

Goad & Rose motivate the existence of these constraints using data from the L1 acquisition of left-edge clusters in West Germanic as well as data involving asymmetries in syllable structure complexity between head and non-head syllables like that attested in southeastern Brazilian Portuguese (§2.1.3.1). Data from Rose (2000) provide further motivation for this constraint. Rose demonstrates that both MAXHEAD(FOOT) and MAXHEAD(ONSET) play a central role in children's choice of which syllable or consonant to delete in those cases where target prosodic structures are simplified to conform to the relatively unmarked structures permitted in the child learner's grammar.

I argue that it is high ranking MAXHEAD(ONSET) in particular that determines the Mandarin-speaking learners' choice of which consonant of the target liquid-stop or stop-liquid cluster to delete. Before considering this analysis any further, let us briefly entertain two alternative explanations, namely that the learners are simply deleting the least sonorous of the segments in the cluster or that deletion is related to articulatory difficulty.[10] As concerns the first possibility, a number of L1 studies have argued that sonority is the relevant consideration in cluster simplification (e.g. Fikkert 1994, Barlow 1997, Ohala 1999). While sonority might be the relevant factor for word-initial clusters, it cannot be the motivating factor for right-edge clusters, regardless of whether the stop is syllabified as a coda or as an onset. Were the Mandarin-speaking learners syllabifying final consonants as codas, one would predict that the liquid would be maintained given that, in the unmarked case, the best codas are sonorants. Moreover, the learners were true beginners.[11] If the L1 end state constitutes a beginner learner's initial state as argued in §3.2.1, Mandarin learners of any language should allow for sonorant codas such as /n,ŋ/ and /ɹ/ in suffixed forms, as these are the sole codas possible in their L1 (see §2.1.3.1). Thus, on both markedness and transfer grounds, were a Mandarin-speaking learner to syllabify final consonants as codas, when reducing a stop-liquid or liquid-stop sequence to a singleton consonant, it should be the liquid that is maintained. Were the beginner

[10] One might also argue that the deletion pattern is motivated by perceptual salience, if word-final stops were more salient than final liquids. However, cues to place and laryngeal properties in stops manifest themselves on the following vowel. As such, at the right edge, such cues are weak. In contrast, liquids have internal cues, cues which remain salient even when such segments occur word-finally.

[11] The learners' total exposure to French was maximally three to four weeks of intensive instruction (i.e. 25hrs/wk), which occurred just prior to testing.

learner to syllabify the non-deleted consonant as an onset, sonority would be irrelevant as both stops and liquids are possible onsets in the L1 grammar (compare [tʷoː] 'many', [lʷoː] 'fall', [ɹʷoː] 'weak')[12] and thus also in the IL grammar following transfer.

The second possible explanation, that deletion is related to articulatory difficulty, finds little support given that an equal number of the targets involved laterals, segments present in the Mandarin speakers' L1. Indeed, as we will see with a different group of learners in §3.3.3.1, French /l/ presents virtually no articulatory difficulty for Mandarin-speaking learners, which is not surprising given that their L1 lateral is also dental.

Before considering the learners' evaluation of target liquid-stop clusters, we first need to introduce two markedness constraints. The first constraint is NUCLEUS, whose definition is given in (8) below.

(8) **NUCLEUS (NUC)**
Syllables must have overt (melodically-filled) nuclei[13]

NUCLEUS requires that syllables have overt nuclei. The target representations for French liquid-stop and stop-liquid clusters in (6a) and (6b) respectively both violate this constraint as the second syllable of both forms contains an empty nucleus (i.e. [kaʁ.p∅], [lɛ.tʁ∅]). The second markedness constraint is CODACONSTRAINT (CODACON). I use this constraint to abbreviate the relevant licensing constraints that conspire to restrict

12 Unless directly relevant, I will omit tones for simplicity's sake when giving Mandarin examples throughout the thesis.

13 The definition of NUCLEUS given here differs from the standard definition (e.g. Prince & Smolensky 1993), which simply requires that syllables have nuclei. Under the latter definition, one could argue that syllables with empty-heads, including OEHS, satisfy the constraint. The requirement that a nucleus have melodic content in order to satisfy NUCLEUS reflects the importance of nuclear melodic content to licensing inheritance discussed in §2.3.2.2. I thus follow Rose (2000) and adopt the definition in (8) that makes reference to the melodic content of such positions. This definition is also consistent with a proposal in Goad & Brannen (in press) who suggest that CON includes a constraint that disfavours empty nuclei.

Mandarin codas to nasals as well as /ɹ/ following suffixation. While Mandarin allows for /ɹ/-final words, as discussed in §2.1.3.1, such forms must be derived. In §4.1.2.2, I will provide evidence that it is not the coda but rather the nucleus that is the licensor of the featural content that distinguishes Mandarin /ɹ/ from /n,ŋ/. As such, candidates whose representation involves the licensing of segments other than /n,ŋ/ by the coda violate CodaCon.

Now consider the learners' evaluation of a liquid-stop cluster such as *carpe* [kaʁp] 'carp' given in (9) below. As discussed in §3.2.1, if constraints like MaxHead exist, inputs *must* be prosodified.[14,15] The candidates in (8a,b,e), whose representations involve the licensing of an illicit L1 coda, all incur fatal violations of CodaCon and are thus eliminated. Candidates (c) and (d) are both eliminated by MaxHead(Ons). In the second syllable of the input, /p/ is prosodified in the head of the onset. As such, it must appear in the head of the onset in the output if a violation of MaxHead(Ons) is to be avoided; this is not the case in (8c,d) nor in (8b,e). Of the two remaining candidates, (f) [ka.p] and (g) [ka.pə], the former is chosen as optimal as it does not incur a Dep violation. Note that, if MaxHead(Ons) were not relevant in determining the optimal candidate, we would predict that both candidates (c) [ka.ʁ] and (f) [ka.p] would be optimal. However, as the summary of the data in (4) shows, this is not the case.

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[14] In the absence of evidence to the contrary, I also assume that L2 learners' inputs are target-like. In §3.3.3.1, I will present evidence from another study of Mandarin learners of French that suggests that phonetic differences between the realization of a segment in the L1 and target language may lead learners to misanalyse the target and thus construct non-native-like inputs.

[15] For the sake of space, I omit the nuclear, syllable and higher levels of projection from both input and output representations in the tableaux.

(9) *Mandarin learners' evaluation of target French liquid-stop clusters*

Input: O R O R X X X X X k a ʁ p	CODA CON	MAX HEAD (ONS)	MAX-IO	DEP-IO	NUC
a. [kaʁp] O R O R X X X X X k a ʁ p	*!				*
b. [kaʁ] O R X X X k a ʁ	*!	*	*		
c. [kaʁ] O R O R X X X X k a ʁ		*!	*		*
d. [kaʁə] O R O R X X X X k a ʁ ə		*!	*	*	
e. [kap] O R X X X k a p	*!	*	*		
☞ f. [kap] O R O R X X X X k a p			*		*
g. [kapə] O R O R X X X X k a p ə			*	*!	

Now consider the learners' evaluation of stop-liquid targets like *couple* [ku.pl] as shown in (11) below. Before doing so, it is necessary to introduce one final constraint, specifically a constraint prohibiting branching OEHS. I label this constraint GOVERNMENT LICENSING following Charette (1991). The constraint is given in (10).

(10) GOVERNMENT LICENSING (GOV LIC; Charette 1991:101)
An onset which inherits its licensing potential from an empty nucleus cannot license a dependent

Charette proposes that the inability of a final OEHS to license a dependent in many languages is directly related to it being (interconstituent) licensed by an empty word-final nucleus, a marked licensing configuration.[16] GOVERNMENT LICENSING, when ranked highly enough in the grammar, will prohibit branching OEHS in output representations

The candidate in (11a) [ku.pl], which is completely faithful to the target, is ruled out from being optimal given that its representation violates undominated GOVERNMENTLICENSING. Candidates (c) [kup.] and (f) [kul.], whose representations involve illicit L1 codas, are eliminated as they violate the coda constraint. As was the case with liquid-stop targets, high-ranking MAXHEAD(ONS) rules out candidate (11g) [ku.l] in which a segment syllabified in the head of an onset in the input is not syllabified as such in the output. This leaves candidates (b) [ku.plə] and (e) [ku.pə]. The learner chooses the candidate (b) [ku.plə], as [ku.pə] is unnecessarily unfaithful to the target. While [ku.plə] violates *COMPLEX(ONS), this constraint must be ranked below NUC in the IL grammar, as attested to by the fact that 57% of the learners' outputs (TL: 15%, C1C2V: 42%; see table in (5)) involved branching onsets.

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16 The definition in (10) differs somewhat from that of Charette, as the theory of licensing adopted in this thesis does not include a theory of government. Note, however, that both definitions of the constraint attribute the inability of OEHS to license a dependent to the fact that such positions are themselves interconstituent licensed by empty nuclei.

(11) *Mandarin learners' evaluation of target French stop-liquid clusters*

Input: O R O R X X X X X k u p l	GOV LIC	CODA CON	MAX HEAD (ONS)	MAX-IO	DEP-IO	NUC
a. [kypl] O N O N X X X X X k u p l	*!					*
☞ b. [kyplə] O N O N X X X X X k u p l ə					*	
c. [kyp] O N X X X k u p		*!	*	*		
d. [kyp] O N O N X X X X k u p				*		*!
e. [kypə] O N O N X X X X k u p ə				*	*!	
f. [kyl] O N X X X k u l		*!	*	*		
g. [kyl] O N O N X X X X k u l			*!	*		*

In summary, the Mandarin-speaking learners' outputs for French word-final liquid-stop and stop-liquid clusters provide evidence for the role of head preservation, namely the preservation of onset heads required by the faithfulness constraint MAXHEAD(ONS). In the next section, we will examine phonetic evidence that supports the view that the stop in [kap] and [kup] outputs for targets [kaʁp] and [kupl] is syllabified as an onset and not a coda, consistent with the relative markedness of these two representations discussed in Chapter 2.

3.2.2.2 Codas versus onsets: phonetic evidence for representation

In §2.1.3.2, I assumed, following Piggott (1999), that UG provides two options for the syllabification of final consonants, either as onsets or codas. Furthermore, following Piggott (1991, 1999) and Goad & Brannen (2000, in press), I proposed in §2.3.2.3 that onset syllabification is the relatively less marked of the two syllabifications. If this is true, we predict that at least some learners will begin by syllabifying word-final consonants as onsets, regardless of how final consonants are represented in the target language. In this section, we will examine phonetic evidence that is consistent with this proposal.

While most research on L2 syllabification has focused solely on the prosodic aspects of learners' outputs without attending to the position-specific details of learners' phonetic realization of consonants, in a number of studies, researchers have commented on the release properties of final stops, particularly the presence of aspiration. Flege & Davidian (1984:335), in the discussion of their Polish learners of English, write, "At times, they appeared to produce /b,d,g/ with the syllable termination and voicing characteristics of English [b,d,g], but with the voiceless aspirated release associated with English [p,t,k]". Heyer (1986) echoes this observation in her description of Mandarin learners' 'hyperaspiration' of target English final stops.

The Mandarin-French data in (5) and (6) provide strong quantitative weight to this observation. As shown in the table in (12), on average, 94% of final voiceless stops were (heavily) aspirated.[17] For example, target [kaʁp] was realized not as [kap] but rather as [kap^h].

(12) *Mandarin-speaking learners' aspiration of final voiceless stops*

Subject	Voiceless Final Stops: # Aspirated	Total CVC stop outputs	% Aspirated
NF1C	44	47	93.6
NF2C	41	46	89.1
NF3C	41	42	97.6
NF4C	51	55	92.7
NF6C	37	37	100
NF7C	51	55	92.7
Total/Average	265	282	94.0

Even though the learners' L1 contrasts stops not through voicing but rather in terms of aspiration (e.g. [p^han] 'judge', [pan] 'half'), the aspiration in (12) cannot simply be the learners' implementation of target French voiceless stops, as target initial and medial voiceless stops were virtually never realized as aspirated stops in the learners' outputs. Rather, in the spirit of Goad & Brannen (2000, in press), I argue that the "aspiration" (technically final release, Laver 1994) observed is the consequence of the learners' representation of final stops onsets.[18] Let us briefly review Goad & Brannen's proposal.

Goad & Brannen argue that the phonetic properties, including aspiration, of the final consonants of CVC forms in early L1 acquisition are consistent with onset

17 Two comments are merited here. First, a clear distinction was made between aspiration and epenthesis in the transcription of the data. In those cases where a distinct syllabic pulse was heard, the release was transcribed as epenthesis; this included voiceless schwas (e.g. target [lɛtʁ], learner output [letə̥]). If no pulse was heard, the release was transcribed as aspiration. Second, 'voiceless stops' should be understood as 'output voiceless stops'. This includes the limited number of cases where an input voiced stop was realized as voiceless in a learner's output (e.g. target [kɔʁd], learner output [kɔʁt]). Note that output voiced stops were never aspirated (i.e. finally released) in the learner data.

18 Indeed, there is a distinct difference in representation between the aspiration of stops syllabified as onsets to syllables with overtly realized nuclei, as in the Mandarin learners' L1, and the aspiration of final stops attested in the IL grammar. While the former is the interpretation of a laryngeal feature present in the stop's output representation, the aspiration of final stops in the learners' IL grammar is the phonetic implementation of stops represented as onsets.

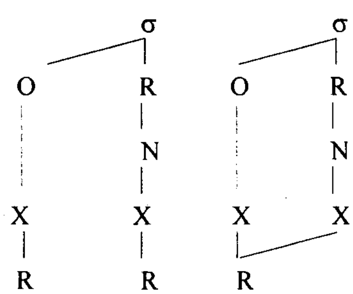
syllabification. The table in (13) provides forms illustrating the aspiration of final stops in early child English discussed by the authors.

(13) *Aspiration of word-final stops in early child English*
(Goad & Brannen in press)

Child		Form			Phonetic Evidence
Name	Study	Target	Child	Gloss	
Lasan	Fey & Gandour (1982)	[dɹɑp] [fiːt]	[dap^{h}] [vit^{h}]	'drop' 'feet'	Aspiration (final release)
Hildegard	Leopold (1939)	[miːt] [bɹoːk]	[mit^{h}] [bok^{h}]	'meat' 'broke'	
Jacob	Menn (1978)	[bɑik] [ʌp]	[bɑk^{h}] [ap^{h}]	'bike' 'up'	

Rose (2000) also comments on final aspiration in both Clara's and Théo's L1 French outputs (e.g. Clara: target *bloc* 'block' [blɔk]→[blɔˈt^{h}], target *carotte* 'carrot' [kaʁɔt]→[kæˈʁɔt^{h}]; Théo: target *porte* 'door' [pɔʁt]→[pɔt^{h}], target *bicycle* [bɪsɪk]→[b̥ɪsɪk^{h}]). Goad & Brannen argue that the final aspiration in (13) can be explained if the final consonant is represented as an onset-nucleus sequence as shown in (14) below.

(14) *Initial representation of word-final stops in the L1 acquisition of English*



The representation in (14) differs from that proposed for OEHS to this point in that the melodic content (Root node) of the final consonant has spread into the nucleus of the final syllable. Concerning "aspiration", that is final release, Goad & Brannen argue that this constitutes strong support for onset syllabification given that, cross-linguistically, laryngeal contrasts are disfavoured in coda position. In the unmarked case, codas are voiceless, unaspirated and often unreleased (e.g. Lombardi 1991). Importantly, Goad & Brannen's analysis is both consistent with the proposals in §2.3.2.3 and §3.1.3 concerning the unmarked syllabification of final consonants and the role of markedness in phonological acquisition respectively. In the spirit of their proposal, I propose that (heavy) aspiration of final stops in forms such as [kap^h] observed with Steele's (2002) Mandarin learners of French is the phonetic interpretation of a final stop that is represented as an onset, specifically an OEHS, i.e. [ka.p^h].

In summary, the data from (4) and (5) support the hypothesis that representation plays a central role in the L2 acquisition of prosodic complexity. First, the faithfulness constraint MAXHEAD(ONSET) determines which segment is deleted in those cases where the optimal candidate involves cluster reduction. Second, structurally-encoded markedness guides IL development. As shown here, learners begin by syllabifying final stops as OEHS given that this representation is unmarked vis-à-vis coda syllabification. Evidence for such a representation comes from the fact that the Mandarin learners' final stops were (heavily) aspirated virtually without exception. The beginner Mandarin learners thus parallel both Goad & Brannen's L1 English learners and Rose's (2000) two child French learners in syllabifying final consonants as onsets.

In the following section, we continue our investigation of the role of representation in the acquisition of prosodic complexity. While the data will once again come from Mandarin-speaking learners of French, we will focus uniquely on the acquisition of branching onsets. The goal of this investigation will be to demonstrate the role of heads as well as markedness constraints on foot shape and alignment in the L2 acquisition of syllable structure.

3.3 Headedness and markedness in the acquisition of branching onsets

While the L2 data discussed in §3.2 demonstrate an important role for highly-structured representation in the acquisition of word final consonants, both as concerns headedness and onset versus coda syllabification of final consonants, the theory of licensing and markedness discussed in Chapter 2 makes a wider range of predictions for acquisition; let us summarize these predictions before going any further. As we saw in §2.1.3.1 and as summarized in (15), licensing potential is asymmetrically distributed within prosodic structure due to an asymmetry between heads and non-heads.

(15) Head-non-head licensing potential asymmetry

In any head-non-head relationship, the non-head is a weaker licensor than its head due to the licensing potential depletion that characterizes Licensing Inheritance[19]

Head-non-head licensing potential asymmetries typically manifest themselves in the ability of heads to license a greater ranger of contrasts than non-heads, both in terms of prosodic complexity and position-sensitive contrasts. As concerns prosodic complexity, the licensing of complex syllable constituents is restricted to head positions in some languages. For example, we saw that in southeastern Brazilian Portuguese, branching onsets occur in the head syllable of the foot alone. As concerns position-sensitive

[19] The head-non-head asymmetry in (15) subsumes two related yet slightly different cases. The first involves a head-non-head relationship within a syllable constituent, for example the head of the onset versus its dependent. The second involves a head-non-dependent relationship within some higher prosodic constituent such as the Foot or PWd. In this latter case, the dependent position is in turn the head of some lower constituent in the prosodic hierarchy. For example, in §2.1.3.2, we saw that there exists a head-non-head relationship between the two nuclei of a branching foot. While one of these nuclei is in the dependent syllable, it is nonetheless a head at the level of the syllable into which it is prosodified. In this thesis, we will focus on the first of these two types of head-non-head asymmetries.

contrasts, many languages restrict the licensing of certain features to strong positions. Perhaps the most widely attested manifestation of this is the weak licensing potential of codas vis-à-vis onsets. In §2.1.3.1, we saw that Mandarin is typical of such languages: whereas virtually all phonemes are licensed in onset position, the coda is restricted to licensing nasals.

The licensing potential asymmetry in (15) has important consequences for acquisition as outlined in (16).

(16) Licensing-based predictions for acquisition

Acquisition of new syllable positions

a. Head-non-head asymmetries: In the acquisition of a new syllable position, the position will be acquired in the head syllable first or in the head and non-head syllables concurrently;

Acquisition of new position-sensitive contrasts

b. Head-non-head asymmetries: In the acquisition of a new position-sensitive contrast, the contrast will be acquired in the head position first or in the head and non-head concurrently;

c. Non-head-internal asymmetries: Within a non-head position, the member of a contrast whose representation involves less featural content will be acquired first or both members of a contrast will be acquired concurrently.[20]

In the remainder of this chapter, we examine stop-liquid onset data from a study designed to test the prediction in (16a) concerning new syllable structure positions. The prediction made in (16c) concerning the acquisition of new position-sensitive contrasts will be tested in Chapter 4.

[20] While (16c) is formulated as concerns non-heads, such asymmetries will also hold for head positions. The formulation in (16c) reflects the fact that only the former will be investigated in this thesis.

3.3.1 Mandarin-speaking learners' acquisition of French stop-liquid clusters

In order to explore the hypotheses in (16a), an experiment was designed to test Mandarin learners of French on their acquisition of stop-liquid onset clusters in various prosodic environments. French was chosen as the target language for two principal reasons. First, the overwhelming majority of past research on the L2 acquisition of syllabification has looked at learners of English.[21] Given that English syllable structure is more complex than that of many languages and that L2 learners of English are vast in number, this bias is not surprising. However, if one seeks to develop a universal theory of the L2 acquisition of phonology, wider empirical investigation is necessary. A study of the acquisition of L2 French would expand the empirical database available. Second, as we saw in Chapter 2, in French, stop-liquid branching onsets are not limited to word-initial and word-medial position but also occur word-finally (e.g. *table* [tabl], *letter* [lɛtʁ]). Word-final stop-liquid clusters are both rare and highly marked in terms of their licensing. Consequently, as concerns the effect of position, both within the foot and the word, using French as the target language allows for a more complete investigation of the acquisition of stop-liquid onset clusters than languages like English.

Mandarin-speaking learners were chosen as the subject group for two reasons. First, Mandarin lacks branching onsets yet has a phonemic contrast between lateral and rhotic liquids (e.g. Duanmu 2000).[22] Had the subject group consisted of learners whose

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21 Of the 28 published L2 studies consulted for the discussion of transfer and markedness in Chapter 1, 26 looked at the acquisition of English.

22 Some researchers argue that the Mandarin rhotic is the voiced retroflex fricative [ʐ] rather than a liquid. There are at least three arguments against this analysis. The first two come from Duanmu (2000:29). First, Duanmu cites a number of phonetic studies that show that the Mandarin rhotic has little friction. Second, he points out that, were [ʐ] a phoneme of Mandarin, it would be the only voiced obstruent in the language. The third argument is distributional in nature. As we saw in §2.1.3.1, the Mandarin coda is restricted to sonorants. Given that the Mandarin rhotic may occur rhyme-internally

L1 lacked both branching onsets and a phonemic contrast in liquids (e.g. Japanese), in those cases where target stop-liquid clusters were incorrectly realized - especially those cases involving liquid deletion - it would be difficult to determine whether differences between the target and learner outputs were related to segmental or prosodic representation, or both.[23] Second, studying native Mandarin learners of French made it possible to control for the possible effects of non-native input. An unfortunate and arguably underdiscussed aspect of many past studies of L2 phonology is the questionable extent to which the learners had access to native input, i.e. to the target structures under investigation. For example, Hancin-Bhatt's (2000) eleven Thai learners of English, whose mean age was 23.6 years, had spent on average almost 14 years studying English with non-native-speaker teachers. In contrast, they had only been in the United States on average 2.1 months prior to testing. As such, one is led to question the degree to which non-target-like properties of their phonology, including coda-obstruent devoicing and deletion, were reflective of non-native input. By studying Mandarin-speaking learners who had acquired their French in Montreal, it was possible to ensure that the subjects' primary input was from native speakers.

In the remainder of this section, I will discuss details of the subject group, stimuli and task design before moving on to presentation and analysis of the data in §3.3.2.

(see §4.1.2.1 for examples), were [ʐ] the phoneme, it would be the sole obstruent coda allowed in the language.

23 Even when the relevant segmental contrast exists in the learners' L1 and is thus available to the learners following transfer, differences between the L1 and target language in phonetic realization of the liquids may lead to misanalyses of the target form. For example, Mandarin and French both have a phonemic contrast between a lateral and rhotic approximant. However, whereas the Mandarin liquids are phonetically realized as the sonorants [l̪] and [ɹ] (but cf. note 17), the French rhotic is realized as a fricative [ʁ]. While I give [ʁ] as the native phonetic realization of French /r/, some speakers may realize it as the uvular trill [ʀ]. In §3.3.3.1, I will argue that the difference in phonetic realization of /r/ has important consequences for the Mandarin learners' construction of inputs and their prosodification of rhotic forms.

3.3.1.1 Subject group

The subject group consisted of thirteen native Mandarin speakers as well as ten native speaker controls. On average, the Mandarin-speaking learners were 35 years old (range: 31-40). As such, they were true adult learners. Most of them had begun learning French one year prior to testing and, on average, had had one to four months of intensive instruction.[24] The learners reported little use of spoken French (average: 1.2 hrs/wk) and evaluated their French speaking ability as beginner. This concurred with the author's evaluation based on notes completed for each subject subsequent to their testing session.[25] The control group consisted of 10 native speakers of Quebec French,[26] all of whom were undergraduate students at McGill University, Montreal. Their average age was 21 (range: 20-23). Both the learners and controls were remunerated for their participation.

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[24] The majority of the subjects had come to Montreal as immigrants and had participated in the Quebec government's COFI programme. This programme offers non-native speakers up to four months of intensive language instruction consisting of 25 hours/week of classroom instruction.

[25] I will use the subjects' self-evaluation as primary evidence for their beginner level. While the learners were given the vocabulary section of the *Laval test of French as a second language* as an independent measure of their French competence (mean score: 4.8/30), the correlation between vocabulary knowledge and phonological competence is tenuous at best. For example, Steele (2000) used the grammatical section of the same test as a measure of his English learners' level of French. A post-hoc regression analysis showed no correlation (p=.989) between a learner's score on the test and his or her phonological competence, where the latter was evaluated in terms of the total number of target-like outputs in the test. I thus use the learner's self evaluation, which is supported by the author's evaluation at the time of testing, as the primary measure of their level. Given that the learners had on average only a year between the beginning of acquisition and testing, and given their little reported use of spoken French, this assumption does not seem unreasonable.

[26] In Quebec French, underlying final stop-liquid clusters are realized as singleton stops (e.g. /tabl/→[tab], /lɛtʁ/→[lɛt]). The choice to use native speakers of Quebec French as controls was motivated by the fact that the subjects' instructors were also native speakers of this variety. By using controls whose L1 was Quebec French, it was consequently possible to elicit data representative of the learners' input. Importantly, there were virtually no cases of final-liquid deletion in the control data (see Appendix C). I propose that the absence of such deletion is related to the fact that there exists a situation of diglossia in Quebec, particularly with educated speakers, where Quebec French and standard French coexist (e.g. Barbaud 1997, Auger 1998). The standard variety is the language of formal situations, including education. All of the subjects were university students and eight of the ten were second language teachers in training. As such, they would be diglossic speakers. I suggest that the formality of the testing session accessed the standard variety in which final stop-liquid clusters are licit.

3.3.1.2 Stimuli

The stimuli consisted of 102 items: 50 words containing stop-liquid clusters, 16 monosyllabic items beginning or ending in a singleton liquid, and 36 distractors. Several general criteria were considered in the choice of stimuli. First, vowels were limited to the set [i, y, u, ə, e, ɛ, o, ɔ, a], which resembled the learners' L1 vowel inventory /i, y, u, ə, a/.[27] Second, with the exception of target *réglet* [ʁegle], none of the stimuli contained a liquid other than the one involved in the cluster. The exclusion of forms containing liquids other than those of the target clusters was meant to reduce the possibility that errors in deletion or feature change could be related to OCP effects or to the learners' difficulty in articulating two liquids in succession.[28] Third, with a few exceptions (*gris* 'grey', *tableau* 'blackboard, painting', *drapeau* 'flag', *chapitre* 'chapter'), an attempt was made to avoid high frequency items. Controlling for frequency would allow for differences between items or item types, should they exist, to be attributable to properties of the learners' grammar and not to their familiarity with particular items. Fourth, the place and voicing of the stop in the cluster as well as liquid type were controlled for. Having members of each subcategory (i.e. (stop voicing) x (stop place) x (liquid type) x (cluster position)) necessitated that a number of the stimuli be fairly obscure (e.g. *martinet* 'swift', *torpédo* 'runabout (sports car)', *gaulthérie*

[27] While Mandarin only has five phonemic vowels, there is considerable allophonic variation (see e.g. Duanmu 2000:39-41). When this variation is taken into account, all of the vowels in the stimuli except [ɔ] would be familiar to the learners. In any event, the learners' realization of the clusters alone was taken into consideration; errors in vowel production were ignored.

[28] In their study of Hong Kong Cantonese learners' acquisition of the English /l/-/n/ contrast, Wong & Setter (2002) found that 23/53 or 43% of the learners' errors on initial /n/ occurred in words containing another syllable beginning with /l/ or /n/. This contrasted starkly with the 10.7% and 6.5% error rate on initial /n/ and /l/ respectively in targets containing no other nasal or lateral sonorant.

'wintergreen').[29] Moreover, two were nonsense items (*pétagre* 'elf', *pelgomi* 'sword'). Fifth, grammatical category was controlled for. Saunders (1987) found a significantly higher rate of deletion of final clusters in verbs than in nouns; all of the targets in the present experiment were nouns. Finally, items were chosen that were readily pictureable.

The table in (17) gives the 50 stop-liquid stimuli that were the primary focus of the present study.

(17) *French stop-liquid targets (n=50)*

		Labial		*Coronal*		*Dorsal*	
Word Shape	*Liquid*	Voiceless	Voiced	Voiceless	Voiced	Voiceless	Voiced
[ˈCLV] Type: CL1	/l/	*plie* /pli/	*blé* /ble/	---	---	*clou* /klu/	*glas* /gla/
	/ʁ/	*pré* /pʁe/	*broc* /bʁo/	*trot* /tʁo/	*drap* /dʁa/	*croc* /kʁo/	*gris* /gʁi/
[CLV.ˈCV] Type: CL2	/l/	*plateau* /plato/	*blennie* /bleni/	---	---	*clocher* /klɔʃe/	*glacis* /glasi/
	/ʁ/	*préfet* /pʁefɛ/	*brebis* /bʁəbi/	*traîneau* /tʁɛno/	*drapeau* /dʁapo/	*crapaud* /kʁapo/	*grappa* /gʁapa/
[CV.ˈCLV] Type: CL3	/l/	*chapelet* /ʃaplɛ/	*tableau* /tablo/	---	---	*coquelet* /kɔkle/	*réglet* /ʁeglɛ/
	/ʁ/	*cyprès* /sipʁɛ/	*cobra* /kɔbʁa/	*batterie* /batʁi/	*cédrat* /sedʁa/	*maquereau* /makʁo/	*figuerie* /figʁi/
[CV.CLV.ˈCV] Type: CL4	/l/	*diplômé* /diplome/	*sablier* /sablije/	---	---	*bouclier* /buklije/ *baklava* /baklava/	---
	/ʁ/	*soprano* /sopʁano/ *paprika* /papʁika/	---	*patronat* /patʁɔna/	*baudrier* /bodʁije/	*macramé* /makʁame/	*tigridie* /tigʁidi/
[CV.ˈCV.CL] Type: CL5	/l/	*disciple* /disipl/	*fusible* /fyzibl/	---	---	*bicycle* /bisikl/	*monocle* /mɔnɔkl/
	/ʁ/	---	*ténèbres* /tenɛbʁ/ *calibre* /kalibʁ/	*chapitre* /ʃapitʁ/	*cathèdre* /katɛdʁ/	*polacre* /pɔlakʁ/	*pétagre* /petagʁ/

29 When tested, the native speaker controls were asked to estimate the percentage of test items with which they were familiar. Their estimates ranged from 70-80%.

In order to test the hypothesis in (16a), cluster position relative to stress and position within the word was also controlled for resulting in five possible word shapes:[30] [ˈCLV] (stressed and initial), [CLV.ˈCV] (unstressed and initial), [CV.ˈCLV] (stressed and non-initial), [CV.CLV.ˈCV] (unstressed and non-initial) and [CV.ˈCV.CL] (unstressed/foot external and non-initial), labelled CL1-5 respectively. As shown above, not all of the permutations were possible. For example, as discussed in §2.1.1.2, coronal-/l/ clusters are illicit in French. The three remaining accidental gaps (voiceless labial [CV.ˈCV.Cʁ], voiced labial [CV.CʁV.ˈCV], voiced dorsal [CV.ClV.ˈCV]) were filled with a target of the same place of articulation and word shape but opposite voicing.

Along with the fifty stimuli containing the target clusters, sixteen targets were included involving a singleton liquid in initial and final positions. These stimuli were included in order to test the learners' acquisition of the French lateral-rhotic contrast. These targets are given in (18).

(18) *Singleton liquid targets (n=16)*

Word Shape	Liquid	Stimuli
CL1: [LV]	/l/	*laie* /lɛ/, *lacs* /la/, *lot* /lo/, *loup* /lu/
	/ʁ/	*raie* /ʁɛ/, *ré* /ʁe/, *rot* /ʁo/, *roue* /ʁu/
CL2: [CVL]	/l/	*cil* /sil/, *malle* /mal/, *col* /kɔl/, *moule* /mul/
	/ʁ/	*cerf* /sɛʁ/, *bar* /baʁ/, *cor* /kɔʁ/, *tour* /tuʁ/

Nine more stimuli (*chou* /ʃu/, *dé* /de/, *dos* /do/, *métro* /metʁo/, *sorbet* /sɔʁbɛ/, *cabri* /kabʁi/, *tortilla* /tɔʁtija/, *martini* /maʁtini/, *tablier* /tablije/) were included for use in the practice group that began each of the three blocks.

[30] Recall from Chapter 2 that stress in French falls on the last non-schwa vowel.

As distractors, 36 words involving liquid-stop clusters were included. Like the targets clusters in (17), the liquid-stop clusters of the distractors were controlled for stop voicing, stop type, liquid type, and cluster position. In the following section, we will discuss the task design.

3.3.1.3 Task design

Previous L2 syllable research has employed a variety of tasks for data collection. These include elicitation tasks such as picture description (e.g. Tarone 1980, Edge 1991) and object identification (e.g. Flege & Davidian 1984), reading passages (e.g. Altenberg & Vago 1983, Carlisle 1997, Baptista & da Silva Filho 1997, Hancin-Bhatt 2000) and word lists (e.g. Broselow 1983, Stockman & Pluut 1992), translation (e.g. Sekiya & Jo 1997, Cichocki et al. 1999, Cebrian 2000) and word learning tasks (e.g. Broselow & Finer 1991, Wang 1995), as well as spontaneous speech (e.g. Anderson 1983, Sato 1984, Saunders 1987, Benson 1988, Eckman & Iverson 1993, 1994). In choosing the task for the current experiment, three criteria were considered. First, it was necessary to be able to elicit all of the targets described in §3.3.1.2. While spontaneous speech is arguably the most representative of a learner's competence, it would have been impossible to elicit the types and numbers of targets necessary for testing the hypotheses under investigation. The varied and sometimes obscure nature of the vocabulary items in question made a translation task particularly unmanageable. The second criterion was that there be no orthographic input in the test. Previous research (e.g. Altenberg & Vago 1983, Young-Scholten 1995) has shown that L2 learners' pronunciation can be significantly influenced by orthography. For example, Young-Scholten (1995) shows that orthographic input, both during learning and testing, can promote epenthesis. In French, the orthography of final stop-liquid clusters always includes a final <e>, which might serve as a source of epenthesis not otherwise representative of the learners' phonological competence. This criterion eliminated the reading passages and word lists from consideration. Finally, given the large number of targets, the task had to be one that allowed for quick elicitation of each target; the nature of a picture description task thus precluded its use for this reason. Once all three criteria were considered, the only remaining tasks were the object naming and word-learning tasks, which were incorporated into a single task. Before discussing the exact task design, we first discuss the grouping of the items.

The 102 target items were divided into 34 groups containing three words each. Within any group, there was at least one stop-liquid target (17) and one liquid-stop distractor. The third item was taken from the singleton liquid targets in (18), or was another of one of the two types of clusters. The items were distributed among groups so that each group contained one target each of one, two, and three syllables in length. The 34 groups were then divided into three blocks, the first containing 12 groups, the other two blocks having 11 groups each. Each block contained an initial practice group that was not included in the data analysis. The blockings and groupings are shown in (19).

(19) *Target item blockings and groupings*

	Block A	**Block B**	**Block C**
Practice	*chou, métro, tortilla*	*sorbet, dé, martini*	*tablier, dos, cabri*
1	*algue, calibre, laie*	*polka, cerf, croc*	*glas, polacre, cyprès*
2	*pétagre, bar, chapelet,*	*lacs, pelgomi, orgue*	*traîneau, poulpe, cathèdre*
3	*gris, torpédo, parka,*	*tableau, cor, brebis*	*poulbot, lot, corbillat*
4	*sherpa, loup, paprika*	*bilboquet, réglet, carpe*	*tour, cobra, baklava*
5	*chapitre, coquelet, plie*	*raie, melba, sablier*	*martinet, bouclier, cil*
6	*sorbe, plateau, gaulthérie*	*blennie, fusible, roue*	*disciple, barbet, ré*
7	*paletot, tigridie, rot*	*colt, préfet, maquereau*	*garde, cédrat, ténèbres*
8	*caldera, broc, margay*	*tourteau, pré, soprano*	*boldo, kart, narguilé*
9	*solde, monocle, drapeau*	*bicycle, grappa, trot*	*macramé, crapaud, blé*
10	*bardot, malle, cordonnet*	*salpe, figuerie, baudrier*	*moule, drap, balconnet*
11	*malpighie, batterie, clou*	*nilgaut, pergola, col*	*clocher, patronat, foulque*
12	*barque, glacis, diplômé*		

For each of the above groups including the initial practice items, the learners were required to complete the following tasks. Before beginning the test, the subjects were told that the experiment was designed to test their ability to learn new French vocabulary. Within each group, each target word was 'learned' in succession. This was accomplished as follows. The subjects first saw a colour image of the word in question, then heard the target repeated twice. After hearing the target twice, they were asked to repeat the word aloud once. The subjects then heard three sentences containing the word. These sentences were ostensibly to give the learners the occasion to hear the word again if they had misheard it during the initial repetition and to allow them to better understand the meaning of the word. As such, the sentences were hoped to facilitate memorization of the targets. After hearing the three sentences, they were then asked, "Qu'est-ce que c'est?" (i.e. 'What is it?'; henceforth QQC), at which time they said the word aloud again. This 'learning' was repeated for each of the three words in the group in succession. Once the three words in the group had been learned, the subjects were then shown the same three images in randomized order and asked to name each of the images. Before the testing session, the subjects were informed that, once the pattern described above was completed, it would not be necessary to recall the words in a given group any further. The task produced three isolated tokens for each word (Repetition: 1, QQC: 1, Naming: 1).[31]

The presentation of the stimuli was done via a recording. The speaker was a female native speaker of Quebec French with professional voice training, who was told that the recording was for an experiment testing beginner learners on their ability to acquire French vocabulary. The recording was timed so that the stimuli came at regular

[31] That words were produced in isolation controlled for the possible effect of preceding/following segments. Such effects, particularly as concerns epenthesis, have been observed in other studies (e.g. Abramsson 1997, Carlisle 1997).

intervals: there were two seconds between the initial two repetitions of the stimuli, two seconds after the presentation of the sentences containing the target word, then five seconds after the 'Qu'est-ce que c'est?' before the onset of the next item. The stimuli were recorded on audiocassette using an Audio-Technica AT803b omnidirectional lavaliere microphone and Marantz PDM221 recorder.

The learners had two breaks during the testing session. Between Blocks A and B, they were given 15 minutes and asked to fill out a questionnaire concerning their linguistic background. Between Blocks B and C, they were given 10 minutes to complete the Laval vocabulary test. The total time required for the three blocks, questionnaire and Laval test came to one hour forty-five minutes per subject. All of the learners were tested individually by the author and remunerated for their participation.

3.3.2 Data

In the following sections, I discuss how the data from the test sessions were prepared for analysis.

3.3.2.1 Transcription

Each of the test sessions was transcribed independently by two transcribers. The first transcriber was a native speaker of French with undergraduate training in phonetics and previous experience in the transcription of L2 French data. The second transcriber was a native speaker of English and a professional linguist with post-graduate training and much experience in narrow phonetic transcription. Once the test sessions were transcribed, the transcriptions were compared. As concerns the onset clusters, intertranscriber agreement was at 80.5%. All disagreements were noted. In order to resolve these disagreements, the author then transcribed all tokens where the two transcribers disagreed. The final transcriptions were rechecked by the author two months after the original transcription to ensure accuracy.

3.3.2.2 Counts and coding

The experiment was designed with the intention of using the data from the Naming task for the analysis. As argued in Steele (2000), this task is arguably the most representative of the learners' competence as it avoids the problems of rote repetition possible in both the Repetition and, to a lesser extent, the QQC tasks. However, not all of the learners were capable of correctly recalling all of the items in the Naming task. Indeed, when incorrect responses were excluded,[32] only 71.7% of their responses (Range: 52.5-86.9%) for the Naming task were acceptable. This contrasted starkly with their high level of accuracy and recall (99.7%) on the QQC task. Not surprisingly, the more syllables in the target, the more difficult it appeared to be for the learners to recall the form. This was particularly true for trisyllabic targets. Given that all of the final /CL/-clusters occurred at the end of such targets, using the data from the Naming task risked not providing a sufficient number of tokens for such clusters. Thus, given the learners' high rate of accuracy on the QQC task and the potential lack of type CL5 clusters in the Naming task data, a decision was made to use the data from the QQC task.

The data from the QQC task were coded for the location of the cluster with respect to main stress (i.e. Tonic, Pre/PostTonic 1, Pre/Post Tonic 2) and syllabification.

[32] Learner responses such as [ˈliblə] for target *blennie* [bleˈni] or [ˈdɔtχə] for target *tourteau* [tuʁˈto] were deemed incorrect.

The possible syllabification methods are given in the key in (20) below illustrated with examples from the learner data.[33]

(20) *Coding key: syllabification*

Code	Description	Target	Learner Output
TL	Target-like	[dʁa]	[dʁa]
Del Stop	Deletion of stop	[glasi]	[lasi]
Del Liq	Deletion of liquid	[bʁœbi]	[bœ:bi]
C_1VC_2	Epenthesis: cluster medial	[gʁi]	[gəʁi]
C_1C_2V	Epenthesis: following liquid	[bisikl]	[bisiklə]
C_1VC_2V	Epenthesis: after both stop and liquid	[bisikl]	[bisikələ]
Liq>Nas	Liquid realized as nasal	[pli]	[pni]
Liq>Liq	Liquid realized as other liquid[34]	[pʁefe]	[plɪfe]
Dev Liq	Liquid devoiced[35]	[figʁi]	[figχi]
Liq>[x]	Liquid realized as [x]	[makʁo]	[mɑ:kxo]
Liq>[h]	Liquid realized as [h]	[sipʁe]	[siphe]

In many cases, the learners' outputs involved two syllabification means (e.g. Del Stop + C_1C_2V: target *bicycle* [bisikl], learner output [bisikə]; Liq>[h] + C_1VC_2: target *macramé* [makʁame], learner output [makəhamei]); these outputs were coded as such.

3.3.3 Results and analysis

In this section, we will investigate the learner stop-liquid data as concerns the acquisition of new positions. Given the large number of variables (i.e. cluster position, stress, cluster type), only portions of the data will be presented in any given section. The reader who

[33] Before coding for syllabification means, the test stimuli were transcribed. Transcription revealed that the speaker's production of three of the targets (Block A, group 7: *tigridie*; Block C, group 4: *cobra*; Block C, group 7: *cédrat*) contained epenthetic vowels in some of their presentations. As such, it would not be possible for the learners to determine the correct input form with certainty. These three items were consequently excluded from the data analysis.

[34] In the case of targets involving [l], this category meant substitution of [ɹ]. There was only one case where target [ʁ] was realized as [ɹ].

[35] Devoicing of target [l] and [ʁ] differed in the degree of devoicing. Whereas the learners only partially devoiced [l] following voiceless stops, devoicing of target [ʁ] resulted in [ʁ] being realized as [χ] (e.g. target *drapeau* [dʁapo], learner form [dχapo]) following both voiceless and voiced stops.

wishes to examine the data set in its entirety may consult Appendix C for both the individual and group tallies as well as the control data. Before looking at the cluster data, we will first examine two striking characteristics of the learners' outputs, the learners' realization of targets involving /ʁ/ (§§3.3.3.1-3) and the predominance of initial stress (§3.3.3.4). Both of these characteristics will be relevant to the analyses proposed in §§3.3.3.5-9.

3.3.3.1 Learners' realization of singleton /ʁ/ versus /l/

As discussed in §3.3.1.2, along with targets containing stop-liquid clusters, the singleton liquid targets in (18) were included among the test items; we focus on the /LV/ targets here. Inclusion of /l/-initial (*laie* [lɛ], *lacs* [la], *lot* [lo], *loup* [lu]) and /ʁ/-initial forms (*raie* [ʁɛ], *ré* [ʁe], *rot* [ʁo], *roue* [ʁu]) was meant to test the learners' ability to correctly realize the liquids when not in a cluster (i.e. when syllabified in a head position). Following the hypothesis in (16b), a learner should first acquire the contrast between /l/ and /ʁ/ in the head of the onset before being able to license the contrast in the onset dependent. Were any of the learners to have difficulty with the branching stop-liquid onsets, it would be necessary to determine whether the difficulty was related to a more general difficulty with the representation and realization of /l/ and /ʁ/ as segments. As we will see shortly, the data from the /LV/ targets were indispensable in sorting out the /CL/ cluster data.

The table in (21) gives both the individual counts as well as the group mean for the learners' syllabification of /l/-initial targets.

(21) *Mandarin-speaking learners' outputs for French /lV/ targets (QQC task)*

Subject		TL	Liq>[n]
C1		2	2
C2		4	
C3		4	
C4		4	
C6		4	
C9		4	
C11		4	
C14		4	
C15		4	
C16		4	
C17		4	
C20		4	
C22		3	1
Group	Count	49	3
	%	94.2	5.8

With the exception of three tokens from learners C1 and C22, all of the learners' outputs were target-like. In the case of the three non-target-like outputs, the target lateral was realized as the nasal [n]. It is somewhat surprising that any of the learners had difficulty with /l/-initial targets as /l/ is a phoneme in Mandarin and can occur word-initially (e.g. [lai] 'come'). Note that the substitution of [n] for target [l] is a phenomenon frequently attested in the L2 English of Cantonese speakers (see e.g. Wong & Setter (2002) and references therein).[36] However, in the overwhelming majority of outputs, the target lateral was realized in a native-like manner with the relevant SV-structure being licensed as necessary.

In contrast to the /lV/ items, the learners' outputs for /ʁV/ forms were overwhelmingly non-target-like as shown in (22).

[36] The Cantonese L2 English facts differ somewhat from those reported here for Mandarin in that the phonemic status of /l/ and /n/ in the Cantonese learners' grammar is uncertain given the ongoing merger between these phonemes in Hong Kong Cantonese. See Wong & Setter (2002:351-352) for discussion and references.

(22) *Mandarin-speaking learners' outputs for French /ʁV/ targets (QQC task)*

Subject		TL	Feature Change		
			Dev Liq	Liq>[x]	Liq>[h]
Cl		1	3		
C2		1	2		1
C3					4
C4				2	2
C6			3	1	
C9				4	1
C11			1	2	1
C14				4	
C15			3	1	
C16				2	4
C17				4	
C20				2	2
C22			1	1	2
Group	Count	2	13	23	17
	%	3.7	23.6	41.8	30.9

As shown in the table above, only 3.7% of /ʁ/-initial targets were realized in a native-like manner. In the majority of cases, the [ʁ] of an /ʁV/ target was devoiced to [χ] (23.6%) or realized as another post-coronal fricative, either [x] (41.8%) or [h] (30.9%); in Mandarin, [x] and [h] are allophones of the same phoneme (see e.g. Duanmu 2000:27). For example, in the case of target *roue* [ʁu], learner outputs included [χu], [xu], and [hʉ].[37] It should be noted that there were virtually no cases of target /ʁ/ being realized as [ɹ] or [l], or as any other type of sonorant. This fact, coupled with the learners' frequent devoicing of target /ʁ/ to [χ], is consistent with an obstruent analysis. Indeed, in Mandarin, all obstruents are voiceless. We will see further evidence for such an analysis shortly.

[37] For the moment, I set aside discussion of inter-learner differences to which we return in §3.3.3.2. The interested reader may consult Appendix C where tallies for each of the learners for all cluster types are given.

In order to understand the learners' devoicing and substitutions, it is necessary to consider both the L1 consonant inventory and the target phonetic realization of /ʁ/, both in singleton and complex onsets. As mentioned above, Mandarin has a phonemic contrast between /l/ and /ɹ/. Phonetically, both of the liquids are realized as coronal approximants as shown in (23).

(23) *Mandarin liquid minimal pairs*

[l̺əu4]	'leak'	[ɹəu4]	'meet'
[l̺ʷuŋ2]	'thriving'	[ɹʷuŋ2]	'melt'

While Mandarin does not have a uvular fricative, it does have the voiceless velar fricative [x] (e.g. [xaː] 'toad', [xən] 'very'). Now consider the realization of native French /ʁ/ illustrated in (24).

(24) *Phonetic realization of native French /ʁ/ in onsets*

Target type	Voiceless		Voiced	
/ʁV/	*Illicit*		*ré*	[ʁe]
/Cʁ/ cluster	*pré* *batterie* *chapitre*	[pʁ̥e] [batʁ̥i] [ʃapitʁ̥]	*broc* *figuerie* *calibre*	[bʁo] [figʁi] [kalibʁ]

In French, the liquid of a stop-liquid cluster is devoiced in those cases where the stop is voiceless. While typical descriptions propose that there is partial devoicing in the environment $C_{voiceless}$_V and full devoicing in $C_{voiceless}$_#, the native speaker data show that the degree of devoicing may vary independent of context. While the majority (59.4%) of the controls' outputs involved partial devoicing (e.g. *batterie* [batʁ̥i]), a significant number (40.6%) of tokens involved complete devoicing [ʁ̥] (e.g. *pré* [pʁ̥e]), the latter variant being phonetically equivalent to [χ]. As such, the beginner Mandarin learners would have encountered three output forms corresponding to input /ʁ/ in their acquisition of French, namely devoiced [ʁ̜] or [ʁ̥] in voiceless onset clusters versus [ʁ] elsewhere.[38]

The Mandarin L1 liquid contrast has important consequences for the learners' analysis of targets containing [ʁ] such as those in (24) above. Specifically, following transfer, a Mandarin-speaking learner of any language will expect the lateral-rhotic contrast, if it exists, to be realized as a contrast between [l] and [ɹ], and not [l] and [ʁ].[39] Neither of the fricatives in (24) corresponds to the learners' L1 [ɹ]: whereas Mandarin [ɹ] is a (voiced) retroflex coronal approximant, French [ʁ] and [ʁ̜]/[ʁ̥] are dorsal fricatives. I argue that the salient contrast in place and manner as well as voicing that exists between the L1 and target language rhotics leads the learners to reanalyse the target segment in order to assign an input representation to [ʁ]/[ʁ̜]/[ʁ̥], specifically one that differs from the L1 input for liquid [ɹ].[40]

Two possible candidates for the learners' analysis are given in (25) below.[41]

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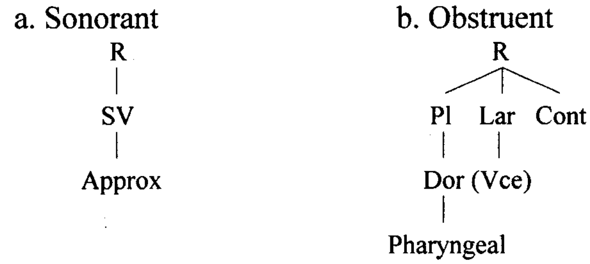
[38] As mentioned in note 17, a fourth possible variant is the uvular trill [ʀ]. Indeed, seven of the ten controls used this variant in at least some of their outputs.

[39] Recall from footnote 8 that the Mandarin learners tested all spoke English. Given that the English lateral-rhotic contrast is also one between [l] and [ɹ], I assume that this would reinforce this expectation.

[40] It is even possible that a learner may analyse [ʁ] and [ʁ̥]/[ʁ̜] as different segments and not as two allophones of the same phoneme. Indeed, I will propose shortly that at least some of the learners analysed [ʁ̥]/[ʁ̜] in clusters as aspiration on the preceding stop (e.g. target *trot* [tʁ̥o], learner input /tʰo/).

[41] The reader might ask if the representation in (25a) differs from that of the learners' L1 /ɹ/. I assume that Mandarin /ɹ/ is specified for [retroflex] under Coronal, rather than as placeless as in (25a). In §4.1.2.2, we will see evidence for this representation.

(25) *Possible input representations for target* [ʁ]/[ʁ̥]/[ʁ̜]



As discussed in §2.2.1.3, following Goad & Rose, the representation in (25a) is the cross-linguistically unmarked representation for /r/. In contrast, the representation in (25b) is that of a uvular fricative. As I will argue immediately below, depending upon the relative weighting that the Mandarin learners give to the phonetic versus phonological properties of target French [ʁ]/[ʁ̥]/[ʁ̜], they may either posit the sonorant representation in (25a) or the obstruent representation in (25b). Let us now consider what cues exist for each of the representations above.

In the absence of orthographic input, the native Mandarin learners must rely solely on the phonetic and phonological properties of target /ʁ/ in order to posit the correct input representation. Specifically, they must realize that, while phonetically a fricative, /ʁ/ is the French rhotic and patterns phonologically as a liquid on par with /l/. Cross-linguistically, there are both phonetic and phonological cues to a segment being a liquid. Phonetically, liquids are sonorants and thus they are inherently voiced. As concerns rhotics in particular, Maddieson (1984) reports that, of the 317 languages included in the UCLA Phonological Segment Inventory Database, 308 or 97.5% of rhotics are voiced. French [ʁ] and [ʁ̜]/[ʁ̥] are fricatives. Moreover, French [ʁ̜]/[ʁ̥] is partially devoiced/voiceless and thus a particularly poor candidate for a rhotic. Based on their phonetic properties alone, [ʁ] and [ʁ̜]/[ʁ̥] are more similar to the French fricatives [f/v,s/z,ʃ/ʒ] than to the liquid [l]. Furthermore, fully devoiced [ʁ̥] is phonetically equivalent to [χ] and thus maps closely to the learners' L1 [x].

Phonologically, the cues to a segment's liquid status are distributional in nature. First, in languages that allow branching onsets, liquids are the least marked dependent (e.g. Clements 1990, Kaye, Lowenstamm & Vergnaud 1990). Thus, if a segment can occur as the second member of a syllable-initial non-homorganic CC sequence, the probability of the segment being a sonorant is high.[42] Second, the distribution of [ʁ] and [ʁ̞]/[ʁ̥] is identical to that of [l] and [l̞]/[l̥]; consider the pairs *blé* [ble]-*braie* [bʁɛ] and *clos* [kl̞o]/[kl̥o]-*croc* [kʁ̞o]/[kʁ̥o]. In summary, the phonetic and phonological properties of French [ʁ] and especially [ʁ̞]/[ʁ̥] provide contradictory cues to the learner: whereas the phonetic properties of the segments are those of a fricative, the phonological distribution is that of a liquid.

Given this contradiction in cues, it is highly possible that at least some of the learners might have yet to acquire the target input representation in (25a), that is, one in which /ʁ/ is a liquid. If a learner initially gives a greater weighting to phonetic cues than to the segment's phonological distribution, target [ʁ]/[ʁ̞]/[ʁ̥] might be analyzed as an obstruent (26b).[43] Ultimately, it is impossible to determine the status of [χ], [x], and [h]

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42 Were a Mandarin learner to map [ʁ̥]=[χ] to his or her L1 [x] and to entertain the possibility that the [kχ] cluster of a target like *croc* [kχo] was a velar affricate (i.e. [k͡x]) on par with the L1 affricates [t͡s,t͡ʂ], non-homorganic clusters such as [tχ] (e.g. *trot* [tχo]) and [pχ] (e.g. *pré* [pχe]) would constitute counterevidence to such a hypothesis.

43 Steele (2001) argues that phonetic cues play an important role in the earliest stages of acquisition. Contrary to hypotheses based on transfer, the beginner English learners of French discussed (data from Steele 2000), who had similar amounts and quality of exposure as the Mandarin learners discussed here, did not begin by syllabifying target word-final stop-liquid sequences (e.g. *table* [tabl], *lettre* [lɛtʁ]) as onset-nucleus sequences as is the case in their L1 (e.g. *table* [teːbl̩], *letter* [lɛtɹ̩]). Steele argues that liquid devoicing in the dependent position of a branching onset in the target (as per (25)) is

in the learners' grammars through an examination of their outputs for /ʁV/ targets in (22) alone as the L1 grammar allows both fricatives (e.g. [xʷuː] 'lake') and liquids (e.g. [ɹʷuː] 'enter') in onset position. However, if liquids can be identified through consideration of their distributional properties as argued above, an examination of the distribution of [χ], [x], and [h] in the learners' outputs should offer the necessary insight into the phonological status of these segments in the learners' IL grammars. This will be the goal of the following section.

3.3.3.2 Cross-learner differences in the construction of inputs for target /ʁ/

The table in (26) allows for a comparison of the syllabification of /ʁV/ and /CʁVCV/ targets for four of the thirteen subjects tested.[44] These four subjects were chosen based on their realization of target [ʁ]: subject C1 and C6 realized target [ʁ] as [χ] in the majority of cases (devoiced liquid), whereas subjects C17's and C3's outputs involved [x] and [h] respectively. These four learners are representative of the subject group as whole as concerns the three potential realizations of target [ʁ]; we will return to an examination of all of the subjects in the group shortly.

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an appropriate cue to the non-nuclear status of such a segment. Specifically, he argues that, in the unmarked case, the liquid of a branching voiceless stop-liquid onset is devoiced whereas nuclei are voiced. As such, markedness serves to evaluate the representation of the devoiced target liquid. This results in the beginner learner quickly restructuring his or her IL grammar so that syllabic liquids are illicit in spite of transfer.

44 /CLVCV/ as opposed to /CLV/ targets are used for comparison with /LV/ to control for other variables that might effect the percentage of target-like outputs. As I will argue in §3.3.3.8, epenthesis in learners' outputs for /CLV/ targets appears to be motivated at least in part by Foot Binarity. As such, an examination of /CLVCV/ bisyllabic targets eliminates this other potential source of epenthesis and allows for a clearer evaluation of the relation between target-like forms and the wellformedness of branching onsets in the learners' IL grammars.

(26) *Selected comparison of learner outputs for* /LV/ *and* /CLVCV/ *targets*

Subject	*Target*	n	TL	*Deletion* Stop	*Deletion* Liq	*Epen* C_1VC_2	*Feature Change (+ Epenthesis)* Liq> Nas	Dev Liq	Liq> [x]	Liq> [h]	Liq>Nas + C_1VC_2	Dev Liq + C_1VC_2	Liq>[x] + C_1VC_2	Liq>[h] + C_1VC_2
C1	*loup*	4	.50				.50							
	plateau	5	.40			.20					.40			
	roue	4	.25					.75						
	préfet	6	.67		.33									
C6	*loup*	4	1.00											
	plateau	5	.40			.40					.20			
	roue	4						.75	.25					
	préfet	6	.50					.17				.17		.17
C17	*loup*	4	1.00											
	plateau	4	.75			.25								
	roue	4							1.00					
	préfet	6			.67								.33	
C3	*loup*	4	1.00											
	plateau	4	.50			.50								
	roue	4								1.00				
	préfet	6			.50									.50

We begin with the targets involving /l/. Subjects C6, C17 and C3 correctly realized targets like *loup*, involving initial singleton onsets, in all cases. Subject C1's outputs, in contrast, were target-like in half of the cases; otherwise, target [l] was realized as [n]. As concerns the branching /Cl/ onset of targets like *plateau*, all subjects had some target-like outputs. Stated otherwise, the learners' IL grammars have begun to be reshaped so that branching onsets are realized as such in some of their outputs.

Now consider the targets involving /ʁ/. As we have already seen, in contrast to the /lV/ targets, outputs for /ʁV/ targets were rarely native-like. In subject C17's and C3's outputs, target [ʁ] was substituted with [x] and [h] respectively. If [x] and [h] are simply phonetic approximations of target [ʁ] but their representation is that of a liquid (25a), we should expect that at least some of these learners' outputs for the /Cʁ/-initial targets will involve realization of both the stop and liquid (e.g. target *préfet* [pʁ̥efe], learner output [pxefe] or [phefe]) on par with the /Cl/-initial targets. However, as shown in (26), there were no such outputs for either learner. Rather, these learners deleted target /ʁ/ or epenthesized a schwa accompanied by substitution of either [x] or [h]. These two processes are exactly what one would expect were a learner to posit the obstruent representation in (25b) for the [ʁ] of a target such as [pʁ̥efe]. Cluster-medial epenthesis is a particularly logical option if the learner analyses the [ʁ̥] of *préfet* as an obstruent and assumes that there is an empty-position between the two members of the cluster (i.e. [p∅.χe.fe]) in the target representation.[45] Epenthesis allows for a close approximation of the target or the hypothesized target in those cases where the learner's IL grammar does not allow (word-medial) empty positions.

Now consider subjects C1 and C6. These two learners realized target [ʁ] as [χ] in the majority of cases. There are two possible explanations for the devoicing. The first is that the learners realize that [ʁ] is a liquid on par with [l] but that they have yet to master the articulation of voicing in fricatives including target French /ʁ/. An examination of the transcriptions of both these learners' tests shows that voicing in stops was generally accurate. This, however, need not extend to fricatives. Zhu & Lim's (2002) study of 7 young Mandarin-speaking learners of English revealed that, while voicing in syllable-initial stops posed no difficulty for the learners, [z] was devoiced in onset position in 57.1% of the learners' outputs. The mastery of voicing in fricatives may well present greater articulatory difficulty than voicing in stops. In fact, in many languages (e.g. some Dutch dialects), while stops contrast for voicing, fricatives are uniquely voiceless.

[45] For a discussion of word-internal empty-positions, see Government Phonology (e.g. Charette 1991, Harris 1994).

The second possible explanation is that subjects C1's and C6's [χ] has the same status as subject C17's [x] and C3's [h], i.e. phonologically it is an obstruent. If so, we should expect that, as was the case with the latter learners, subjects C1 and C6 will syllabify target /Cʁ/ clusters either via deletion or epenthesis. Moreover, there should be (virtually) no target-like outputs. As shown in (26), this is not the case. Indeed, two-thirds and one-half respectively of C1's and C6's outputs for /Cʁ/ targets were native-like. As such, [l] and [χ] pattern similarly in that both may appear as the dependent of a branching onset; for these learners, I thus conclude that [χ] is phonologically represented as a liquid.

We now return to the group as a whole. I will demonstrate that the group data reveal a three-stage developmental pattern in the acquisition of [ʁ]. We begin with the six learners whose group means for /ʁV/ targets as well as the five targets involving /Cʁ/ clusters are given in (27) below.

(27) *Stage 1 in Mandarin-speaking learners' acquisition of French /ʁ/: misanalysis (Learners C3, C4, C9, C14, C17, C20)*

Target				*Deletion*		*Feature Change (+ Epenthesis)*											
Type	Example	n	TL	Stop	Liq	Liq> Liq	Dev Liq	Liq> [x]	Liq> [h]	Del Liq + C_1C_2V	Dev Liq + C_1C_2V	Liq> Liq + C_1VC_2	Liq> [x] + C_1VC_2	Liq> [x] + C_1C_2V	Liq>[x] + C_1VC_2V	Liq> [h] + C_1VC_2	Liq> [h] + C_1VC_2V
ʁ1	*roue* /ʁu/	25						.64	.36								
Cʁ1	*pré* /pʁe/	35	.03		.43							.06	.26			.22	
Cʁ2	*préfet* /pʁefe/	34		.03	.56	.03					.03		.09			.26	
Cʁ3	*cyprès* /sipʁe/	23		.04	.48	.09		.04				.04	.09			.22	
Cʁ4	*soprano* /sopʁano/	25			.76	.04		.08								.12	
Cʁ5	*chapitre* /ʃapitʁ/	30	.03		.20		.07	.07	.03	.20	.03		.03	.03	.20		.10

All six of these learners realize target /ʁ/ as [x] or [h] in singleton /ʁV/ targets as well as in a large percentage of their outputs for /Cʁ/ forms. As was argued for learners C3 and C17 in (26), each of the learners in the Stage 1 group has misanalysed the French rhotic as an obstruent and has assigned it the input representation in (25b). As an obstruent, /ʁ/ cannot be the second member of a branching onset as attested to by the virtual absence of target-like forms and the low percentage of forms involving branching onsets (i.e. Liq>Liq, Dev Liq, Liq>[x], Liq>[h]). Rather, in those cases where target /ʁ/ is realized,[46] be it as [x] or [h], the learners syllabify /ʁ/ as an onset via epenthesis (i.e. Liq>[x] + C_1VC_2: target [bʁəbi], output [bə.xi.bi]; Liq>[h] + C_1VC_2: target [makʁ̥ame], output [ma.kə.ha.mei]).

Now consider the four learners whose group means are given in (28). I argue that these learners' outputs are representative of Stage 2. At this point in development, the learners have already realized the misanalysis that occurred at Stage 1 and are in the process of positing native-like inputs for targets involving /ʁ/. Three of the four subjects in (28) differ from the Stage 1 learners in that they realize target /ʁ/ as [χ] in at least one of their outputs for /ʁV/ targets (see Appendix B). More importantly and more revealingly, for cluster types Cʁ2, Cʁ3, Cʁ4 and Cʁ5, there is a growing number of target-like outputs.[47] It is also the case that the percentage of outputs involving epenthesis has decreased vis-à-vis Stage 1. Were the Stage 2 learners to represent /ʁ/ as an obstruent as do the Stage 1 learners in (27), we would expect [Cʁ] clusters to be illicit across the

[46] In §3.3.3.4, I will propose an explanation for outputs involving deletion.

[47] As I will argue in §3.3.3.8, the absence of native-like outputs for Cʁ1 targets at this stage is related to the importance of Foot Binarity in the learners' grammars.

board. Thus, the appearance of target-like outputs or outputs involving branching (i.e. Dev Liq alongside Liq>[x], Liq>[h]) supports the hypothesis that the learners have begun to posit a representation for /ʁ/ in which it is a liquid, at least in some cases.

(28) *Stage 2 in Mandarin-speaking learners' acquisition of French /ʁ/: reanalysis of inputs (Learners C11, C15, C16, C22)*

Target				Deletion		Epen		Feature Change (+ Epenthesis)									
Type	Example	n	TL	Stop	Liq	C_1VC_2	C_1VC_2V	Liq > Liq	Dev Liq	Liq > [x]	Liq > [h]	Del Liq + C_1C_2V	Dev Liq + C_1VC_2	Liq> [x] + C_1VC_2	Liq> [x] + C_1VC_2V	Liq> [h] + C_1VC_2	Liq> [h] + C_1VC_2V
ʁ1	*roue* /ʁu/	18							.28	.33	.39						
Cʁ1	*pré* /pʁe/	23			.22	.13							.17	.30		.18	
Cʁ2	*préfet* /pʁefe/	23	.13	.04	.13	.13		.04					.13	.13		.27	
Cʁ3	*cyprès* /sipʁe/	14	.29		.07				.29		.07		.07		.14	.07	
Cʁ4	*soprano* /sopʁano/	17	.12		.53				.12	.06						.17	
Cʁ5	*chapitre* /ʃapitʁ/	21	.14		.14		.05		.23	.19	.05	.05	.05		.05		.05

We now consider the last group of learners, who are representative of Stage 3. I argue that, by this stage, the learners have acquired the target representation of French /ʁ/, i.e. (25a). The Stage 3 learners distinguish themselves from the other groups in three respects. First, the majority of their realizations of the initial [ʁ] of /ʁV/ forms are target-like or devoiced. Second, their outputs for targets involving /Cʁ/ clusters are becoming increasingly native-like. An increase in target-like outputs is exactly what one would expect once /ʁ/ is represented as a liquid in the learners' IL grammar. Finally, for the majority of target types, the Stage 3 learners' outputs for /Cʁ/ targets parallel those for /Cl/ targets (see Appendix C or §3.3.3.6). The parallel between outputs for /Cʁ/ and /Cl/

outputs is particularly strong evidence that /ʁ/ has the same status as /l/ for these learners, i.e. it is a liquid.

(29) *Stage 3 in Mandarin-speaking learners' acquisition of French /ʁ/: target-like (Learners C1, C2, C6)*

Target				*Deletion*		*Epenthesis*		*Feature Change (+ Epenthesis)*								
Type	Example	n	TL	Stop	Liq	C_1VC_2	C_2V	Liq> Liq	Dev Liq	Liq> [x]	Liq> [h]	Dev Liq + C_1VC_2	Dev Liq + C_1VC_2V	Liq>x] + C_1VC_2	Liq> [x] + C_1C_2V	Liq> [h] + C_1VC_2
ʁ1	*roue* /ʁu/	12	.17						.67	.08	.08					
Cʁ1	*pré* /pʁe/	20	.65		.05	.10			.10			.05		.05		
Cʁ2	*préfet* /pʁefe/	18	.66		.16				.06			.06				.06
Cʁ3	*cyprès* /sipʁe/	10	.60		.10	.10		.20								
Cʁ4	*soprano* /sopʁano/	13	.30	.08	.38			.08		.08				.08		
Cʁ5	*chapitre* /ʃapitʁ/	18	.22		.17		.05		.26	.10		.05	.05	.05	.05	

In summary, when the three groups are examined together, the Mandarin learners' realization of targets involving /ʁ/, either as a singleton onset or as the dependent of a branching stop-liquid cluster, attests to three separate stages in the acquisition of the segment's phonological representation as shown in (30) below.

(30) *Stages in Mandarin-speaking learners' acquisition of French /ʁ/*

Stage		Input representation		
		Input	*Output*	*Phonological status*
1	Misanalysis	/χ/	[x], [h]	Obstruent
2	Reanalysis	/χ/ or /ʁ/	[χ], [h], [h]	Obstruent or liquid
3	Target-like	/ʁ/	[ʁ̥], [ʁ]	Liquid

At Stage 1, the learners assign the obstruent representation in (25b);[48] such an analysis is consistent with the phonetic properties of the target segment. At Stage 2, the learners

48 I assume that the input at Stage 1 is /χ/ as the learners perceive the target's uvular place (see §3.3.3.3 for discussion). However, it may be the case that the Stage 1 learners sometimes posit /x/.

have already realized that target /ʁ/ is not an obstruent and, as a consequence, begin to posit a sonorant representation for /ʁ/, i.e. (25a). Presumably, by this time, they have had sufficient exposure to the target language as to be able to use the distributional cues to the rhotic's liquid status. Finally, at Stage 3, the learners acquire the target input representation for /ʁ/. At this last stage, the percentage of target-like forms increases dramatically.

Before concluding our discussion of the representation of /ʁ/ in the learners' grammars and its consequences for the prosodification of /Cʁ/ onset clusters, we will investigate one last aspect of the learners' outputs for these targets that provides evidence for the central role of perception in the construction of inputs.

3.3.3.3 The role of voicing in the construction of inputs for target /ʁ/

As we will see in §3.3.3.5, in the syllabification of /Cl/ targets, there were virtually no outputs in which the native Mandarin learners deleted the liquid (Cl1, Cl2, Cl4: 0%; Cl3: 2%; Cl5: 4%). This characteristic of the learners' outputs would suggest that MAX-IO is undominated in the learners' IL grammars. If this is indeed the case, one should expect that the learners' syllabification of /Cʁ/ targets too will not involve deletion. However, to the contrary, a considerable amount of deletion (Cʁ1: 27%, Cʁ2: 33%; Cʁ3: 28%; Cʁ4: 60%; Cʁ5: 17%; see Appendix C for a detailed summary) figured in the learners' outputs for /Cʁ/ targets.

Given that I have proposed that /ʁ/ is represented as the obstruent /χ/ for many of the learners, one could argue that deletion of this segment is simply one of the available repair mechanisms for illformed initial stop-fricative clusters. However, if MAX-IO is highly ranked in the learners' grammar as suggested by the /Cl/ cluster data, we might expect epenthesis to be preferred over deletion. While epenthesis is indeed licit as shown in the tables in (27)-(29), a larger portion of the learners' outputs involved deletion.[49] Let us explore the possibility that deletion is not motivated by some high-ranking constraint on outputs, but is instead driven by some aspect of the learners' inputs.

As shown in (31), there is a strong asymmetry between voiceless and voiced /Cʁ/ clusters as concerns the percentage of outputs involving deletion of the liquid. I argue that the learners' deletion is driven by their perception and (mis)analysis of the [ʁ̥]/[ʁ̦] of voiceless /Cʁ/ targets.

(31) *Asymmetry in deletion of /ʁ/ in voiceless and voiced /Cʁ/ clusters: all learners (i.e. Stages 1-3)*

	Cluster		*Syllabification Means* (%)	
Type	Voicing	n	TL	Del Liq
/Cl/	Voiceless	152	42.8	1.3
	Voiced	108	42.6	1.9
/Cʁ/	Voiceless	154	20.1	53.3
	Voiced	167	6.0	5.4

While a mere 5.4% of outputs for voiced /Cʁ/ clusters involved deletion, in contrast, 53.3% of their outputs for voiceless targets involved the stop alone. Moreover, when voiced and voiceless /Cl/ and /Cʁ/ clusters are compared, it is only with voiceless /Cʁ/ clusters like *pré* [pʁ̥e] 'prairie' and *maquereau* [makʁ̥o] 'mackerel' that there is any significant percentage of outputs involving deletion. Indeed, 92.5% of all deletion observed in the data set involved voiceless /Cʁ/ targets.

49 See Appendix B for tables giving the individual means for the learners in each of the three groups discussed in §3.3.3.2.

If perception is driving the deletion in the voiceless /Cʁ/ targets, the question arises as to how the Mandarin speaking learners' input representation for /ʁ/ differs in voiceless versus voiced /Cʁ/ clusters. I propose that it is not the case that that the Mandarin learners fail to perceive the devoiced [ʁ̥] of targets such as *pré* and *maquereau.* Rather, I argue that they differ from native speakers of French in that they perceive the devoiced rhotic not as independent segments but rather as fortis release of the stop. As discussed earlier, in Mandarin, stops contrast not for voicing but for aspiration (e.g. [pʰəi] 'accompany', [pəi] 'north', *[bəi]). Thus, following transfer, a native Mandarin learner will expect a contrast in stops, should it exist, to involve aspiration. I argue that at least some of the learners parse the [pʁ̥] of [pʁ̥e] and the [kʁ̥] of [makʁ̥o] as [pʰ] and [kʰ] and construct their inputs accordingly (i.e. /pʰe/ and /makʰo/). If this is the case, we should expect that, in those cases where target [ʁ̥] is 'deleted', the stop of the cluster will be realized as aspirated. Inspection of the data shows that this prediction holds in 37.9% of cases.[50]

While misanalysis of [ʁ̥] as the aspirated release of the stop can account for 37.9% of the learners' 'deletions', it does not account for the remaining percentage of cases in which the output stop was not aspirated. I propose that, in these cases, the learners posit an input representation that differs slightly, albeit one in which [ʁ̥] is represented as fricated release (heavy aspiration). If the learners perceive the uvular place of [ʁ̥], they will encode this in their inputs. In these cases, [ʁ̥] will be represented as

[50] There was a considerable amount of variation between learners (Range: 0-71.4%) as concerns the percentage of stops aspirated in these cases.

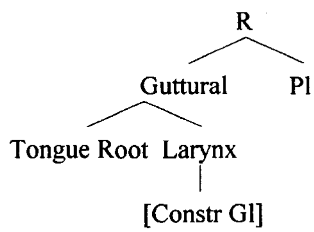
pharyngeal release (i.e. /$p^{\chi}e$/ and /$mak^{\chi}o$/).[51] I argue that such a representation involves the feature [pharyngeal] as a dependent of the Laryngeal node. A comparison of the representation of stops with aspirated and fricated release is given in (32) below.[52]

(32) *Input representation of stops with aspirated and fricated release*

a. Aspirated /p^h/ b. Fricated /p^{χ}/

While we have already seen the representation in (32a) in §2.2.1.2, the representation in (32b) requires motivation. A proposal in Halle (1994) provides such motivation. In an attempt to provide an account of the patterning of the class of gutturals in Semitic languages, Halle proposes that the representation of the members of this class (i.e. uvulars, pharyngeals, and laryngeals) all share the structure in (33).

(33) *Representation of uvulars, pharyngeals and laryngeals: Halle (1994)*



In previous proposals (Halle 1989,1992), Halle refers to the Guttural node in (33) as Laryngeal. Following from this, I equate 'Guttural' in (33) with the Laryngeal node in (32). Finally, Tongue Root is typically assumed to be equivalent to Pharyngeal.

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51 Such an equivalence is motivated by Halle's (1994) claim that uvulars are pharyngeals with a secondary Dorsal articulation.

52 A comparison of the representation in (32b) with that of (25b) reveals that Pharyngeal may be a dependent of either Dorsal or Laryngeal. I argue that Pharyngeal under Dorsal is interpreted as uvular place. When a dependent of the Laryngeal node, it is interpreted as noisy (uvular/pharyngeal) release.

Returning to the Mandarin data, in those cases where the learners perceive the uvular articulation of [ʁ̥], they will represent the release not through [asp] as in (32a), but rather via the feature [pharyngeal] as per (32b). This representation provides an account of those cases where the voiceless [ʁ̥] is deleted yet the output stop is not realized with aspiration. In such cases, the learners have posited the representation in (32b), yet, following transfer, their grammar cannot license [pharyngeal]. Thus, while [pharyngeal] serves to encode the uvular place the learners perceive in the targets, it cannot be licensed in outputs. As such, the stop will surface as plain (i.e. voiceless) in their outputs.

In summary, the learners perceive the [ʁ̥] of target voiceless /Cʁ/ clusters not as an independent segment, but rather, as the (noisy) release of the stop. This misanalysis leads them to construct inputs for the clusters in which the stop-/ʁ/ sequence is represented as a stop with either aspirated or pharyngeal release. As such, outputs like [p^he] for target [pʁ̥e] and [mako] for target [makʁ̥o] appear to involve deletion yet they do not and thus fail to violate highly ranked MAX-IO.

One final comment should be made before concluding this section. In §3.2.2, we examined data from Steele (2002) who investigated beginner Mandarin learners' acquisition of French final liquid-stop and stop-liquid clusters. In contrast to the Mandarin learners in the present study, /ʁ/ was realized as [ʁ] in 97% of the learners' outputs for target word-final stop-liquid clusters. The question arises as to the source of the difference in the behaviour between the two subject groups, groups composed of learners with the same L1, similar learning experiences, and comparable L2 linguistic ability. What did differ between the two studies is the way in which the stimuli were presented. Recall that in the present study, the subjects only received aural input. In contrast, the subjects in Steele (2002) received both aural and orthographic input. As such, Steele's (2002) subjects would have been able to make the grapheme-phoneme pairing between orthographic <r> and the corresponding [ʁ] of targets such as *porte* [pɔʁt] 'door' and *lettre* [lɛtʁ̥] 'letter'; the subjects in the present study lacked such cues. It would appear that orthographic input may play an important role in the construction of inputs when a segment's phonetic and phonological properties offer conflicting evidence to the learner.

While the focus of this and the previous two sections has been on the learners' variable realization and input construction for target [ʁ], in the next section, we examine an invariant property of the learners' outputs, namely a preference for initial stress.

3.3.3.4 Stress in learners' outputs

One of the most salient aspects of the beginner learners' outputs is the predominance of word-initial stress. As shown in (34) below, 67.8% of multisyllabic targets received initial stress in the QQC task.[53]

(34) *Stress in learners' multisyllabic outputs (QQC task)*

Target		Learner Forms		
			Initial Stress	
Type	Example	n	Count	%
CL2	[plaˈto]	130	106	81.5
CL3	[ʃaˈple]	97	80	82.5
CL4	[diploˈme]	105	86	81.9
CL5	[diˈsipl]	121	35	28.9
Average		453	307	67.8

53 The predominance of initial stress also held for the data from the Repetition and Naming tasks.

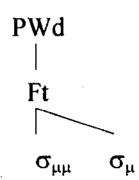
If forms ending in branching OEHS (type CL5) are excluded from the calculation, the percentage of initially-stressed forms jumps to an average of 81.9%.[54] The predominance of initial stress might seem somewhat surprising given that, in the target language French, stress is without exception final. However, if one considers the nature of word stress in the beginner learners' L1, transfer offers a straightforward explanation.

Yip (1995), Duanmu (2000) and Lin (2001) argue that word stress in Mandarin is initial.[55] As concerns foot shape, I follow Yip (1995:490, pc) in particular who argues that, in Mandarin, prosodic words consist of one stressed and tone-bearing syllable, followed by zero or more unstressed toneless ("neutral-toned") syllables. Examples of words of one, two and three syllables in length are given in (35) below.

(35)	ˈ*guo*2	'country'
	ˈ*da*3*le*	'hit (perf.)'
	ˈ*ta*1*mende*	'their'

As is always the case, the initial syllable of each of the words in (35) is bimoraic. Given that a single bimoraic syllable such as *guo* constitutes a wellformed word, this suggests that the Mandarin foot is a moraic trochee. The representation in (36) is consistent with this.

(36) *Mandarin foot*



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54 In §3.3.3.9, I offer an explanation for the non-initial stress in the learners' outputs for CL5 targets.

55 Many traditional accounts (e.g. Chao 1968) have argued that Mandarin word stress is final using final syllable lengthening as evidence. However, see both Duanmu (2000:135-136) and Lin (2001:145-148) for convincing arguments that final syllable lengthening is a phonetic phenomenon that does not constitute evidence for final stress.

Cross-linguistically, a single bimoraic syllable $(\sigma_{\mu\mu})_{Ft}$ or two monomoraic syllables $(\sigma_{\mu}\sigma_{\mu})_{Ft}$ constitute wellformed moraic trochees (e.g. Hayes 1995). Interestingly, in Mandarin the latter option is illformed. I propose that this is a direct consequence of the constraint in (37), which is undominated in Mandarin.

(37) **HEADPROMINENCE** (Piggott 1998, 2001; Mellander 2001, 2002)
The head of a foot is intrinsically prominent

HEADPROMINENCE requires the head syllable of the foot be more prominent than its dependent. Prominence may manifest itself in terms of differences in quantity, sonority, and/or tone (see Mellander 2002 for discussion). In Mandarin, quantity and tone are the relevant manifestations: head syllables are bimoraic and tone-bearing, in contrast to non-head syllables which are monomoraic and toneless.

Duanmu (2000) argues that bimoraic head syllables are short underlyingly and lengthened to satisfy a template that requires that 'full' (i.e. head) syllables be bimoraic. I do not adopt this assumption as it is inconsistent with the principle of Lexicon Optimization (Prince & Smolensky 1993:192). Prince & Smolensky propose Lexicon Optimization as a manner in which the optimal input for a given output may be selected. Stated simply, in the absence of evidence to the contrary, Lexicon Optimization requires that the learner posit the input that is the most harmonic (i.e. similar) to the output. In the case of Mandarin long vowels, both /V/ and /V:/ will surface as [V:] in head position, given high ranking HEADPROMINENCE. Following Lexicon Optimization, /V:/ is the most harmonic. Consequently, I assume that the Mandarin L1 learner will posit a long input vowel for the long output vowel of a head syllable. In §3.3.3.8, we will see evidence from the Mandarin-French data that supports this assumption.

Returning to the patterns in (34), transfer of the left-aligned foot in (36) provides a straightforward explanation of the learners' preference for initial stress. The relatively few outputs with final stress is nonetheless surprising, given that this is the sole stress pattern in the input. In §3.3.3.8 and §3.3.3.9, we will see some evidence that the learners' outputs for Cl1 target like *plie* and Cl5 targets like *disciple* respectively have begun to move towards the French pattern of final stress.

The discussion of the learners' realization of target /ʁ/ and the analysis of stress in the learners' L1 and IL grammars in this section are relevant to the analyses to be proposed in the remainder of the chapter. Given the analyses propsoed in §§3.3.3.1-3 concerning the representation of target /ʁ/ as either an obstruent or as release in the majority of the learners' grammars, discussion of the acquisition of branching onset clusters will focus on the learners' outputs for /Cl/ targets alone. We now examine the onset data to test the structural markedness hypothesis for which the experiment was designed.

3.3.3.5 The acquisition of branching onsets

In §3.3, we outlined a number of predictions for IL development that followed from the types of licensing asymmetries discussed in §2.1.3.1. In (38), I present the first of these hypotheses formulated specifically as concerns the acquisition of branching onsets.

(38) *Licensing-based prediction for the acquisition of branching onsets: head-non-head asymmetries*

In the acquisition of branching onsets, the dependent position will be acquired in the head syllable first or in head and non-head syllables concurrently.

In the rest of the chapter, we will test the hypothesis in (38) using data from the experiment thus far discussed.

However, before considering the L2 data, we will first examine L1 data from Rose's (2000) study of two child learners of Quebec French. As mentioned in §3.2.2.1, concerning the acquisition of branching onsets, Rose proposes that the learners go through three stages. At Stage 1, all onsets are reduced to singletons. At Stage 2, onset complexity emerges but only in stressed syllables; branching in unstressed syllables is reduced via deletion of the liquid. Finally, at Stage 3, branching onsets are realized as such regardless of the position of the cluster in the word. The table in (39) provides data representative of these three stages from one of the two children, Clara.

(39) *L1 acquisition of branching onsets in Quebec French: data from Clara* (Rose 2000)

Stage	Word	Target form	Child's output	Gloss
Stage 1	*pleure* *brisé*	[plœʁ] [bʁiˈze]	[pœː] [bœːˈçiː]	'(s/he) cries' 'broken'
Stage 2	*glisse* *brûlé*	[glɪs] [bʁyˈle]	[klɪs] [biˈle]	'(s/he) slides' 'burned'
Stage 3	*gros* *plancher*	[gʁo] [plɑ̃ˈʃe]	[gʁo] [plɑ̃ˈʃe]	'big' 'floor'

The L1 data in (39) are consistent with the prediction in (38): branching onsets are acquired first in head (i.e. stressed) syllables before emerging in non-head syllables. We now turn to the Mandarin L2 French data to investigate whether the same asymmetry holds.

In the present experiment, all of the stimuli were constructed controlling for the variables of position of the cluster within the foot (head versus non-head (e.g. [ˈpli] versus [plaˈto]), overt head versus non-overt head (e.g. [(plaˈto)$_{Ft}$] versus [(di'si)$_{Ft}$pl∅]),[56] and position within the word (initial versus non-initial). The decision to control for position in the word was motivated by the fact that word-initial position may favour the preservation of contrasts (e.g. Beckman 1997). Were word-position to play a role separate from that of headedness in the Mandarin learners' syllabifications, the inclusion of both ['ClV] and [ClV'CV] targets would allow the effect to be teased out. As shown in (40), each cluster type represented one of five possible permutations of these two variables.

(40) /Cl/ *stimuli: cluster position in word and foot*

Target			Word		Foot		
					Internal		External
Code	*Example*		Initial	Non-initial	Head	Non-head	Non-head
Cl1	*plie*	['pli]	✓		✓		
Cl2	*plateau*	[pla'to]	✓			✓	
Cl3	*chapelet*	[ʃa'ple]		✓	✓		
Cl4	*diplômé*	[diplo'me]		✓		✓	
Cl5	*disciple*	[di'sipl]		✓			✓

If complexity is acquired in heads first, branching onsets should be realized in a target-like manner more often in Cl1 *plie* and Cl3 *chapelet* targets than in Cl2 *plateau*, Cl4 *diplômé*, and Cl5 *disciple* targets, in which the cluster is in a non-head position. Moreover, if word-initial position favours contrast, branching onsets should be the most robust in the learners' outputs for Cl1 targets like *plie* and *plateau*. Taken together, the learners should be the most accurate with Cl1 targets like *plie*. However, as we will see in (44) immediately and discuss in §3.3.3.8, this was not the case.

56 The difference between syllables with overt and non-overt heads also correlates with a difference between foot-internal versus foot-external non-head syllables. In §3.3.3.9, we will see that this latter difference too is relevant to the learners' syllabification of Cl5 forms like *disciple*.

As discussed in §3.3.3.2, with the exception of Cl5 targets in which stress fell mainly on the second syllable (e.g. target *disciple* [di'sipl], learner output [di'siplə]: 71.1%), stress in the Mandarin learners' multisyllabic outputs was overwhelmingly initial. Given the difference between the target language and the learners' IL grammar as concerns the position of word stress (i.e. the head of the foot), it is necessary to reformulate the statements given under (40). The table in (41) re-evaluates cluster position in the foot and word taking into account the Mandarin learners' initial stress.

(41) *Learners' outputs for stress in /Cl/ targets: cluster position in word and foot*

Learner output		Word		Foot		
		Initial	Non-initial	Internal		External
Code	*Example*			Head	Non-head	Non-head
Cl1	*plie* ['pli]	✓		✓		
Cl2	*plateau* ['plato]	✓		✓		
Cl3	*chapelet* ['ʃaple]		✓		✓	
Cl4	*diplômé* ['diplome]		✓		✓	
Cl5	*disciple* [di'sipl]		✓		✓	

Based on (41), if an asymmetry exists, the highest percentage of outputs containing branching onsets should occur in the learners' outputs for target types Cl1 *plie* and Cl2 *plateau*, where the clusters are prosodified in the head of the foot and are word-initial. The learners' realization of the stop-liquid cluster of Cl3 *chapelet* and Cl4 *diplômé* targets, which are prosodified in non-head syllables, should be less accurate than Cl1 and Cl2 clusters. Finally, Cl5 targets such as *disciple* should be the most difficult given that they involve both non-head syllables and branching OEHS. The above predictions are summarized in (42).

(42) *Predicted order of accuracy: Mandarin learners' acquisition of French /Cl/ clusters*

Cl5 ⊃ Cl3, Cl4 ⊃ Cl1, Cl2

In order to determine the effect of foot structure (i.e. head versus non-head), the data were coded for the position of the cluster relative to stress. The coding key is given in (43).[57]

(43) *Key for coding of position of cluster relative to stress*

Code	Description	Learner Output
Ton	Cluster syllabified in stressed syllable	[ˈplato]
PreTon1	Cluster syllabified in syllable preceding word stress	[plaˈto]
PsTon1	Cluster located 1 syllable following tonic stress	[ˈʃaple]
PsTon2	Cluster located two syllables following tonic stress	[ˈdisiplə]

The table in (44) below gives the group means for the 13 Mandarin learners' syllabification of the /Cl/ targets. For the sake of clarity, only the means for target-like (TL) syllabifications as well as outputs involving epenthesis (Medial: C_1VC_2; Final: C_1C_2V; Medial and Final: C_1VC_2V) are included in the table. The complete summary for all syllabification methods can be found in Appendix C.

[57] In those cases where the cluster was broken up by epenthesis, tokens were coded with respect to the position of the head (i.e. stop) of the cluster. For example, a learner output like [ˈʃapəle] for target *chapelet* [ʃaˈple] was coded PsTon1.

(44) *Mandarin group means for syllabification of /Cl/ onset clusters: target-like and epenthetic outputs*

Target					*Epenthesis*			
Type	Example	Stress	n	TL	C_1VC_2	C_1C_2V	C_1VC_2V	Total
Cl1	*plie* /pli/	Ton	54	.31	.61			.92
Cl2	*plateau* /plato/	PrTon1	1	1.0				1.0
		Ton	54	.67	.26			.93
		Total	55	.67	.25			.92
Cl3	*chapelet* /ʃaple/	PsTon1	45	.64	.29			.93
		Ton	5	.80	.20			1.0
		Total	50	.66	.28			.94
Cl4	*diplômé* /diplome/	PrTon1	3	1.0				1.0
		PsTon1	42	.90	.07			.97
		Ton	5	.80	.20			1.0
		Total	50	.90	.08			.98
Cl5	*disciple* /disipl/	PsTon1	30		.03	.57	.30	.90
		PsTon2	19			.63	.11	.94
		Ton	2			1.0		1.0
		Total	51		.02	.61	.22	.85

As shown by the rightmost column 'Total', the majority of the Mandarin learners' realizations of the /Cl/ clusters were either target-like or involved epenthesis.[58] As predicted in (42), the learners were the least accurate with Cl5 targets like *disciple* in which the stop-/l/ cluster is syllabified as a branching OEHS. The majority of their outputs for such targets involved word-final epenthesis (C_1C_2V, output [disiplə]). Turning to monosyllabic targets like *plie*, the learners were slightly more accurate (TL: 31%). The percentage of target-like outputs for Cl2-type (e.g. *plateau*) and Cl3-type clusters (e.g. *chapelet*) was essentially identical (67% versus 66% respectively). Finally, the learners were most accurate with Cl4 targets like *diplômé*: 90% of their realizations of the stop-/l/ clusters of such targets were accurate.

[58] In the vast majority of cases, the epenthetic vowel was [ə].

As shown in (45) below, whereas the learners' difficulty with Cl5 targets like *disciple* is consistent with the predictions made based on structural markedness, their accuracy with the other cluster types is not.

(45) *Predicted versus actual order of acquisition: Mandarin learners' syllabification of French* /Cl/ clusters

Predicted: Cl5 ⊃ Cl3, Cl4 ⊃ Cl1, Cl2

Actual: Cl5 ⊃ Cl1 ⊃ Cl2, Cl3 ⊃ Cl4

In the rest of this section and those that follow, I will provide an analysis of the data beginning with Cl2 targets (e.g. *plateau*).

In the analyses to be proposed, a number of constraints unencountered to this point will play a central role; I introduce the majority of them here. The first of these constraints is a licensing constraint that prohibits branching onsets. While we have already seen a constraint against complex constituents, namely Prince & Smolensky's (1993) *COMPLEX, as argued in §2.4, such a constraint lacks explanatory adequacy. Consequently, in keeping with the central role of head-dependent relationships in assuring representational wellformedness, I redefine *COMPLEX in terms of licensing as in (46).

(46) ***COMPLEX(α)**
Sub-syllabic constituents cannot license a dependent (i.e. branch)
α ∈ {Onset, Rhyme, Nucleus}

While undominated *COMPLEX(ONS) allows for languages like Mandarin which prohibit branching onsets across the board, it cannot account for languages which enforce positional restrictions on branching, for example languages such as southeastern Brazilian Portuguese (§2.1.3.1) in which branching is restricted to head syllables and banned in non-head syllables both internal (e.g. *[(ˈli.vru)$_{Ft}$]) and external to the foot (e.g. *[pra.(ˈtʃi.ɲu)$_{Ft}$]). In order to account for such languages, it must be the case that *COMPLEX(ONS) is a member of a set of constraints which also includes the position-sensitive constraint in (47).

(47) ***COMPLEX(ONSET)-NONHEAD**
The onset of a non-head syllable cannot license a dependent

In languages like southeastern Brazilian Portuguese, the ranking *COMPLEX(ONSET)-NON-HEAD » MAX-IO » *COMPLEX(ONS) results in branching onsets being restricted to syllables prosodified within the head of the foot.[59]

The second constraint to be introduced evaluates the wellformedness of the dominance relationships that hold between feet and syllables. In the discussion of prosodic organization in §2.1.1, we saw that prosodic constituents are recursively grouped into larger constituents as per the Prosodic Hierarchy. As concerns syllables in particular, in the unmarked case, they are parsed into feet. In OT, such a dominance relationship is enforced through the constraint PARSE(σ), whose definition is given in (48) below.

(48) **PARSE(σ)**
Syllables must be parsed by Feet

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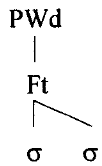
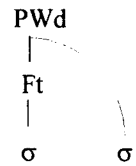
59 Admittedly, the constraint in (47) merely restates the observation. As such, its nature is contrary to the discussion in §1.2.1, where it was argued that OT constraints of this type lack explanatory adequacy. While one could offer a more explanatory account of the facts using MAXHEAD(FOOT) and MAXHEAD(ONSET) as done in Goad & Rose (in press), I do not do so here for two reasons. First, both of these constraints are Faithfulness constraints whereas it is markedness that underlines the distributional facts concerning branching onsets. Second, in §3.3.3.9, I will argue that *COMPLEX(ONSET) must be further divided in order to contrast foot-internal versus foot-external non-heads. Indeed, while *COMPLEX(ONSET)-NONHEAD combined with MAXHEAD would appear to handle the facts in southeastern Brazilian Portuguese, it cannot account for languages, including IL grammars, where there is a distinction between foot-internal and foot-external syllables as concerns the wellformedness of branching onsets. As I cannot currently offer an account of these latter facts using MAXHEAD(FOOT) and MAXHEAD(ONSET), I will use the formulation in (47), leaving investigation of the exact nature of the constraint for future research.

Of the two representations in (49), the representation in (49b) violates PARSE(σ) as the second syllable is not associated to the Foot but rather directly to the PWd.

(49) a. 

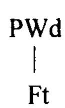
b. 

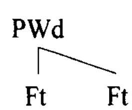
The final constraint immediately necessary for our analyses is an alignment constraint. Alignment constraints require that the edge of a given prosodic or grammatical category be aligned with the edge of some other prosodic or grammatical category. Their general formulation is given in (50).

(50) **Generalized alignment** (McCarthy & Prince 1993b)

Align (Cat_1, $Edge_1$, Cat_2, $Edge_2$) $=_{def}$
$\forall$ Cat_1 $\exists$ Cat_2 such that $Edge_1$ of Cat_1 and $Edge_2$ of Cat_2 coincide
Where Cat_1, $Cat_2 \in$ ProsCat $\cup$ GramCat
$Edge_1$, $Edge_2 \in$ {Right, Left}

In §3.3.3.5, we saw that the Mandarin learners' outputs are characterized by a preference for initial stress. In optimality-theoretic terms, such a stress pattern results from the presence of high-ranking ALIGN(FT,L,PWD,L), which requires that the left edge of every foot be aligned with the left edge of some prosodic word. Of the two representations in (51), the structure in (b) violates ALIGN(FT,L,PWD,L) because the rightmost foot is not aligned with the left edge of the PWd.

(51) a. 

b. 

With these constraints now defined, it is necessary to determine their ranking, as well as that of CODACON, DEP, and NUC, in the IL grammar; recall from §3.3.3.6 that

CODACON is a label for the group of constraints that together prohibit the licensing of codas other than /n,ŋ/. I propose that the IL ranking is that given in (52).[60]

(52) *IL constraint ranking*

CODACON, *COMP(ONS)-NONHEAD » ALIGN(FT,L,PWD,L), PARSE(σ),*COMP(ONS) » DEP » NUC

I will demonstrate that such a ranking is plausible given the L1 endstate ranking and the positive evidence available to the Mandarin learners. To begin with, I propose that the native language ranking of the constraints in question is that in (53).

(53) *Mandarin L1 constraint ranking*

CODACON, *COMP(ONS), *COMP(ONS)-NONHEAD, NUC, ALIGN(FT,L,PWD,L) » PARSE(σ), DEP

The first five constraints are undominated. Indeed, Mandarin categorically prohibits codas other than /n,ŋ/ (CODACON), branching onsets (*COMP(ONS), *COMP(ONS)-NONHEAD) and empty-headed syllables (NUC), while enforcing initial word stress (ALIGN(FT,L,PWD,L)). Evidence for the domination of PARSE(σ) and DEP within the constraint ranking comes from the observation that they are violable. As was shown in (36), PARSE(σ) is violated in words involving more than two syllables. Foreign language borrowings provide evidence for the violability of DEP: when borrowings in the source language contain clusters or non-nasal codas, illicit syllable structures are repaired via epenthesis (e.g. English *bus*, Mandarin *bashi*; English *disco*, Mandarin *disike* (Sun & Jiang 2000)).

Following the assumptions concerning constraint reranking stated in §3.2.1, in order for the IL ranking to be that in (52), there must be positive evidence in French for

60 As discussed in §3.3.3.1, the virtual absence of outputs for /Cl/ targets involving deletion is consistent with MAX-IO being undominated in the learners' grammars. For the sake of space, I omit MAX-IO from the ranking and tableaux, and do not consider candidates involving deletion.

the demotion of *COMP(ONS), ALIGN(FT,L,PWD,L), and NUC.[61] Evidence for the demotion of *COMP(ONS) is robust in French. As we have seen, French allows branching onsets word-initially, medially, and finally. As such, any non-homorganic stop-liquid cluster would provide the learner with evidence that branching onsets are licit as the optimal parse for such a sequence is an onset head-dependent relationship. Evidence for the demotion of ALIGN(FT,L,PWD,L) is also plentiful. Given that French stress is always final, any word of three syllables or more would constitute evidence for the demotion of ALIGN(FT,L,PWD,L). To illustrate, consider a word like *professeur* [pʁɔ.fe.ˈsœʁ] 'teacher'. Regardless of whether a beginner Mandarin learner posits a trochaic ([pʁɔ.fe(ˈsœʁ)]) or iambic footing ([pʁɔ.(fe.ˈsœʁ)]), such forms constitute evidence that ALIGN(FT,L,PWD,L) can be violated given that the left edge of the foot and word do not coincide. Evidence for the violability of NUC comes from the profile of right-edge consonants in French. As discussed in §2.1.2.1, both the sets of word-final singleton consonants and word-final obstruent-liquid sequences are identical to the set of word-initial and word-medial singleton and branching onsets. As such, the profile of word-final consonants and obstruent-liquid sequences provides strong evidence that OEHS are licit in French, that is, that NUC is undominated.

With this core set of constraints and their IL ranking established, we are now ready to proceed to the learners' evaluation of each of the five target types.

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[61] Two comments are necessary here. First, it is not necessary to provide evidence for the demotion of DEP. In fact, there will never be positive evidence for the demotion of Faithfulness constraints. This is not problematic under the assumption that constraint demotion is minimal. Second, while there is evidence for the demotion of *COMPLEX(ONS)-NONHEAD, this constraint has yet to be demoted. This suggests that not all positive evidence will effect a change in the grammar at once.

3.3.3.6 The role of heads and positional prominence

Based on the table in (41), we predicted that the learners' outputs for Cl2 targets like *plateau*, along with their outputs for Cl1 targets like *plie*, would be the most accurate. However, as we have already seen, this was not the case. Rather, the learners were the most accurate on Cl4 targets like *diplômé*. The extremely high percentage of target-like syllabifications with Cl4 targets is indeed surprising; the Mandarin learners' realization of stop-liquid clusters was more accurate in Cl4 targets than in any other target type (Cl4 vs Cl1: $F(1,12)= 55.383$, $p<.0001$; Cl4 vs Cl2: $F(1,12)= 14.368$, $p<.01$; Cl4 vs Cl3: $F(1,12)= 12.763$, $p<.01$; Cl4 vs Cl5: $F(1,12) = 373.412$, $p<.0001$). Moreover, the 90% accuracy rate is almost native-like.

Under the assumption that the consonant clusters in the learners' outputs are all syllabified as branching onsets, the data would appear to constitute strong evidence against the predictions made in the preceding section based on structural markedness. However, given that there is more than one possible representation of stop-liquid clusters available to the learners, one must be wary of immediately assuming that the beginner Mandarin learners will immediately represent such clusters as branching onsets without considering other possible analyses. In §3.3.3.7, I will explore one such alternative, namely that the learners' native-like accuracy with clusters in Cl4 targets such as *diplômé* is related to their representation not as branching onsets but, rather, as onset-onset sequences separated by an empty nucleus (i.e. [di.p∅.lo.me]). As we will see, such a representation allows the Mandarin learners to avoid the marked branching onset representation while effectively approximating the target.

If the analysis to be proposed in §3.3.3.8 is correct, that is, if word-medial stop-liquid clusters of targets like *diplômé* are syllabified as onset-onset sequences, the question then arises as to whether or not the learners posit a similar representation for word-initial clusters, at least at early stages of acquisition. Indeed, this might allow their outputs for Cl1 targets like *plie* and Cl2 clusters like *plateau* to be equally target-like. For the moment, I put aside the Cl1 targets to which we will return in §3.3.3.8 and use targets like *plateau* for illustration. Onset-onset syllabification of word-*initial* clusters (e.g. *plateau* [p∅.la.to]) appears to be disfavoured cross-linguistically. Data from Charette (1991) provide support for this. She discusses a number of languages, including Tangale, Mongolian, Tonkawa, Yawelmani, Turkish, and Parisian French that exhibit an asymmetrical pattern of vowel-∅ alternations. In these languages, vowel-∅ alternations are permitted virtually everywhere except in word-initial syllables, which must be phonetically realised. I propose that the markedness of such a syllabification is related to the observation that word-initial position is inherently prominent (e.g. Beckman 1997). Empty nuclei, in contrast, are fundamentally lacking in prominence given that they possess no audible melodic content. The constraint in (54) expresses this state of affairs.[62]

(54) **INITIALPROMINENCE (INITPROM)**
Word-initial syllables must have overt (melodically-filled) nuclei

I propose that the absence of word-initial V-∅ alternations in such languages results from the presence of undominated INITIALPROMINENCE: a position lacking melodic content also lacks prominence and is thus prohibited word-initially.

[62] As was the case with *COMPLEX(ONS)-NONHEAD in (47), INITIALPROMINENCE merely describes the observation. The exact formulation of this constraint requires further research.

Under the assumption that Markedness » Faithfulness in the L1 initial state (§3.1.1) and given the absence of positive evidence in Mandarin for word-initial empty syllables, a markedness constraint such as INITIALPROMINENCE must be undominated in the learners' native language grammar and thus in the IL grammar following transfer. Undominated INITIALPROMINENCE precludes the onset-onset syllabification of initial stop-liquid clusters (e.g. *plateau* /plato/ → *[p∅lato]).

If the Mandarin learners wish nonetheless to avoid branching onsets in this position, they could epenthesize a vowel cluster-internally, [pəlato]. While cluster-medial epenthesis avoids a branching onset, epenthesis comes at a cost. First, it violates input-output faithfulness (DEP). Second, in a grammar like the Mandarin learners' IL that seeks to align the left edge of the foot with the left edge of the PWd, satisfaction of both alignment and epenthesis requires that the head of the foot be epenthetic, [(ˈpəla)$_{Ft}$to]. I argue that such a representation violates another constraint on prosodic prominence that we have already seen, namely HEADPROMINENCE. Recall from (37) that HEADPROMINENCE requires that the head of the foot be inherently prominent. Schwa lacks such prominence as its representation involves reduced structure vis-à-vis other vowels (e.g. Steriade 1995; cf. Piggott 1998).[63] We have already seen that consonants such as [ʔ], [ŋ], and [r] may be the surface realization of a minimally specified stop, nasal and liquid respectively.[64] I adopt the position that epenthetic [ə] is like these consonants in being the phonetic interpretation of a minimally specified segment,

63 Piggott's (1998) proposal is somewhat different in that it is not the featural content of schwa that differs from other vowels. Rather, he argues that unstressable vowels are weightless (i.e. lack a mora). Such a proposal is consistent with the claim that their structural representation is reduced vis-à-vis other vowels.

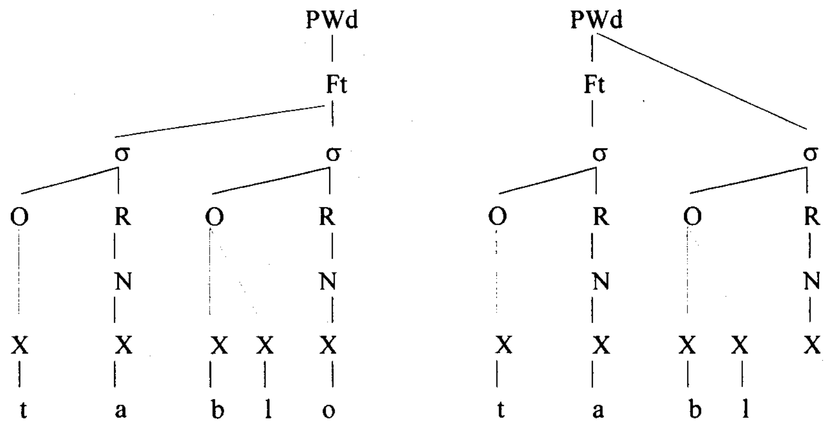
64 [ʔ] may be the phonetic interpretation of a bare Root node, [ŋ] of a Root node and SV node, [r] of a Root node, SV node and dependent [approx].

specifically a vowel with minimal melodic structure inserted uniquely for syllabification needs. As such, [ə] fundamentally lacks prominence.

One consequence of this lack of prominence manifests itself in French, where schwa is prohibited from occupying the head position of the foot. To illustrate, consider the representations of the minimal pair *tableau* [tablo] 'painting' and *table* [tabl] 'table' given in (55).

(55) *Representation of French 'tableau'* [tablo] *and 'table'* [tabl]

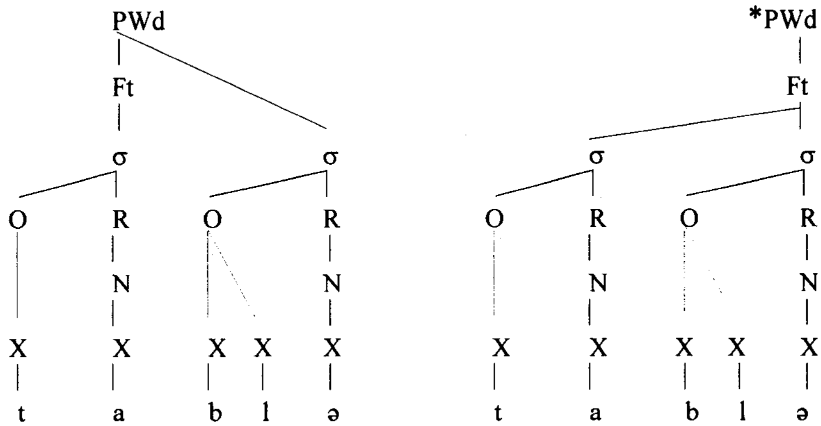
a. *tableau* [tablo] 'painting' b. *table* [tabl] 'table'



The two representations above differ as concerns the location of the head of the foot within the word. Whereas the head is final in *tableau* (55a), in *table* (55b), the head of the foot is the penultimate syllable. Now consider the representations in (56).

(56) *Prosodification of French 'table'* [tablə]

a. [ˈtablə] b. *[taˈblə]



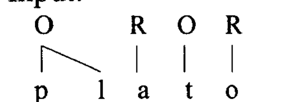
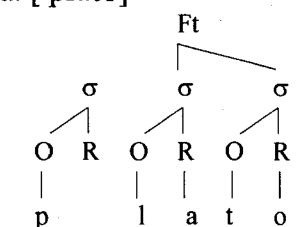
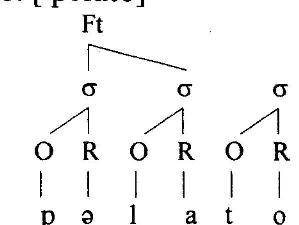
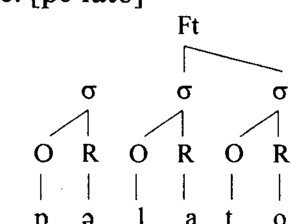
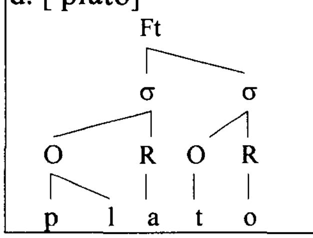
In French, word-finally branching OEHS are variably realized with final epenthetic schwas. Were the differences in foot structure in (56) simply related to the absence of melodic content in the second syllable of *table* [ta.bl∅], epenthesis should allow for right alignment of the foot. However, a comparison of (55b) and (56a) shows that the foot structure of [tabl∅] and [tablə] is identical while (56b) is ill-formed. Indeed, in French, stress is borne by the vowel of the ultimate syllable except for those cases where the vowel is schwa. The footing in (56a) is consistent with schwa being prohibited from occupying the head of the foot in languages in which HEADPROMINENCE is undominated.

We now turn to the evaluation of Cl2 targets like *plateau* in (57).[66] The representations of candidates (a) [p∅.ˈla.to] and (b) [ˈpə.la.to] each violate one of the undominated constraints on prosodic prominence, INITIALPROMINENCE and HEADPROMINENCE respectively. Such violations eliminate them from competition. In order to avoid the fatal violation of HEADPROMINENCE, the Mandarin learners might posit

[66] Here and in the rest of the thesis, X-slots, nuclei and structure above the Foot are omitted from all tableaux for the sake of space. Furthermore, inputs are only partially prosodified.

a representation in which the cluster is broken up by epenthesis but where the foot is constructed over the last two syllables, as in candidate (c). While such a candidate avoids violating either of the undominated prominence constraints, its penultimate stress violates both ALIGN(FT,L,PWD,L) and PARSE(σ), making it suboptimal.

(57) *Mandarin learners' evaluation of Cl2 targets: plateau* [plaˈto]

Input: 	INIT PROM	HEAD PROM	ALIGN (FT,L, PWD,L)	PARSE σ	*COMP (ONS)	DEP	NUC
a. [ˈplato] 	*!		*	*			*
b. [ˈpəlato] 		*!		*		*	
c. [pəˈlato] 			*!	*		*	
☞ d. [ˈplato] 					*		

This leaves candidate (d) [ˈplato] as optimal. While the representation of this candidate involves a branching onset, it is prosodified in the head syllable of the foot. Given that

*COMPLEX(ONSET) has been demoted below the prominence constraints in the presence of positive evidence, such a marked structure is now licit in the learners' grammars.

In summary, the stop-liquid sequences of Cl2 targets like *plateau* are syllabified as branching onsets in the Mandarin learners' IL grammar. This is consistent with complexity being allowed in head positions. In the following section, we will investigate the learners' outputs for Cl3 targets like *chapelet* and Cl4 targets like *diplômé*.

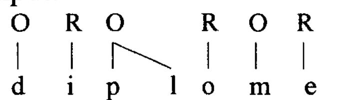
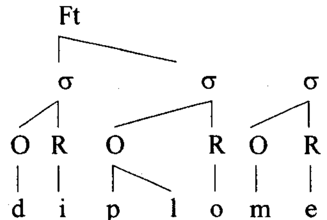
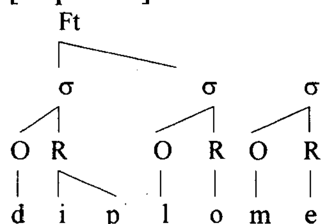
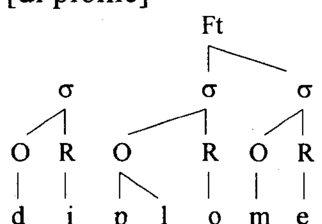
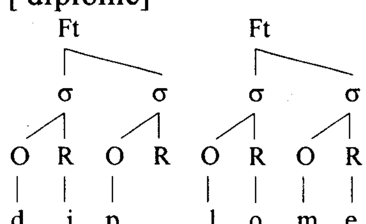
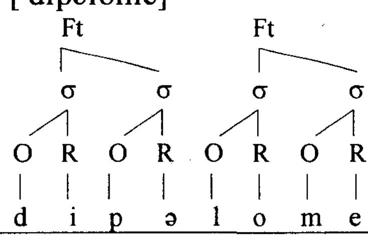
3.3.3.7 Word-internal empty-headed syllables

If the clusters of Cl3 and Cl4 targets are syllabified as branching onsets, this will require branching in non-head syllables, a marked option. As mentioned earlier, I will argue that, in order to avoid such a representation, the learners adopt an onset-onset representation. Given the Mandarin learners' preference for initial stress, were the [pl] sequence of *diplômé* syllabified as a branching onset as in candidate (58a), the cluster would be prosodified in a non-head syllable, a weak licensing position. Such a candidate fatally violates undominated *COMP(ONS)-NONHEAD.[67] In order to avoid this violation, there are two possibilities in a grammar like that of the Mandarin learners in which MAX-IO is undominated. First, a learner might posit the representation in (58b) where the stop of the cluster is syllabified as a coda. However, such a representation fatally violates the constraint prohibiting coda obstruents which is undominated in the IL grammar. The other option is to leave the first syllable unfooted and construct a trochee aligned with the left edge of the syllable containing the cluster, as in (58c). While this representation

[67] While CODACON and *COMPLEX(ONS)-NONHEAD are undominated in the tableau in (58), in §3.3.3.9, we will see evidence for *COMPLEX(ONS)-NONHEAD being violable.

avoids violations of undominated CODACON and *COMPLEX(ONSET)-NONHEAD, it forces one violation each of ALIGN(FT,L,PWD,L), PARSE(σ), and *COMPLEX(ONSET).

(58) *Mandarin learners' evaluation of Cl4 targets: diplômé* [diplo'me]

Input: 	CODA CON	*COMP (ONS) NONHD	ALIGN (FT,L, PWD,L)	PARSE σ	*COMP (ONS)	DEP	NUC
a. ['diplome] 		*!		*	*		
b. ['diplome] 	*!			*			
c. [di'plome] 			*	*!	*		
☞ d. ['diplome] 			*				*
e. ['dipəlome] 			*			*!	

Although these violations are less serious than violations of undominated CODACON and *COMP(ONS)-NONHEAD under the IL constraint ranking, the optimal candidate in (58d) incurs fewer violations of these three constraints. Indeed, an output like $[{}^{\text{ˈ}}(\text{di.p}\varnothing)_{\text{Ft}}(\text{lo.me})_{\text{Ft}}]$ acquires a violation mark for of ALIGN(FT,L,PWD,L) and well as for lowly ranked NUC. Were the learner to attempt to avoid the latter violation by epenthesizing a vowel cluster-medially as in (58e), such a representation would violate DEP. Given the relative ranking of DEP and NUC, it is the candidate in (d) that is optimal.

In summary, output $[{}^{\text{ˈ}}(\text{di.p}\varnothing)_{\text{Ft}}(\text{lo.me})_{\text{Ft}}]$ for target $[\text{di}(\text{plo.}{}^{\text{ˈ}}\text{me})_{\text{Ft}}]$ allows the Mandarin learners to approximate the target while avoiding a branching onset cluster in a non-head syllable, a marked syllabification following Licensing Inheritance. Two final comments are merited concerning the representation of the optimal candidate (58d). First, we will see that the optimal candidate for Cl3 targets like *chapelet* in (60) and Cl5 targets such as *disciple* in (67) involve unparsed syllables. This raises the question as to why the learners' preferred syllabification of target *diplômé* involves two feet as opposed to one foot followed by two unparsed syllables. If we examine the percentage of target-like forms for each cluster type, we see that representations involving unfooted syllables, including those of the optimal candidate for *chapelet* and *disciple*, were native-like in only two-thirds of cases. In contrast, in representations where all syllables are footed, as in (58d), the percentage of target-like outputs rises to an almost native-like 90%. Clearly, the learners' grammars prefer that syllables be footed where possible. Second, if the learners' representation of targets like *diplômé* involves two feet as shown, one should expect the output to exhibit secondary stress, not a single primary stress as in [ˈdiplome]. The absence of secondary stress is not unique to Cl4 targets but is attested across target types: inspection of the data from all three tasks (Repetition, QQC, Naming) reveals that only 2 of the 1291 learner outputs bore two stresses. In order to account for the absence of secondary stress, I adopt a proposal made in Crowhurst (1996). In her analysis of the metrical structure of Cairene Arabic, Crowhurst argues that the lack of secondary stress in outputs containing multiple feet is related to the relative ranking of the two constraints in (59).

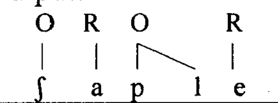
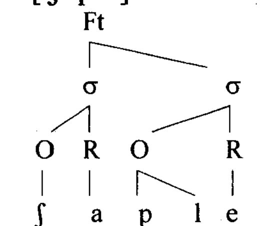
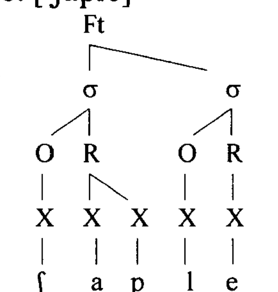
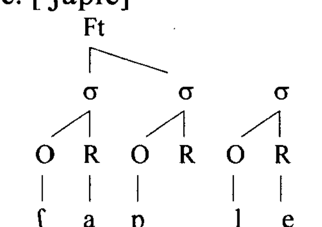
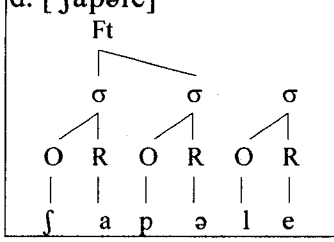
(59) **FT-TO-HEAD** (Crowhurst 1996:417)
Link (Foot, Head(Ft))

HEADMAX
Link (Head(Ft), Head(PWd))

FT-TO-HEAD requires that every foot dominate a head, i.e., that there be no headless feet. HEADMAX requires that the head of every foot be associated with the head of the PWd. Crowhurst argues that, in general, prominent elements are required to be maximal in their domain. Stated otherwise, a position that is the head of a prosodic constituent at some level will seek to be the head of some superordinate constituent. HEADMAX captures this generalization at the level of the foot. As argued by Crowhurst, in most languages, FT-TO-HEAD dominates HEADMAX, allowing for secondary stress. However, in languages like Cairene where HEADMAX » FT-TO-HEAD, secondary stress is prohibited. The lack of secondary stress in the learners' L1Mandarin is consistent with such a ranking, which is transferred into the learners' IL grammar. Both constraints in (59) are in keeping with the importance of heads to prosodic organization argued for in Chapter 2.

To conclude this section, we examine the learners' evaluation of Cl3 targets like *chapelet* [ʃa'ple] as shown in (60).

(60) *Mandarin learners' evaluation of Cl3 targets: chapelet* [ʃa'ple]

Input: 	CODA CON	*COMP (ONS) NONHD	ALIGN (FT,L, PWD,L)	PARSE σ	*COMP (ONS)	DEP	NUC
a. ['ʃaple] 		*!			*		
b. ['ʃaple] 	*!						
☞ c. ['ʃaple] 				*			*
d. ['ʃapəle] 				*		*!	

Once again, I argue that the learners represent the [pl] cluster of such targets as onset-onset sequences (i.e. ['ʃa.p∅.le]) in order to avoid a representation in which a branching onset is prosodified in a non-head syllable (candidate (60a) below). As was the case with Cl4 targets such as *diplômé*, coda syllabification of [p] in candidate (b) violates the coda condition. The only option remaining for a learner who seeks to be faithful to both members of the cluster is to syllabify both the [p] and the [l] of target [ʃa.ˈple] as onsets, even if this requires a violation of PARSE(σ). This option is chosen in candidates (c) and (d). The two representations differ only as concerns the realization of the nucleus of the syllable to which [p] is an onset. Given the IL ranking DEP » NUC, candidate (c) emerges as optimal: candidate (d) is unnecessarily unfaithful to the input.

In summary, the learners' onset-onset representation of the stop-liquid clusters of Cl3 targets like *chapelet* and Cl4 targets such as *diplômé* is consistent with branching being prohibited in non-head syllables consistent with (38). Such a representation contrasts with that of word-initial stop-liquid clusters; as we saw in §3.3.3.7, the /pl/ cluster of a target such as *plateau* is syllabified as a branching onset in the Mandarin learners' IL grammars. In the next section, we will investigate how the learners represent the initial stop-liquid sequence of monosyllabic forms like *plie*. Recall from (44) that, whereas two-thirds of the learners' outputs for forms like *plateau* were target-like, less than one-third of outputs for Cl1 targets such as *plie* contained branching onsets. In the next section, I will argue that the asymmetry is related to Foot Binarity.

3.3.3.8 The role of foot binarity

While the learners' extremely high accuracy with Cl4 targets is striking, another asymmetry in the data is also surprising. Based on position in the foot and word, it was predicted in (42) that the learners would be equally accurate with the word-initial branching onsets of Cl1 *plie* and Cl2 *plateau* targets. However, as we saw in (44), whereas 67.3% of the learners' outputs for targets like *plateau* were native-like, only 31.5% of outputs for targets like *plie* were accurate; this difference was highly significant

(F(1,12)= 28.971, p<.0001). The key to understanding this asymmetry lies in a mirror-image asymmetry involving epenthesis rates: whereas 61.1% of monosyllabic targets like *plie* involved epenthesis (i.e. learner output [pəli]), medial epenthesis occurred in only 25.5% of learner outputs for bisyllabic targets like *plateau* (resulting learner output [pəlato]). These differences are summarized in (61) below.

(61) *Asymmetry in percentage of target-like and cluster medial epenthesis syllabifications: Mandarin learners' outputs for French* /ClVC/ and /ClVCV/ *targets*

Target				*Target-like*	*Medial epenthesis* (C_1VC_2)
	Shape	Example	n	%	%
Cl1	ClV	*plie*	54	31.5	61.1
Cl2	ClVCV	*plateau*	54	67.3	25.5

Before outlining an explanation for this difference, let us first consider a similar asymmetry discussed in Wang (1995).

Wang (1995) investigated the acquisition of word-final stops and nasals by Mandarin learners of English. Interestingly, she found an asymmetry that parallels the one found in the Mandarin L2 French data discussed above. As shown in the table in (62), whereas the final stop or nasal of a /CVC/ form was syllabified via epenthesis in 71.7% of outputs (e.g. target *bim*, learner output *bim*[ə]), the final stop or nasal of a /CVCVC/ target was deleted in 62.5% of cases (e.g. target *modit*, learner output *modi*).[68]

(62) *Mandarin learners' epenthesis asymmetries: /CVC/ versus /CVCVC/ targets* (Wang 1995)

Target			*Epenthesis*		*Deletion*	
Shape	Example	n	Count	%	Count	%
CVC	*bim*	60	43	71.7	5	8.3
CVCVC	*modit*	120	21	17.5	75	62.5

[68] All of the targets in Wang's study were nonce words.

Wang correctly points out that final epenthesis in /CVC/ targets and the deletion of the final obstruent of /CVCVC/ forms both favour bisyllabic outputs. She argues that such a preference is transferred from the learners' L1, Mandarin.[69]

As was the case in the IL grammars of Wang's Mandarin learners of English, I assume that binarity plays an important role in the Mandarin learners' outputs for French. Specifically, I argue that highly ranked Foot Binarity prohibits monomoraic outputs like [pli]. The constraint is given in (63).

(63) **FOOTBINARITY (FTBIN)** (e.g. McCarthy & Prince 1995:321)
Feet are binary (σσ or μμ)

In §3.3.3.2, we saw that the Mandarin foot is a bimoraic trochee. Furthermore, monomoraic words are subminimal (Yip 1992, 1994). Such a fact constitutes evidence that FTBIN is inviolable in Mandarin. Following transfer, it would also be undominated in the learners' IL.

This raises the question as to why the Mandarin learners' preferred output for target [pli] was [pəli] and not [pli:]. Indeed, the latter form alone is wellformed in the learners' L1. I propose that this is directly related to the learners' inputs. In §3.3.3.4, I argued that Lexicon Optimization forces the Mandarin learner to posit input long vowels for the bimoraic vowels of head syllables in their L1. Consequently, there is no reason for DEP(μ) to be lowly-ranked. French, unlike Mandarin, has no long vowels. Consequently,

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69 Wang also argues that the learners' preference for penultimate stress plays a role in the choice of epenthesis versus deletion for /CVCVC/ targets. In a pilot test to her study, she found that learners' stress errors could all be explained as a preference for penultimate stress. In the main study from which the data discussed here are taken, Wang included an equal number of targets with initial (i.e. [ˈCVCVC]) and final stress (i.e. [CVˈCVC]); the table in (62) collapses both together. Whereas 5% of learner outputs for [ˈCVCVC] targets involved final epenthesis, 30% of outputs for [CVˈCVC] targets involved an epenthetic vowel; this difference was significant ($\chi^2=13$, $p<.005$). Wang argues that the higher rate of epenthesis with targets bearing final stress is motivated by the learner's preference for penultimate stress (i.e. target [CVˈCVC], learner output [CVˈCVCə]).

Lexicon Optimization will require that the Mandarin learners posit short vowels in all of their IL inputs (i.e. /pli/, */pli:/). In order for [pli:] to be optimal, mora insertion must come at a relatively low cost. I propose that DEP(μ) is ranked highly enough in the L1 grammar, and thus in the IL grammar following transfer, to prohibit this.

Leaving aside candidate [pli:], we now consider the learners' evaluation of Cl1 targets for *plie* as shown in (64).

(64) *Mandarin learners' evaluation of target plie* [ˈpli]

Input: O R / p l i	INITIAL PROM	HEAD PROM	FTBIN	ALIGN (FT,L, PWD,L)	PARSE σ	*COMP (ONS)	DEP	NUC
a. [ˈpli] Ft – σ – O R – p l i			*!			*		
b. [ˈpli] Ft – σ σ – O R O R – p l i	*!					*		*
☞ c. [pəˈli] Ft – σ σ – O R O R – p ə l i							*	
d. [ˈpəli] Ft – σ σ – O R O R – p ə l i		*!					*	

As was the case with Cl3 targets like *plateau*, onset-onset syllabification of the cluster as in (64b) is ruled out by INITIALPROMINENCE. Were a learner to avoid a violation of INITIALPROMINENCE through cluster medial epenthesis, in a form like (64d) in which stress is initial, such epenthesis would entail a fatal violation of HEADPROMINENCE. This leaves two possible candidates. While the monosyllabic candidate [ˈpli] satisfies both prominence constraints, it violates undominated FTBIN. This leaves candidate (c) [peˈli] as optimal. Note that [peˈli] is not a not a wellformed moraic trochee. I assume that, while FTSHAPE(TROCHEE) is still highly ranked in the learner's grammars, they have begun to demote it on the basis of the ambient French data, i.e., data in which stress is uniquely final; FtShape(Trochee) is minimally dominated by FTBIN in the IL grammar.

To conclude our discussion of the branching onset data, in the next section, we examine the learners' outputs for Cl5 targets like *disciple*.

3.3.3.9 Complexity in foot-internal versus foot-external non-heads

The learners' preferred output for Cl5 targets such as *disciple* differed from their outputs for other cluster types in two important respects. First, whereas stress was initial in the majority of their outputs for Cl2, Cl3 and Cl4 multisyllabic targets, Cl5 targets were an exception to this: 68.4% of outputs involved stress on the second syllable ([diˈsiplə]). Second, such outputs involve branching in non-head syllables ([di.(ˈsi.plə)$_{Ft}$). This contrasts with the learners' syllabification of Cl3 and Cl4 targets discussed in §3.3.3.8, where I argued that, in order to avoid branching in non-head syllables, the learners adopted an onset-onset representation of the stop-liquid clusters.

While most of the learners' outputs for targets like *disciple* do seem to involve branching in a non-head syllable, that the learners shifted stress from the initial to second syllable in 60% of outputs suggests that not all non-head syllables are equally good licensors of such complexity. Had the learners kept the predominant initial stress pattern for Cl5 targets, the cluster would have been prosodified in a syllable that was both a non-head and foot external (i.e. [(ˈdi.si)$_{Ft}$.plə]). As such, I propose that the shift of stress to the second syllable is motivated by the learners' desire to avoid complexity in non-head syllables prosodified outside of the foot.

In §3.3.3.5, I proposed that *COMPLEX(ONSET) must have a sister constraint *COMPLEX(ONSET)-NONHEAD. The discussion immediately above suggests that a further distinction must be made, specifically between foot-internal and foot-external non-heads. I propose that the constraint necessary for this distinction is that in (65).

(65) ***COMPLEX(ONS)-FOOTEXTERNAL**
The onset of a syllable external to the foot cannot license a dependent

At this point in time, I do not possess the natural language data necessary to support the distinction between foot-internal and foot-external non-head syllables proposed in (65). However, given the nature and role of nucleus-nucleus licensing in distributing licensing potential within the Foot and PWd, I predict that such an asymmetry should exist in some languages. While the nucleus of the dependent syllable is in an interconstituent relationship with the head nucleus of the foot, a foot-external nucleus is not. If a foot-external nucleus also inherits its licensing potential from the head nucleus of the PWd, it is minimally one path more removed than the nucleus of the dependent syllable and, thus, following licensing inheritance, a weaker licensor. *COMPLEX(ONS)-FOOTEXTERNAL allows for the finer grained distinction between the two types of non-head syllables proposed above. I propose that it is undominated in the learners' IL grammar. Let us now consider the learners' evaluation of Cl5 targets like *disciple*.

The first two candidates in (67a,b) incur fatal violations of undominated GOVERNMENTLICENSE, which prohibits branching OEHS (see (10)). It is possible to avoid violation of this constraint through epenthesis. Each of the candidates in (67c-f) demonstrates a different option. In candidates (c) [di'sipələ] and (d) ['disipələ], two epenthetic vowels are inserted. Following Kaye, Lowenstamm & Vergnaud (1990), I assume that such representations violate PROPERGOVERNMENT, the definition of which is given in (66).[69]

(66) **PROPERGOVERNMENT (PROPGOV**; Kaye, Lowenstamm & Vergnaud 1990:219)
The licensor of an epenthetic vowel cannot itself be epenthetic

Following PROPERGOVERNMENT, I assume that the ban on consecutive schwas is related to the hypothesis that two contiguous syllables headed by an epenthetic segment cannot constitute a wellformed interconstituent licensing path as the head of the licensing path lacks sufficient structure. Recall from the discussion of interconstituent licensing in §2.1.3.2 that, in the case of the relationship between two nuclei, one of the positions must be the head of the licensing path. If the structural content of an epenthetic schwa is reduced vis-à-vis a regular input vowel (§3.3.3.7) and structural content is crucial to the distribution of licensing potential (§2.3.2.2), then it follows logically that two consecutive syllables headed by epenthetic vowels cannot constitute a wellformed licensing path. Any such sequence will violate the constraint PROPERGOVERNMENT.

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69 As was the case with GOVERNMENTLICENSING in (10), the definition given here for PROPERGOVERNMENT differs from the original in order to be consistent with the theory of licensing adopted in the thesis. Kaye, Lowenstamm & Vergnaud propose that a governor (i.e. head) cannot itself be governed, where 'governed' translates into 'epenthetic' in the case of word-final vowels.

In the remaining two candidates, epenthesis occurs only word-finally. If the learners construct a branching foot over the first syllable in order to achieve the preferred initial stress pattern, as in candidate (e), the cluster falls outside of the foot and thus violates undominated *COMP(ONS)-FTEXT. Such a violation is fatal, leaving candidate (f), in which the foot is not left-aligned to ensure that branching occur within the foot, as optimal.

(67) *Mandarin learners' evaluation of Cl5 targets: disciple* [di'sipl]

Input: O R O R O / d i s i p l	GOV LIC	PROP GOV	*COMP (ONS)-FTEXT	*COMP (ONS)-NONHD	ALIGN (FT,L, PWD,L)	PARSE (σ)	*COMP (ONS)	DEP	NUC
a. ['disipl] (Ft over σ σ; σ σ σ; O R O R O R; d i s i p l)	*!		*	*		*	*		*
b. [di'sipl] (Ft over σ σ; σ σ σ; O R O R O R; d i s i p l)	*!			*	*	*	*		*
c. [di'sipələ] (Ft over σ σ; σ σ σ σ; O R O R O R O R; d i s i p ə l ə)		*!			*	**		**	
d. ['disipələ] (Ft over σ σ; σ σ σ σ; O R O R O R O R; d i s i p ə l ə)		*!				**		**	

Input: O R O R O d i s i p l	Gov Lic	Prop Gov	*Comp (Ons)-FtExt	*Comp (Ons)-NonHd	Align (Ft,L, PWd,L)	Parse (σ)	*Comp (Ons)	Dep	Nuc
e. [ˈdisiplə] Ft σ σ σ O R O R O R d i s i p l ə			*!	*		*	*	*	
☞ f. [diˈsiplə] Ft σ σ σ O R O R O R d i s i p l ə				*	*	*	*	*	

In summary, the exceptional stress 'shift' in Cl5 targets is driven by the learners' attempt to syllabify the cluster within the foot. Candidates in which branching onsets are prosodified outside of the foot will be eliminated by *COMPLEX(ONS)-FTEXT.

3.4 Chapter Summary

In this chapter, we have examined data from two separate studies on the acquisition of consonant clusters by Mandarin learners of French, which demonstrate the important roles of highly-articulated representations and structurally-defined markedness in IL development. The data from Steele's (2002) study of the acquisition of word-final liquid-stop and stop-liquid clusters revealed two roles for representation. First, in those cases where the clusters were reduced, it was virtually always the case that the learners deleted the liquid. In §3.2.2.1, I argued that this deletion pattern is consistent with head preservation enforced by MAX(HEAD). I also argued that the learners' final aspiration of output stops was driven by their representation as onsets. Following the proposal in Goad & Brannen (in press), I argued that onset syllabification of final consonants is unmarked.

The data from the present experiment has also provided evidence for the role of markedness in the L2 acquisition of prosodic complexity. The strongest evidence came from the learners' syllabification CL5 targets like *disciple* where I argued that the shift of stress from the initial syllable was motivated by the learners' attempt to avoid the violation of two undominated markedness constraints, namely *COMPLEX(ONS)-FTEXT and PROPERGOVERNMENT. Further evidence for the role of markedness was presented in §3.3.3.8. The epenthesis in the learners' outputs for Cl1 targets like *plie* was driven by the need to satisfy Foot Binarity.

The present study also provided evidence for the role of constraints on positional prominence, namely INITIALPROMINENCE and HEADPROMINENCE. Such constraints prohibit word-initial empty nuclei and epenthetic heads respectively.

Finally, the Mandarin-French branching onset data have demonstrated that acquisition does not consist of constraint ranking alone; the construction of inputs also plays a central role. This is true in two respects. First, in §3.3.3.2, I proposed that the Mandarin learners' misanalysis of target /ʁ/ had important consequences for their representation of /Cʁ/ clusters. Given the contradictory phonetic and phonological cues of French [ʁ], many of the learners posited inputs in which /ʁ/ was an obstruent. This representation then precluded target-like syllabification. Second, in §3.3.3.3, I proposed that the devoicing of /ʁ/ in voiceless stop-liquid clusters led the learners, at least in some cases, to misanalyse /ʁ/ as fortis release, and not as a separate segment.

Having investigated the role of representation and licensing in the acquisition of prosodic complexity in this chapter, in the following chapter, we will turn to their role in the acquisition of position-sensitive contrasts.

4 *Issues in the L2 acquisition of position-sensitive contrasts*

4.0 Introduction

In Chapter 3, we investigated the L2 acquisition of new syllable structure positions including word-final OEHS and the dependent of a branching onset. In all of the analyses proposed, it was argued that the acquisition of new positions can be understood formally as the acquisition of new P-licensing possibilities. In this chapter, we continue to investigate the role of licensing in the acquisition of syllable structure complexity. However, the focus will shift from P-licensing and the acquisition of prosodic complexity to A-licensing and its role in the acquisition of position-sensitive contrasts.

As discussed in §2.1.3.1, languages differ not only in terms of the types of syllable positions they P-license but also as concerns the types of contrasts that may be A-licensed in a given position. To illustrate, consider Mandarin and French. While both languages P-license rhymal dependents, the set of contrasts possible in Mandarin codas (both word-internal and word-final consonants) is somewhat restricted compared to those contrasts licensed in French (word-internal position only). To review the facts, in Mandarin, codas are limited to the nasals /n,ŋ/ as well as /ɹ/ in suffixed forms. In French, by comparison, voiceless obstruents (*absent* [ap.sɑ̃] 'absent', *biscuit* [bis̠.kɥi] 'cookie') as well as liquids (*culture* [kyl̠.tyʁ] 'culture', *normal* [nɔʁ̠.mal] 'normal') may appear syllable finally. Stated in terms of licensing, the Mandarin coda is relatively unmarked in that it is restricted to licensing sonorants (i.e. SV structure).[1] French codas, in contrast, can A-license a greater range of melodic material, including place features in the case of obstruent codas and the feature [continuant] necessary for the representation of fricatives. Consequently, a native speaker of Mandarin who seeks to acquire French as an L2 must restructure his or her IL grammar so that the coda can license a greater range of featural contrasts, including place features and [continuant]. The Mandarin learner of French must also come to permit word-final OEHS.

In this chapter, we will investigate how L2 learners acquire these types of position-sensitive contrasts, restricting the investigation to place features and, in the case of word-final consonants, [voice]. In parallel to the analyses proposed in Chapter 3 for the acquisition of new positions, I will argue that acquisition of an L2 with a greater range of position-sensitive featural contrasts, including the acquisition of such contrasts in OEHS, involves acquiring new licensing possibilities. I will also argue that structurally-determined markedness plays a similar role in the acquisition of position-sensitive contrasts as it does in the acquisition of new positions. In §3.3, I argued that the theory of licensing-based markedness outlined in Chapter 2 makes three specific predictions as concerns the relative order of acquisition of new positions and position-sensitive contrasts; I repeat the third of these predictions in (1) below.

(1) *Licensing-based prediction for the acquisition of position sensitive contrasts: non-head-internal asymmetries*

Within a non-head position, the member whose representation involves less featural content will be acquired first or both members of a contrast will be acquired concurrently.

[1] In §4.1.2.2, we will closely examine exactly what structure the Mandarin coda can license. For the moment, the descriptive account given above will suffice.

For any given segmental contrast, the segment whose output representation involves greater structural complexity will be acquired either concurrently or subsequently to the member or members of the contrast whose representation involves relatively less segmental structure. For example, in the acquisition of a voicing contrast in coda position, voiceless obstruents will be acquired first as the representation of their voiced counterparts involves the licensing of greater structural complexity, namely the structure Laryngeal-[voice]. As the prediction in (1) makes reference to non-head positions and not dependent positions alone, it can be extended to OEHS. Recall from §2.1.2.1, note 12 that, while strong licensors vis-à-vis codas, restrictions may hold of OEHS as concerns the segmental contrasts they license that do not hold for onsets of melodically filled syllables.

The present chapter is organized as follows. In §4.1, we will investigate the acquisition of place both in the dependent of a branching onset and in coda. In the case of branching onsets, we will compare the acquisition of French /Cl/ and /Cʁ/ clusters and test the hypothesis that the latter should be acquired more readily given the relatively less complex representation of /ʁ/. In the case of codas, we will focus primarily on nasal codas that contrast for place. One of the primary conclusions in this section will be that place contrasts are acquired more readily when the relevant place features can be parasitically licensed by the following onset. In §4.2, the focus will turn to the acquisition of voice contrasts in word-final stops syllabified as OEHS or codas. We will see that the relatively higher cost of licensing a voiced versus voiceless stop in coda position or as an OEHS results in a higher rate of epenthesis following the voiced member of the contrast: if the coda or OEHS is too weak a licensor in the IL grammar to license [voice], epenthesis allows for the syllabification of the target final stop as the onset of a syllable whose head is melodically filled, i.e. in a strong position. We now turn to the role of A-licensing in the acquisition of place in the onset dependent and coda positions respectively.

4.1 Asymmetries in the acquisition of place

As discussed in §2.2.1.1, UG allows for the representation of contrasts in place via a Place node and its dependents, the articulators [lab], [cor], and [dor]. In this section, we will investigate a number of asymmetries in the acquisition of place contrasts in the non-head of a branching onset and in coda position. I will argue that a theory of representation in which feature licensing comes at a cost allows for an explanatory account of such asymmetries.

4.1.1 Onsets

Cross-linguistically, the unmarked branching onset is a stop-liquid cluster (e.g. Clements 1990). In this section, we will analyze data from two studies that investigated the acquisition of French stop-liquid clusters, both by English (Steele 2000) and Mandarin learners (Steele 2002).[2] Whereas the discussion of the Mandarin data from Steele (2002) in §3.2.2 grouped the lateral and rhotic targets together, in the present section, we will reanalyze the data from both studies controlling for the type of liquid.

In §2.1.3.1, we saw that, in Dutch, there exists an asymmetry between /Cl/ and /Cr/ clusters. While both types of clusters are licit in the head of the foot, only stop-rhotic clusters occur in non-head syllables. In the examination of the L2 French stop-liquid

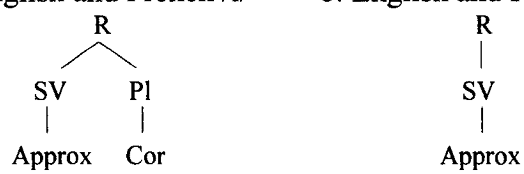
[2] Although the data discussed in the beginning of this chapter come from two previous studies, the analyses presented here are new. Indeed, in the case of /NC/ clusters, while the data come from the experiment in Steele (2002), they are reported here for the first time.

cluster data, we will see that there exists a parallel asymmetry involving the rate at which /Cl/ and /Cʁ/ onset clusters are acquired. I will argue that the explanation for such an asymmetry falls out from the differences in representation of /l/ and /ʁ/ discussed in §2.2.1.3.

Recall that in languages like English and French, the lateral-rhotic contrast is represented in terms of the relative amount of place structure. Specifically, whereas /r/ has no place specification, /l/ is coronal. The relevant representations are repeated in (2) below.

(2) *Representation of English and French liquids*

a. English and French /l/ b. English and French /r/



The hypothesis in (1) that, within a given non-head position, a representation involving less featural material will be acquired before one that is melodically more complex, makes a strong prediction for the relative order of acquisition of /Cl/ versus /Cr/ clusters. Given the greater structural complexity of /l/ vis-à-vis /r/ shown in (2), one should predict that, once the representations in (2a,b) are acquired in strong positions (i.e. head of the onset) and that the IL grammar has been restructured so as to allow for the P-licensing of onset dependents, learners' outputs involving /Cr/ onsets should be equally or more accurate than those for target /Cl/ clusters, as the acquisition of the latter involves the A-licensing of relatively more featural content in a weak position. We will see immediately that data from the two studies in question support this prediction.

4.1.1.1 /CL/ clusters

The English speakers in Steele (2000) were tested on their syllabification of French word-final clusters including stop-liquid branching OEHS using the same methodology as in Steele's (2002) study of Mandarin speakers, namely a word-learning experiment.[3] While English has initial (e.g. *play*, *pray*) and medial (e.g. *com<u>pl</u>ex*, *com<u>pr</u>ess*) stop-liquid branching onsets, word-final stop-liquid clusters are syllabified as onset-nuclear sequences (e.g. *letter* [lɛ.tɹ̩], *table* [teː.bl̩]). As we saw in §2.1.1.2, in contrast to English, French word-final stop-liquid clusters are syllabified as branching OEHS (e.g. *lettre* [lɛ.tʁ∅], *table* [ta.bl∅]). Although English does have singleton word-final OEHS, including the second member of a nasal-obstruent (e.g. *hand* [hæn.d]) or liquid-obstruent (e.g. *milk* [mɪl.k]) cluster, OEHS may not branch. Consequently, for an English-speaking learner of French to acquire the target-like representation of French word-final stop-liquid clusters, his or her IL grammar must be reshaped so as to allow for the licensing of the dependent member of a branching OEHS and the relevant rhotic-lateral contrast, namely the Place-Coronal structure necessary for the representation of /l/. While the data reported in Steele (2000) group the lateral and rhotic targets together, we reanalyze the data here, controlling for liquid type. The breakdown for the beginner learners tested in the study is given in (3) below.[4]

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[3] An equal number of voiced and voiceless stops were included in both the /Cl/ and /Cʁ/ targets.

[4] While four levels of learners were tested in the original study, I only present the data from the beginner learners here for two reasons. First, not surprisingly, the lateral-rhotic asymmetry was the strongest in these learners' productions. Second, examining the beginner native English speaker data here allows for comparison with the beginner Mandarin learners discussed immediately afterwards as both groups had a similar amount of exposure to the target language, namely two to four weeks of intensive instruction. Note that the English learners described here as 'beginner' were called 'novice' in Steele (2000) in order to distinguish them from a slightly more advanced group of beginner learners.

(3) *Syllabification of French word-final* /CL/ *clusters: Beginner English-speaking learners* (Steele 2000)

Syllabification Method	/Cl/		/Cʁ/	
	Count	%	Count	%
Deletion	0 / 69	0	5 / 107	4.7
Epenthesis	56 / 69	81.0	61 / 107	56.9
Target	13 / 69	19.0	41 / 107	38.3

As shown in (3), the most common syllabification strategy for both types of clusters involved the insertion of an epenthetic schwa (e.g. target [ta.bl], learner form [ta.blə]; target [lɛ.tʁ], learner form [lɛ.tʁə]).[5] However, while epenthesis was used to syllabify both types of word-final /CL/ clusters, the rate of epenthesis in the learners' outputs for /Cl/ clusters was higher (i.e. 81.0% versus 56.9%); this difference was significant ($t(8)=4.974$, $p=.001$). Moreover, there were more target-like outputs for the /Cʁ/ clusters (i.e. /Cʁ/: 38.3%, /Cl/: 19.0%); this difference too was significant ($t(8)=-3.574$, $p=.007$). Before discussing this asymmetry any further, let us investigate the data from Steele's (2002) Mandarin learners in order to see whether a similar asymmetry manifests itself.

In this second study, the same test was administered to a group of beginner of native Mandarin speakers. The learners, whose L1 grammar disallows OEHS, needed to acquire both positions of the OEHS in order to acquire the target-like representation of French word-final stop-liquid clusters. Once again, we reanalyze the data here separating out the rhotic and lateral targets. In doing so, we discover that the same type of

[5] One might ask why word-final /Cl/ targets were not sometimes realized as [Cʁ] if licensing is the relevant factor. Indeed, if French [l] and [ʁ] differ only as concerns place structure, one might expect that, at some point in development, a learner who can only license SV structure in the dependent of a branching onset might sometimes realize target [Cl] as [Cʁ]. I suggest that faithfulness to the target rules out such outputs. As long as FAITH(COR) is ranked above DEP-IO, learners will epenthesize a final vowel (i.e. output [ta.blə]) rather than realizing target [l] as [ʁ] (i.e. output [ta.bʁ]).

asymmetry between the /Cl/ and /Cʁ/ clusters observed with the English speakers emerges in the Mandarin-speaking learners' data as shown in (4).

(4) *Syllabification of French word-final /CL/ clusters: Beginner Mandarin-speaking learners* (Steele 2002)

Syllabification Method	/Cl/		/Cʁ/	
	Count	%	Count	%
Deletion	1 / 36	2.8	11 / 61	18.0
Epenthesis	30 / 36	82.3	9 / 61	14.8
Target	5 / 36	13.9	40 / 61	67.2

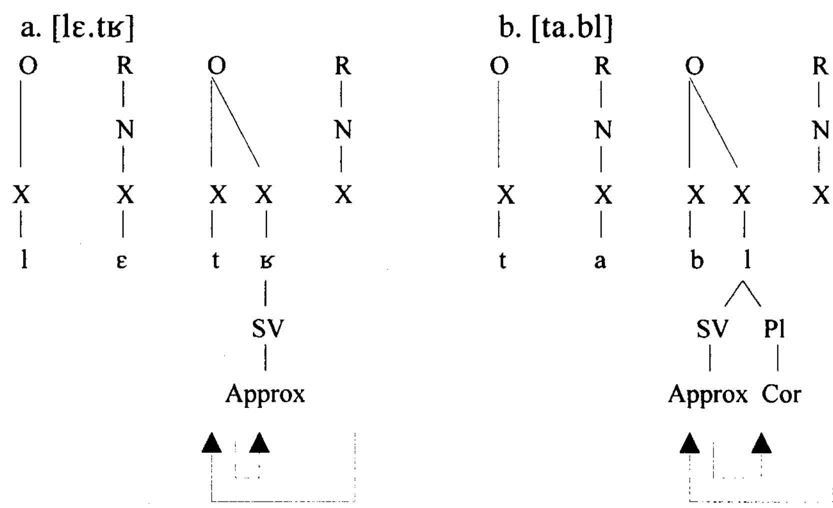
Indeed, there was a significant difference in the rate of epenthesis between target /Cl/ and /Cʁ/ clusters ($t(4)=6.716$, $p=.003$): whereas 82.3% of word-final /Cl/ targets were syllabified via epenthesis, in sharp contrast, only 14.8% of the learners' outputs for /Cʁ/ targets contained an epenthetic vowel. More strikingly, 67.2% of the /Cʁ/ targets were native-like in contrast to a mere 13.9% of the /Cl/ targets; this difference too was significant ($t(4)=-4.325$, $p=.012$).[6]

In summary, both the English- and Mandarin-speaking learners of French were more accurate on the /Cʁ/ than /Cl/ targets. Interestingly, the asymmetry manifested itself in both groups of learners' grammars in a similar manner, in spite of the fact that Mandarin learners needed to acquire both positions of the OEHS whereas, following transfer, the English learners needed only to acquire the OEHS dependent. As such, the stop-liquid data provide strong evidence that structural markedness guides IL development regardless of the representations available in a learner's initial IL grammar.

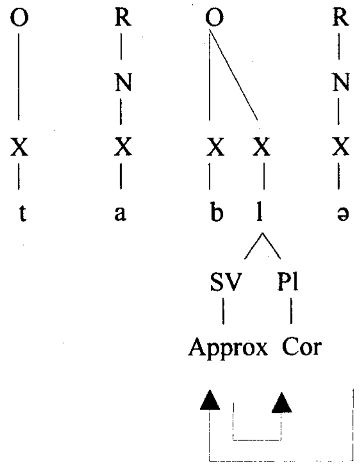
6 The Mandarin learners' high accuracy on the /Cʁ/ clusters is surprising in two respects. First, their accuracy rate is substantially higher than that of the beginner English learners (67.2% versus 38.3%), learners whose L1 already licenses singleton OEHS. Second, given the Mandarin learners' high rate of accuracy with the /Cʁ/ clusters, their 18.0% deletion rate is surprising as epenthesis is sanctioned by their IL grammars. As concerns the first observation, it may simply be the case that the Mandarin learners were more advanced. I offer no explanation for the second observation.

I argue that the asymmetry observed with both learner groups results from the difference in the representation of the two liquids as proposed in (2). Given that the representation of /l/ involves more featural content than that of /ʁ/, under a structure-building approach, /l/ should be acquired simultaneously or subsequently to /ʁ/. The learners' higher accuracy rate on target /Cʁ/ clusters is consistent with this prediction. I argue furthermore that the higher rate of epenthesis following /Cl/ clusters is another way in which the relative cost of licensing more as opposed to less featural content manifests itself: as onsets inherit their licensing potential from the following nucleus and as empty-onsets have relatively less licensing power to imbue than those which are melodically-filled (cf. §2.3.2.2), the greater cost of licensing the structure Place-Coronal for /l/ in the dependent position of a branching OEHS triggers epenthesis more readily following /l/ than following /ʁ/. To illustrate, consider the representations in (5).

(5) *Licensing of word-final* /CL/ *OEHS*



c. [ta.blə]



In each of the representations in (5a-c), the obstruent in the head of the onset of the final syllable inherits its licensing potential from the following nucleus. The head of the onset must then in turn imbue its dependent position with enough licensing potential to A-license the featural content of the liquid. In the case of a [Cʁ] cluster like that in (5a), less licensing potential is necessary in the dependent position than in the case of the [Cl] cluster in (5b), as [l] has more place structure. If the IL grammar cannot license the extra structure necessary for the representation of target [l] in the dependent of a branching OEHS, epenthesis may occur (5c). Epenthesis fills the following nucleus with content and thus increases the nucleus's ability to imbue what would otherwise be an OEHS with the licensing potential necessary for the A-licensing of the structural content of target [Cl]. In summary, epenthesis occurs more frequently following /Cl/-clusters, as clusters with a lateral in the dependent position require a greater amount of licensing potential than those involving a rhotic dependent, given the more elaborated place structure of the lateral. Let us now turn to similar asymmetries in the acquisition of place contrasts in coda position.

4.1.2 Codas

As we have seen many times to this point, the coda, like the dependent of a branching onset, is a relatively weak licensor vis-à-vis the head from which it inherits its A-licensing potential. Consequently, one should predict that the types of asymmetries in the acquisition of place contrasts discussed immediately above for the dependent position of a branching onset should also manifest themselves in the acquisition of coda contrasts. In the following two sections, we will examine data from Mandarin-speaking learners of English and French that will show that this prediction is borne out.

4.1.2.1 Final /N/ versus /NC/

In §2.1.3.2, we saw that in many languages the featural content of word-internal codas must be licensed by the following onset. For example, in Selayarese, word-internal codas are restricted to the first half of a partial (e.g. [sam.baŋ] 'to trip') or full geminate (e.g. [tuk.kaŋ] 'walking stick'), or to glottal stop (e.g. [taʔ.mu.ri] 'smile'). In such languages, the coda itself cannot license place features. Rather, such features must be parasitically licensed by the following onset. Indeed, if coda features cannot be parasitically licensed, they will not be licensed at all. It is consequently not surprising that the only non-geminate coda licit in Selayarese is [ʔ], whose representation consists of a bare Root node, i.e. a segment lacking any featural specification that need be licensed.[7]

Like Selayarese, Mandarin too is a language in which there are restrictions on the licensing of place structure in coda. However, in contrast to Selayarese which bans any amount of place structure in coda position, in Mandarin, it is only the licensing of

[7] I do not mean to imply that any language that allows for (partial) geminates will also allow for [ʔC] sequences.

articulators that is prohibited; a bare Place node alone is licit. As such, a Mandarin-speaking learner of any language in which codas contrast for place, including English and French, must acquire the ability to A-license articulators in coda position. As expected under the current approach, a comparison of data from two separate studies suggests that coda place is acquired more readily when it can be parasitically licensed by the following onset.

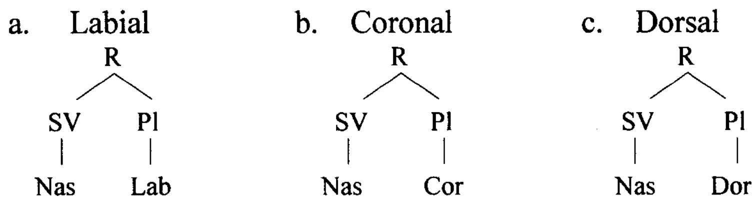
The first of the two studies to be compared is Wang (1995), who tested intermediate native Mandarin speakers on their syllabification of English word-final stops and nasals; we focus on the nasal data here. As shown in (6), while the Mandarin-speaking learners were highly accurate on /n/- and /ŋ/-final forms, forms licit in their L1 and thus in their IL grammar following transfer, coda /m/ was produced accurately in less than half of all cases.

(6) *Mandarin-speaking learners' accuracy (%) in the syllabification of English* /CVN/ (Wang 1995)

	/m/	/n/	/ŋ/
% Correct	46.7	90.0	100

Interestingly, the learners' errors with target English word-final /m/ did not involve deletion or epenthesis but rather feature change: in all cases where the learners' production was not native-like, target /m/ surfaced as /n/. In order to understand this asymmetry, it is necessary to consider the types of representations from which surface nasals may result. We begin with the input representations in (7) for nasals showing a three-way place contrast.

(7) *Input representation of nasals contrasting for place*



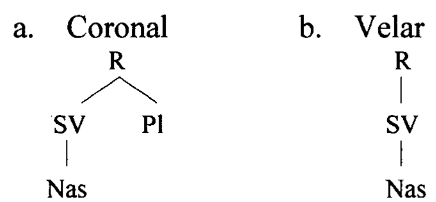
In Mandarin, a three-way contrast in place is licensed in onset position (e.g. [paŋ] 'stick', [taŋ] 'swing', [kaŋ] 'harbour').[8] Were the Mandarin coda able to license place, one would expect a three-way contrast between labial, coronal, and dorsal nasals as is the case in related Chinese varieties including Cantonese and Taiwanese (e.g. Cantonese [lam] 'blue', [lan] 'lazy', [laŋ] 'cold'). That Mandarin nasal codas only show a two-way contrast – [n] versus [ŋ] – suggests that contrastive place features are not licensed in coda position.

If place cannot be licensed in coda, one must ask how the two-way contrast between coronal and velar nasals is represented in such a language. I argue that the answer lies in the hypothesis that there are two potential representations from which surface coronal and velar nasal codas can result. The first is the type of place-specified representations given in (7a-c). In languages that license place in coda, the output representations of coronal and velar nasals will contain both a Place node and the relevant articulator. The second type of representation from which such a two-way contrast results involves reduced or no place structure that is interpreted as coronal and velar by the phonetics. In §2.2.2, we examined the role of the phonetics in interpreting phonological outputs and saw that the default phonetic intepretation of a bare Place node is [coronal].

[8] A two-way place contrast in nasals is possible in onset (e.g. [nan] 'man', [man] 'slow'). As is the case in other languages including English, [ŋ] is barred from appearing in onset position, with exceptions under limited circumstances.

Thus, the representation in (8a), where the Place node is licensed yet lacks any articulator dependents, is phonetially interpreted as [n]. Concerning (8b), given that other segments lack a Place node altogether, namely /r/ and /ʔ/, it is plausible that nasals could too. Following Rice (1996), among others, I assume that the cross-linguistic default interpretation of a nasal lacking any place structure is [ŋ]. Thus, if the output representation of a nasal segment lacks both place features and a Place node, it will be interpreted as velar as shown in (8b).[9]

(8) *Phonetic interpretation of nasal outputs lacking articulators/ Place node*



To summarize, cross-linguistically, surface coronal and velar nasal codas may result from two different output representations. In some languages, their representation includes both a Place node and the relevant articulators. In other languages that do not license place in coda but nonetheless have a two-way contrast between coronal and velar nasals in this position, the output representations of the coronal and velar nasal involve no articulators: whereas the representation of the coronal nasal includes a bare Place node that is interpreted as coronal, a nasal lacking a Place node is interpreted as the velar [ŋ].

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9 The analysis proposed here for the Mandarin-speaking learners is also supported by data from the L1 acquisition of Mandarin. Hua & Dodd (2000), in their study of the acquisition of 129 child learners, found that 55% of the children replaced target [n] with [ŋ] to some degree; the authors do not provide individual or group mean rates of substitution. In stark contrast, only 3% of children replaced [ŋ] with [n]. Hua & Dodd cite Li (1977) who reports similar findings. The striking asymmetry between [n]→[ŋ] and *[ŋ]→[n] is consistent with the structure-building, licensing approach proposed here. If [ŋ] is the default interpretation of a nasal lacking any place structure, in those cases where the children's grammar can license an SV-node but not a Place node, [ŋ] surfaces.

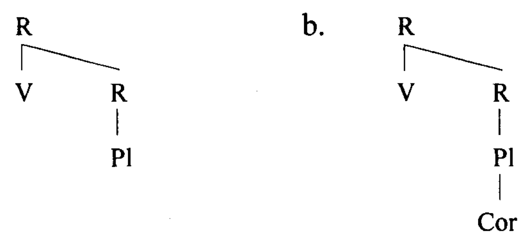
In an OT framework, the ability of the coda to license a Place node and/or its dependent articulators is related to the relative ranking of Faithfulness and the two markedness constraints in (9), NoCoda(Pl) and NoCoda(Articulator).

(9) **NoCoda(Place)**
The coda may not license a Place node

NoCoda(Articulator)
The coda may not license an articulator (i.e. [lab], [cor] or [dor]).

Both of the constraints in (9) are A-licensing constraints. Whereas NoCoda(Place) bans the licensing of a Place node in coda, NoCoda(Articulator) prohibits the licensing of articulators. The representations in (10a,b) both violate NoCoda(Place). Moreover, (10b) also violates NoCoda(Articulator).

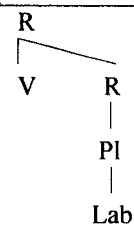
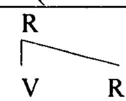
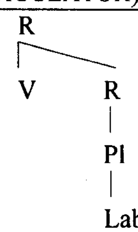
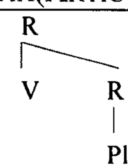
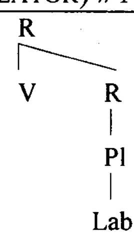
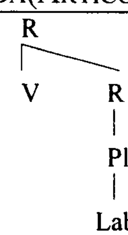
(10) a. b.



In languages like Selayarese that allow only default /ŋ/ (and /ʔ/) in coda, the coda cannot license a Place node. Stated otherwise, in such languages NoCoda(Pl) dominates the faithfulness constraint Max(Pl), which requires Place nodes present in the input to surface in the output. Languages that allow a two-way contrast, such as Mandarin, license a Place node but not its dependent articulators. In such languages, Max(Pl) must dominate NoCoda(Pl). However, given that the three-way contrast possible in onsets is not licensed in codas, it must also be the case that the coda cannot license articulators (i.e. NoCoda(Articulator) » Max(Articulator)). Finally, in languages like English and French in which codas license a three-way contrast in place in parallel to onsets, both faithfulness constraints must dominate the markedness constraints (Max(Pl),

MAX(ARTICULATOR) » NOCODA(PL), NOCODA(ARTICULATOR)). This three-way typology is illustrated in (11) below.

(11) *Cross-linguistic typology of coda place licensing*

Language	Hypothetical Input	Output
a. No contrast: NOCODA(PL), NOCODA(ARTICULATOR) » MAX(PL), MAX(ARTICULATOR)		
Selayarese		
b. Two-way contrast: MAX(PL), NOCODA(ARTICULATOR) » NOCODA(PL), MAX(ARTICULATOR)		
Mandarin		
c. Three-way contrast: MAX(PL), MAX(ARTICULATOR) » NOCODA(PL),NOCODA(ARTICULATOR)		
English, French		

In summary, the difference between languages that allow for a one-, two- or three-way contrast in place is intimately tied to the way in which place structure is represented and the interaction between markedness and faithfulness constraints that determine the wellformedness (i.e. licensing) of such structure.

As stated above, the Mandarin coda cannot license place features (i.e. MAX(PL), NOCODA(ARTICULATOR) » MAX(ARTICULATOR), NOCODA(PLACE)). The relative ranking of these four constraints is transferred into the L2 grammar. While this allows for a Place node present in the input to be licensed in the output as in (11b), any input representation containing a coda consonant specified for an articulator will be suboptimal in the IL grammar until NOCODA(ARTICULATOR) and MAX(ARTICULATOR) have been reranked so that MAX(ARTICULATOR) dominates. This ranking makes a strong prediction for the realization of coda nasals whose input includes a [labial] feature. Were the Mandarin coda incapable of licensing a Place node, not simply an articulator, the theory presented here would predict that input coda labials would surface as velars, given that a nasal lacking any place structure would be interpreted as [ŋ] as is illustrated in (12a).

(12) *Consequences of loss of place structure for input nasals*

However, given that the Mandarin coda licenses a bare Place node, an input containing a Place-[lab] structure should only lose the articulator in the output as the ranking MAX(PL) » NOCODA(PL) will ensure faithfulness to the Place node. Indeed, loss of the Place node would incur an unnecessary violation of MAX(ARTICULATOR). This bare Place node will be interpreted as coronal (12b), and not velar, by the phonetics. That the substitution for target [m] was without exception [n], and not [ŋ], is consistent with this prediction.

To illustrate, consider the Mandarin-speaking learners' evaluation of target form *bim* shown in (13) below.[10] The first two candidates, whose representations are specified for articulators, both incur a fatal violation of NOCODA(ARTICULATOR). High-ranking MAX(PL) eliminates the fourth candidate (13d), [bɪŋ], as its representation is

[10] As mentioned in §3.3.3.9, Wang's stimuli consisted uniquely of nonce words like *bim*.

unnecessarily unfaithful to the Place node in the input. This leaves the third candidate, (13c) [bɪn], as optimal. While this candidate violates both NOCODA(PL) and MAX(ARTICULATOR), the ranking of these constraints below MAX(PL) and NOCODA(ARTICULATOR) leaves them powerless to determine the optimal candidate.

(13) *Mandarin learners' acquisition of place contrasts in English nasal codas*

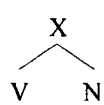
	Input: O R b ɪ m Pl SV Lab Nas	NOCODA (ARTICULATOR)	MAX(PL)	NOCODA(PL)	MAX (ARTICULATOR)
	a. [bɪm] O R b ɪ m Pl SV Lab Nas	*!		*	
	b. [bɪn] O R b ɪ n Pl SV Cor Nas	*!		*	
☞	c. [bɪn] O R b ɪ n Pl SV Nas			*	*
	d. [bɪŋ] O R b ɪ ŋ SV Nas		*!		*

In summary, the failure of input coda /m/ to surface as such in the Mandarin learners' outputs is related to their IL grammars' inability to license articulators in coda position. Given that the learners' grammars license a Place node and that the phonetic interpretation of a bare Place node is [coronal], input /m/ is realized as [n] in the learners' outputs.

While the inability of the Mandarin-speaking learners' IL grammars to license place structure in final consonants syllabified as codas results in the unfaithful realization of such segments as concerns their input articulators, languages like Selayarese demonstrate that output codas may bear place features when such features can be licensed by the following onset. This raises the question as to whether learners would be more accurate with targets in which coda nasals were followed by onsets. Data from Steele (2002) allows for an investigation of this hypothesis. In this study, beginner Mandarin-speaking learners of French were tested on their syllabification of word-final clusters including nasal-stop clusters (i.e. target *lampe* [lɑ̃p] 'lamp', *conte* [kɔ̃t] 'tale', *banque* [bɑ̃k] 'bank'), on which we focus here.[11]

Before discussing the learner data, a brief discussion of the target representation of such forms is warranted. I assume, following others (e.g. Schane 1968, Anderson 1982, Dell 1995, Paradis & Prunet 2000), that French nasalized vowels are the phonetic interpretation of a branching X-slot that dominates the melodic content of a vowel-nasal consonant sequence. The relevant representation is given in (14) below.

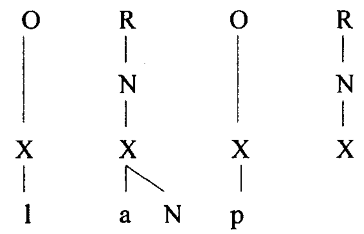
(14) *Output representation of French nasal vowels*



[11] See footnote 12 for evidence that the learners' IL input representation of such targets involves final /NC/ clusters.

As such, a form like *lampe* [lɑ̃p] 'lamp' has the output representation in (15) below.

(15) *Output representation of French lampe* [lɑ̃p]



Without an independent skeletal slot for the nasal, the nasal segment surfaces as nasalization on the vowel and not as an independent nasal stop.

Returning to the learner data, as was the case with the beginner English learners in Steele (2000), the beginner Mandarin-speaking learners in Steele (2002) syllabified the /NC/ sequence as a coda-onset sequence, i.e. in a non-native fashion.[12] However, in contrast to Wang's learners of English in (6), Steele's Mandarin-speaking learners of French did not show an asymmetry between coda /m/ versus /n/ and /ŋ/: whereas Wang's learners' /CVm/ inputs surfaced as [CVn], Steele's learners' /CVmC_{lab}/ inputs surfaced as [CVmC_{lab}] as shown in (16) below.

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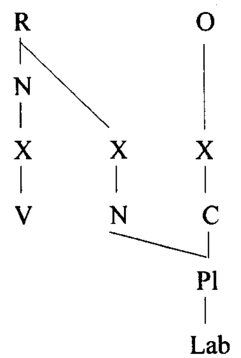
12 I assume that the learners perceive targets like [lɑ̃p] as [lɑmp] and consequently posit the input form /lɑmp/. Such an assumption is supported by Lahiri & Marslen-Wilson (1991). In this study, English and Bengali native speakers were tested for the effect of vowel nasalization on the speakers' perception of CV-stimuli using a gating procedure. While both languages have an allophonic process whereby outputs vowels for /CVN/ inputs are nasalized, nasality is also phonemic in Bengali. Marslen-Wilson & Lahiri found that, when presented with a CV sequence in which the vowel was nasalized, the Bengali native speakers perceived the nasalization as a nasal vowel whereas the nasalization lead the English speakers to anticipate a following nasal consonant. Mandarin is like English in having allophonic vowel nasalization in /CVN/ forms (Duanmu 2000:73) and in lacking phonemic nasal vowels. Based on Marslen-Wilson & Lahiri's results, I propose that the nasalized vowel of targets like [lɑ̃p] leads the beginner Mandarin learners to anticipate a nasal coda and thus posit /lɑmp/ as the input representation. Note that data from Steele's (2000) study of English learners of French support this hypothesis as the majority of the English learners' outputs (i.e. [lɑmp]) for French /CVNC/ targets such as *lampe* were also consistent with inputs containing final /NC/ sequences.

(16) *Mandarin-speaking learners' syllabification of target French* [$CV_{nas}C$] (Steele 2002)

	/mC/	/nC/	/ŋC/
% I-O place identity for NC	91.7	85.7	96.3

I argue that the lack of asymmetry in the French data is related to the fact that the French forms contain a final obstruent capable of parasitically licensing the [labial] feature of the nasal as shown in (17).[13]

(17) *Parasitic licensing of nasal place features*

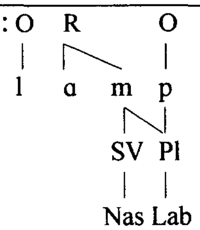
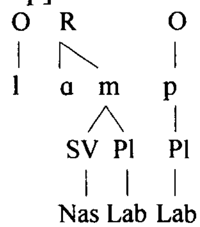
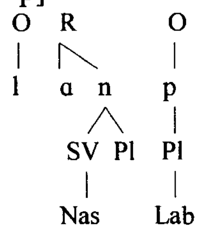
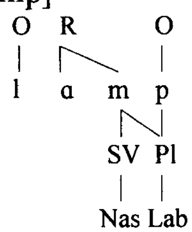


The representation in (17) allows the learners to be faithful to the place specification of the nasal, even when their IL grammars do not license articulators in coda position (i.e. when NOCODA(ARTICULATOR) » MAX(ARTICULATOR)).

The Mandarin-speaking learners' evaluation of the three most likely outputs for input /lɑmp/ is shown in (18) below.

[13] Under the assumption that the licensing possibilities of early IL grammars are those options transferred from the learners' L1, the analysis proposed here would be strengthened by evidence of parasitic licensing in Mandarin, which is not observed in /NC/ coda-onset contexts, e.g. [pʲanpʲaɹdə] 'flat'. However, all /NC/ strings are interrupted by a compound boundary. Mandarin does though have place sharing in other contexts which could be extended to the coda-onset domain in the IL grammar. Place sharing is observed with nuclear harmonies. In Mandarin, the glide of a /VG/ sequence must agree in frontness and rounding with the preceding vowel (e.g. Duanmu 2000:55). Such a harmony is consistent with a requirement that the head of the nucleus parasitically license (some of) the featural content of the glide. Furthermore, in §4.1.2.2, I will argue that the melodic content of word-final /ɹ/ is parasitically licensed by the nucleus.

(18) *Mandarin-speaking learners' evaluation of French /NC/ inputs*[14]

Input: 	NOCODA (ARTICULATOR)	MAX(PL)	NOCODA(PL)	MAX (ARTICULATOR)
a. [lɑmp] 	*!		*	
b. [lɑnp] 			*!	
☞ c. [lɑmp] 				

The first candidate (18a) fatally violates NOCODA(ARTICULATOR). The representation of the coda nasal in candidate (b) is identical to that of the optimal candidate in (13). While violation of NOCODA(PL) and MAX(ARTICULATOR) is not fatal for the native Mandarin learners' syllabification of English labial nasal codas in (13), such violations are indeed fatal when parasitic licensing is possible. As shown with candidate (c), the Place-[lab] structure of the input can be licensed by the following onset. Under the assumption that the representation of candidate (c) involves fusion of the Place-[lab] structure of the input

14 The input representation for target [lɑ̃p] in (18) contains a single Labial articulator following Lexicon Optimization. Even were the learners to posit an input representation in which the coda had its own Labial articulator, given the ranking in (18), output (18c) would nonetheless be optimal.

coda-onset sequence, the parasitic licensing of coda place features allows for a "target-like" representation while satisfying NoCODA(ARTICULATOR) and MAX(PL). While the coda nasal in (18c) is specified for [lab], the articulator is licensed by the following onset. As such, the candidate fails to violate NoCODA(ARTICULATOR), which makes reference only to the position which licenses the feature (see (9)), not the position into which the feature is parsed. The representation in (18c) also fails to violate MAX(PL), which requires simply that a Place node in the input have a correspondent in the output. The fused Place node doubly linked to [m] and [p] thus satisfies MAX(PL) for both articulators in the input. The importance of parasitic licensing in the acquisition of coda place will be further demonstrated in the next section where we examine an asymmetry in the acquisition of final /NC/ versus /LC/ clusters found in data from Steele (2002).

4.1.2.2 Final /NC/ versus /LC/

In the preceding section, I argued that the presence of labial codas in Steele's (2002) Mandarin-speaking learners' outputs for target French /NC_{lab}/ forms – in contrast to the word-final labial coda neutralisation attested with Wang's (1995) learners of English – was due to the fact that the place features of the coda could be parasitically licensed by the following onset. If this line of analysis is correct, we should predict that, at least at early stages of acquisition, learners will always be less accurate with final coda-onset sequences in which the coda segment bears place features and where such features cannot be licensed by the following onset. A comparison of further data from Steele (2002) will allow for the testing of this prediction.

Steele tested beginner Mandarin-speaking learners on their syllabification of /LC/-final forms as well as /NC/-final ones. As we will see in (22), while the learners were extremely accurate with /mC/ targets, their outputs for both /lC/ and /ʁC/ targets were not native-like. As in the previous section, I will argue that their accuracy with the nasal targets is related to parasitic licensing of the place features of the nasal. However, before examining this asymmetry any further, one important representational issue requires further elaboration. To this point, the Mandarin codas have been given as the nasals [n,ŋ] as well as [ɹ] in suffixed forms. Under the assumption that [ɹ] is a possible coda in Mandarin, one aspect of the data to be examined in (22) is particularly surprising: given that [l] is not a possible L1 coda,[15] we should predict that, following transfer, the learners' outputs for /ʁC/-final targets would be more accurate. However, as we will see, the /ʁC/-final forms patterned like those involving /lC/ clusters.

In order to understand the lack of an asymmetry among the liquids, it is necessary to distinguish between the position into which Mandarin word-final [ɹ] is syllabified and the position that licenses its featural content. I will argue that, when [ɹ] is syllabified in coda position, it is not the coda but rather the nucleus that licenses its featural content. Consider the data in (19) below.

(19) *Mandarin* [ɹ]*-final forms*

a. Monomorphemic forms

[əɹ2][16] 'son'
[əɹ3] 'ear'
[əɹ4] 'two'

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[15] While /m/ is also not a possible coda, as discussed in §4.1.2.1, it differs from /l/ in that its place features are always licensed by the following onset.

[16] Numerals indicate tone.

b. *-er* suffixed forms

Root	Suffixed Form	Gloss
/pʰai/	[pʰa˞ɹ]	'plate (dim.)'
/pʰan/	[pʰa˞ɹ]	'dish (dim.)'

As shown in (19), [ɹ]-final words fall into two classes. The first class (19a) is restricted to three lexical items, all of which consist of the VC-sequence [əɹ]. Curiously, the restriction to schwa does not hold for other codas (e.g. /n/-final: [tan] 'egg', [pən] 'stupid', [jin] 'sound'; /ŋ/-final: [taŋ] 'swing', [pəŋ] 'jump', [sʷuŋ] 'send'). Were the [ɹ] of the forms in (19a) syllabified in coda on par with nasal-final forms, such a phonotactic restriction should not hold. Consequently, I assume, following Wiese (1988:46), that the [əɹ] of the monomorphemic forms in (19a) is not a nucleus-coda sequence but rather a syllabic liquid, i.e. [əɹ2] = [ɹ̩2] 'son'. Mandarin does indeed allow for syllabic consonants in other monomorphemic words including syllabic [ɹ] (e.g. [ʈʂɹ̩] 'know', [ɹɹ̩] 'sun').

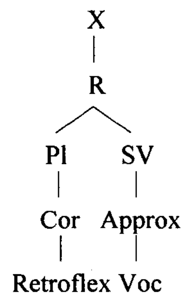
The second class of [ɹ]-final words (19b) is derived through suffixation. When the diminutive suffix *-er* is added to a root ending in a coronal vowel or consonant, the final segment is 'replaced' by [ɹ] as shown in (19b).[17] The key to understanding how the featural content of the suffix is licensed rests with the fact that, following suffixation, the entire rhyme is retroflexed, as indicated by the superscript [˞] on the vowel.[18] I argue that the retroflexion of the vowel is directly related to the fact that it is the nucleus, and not

[17] In contrast, when the root ends in a non-coronal segment, the suffix surfaces as retroflexion on the rhyme (e.g. [hu:] 'lake', suffixed form [hu:˞]; [kaŋ] 'jar', suffixed form [kã˞ŋ˞]). As the suffix does not surface as a coda in these forms, I discuss them no further.

[18] Qiuwu (2001:2), citing both Wang and He's (1985:27) acoustic and perceptual experiments and Lin and Wang (1992:169), states that "the retroflex action is almost simultaneous with the articulation of the rime of a syllable".

the coda, that licenses the featural content of the suffix. The representation of the *-er* suffix is given in (20).[19]

(20) *Input representation of -er suffix*



As shown by the Approx-Voc structure in (20), I propose that the *-er* suffix is a glide, not a liquid. The proposal that [ɹ] may be a glide has been made elsewhere (e.g. Kahn (1976:82) for English). If the input form of the root to which *-er* is suffixed ends in a coronal, the Coronal node of the suffix is fused with that of the root in the output representation. However, as discussed in §4.1.2.1 above, the Mandarin coda cannot license articulators (i.e. NoCoda(Articulator) » Max(Articulator)). In order for the suffix to be realized, its featural content must be licensed in some other fashion. As shown in (21b), the Coronal node of the suffix and the SV dependent structure Approx-Voc can be parasitically licensed by the nucleus. If it were the coda that licensed the place structure of the suffix, there would be no reason for the nucleus to harmonize for retroflexion. However, the vowel in (21b) has two articulators: its input Dorsal articulator as well as the retroflexion shared with the coda. The question arises as to why, if the nucleus is the licensor, the segmental content of the suffix is also syllabified in the coda.

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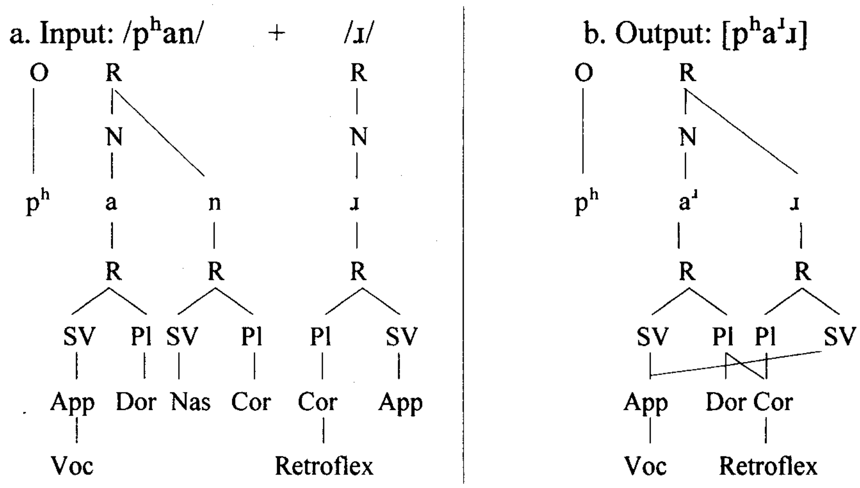
19 Wang (1993), Duanmu (2000), and Qiuwu (2001) assume that the suffix is not a full segment but rather a feature complex involving [retroflex]. I do not adopt this assumption as it would be equivalent to allowing for constraints on inputs contra the Richness of the Base hypothesis (§2.2.2).

Following Qiuwu (2001:20), I assume that, as a suffix, *-er* must be right aligned with the right edge of the stem.

(21) *Representation of words involving diminutive /ɹ/ suffixation*



The representation in (21b) above allows for the realization of the suffix at the right edge even when the coda itself cannot license the Place and SV structure present in the suffix's input representation in (21a). That the nucleus is the licensor of the suffix's featural content is witnessed to by the fact that the vowel too is retroflexed. In summary, in the case of both monomorphemic (19a) and suffixed (19b) [ɹ]-final forms, the coda is never the relevant featural licensor. In both cases, the content of [ɹ] is licensed by the nucleus, either through [ɹ] being syllabic or through parasitic licensing of its Place and SV dependents.

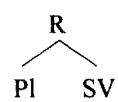
Having seen that the Mandarin coda is not the licensor of the featural content of [ɹ], we are now ready to return to the asymmetry in the L2 data in question. As shown in (22), input labial nasal codas surfaced in learners' outputs much more often (e.g. target *lampe* [lɑ̃p] 'lamp', learner form [lamp] or [lampə]: 91.7%) than rhotic codas (target *porte* [pɔʁt], learner form [pɔʁt] or [pɔʁtə]: 19.0%) or lateral codas (e.g. target *volt* [vɔlt] 'volt', learner form [vɔlt] or [vɔltə]: 13.6%); the differences were highly significant (/mC/ versus /ʁC/: t(4)=4.695, p=.009; /mC/ versus /lC/: t(4)=9.831, p=.001).

(22) *Mandarin learners' syllabification of French word-final* /mC/, /lC/ *and* /ʁC/ *clusters* (Steele 2002)

	/mC/		/ʁC/		/lC/	
	Count	%	Count	%	Count	%
Target	17 / 24	70.9	2 / 21	9.5	2 / 22	9.1
Target + *v*	5 / 24	20.8	2 / 21	9.5	1 / 22	4.5
Total	22 / 24	91.7	4 / 21	19.0	3 / 22	13.6

The asymmetry in question can be accounted for using the same type of parasitic-licensing analysis provided for the asymmetry in the Mandarin learners' syllabification of English /CVN/ forms versus French /CVNC/ forms discussed in the preceding section. As we have seen, the Mandarin coda is restricted to licensing the structure in (23), specifically Place and SV nodes but not their dependents.

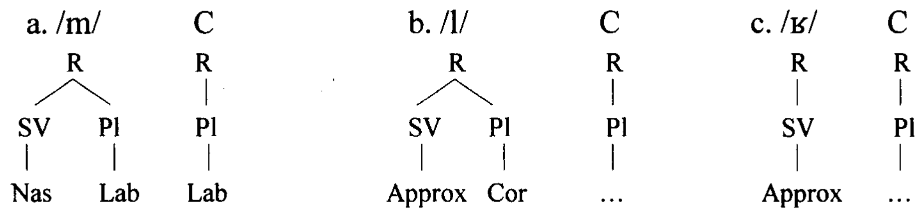
(23) *Maximal structure licensed by Mandarin coda*



Now consider the learners' IL input representations for /mC/, /lC/ and /ʁC/ coda-onset sequences given in (24).[20]

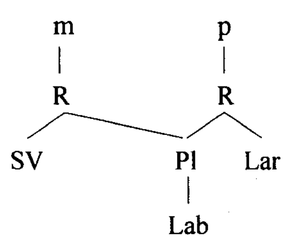
[20] The representation of /ʁ/ in (24c) differs from that of L1 Mandarin /ɹ/ in (20). I propose that several properties of French /ʁ/, both phonological and phonetic, will cue the learner to the target representation. First, /Cʁ/ branching onsets are licit in French. Given that glides are marked in the dependent position of a branching onset cluster, the learner will not posit [vocalic] under the SV node in the first instance. Second, the learner will not project [retroflex] or Coronal given that target /ʁ/ is uvular. The positing of bare Coronal would also make /ʁ/ indistinguishable from /l/.

(24) *IL input representation of French word-final* /mC/, /lC/ *and* /ʁC/ *clusters*



The input representation of all three sonorant consonants includes an SV-node that dominates either [nasal] or [approximant].[21] Furthermore, both /m/ and /l/ bear an articulator. Given the input representations in (24) and the fact that the Mandarin coda is restricted to licensing the structure in (23), one would predict that /ʁC/-final forms should be the 'easiest' for the learners, as the representation of /ʁ/ involves less place structure, i.e. no articulator, that must be licensed by the coda, a weak licensor. However, as we saw in (19), this prediction is not borne out. The learners' higher accuracy on /mC/ targets relates to both parasitic licensing and default phonetic interpretation. Consider the output representations of word-final [mC] given in (25).

(25) *Beginner Mandarin-speaking learners' output representation of word-final* /mC/ *clusters* (e.g. Target *lampe* /lamp/)



[21] The input representation for /ʁ/ in (24c) contains SV structure. The reader might ask why this is, given that many of the native Mandarin learners in the experiment in §3.3 misanalysed target [ʁ] as an obstruent. Recall from (4) in §4.1.1.1 that the Mandarin-speaking learners tested on the syllabification of word-final liquid-stop, stop-liquid and nasal-stop clusters in Steele (2002) syllabified word-final /Cʁ/ clusters in a native-like manner in 67.2% of cases. The learners' high rate of accuracy with such clusters, which contrasts with the Mandarin-speaking learners discussed in §3.3, is incompatible with [ʁ] being represented as an obstruent, i.e., without SV structure.

As shown above, in an /mC/ cluster, the coda need not license its own place feature as the structure Place-[lab] can be parasitically licensed by the following onset. Moreover, as discussed in §2.2.2, cross-linguistically, the phonetic interpretation of a bare SV-node is nasal. Thus, the significantly higher accuracy on /mC/ forms is related to two licensing facts. First, in the case of word-final /mC/ forms, the coda need not license the place structure of the nasal as place structure can be parasitically licensed by the following onset. This makes licensing of /mC/ less costly than licensing of /lC/, whose representation requires the licensing of Place-[coronal]. Second, while the input representation of all three sonorants /m/, /l/ and /ʁ/ contains an SV-feature complex (24), the Mandarin coda cannot license SV dependents. Moreover, only nasality can result from default interpretation. Thus, even when a Mandarin learner's grammar fails to license the relevant feature under the SV-node, the nasal can surface in a target-like fashion.

With these analyses in mind, we turn from the acquisition of coda place to the acquisition of voice in coda and final onsets. We will see that similar asymmetries in the acquisition of voice in word-final stops can be explained with reference to licensing.

4.2 Asymmetries in the acquisition of voice in coda and final OEHS

In the discussion of the acquisition of French word-final branching OEHS in §4.1.1.1, I argued that the cost of licensing the more complex place structure of /l/ as opposed to /ʁ/ in the dependent position of a word-final branching OEHS manifested itself in epenthesis with /Cl/-final forms. If the onset inherits its licensing potential from a following nucleus and if the ability of a nucleus to discharge licensing potential is intimately related to it having melodic content, vowel epenthesis serves to imbue an empty nucleus with licensing potential that it would not otherwise possess in the IL grammar. Furthermore, as the acquisition of new positions and new contrasts involves structure building, one would expect that progressively more featural material will be able to be licensed in a weak position during the course of acquisition.

In §2.2.1.2, we saw that the representation of voice contrasts in obstruents involves the Laryngeal node and its dependent [voice]: whereas the input representation of voiceless obstruents only involves a Laryngeal node, the representation of voiced obstruents includes Laryngeal-[voice]. As such, the contrast between voiceless and voiced obstruents mirrors the contrast between the place structure of /r/ and /l/ in languages like English and French in that the representation of the first member of the pair involves relatively less segmental structure.[22] Given this parallel, we predict that epenthesis will be triggered more often by voiced as opposed to voiceless obstruents in the same way it was triggered more frequently following /Cl/ as opposed to /Cr/ clusters. In the following sections, we will examine data consistent with such a prediction.

4.2.1 Epenthesis in final voiced versus voiceless stops

The hypothesis discussed in (1) - that learners will be equally or more, but never less, accurate with representations involving less as opposed to more featural structure - makes a strong prediction for the acquisition of voicing contrasts in relatively weak positions including OEHS and codas. We begin by examining OEHS. While the licensing of

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22 In languages that do not license Laryngeal in coda position, the representation of voiceless coda stops will not contain any Laryngeal structure. This will contrast will voiceless stops syllabified as OEHS, which will be specified for a Laryngeal node. Regardless of whether final voiceless stops are syllabified as codas or as OEHS, their representation will involve less structure than voiced stops, which are always specified for Laryngeal-[voice].

[voice] in the onset of a syllable whose head is melodically-filled is possible in languages that allow for a voicing contrast in obstruents, the licensing of the same contrast in an OEHS is more costly as the nucleus from which the onset inherits its licensing power is a relatively weak licensor, given its lack of featural content. An L2 learner whose L1 grammar does not allow for OEHS must first acquire the ability to P-license such a position. Once the position is acquired and the bare Laryngeal of a voiceless obstruent like [t] can be licensed, the learner must then acquire the ability to A-license the feature [voice] if obstruents contrast for voice word-finally in the target language. As such, the licensing of voiced obstruents requires a greater stock of licensing potential than that necessary for the licensing of their voiceless counterparts.

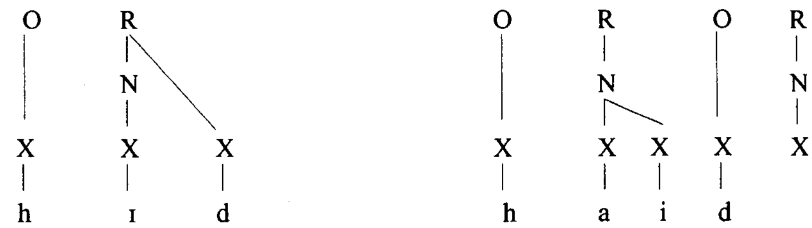
Similarly, the coda, as a non-head, is a weak licensor vis-à-vis the position from which it inherits its A-licensing potential, namely the following onset if word-internal or the nucleus when word-final (cf. §2.3.2.3). If a learner's L1 grammar does not allow coda obstruents, the learner must first acquire the ability to A-license the Laryngeal node of the obstruent. A further stage of development would involve the acquisition of the A-licensing of [voice] under Laryngeal. At a previous stage in development where the IL coda cannot license Laryngeal-[voice], the learner who wishes to remain faithful to the voicing of the target obstruent can syllabify the voiced obstruent in the onset of an epenthetic syllable (e.g. target [bæd], IL output [bæ.də]), a strong position. Indeed, this leads one to predict that faithfulness to voicing in final obstruents will require epenthesis at any stage in development where [voice] cannot be licensed in codas (or OEHS).

Data from Sekiya & Jo's (1997) study of Japanese-speaking learners of English demonstrate that the difference in amount of licensing potential necessary for the licensing of voiceless versus voiced obstruents results in a difference in epenthesis rate that correlates directly with voicing. These researchers tested 40 intermediate Japanese-speaking learners of English on their syllabification of word-final stops using a word list task. The stimuli included both voiceless (n=52; $n_{/VC/}$=21, $n_{/V:C/}$=31) and voiced (n=49; $n_{/VC/}$=26, $n_{/V:C/}$=23) targets. In English, final stops are syllabified as codas when the preceding vowel is short (e.g. *hid* [hɪd.]) and as OEHS when the preceding vowel is long (e.g. *hide* [hai.d]). The latter is directly related to rhyme binarity (cf. (5) in §2.1.1). When a word-final stop follows a bipositional rhyme such as that of a long vowel or diphthong, binarity, which limits a syllable constituent to a head-dependent relationship, precludes coda syllabification of the final stop, as the bipositional nucleus already constitutes the maximal head-dependent relationship. Consequently, the [d] of a word like [hai.d] must be syllabified as an OEHS. In contrast, when the vowel preceding the final stop is short, UG provides two possible syllabifications, either as a coda or OEHS (cf. §2.1.3.2). English chooses the former option.[23] The representations of words containing final stops following short and long vowels are shown in (26a) and (26b) respectively.

[23] Word minimality requires that the final stop of a form like *hid* be syllabified as a coda. In English, prosodic words must minimally by bimoraic (e.g. *sea* [si:], *sun* [sʌn], *[sɪ]). Under the assumption that onsets are never moraic, were the final stop of a *hid* syllabified as an OEHS (i.e. [hɪ.d∅]), the word would be subminimal. See Goad & Kang (2002) for a discussion of differences between CVC and CVXC forms as concerns the inventories of the final consonants consistent with the representations in (26).

(26) *Representation of English final stops following short and long vowels*

a. Target /CVC/, e.g. *hid* [hɪd]   b. Target /CV:C/, e.g. *hide* [haid]



While Japanese has codas, they are restricted to the first part of a geminate including a place-sharing nasal, and /ŋ/ word-finally. As such, the learners' L1 licenses neither obstruent codas nor OEHS at all.

Sekiya & Jo found a significant difference ($p<.001$) between the rate of epenthesis following final voiceless and voiced stops. As shown in (27), whereas the learners almost never epenthesized following voiceless stops, on average, 22% of word-final voiced stops were syllabified via epenthesis.[24]

(27) *Epenthesis rates in native Japanese speakers' syllabification of English word-final voiceless and voiced obstruents* (Sekiya & Jo 1997)

Final Stop	Mean Epenthesis Rate (%)
Voiceless	1.7
Voiced	22.0

The data from Sekiya & Jo once again show that, while contrasts may be acquired, they are not acquired in an all-or-nothing manner. Specifically, when acquiring word-final stops, learners are more proficient with voiceless stops than voiced ones. This asymmetry

24 In their presentation of the data, Sekiya & Jo do not separate out stimuli involving short and long vowels. As such, it is impossible to determine whether the asymmetry reported holds for coda position (i.e. /VC/ stimuli), for OEHS (i.e. /V:C/ stimuli), or both. This does not weaken the argument here: both a coda and an OEHS are weak licensors vis-à-vis onsets of overtly headed syllables and neither position is a licit licensor for an obstruent in the L1 grammar. As such, the asymmetry in epenthesis rates still demonstrates that in the acquisition of new position-sensitive contrasts, representations involving less structure will be acquired more readily. Below, we will examine data from Steele (2002) that shed light on the acquisition of voice in OEHS alone. Moreover, in §4.2.2, we will examine further data from Sekiya & Jo that show differences in devoicing rates following short and long vowels.

falls out directly from the fact that, for any stop pair, the representation of the voiced member involves greater featural complexity, namely the structure Laryngeal-[voice], that must be licensed in a relatively weak position (i.e. coda or OEHS) not possible in the L1.

The type of asymmetries found in the L2 English data can also be found in data from learners of French; we examine further data from Steele's (2002) Mandarin-speaking learners of French and their syllabification of word-final liquid-stop, nasal-stop and stop-liquid sequences. Recall that, in the case of French liquid-stop (e.g. *porte* [pɔʁ.t] 'door') and nasal-stop sequences (e.g. *jambe* [ʒɑ̃.b] 'leg'; learner analysis [ʒɑm.b]), the final stop is syllabified as a singleton OEHS. In the case of stop-liquid clusters (e.g. *table* [ta.bl] 'table'), the rising-sonority cluster is syllabified as a branching OEHS. As we saw earlier, Mandarin does not allow for OEHS. Thus, a Mandarin-speaking learner of French must first acquire the ability to P-license the OEHS, as well as its dependent in the case of the stop-liquid clusters. Then, s/he must acquire the ability to A-license the structural representation of voicing (i.e. Laryngeal versus Laryngeal-[voice]) in order for obstruents to contrast in voicing in this position.

The table in (28) gives the percentages of learner forms involving final epenthesis for each of the three types of clusters, controlling for voicing.

(28) *Epenthesis in beginner Mandarin-speaking learners' syllabification of French word-final liquid-stop, nasal-stop, and stop-liquid clusters* (Steele 2002)

	Voiceless		Voiced	
	Count	%	Count	%
Liquid-Stop	6 / 22	27.3	12 / 19	63.2
Nasal-Stop	2 / 47	4.3	15 / 28	53.6
Stop-Liquid	16 / 44	36.4	25 / 26	96.2
Average	24 / 113	21.2	52 / 73	71.2

What is of relevance to the discussion here is that for all three types of clusters, there was a much higher rate of epenthesis when the stop in the cluster was voiced; the difference between the voiceless and voiced targets was significant for the nasal-stop ($t(4)=-3.275$, $p=.031$) and stop-liquid clusters ($t(4)=-8.506$, $p=.001$) and approached significance in the case of the liquid-stop targets ($t(4)=-2.147$, $p=.098$).[25] This asymmetry effectively parallels the asymmetry in the L2 acquisition of French word-final /Cl/ and /Cʁ/ clusters discussed in §4.1.1 and mirrors the asymmetry in epenthesis rates following voiceless and voiced stops with Sekiya & Jo's Japanese-speaking learners of English. In all three cases, the member of the contrast whose representation involves greater featural content (i.e. /Cl/ in the case of /CL/ clusters, the voiced member of the pair for the clusters in (27) and (28)) triggered epenthesis much more frequently. We look at one further such asymmetry below.

4.2.2 Devoicing following /V/ versus /V:/

One final asymmetry in the acquisition of voice in word-final obstruents will serve to illustrate the role of licensing and the consequences of the differences in licensing potential between different positions for the acquisition of position-sensitive contrasts. We return to Sekiya & Jo's (1997) study of Japanese-speaking learners of English and their acquisition of voice contrasts in word-final stops. As discussed above, in constructing their stimuli, Sekiya & Jo controlled for preceding vowel length: along with

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[25] The question arises to the nature of the constraint violated by the voiced OEHS in the Japanese learners' IL grammar. I propose that a logical candidate is a constraint similar to LICINH (cf. (10) in §3.2.2.1). If this is the correct approach, it would be necessary to have a family of Licensing Inheritance constraints, all of which prohibit the licensing of structure, either prosodic or segmental, by an OEHS, a weak licensor. In the case of the voicing asymmetry, the relevant constraint would be LICINH(VOICE): An onset which inherits its licensing potential from an empty nucleus cannot license [voice].

forms such as *hid* [hɪd] containing short vowels, they included an equal number of forms such as *hide* [haid] containing long vowels/diphthongs.[26] Interestingly, Sekiya & Jo found a difference in devoicing of final voiced stops that correlates with preceding vowel length. I argue that the asymmetry results from differences in the representation of final stops following short and long vowels given in (26). As shown in (29), whereas only 7.2% of stops following long vowels were devoiced, stops following short vowels were devoiced in 42% of cases; this difference was found to be statistically significant ($p<.001$).

(29) *Word-final devoicing in Japanese-speaking learners' syllabification of English word-final obstruents following /V/ and /V:/*
(Sekiya & Jo 1997)

Preceding Vowel Length	Mean Devoicing Rate (%)
/V/	42.0
/V:/	7.2

The asymmetry in devoicing following short and long vowels suggests that the learners' grammars allow for voicing contrasts in OEHS in a target-like manner, whereas voicing in codas is still being acquired. In Chapter 2, I proposed, following Piggott (1991b, 1999) and Goad & Brannen (2000, in press) that the cross-linguistically unmarked syllabification of final consonants is as OEHS. The Japanese-speaking learners' ability to acquire voicing contrasts in OEHS before acquiring the contrast in coda suggests that the unmarked status of OEHS syllabification of final stops is related to the fact that OEHS, as onsets (i.e. heads), are stronger licensors than codas. Furthermore, the Japanese L2 English data show that this holds even for learners whose L1 P-licenses codas but not OEHS.

[26] Sekiya & Jo use the terms 'checked' and 'free' vowels. Free vowels correspond to both long vowels and diphthongs.

4.3 Chapter summary

In this chapter, we have investigated the hypothesis that, in the acquisition of position-sensitive contrasts within a non-head position, the member whose representation involves less featural content will be acquired first or both members of a contrast will be acquired concurrently. The data used to test this hypothesis have come from a number of studies that tested L2 learners on their acquisition of contrasts involving place in the dependent of a branching onset and coda, as well as [voice] in word-final consonants. In parallel to the analyses proposed in Chapter 3 for the acquisition of prosodic complexity (i.e. new positions), I have demonstrated that highly articulated representations and phonological licensing play a central role. Perhaps the most interesting finding of this chapter is the discovery of the role played by parasitic licensing. As we saw in §4.1.2.1, whereas Wang's (1995) Mandarin-speaking learners of English had much difficulty with targets ending in [m], an illicit L1 coda, Steele's (2002) Mandarin-speaking learners were equally accurate on targets involving [mC_{Lab}] final sequences as they were with [nC_{Cor}] and [ŋC_{Dor}] targets. I argued that this is directly related to the ability of the OEHS to license the place features of the preceding coda even though such parasitic licensing is not observed in the L1. As such, the IL grammar of the learners of French is akin to languages such as Selayarese in which place features must be licensed by the following onset.

In the following and last chapter, I will review the findings of this and the previous chapter.

5 *Conclusion*

5.0 Introduction

In this thesis, I have argued that an explanatorily adequate model of L2 syllabification must include a theory of highly-articulated representation as well as a theory of phonological licensing, which distinguishes between the licensing of a given position and the licensing of featural content in such a position. I have demonstrated that the IL syllable-structure-modification processes of deletion, epenthesis, and feature change are all the consequence of the IL grammar's inability to license a syllable position or (some of) the featural content present in such a position in the target representation.

5.1 Representation and licensing

We began in Chapter 2 by outlining the theories of representation and licensing that underpinned the analyses proposed in Chapters 3 and 4. As concerns representation, we saw that prosodic structure is built from a basic set of phonological constituents, all of which minimally consist of a head, with a head-dependent relationship setting the upper limit on constituent size. As we observed on many occasions, in the case of syllables, it is possible for the head to be phonetically unrealized.

Segmental representation too was shown be highly organized via a feature geometry. Particular attention was paid to the representation of place, laryngeal contrasts, and sonorant consonants. I proposed that, while underspecification of inputs was impossible in OT following the Richness of the Base hypothesis, in contrast, underspecification of outputs results in those cases where Markedness constraints banning the licensing of certain featural configurations dominate the relevant Faithfulness constraints. Moreover, we saw that minimally specified nodes, including Place and SV, had particular phonetic interpretations: a bare Place node is interpreted as coronal while a bare SV node is interpreted as nasal.

Much attention was also paid to the role of licensing in assuring representational wellformedness. Licensing relationships were proposed to be of two broad types. The first type, which includes Prosodic and Autosegmental licensing, is a dependency relationship between a licensee and the licensor within which it is embedded. For example, we saw that in the unmarked case, syllables are licensed by feet. The second type of licensing relationship proposed, that of intra- and interconstituent licensing, holds between constituents embedded within some higher prosodic constituent. Intra- and interconstituent licensing were argued to play a particularly important role as concerns markedness as they define a series of head-non-head licensing paths. Following Harris' (1997) principle of Licensing Inheritance, such relationships are inherently asymmetrical, with the result that heads always possess a greater stock of licensing potential than non-heads. Finally, I proposed that an explanatorily adequate theory of syllable structure markedness can be derived from such asymmetries: a syllabification is relatively marked if its representation involves the licensing of a position or feature in a weak position, where non-heads constitute such positions.

5.2 The role of heads: head preservation and prominence

In Chapter 3, we investigated Mandarin-speaking learners' syllabification of French word-final liquid-stop and stop-liquid clusters. The learners' outputs for such clusters often involved deletion, especially in the case of the liquid-stop targets. Interestingly, when deletion occurred, it was virtually always the case that the stop was retained. Under the theory of syllable structure adopted in this thesis, the stop of both a liquid-stop and stop-liquid cluster is syllabified in a head position, specifically the head of an OEHS. As such, I proposed that deletion of the liquid was a manifestation of head preservation motivated by undominated MAXHEAD(ONSET).

The importance of heads to the organization of IL grammars did not reveal itself solely through head preservation. In §3.3.3.6, we also saw that another constraint on heads, HEADPROMINENCE, shaped learners' outputs for stop-liquid initial targets like *plateau*. In the case of initial clusters of targets like *plie*, HEADPROMINENCE precluded epenthesis, as epenthesis would require the head of the left-aligned foot to be epenthetic and thus fundamentally lacking in prominence.

5.3 Licensing and markedness

The data discussed in Chapters 3 and 4 served to investigate two licensing-based markedness predictions. In the case of new syllable positions such as the dependent of a branching onset, it was predicted that such positions would be acquired first in the head of the foot before being acquired in non-head syllables. In the case of new position-sensitive contrasts, the prediction that, within a non-head position, the member of the contrast whose representation involves less structural (i.e. featural) complexity will be acquired first, was supported for the acquisition of contrasts involving both place and voice. We examine the data supporting both hypotheses in the next two sections.

5.3.1 Acquisition of new positions

The first examination of the role of markedness in the acquisition of new positions involved Mandarin-speaking learners' acquisition of final consonant clusters in French. In Chapter 2, I proposed, following Piggott (1999) and Goad & Brannen (to appear) that, in the unmarked case, word-final consonants are syllabified as onsets, and not as codas. I argued that the Mandarin-speaking learners' (heavy) aspiration of final stops was consistent with such a proposal. Given that laryngeal properties (i.e. release) are disfavoured in coda position, I proposed that aspiration was the phonetic interpretation of a final consonant syllabified as an onset, specifically as an OEHS. Such a proposal was made in the spirit of Goad & Brannen (to appear) who argue that early child learners begin by syllabifying final consonants as onsets.

The role of markedness was also investigated as concerns the acquisition of the dependent of a branching onset. Markedness was shown to constrain Mandarin-speaking learners' outputs for target French stop-liquid clusters in two ways. First, based on the analyses provided, branching was acquired in the head syllables (target *plateau*) before being acquired in dependent syllables (targets *chapelet* and *diplômé*). Branching was only allowed in non-head syllables (target *disciple*) in order to satisfy an undominated constraint prohibiting two successive syllables headed by an epenthetic vowel. Second, a number of Markedness constraints, including INITIALPROMINENCE and FOOTBINARITY, played a central role in determining the optimal candidate. While I argued that the learners' syllabification of targets like *diplômé* was directly related to the onset-onset representation of the two members of the stop-liquid cluster, in the case of initial clusters, onset-onset syllabification was prohibited by INITIALPROMINENCE, which bans word-initial empty nuclei. FOOTBINARITY was relevant to targets like *plie*. While branching in such targets should have been possible – on par with forms like *plateau*, where the cluster was prosodified in the head syllable in the learners' outputs – the majority of the learners' syllabifications of such targets involved epenthesis. I proposed that epenthesis occurred in order to satisfy FOOTBINARITY.

5.3.2 Acquisition of new position-sensitive contrasts

The entirety of Chapter 4 was dedicated to the investigation of the role of markedness in the acquisition of new position-sensitive contrasts. All of the data were discussed with reference to the hypothesis that, within a non-head position, the member of the contrast whose representation involved less featural content would be acquired more readily. This was supported for contrasts involving both place and, in the case of word-final consonants, voice.

As concerns place, we investigated both the acquisition of the French /l/-/ʁ/ contrast in the dependent of a branching onset and the acquisition of place in obstruent codas. In the case of the former contrast, we saw that both the English and Mandarin learners of French acquired /Cʁ/ clusters before clusters involving /l/. This is consistent with the proposal made in Chapter 2 that the representations of the two segments differ only in terms of place structure, with /ʁ/ having no Place node. The asymmetry manifested itself with both groups of beginner learners in a similar manner, in spite of the fact that the native Mandarin speakers needed to acquire both positions of the OEHS whereas, following transfer, the English learners needed only to acquire the OEHS dependent. As such, the stop-liquid data provide strong evidence that structural markedness guides IL development regardless of the representations available in a learner's initial IL grammar.

In the case of coda place, we investigated two asymmetries in which nasal codas followed by an onset were acquired more readily than other codas. A comparison of CVN and CVNC data showed that Mandarin-speaking learners' outputs for target French nasal codas were target-like as concerns place when the articulators could be parasitically licensed by the following onset. The parasitic licensing account also allowed for an explanation of the Mandarin learners' greater accuracy on word-final /NC/ versus /LC/ sequences. In the case of the nasal targets, the place features of the coda could be licensed by the following stop in a way not possible with /lC/-final targets.

Finally, we investigated the acquisition of voice in word-final consonants using data from Japanese-speaking learners of English and Mandarin-speaking learners of French. In both cases, the learners were more accurate with voiceless than voiced stops. Moreover, the rate of epenthesis was higher following voiced targets. I proposed that the relatively higher cost of licensing the featural content of voiced versus voiceless stops in coda position or as an OEHS resulted in the significantly higher rate of epenthesis following voiced stops. If the coda or OEHS is too weak a licensor in the IL grammar to license [voice], epenthesis allows for the syllabification of the target final stop as the onset of a syllable whose head is melodically-filled, i.e. in a strong position.

5.4 The role of phonetic cues and perception in the construction of inputs

While the primary focus of investigation of this thesis has been the role of representation and licensing in assuring output wellformedness, data discussed in Chapter 3 provided evidence for the importance of input construction to L2 acquisition. We saw that Mandarin-speaking learners of French both misanalyzed and misperceived the [ʁ] of stop-/ʁ/ clusters, particularly in those cases where the cluster was devoiced.

I proposed that French /ʁ/ is a problematic segment for many of the learners because its phonetic and phonological properties provide contradictory cues to its phonological status: while phonetically a fricative, and devoiced in those cases where it is syllabified as the dependent member of a voiceless branching onset, its phonological distribution is that of a liquid. Learners may initially construct non-target-like inputs, which then have consequences for prosodic representation. Specifically, those learners who initially gave more weight to /ʁ/'s phonetic properties assigned it an obstruent representation. As such, the Mandarin-French data provide evidence that phonetic cues play an important role in the acquisition of syllabification.

In the case of voiceless /Cʁ/ targets, I proposed that some learners perceive the [ʁ̥] of target voiceless /Cʁ/ clusters not as an independent segment, but, rather, as fortis release of the stop. This misanalysis leads them to construct inputs for the clusters in which the stop-/ʁ/ sequence is represented as a stop with either aspirated or pharyngeal/uvular release. Such a proposal accounted for the apparent deletion attested in a large percent of the learners' outputs for /Cʁ/ forms, even when MAX-IO was highly ranked, as attested to by the learners' syllabification of /Cl/ targets.

Finally, I proposed that the learners' misanalysis and misperception of target /ʁ/ suggest that orthographic input may be important to L2 phonological acquisition. While orthography may indeed promote epenthesis (e.g. Young-Scholten 1995) or spelling-based pronunciations (e.g. Altenberg & Vago 1980), it may nonetheless serve as an important cue in the construction of inputs in those cases where a segment's phonetic and phonological properties offer conflicting evidence to the learner. Had the Mandarin learners had orthographic input, they might have been able to make the grapheme-phoneme equivalence between <r> and devoiced [ʁ̥], thus allowing them to realize that the segment in question was the French rhotic (i.e. a liquid), on par with target [l].

5.5 Conclusion

The data investigated in this thesis and summarized in the present chapter provide strong evidence for the central role of representation and licensing in the L2 acquisition of prosodic structure. We have seen that the accounts of learners' epenthesis, deletion and feature change provided in Chapters 3 and 4 allow for a high level of explanatory adequacy: such processes are the direct result of the interaction of Markedness constraints enforcing licit licensing relationships and Faithfulness constraints seeking to maintain contrast present in inputs.

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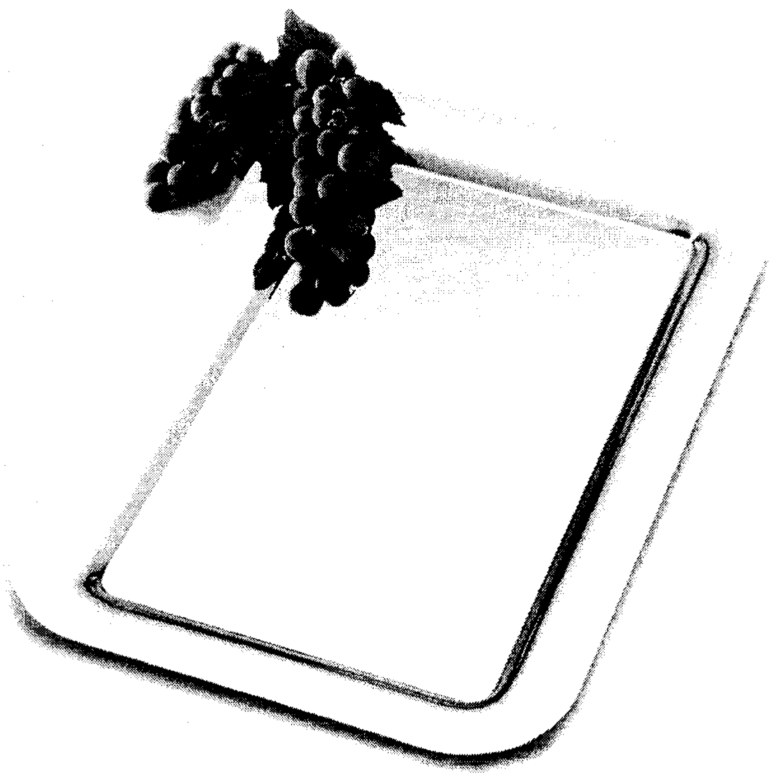
APPENDIX A:

Sample test item for experiment in §3.3



REPEAT:	*plateau – plateau*; *Répétez*
	(2-second pause)
SENTENCES:	*Un plateau est un plat qu'on utilise pour transporter des objets. Ce plateau est en métal, mais on peut les fabriquer en bois ou en verre. Un plateau en argent est un objet de grande valeur.*
	(2-second pause)
	Qu'est-ce que c'est?
	(5-second pause; next item)

APPENDIX B:

Stages in the acquisition of /ʁ/: Mandarin learners of French

- **Stage 1 in Mandarin learners' acquisition of French /ʁ/: misanalysis**

Target					*Deletion*		*Feature Change (+ Epenthesis)*												
Type	Example	Subj	n	TL	Stop	Liq	Liq> Liq	Dev Liq	Liq > [x]	Liq> [h]	Del Liq + C_1C_2V	Dev Liq + C_1C_2V	Liq> Liq + C_1VC_2	Liq> [x] + C_1VC_2	Liq > [x] + C_1C_2V	Liq>[x] + C_1VC_2V	Liq> [h] + C_1VC_2	Liq>[h] + C_1VC_2V
ʁ1	*roue* /ʁu/	C3	4							1.0								
		C4	4						.50	.50								
		C9	5						.80	.20								
		C14	4						1.0									
		C17	4						1.0									
		C20	4						.50	.50								
Cʁ1	*pré* /pʁe/	C3	6	.17		.33											.50	
		C4	5			.40							.20	.20			.20	
		C9	6			.50								.50				
		C14	6			.33								.33			.33	
		C17	6			.50							.17	.33				
		C20	6			.50								.17			.33	
Cʁ2	*préfet* /pʁefe/	C3	6			.50											.50	
		C4	6			.33	.17										.50	
		C9	6		.17	.67											.17	
		C14	4			.50						.25					.25	
		C17	6			.67								.33				
		C20	6			.67								.17			.17	
Cʁ3	*cyprès* /sipʁe/	C3	3			.67											.33	
		C4	4			.25	.50						.25					
		C9	4			.75								.25				
		C14	2														1.0	
		C17	6		.17	.50			.17					.17				
		C20	4			.50											.50	
Cʁ4	*soprano* /sopʁano/	C3	5			.80											.20	
		C4	4			.75	.25											
		C9	4			.75			.25									
		C14	4			.75											.25	
		C17	4			.75			.25									
		C20	4			.75											.25	
Cʁ5	*chapitre* /ʃapitʁ/	C3	5			.20					.20				.20	.20		.20
		C4	6						.17	.17	.33					.17		.17
		C9	6			.67					.17					.17		
		C14	3								.33					.33		.33
		C17	5	.20				.20				.20		.20		.20		
		C20	5			.20		.20	.20		.20					.20		

- **Stage 2 in Mandarin learners' acquisition of French /ʁ/: reanalysis**

Target Type	Target Example	Subj	n	TL	Deletion Stop	Deletion Liq	Epen C_1VC_2	Epen C_1C_2V	Feature Change (+ Epenthesis) Liq> Liq	Dev Liq	Liq > [x]	Liq> [h]	Del Liq + C_1C_2V	Dev Liq + C_1VC_2	Liq> [x] + C_1VC_2	Liq> [x] + C_1VC_2V	Liq> [h] + C_1VC_2	Liq> [h] + C_1VC_2V
ʁ1	*roue* /ʁu/	C11	4							.25	.50	.25						
		C15	4							.75	.25							
		C16	6								.33	.67						
		C22	4							.25	.25	.50						
Cʁ1	*pré* /pʁe/	C11	6			.50								.17			.33	
		C15	6			.33	.17							.17	.17		.17	
		C16	6											.17	.67		.17	
		C22	5				.40							.20	.40			
Cʁ2	*préfet* /pʁefe/	C11	6	.17		.17			.17						.17		.33	
		C15	5	.20	.20	.20								.40				
		C16	6	.17											.33		.50	
		C22	6			.17	.50							.17			.17	
Cʁ3	*cyprès* /sipʁe/	C11	3	.33		.33											.33	
		C15	2	.50						.50								
		C16	5							.60						.40		
		C22	4	.50								.25		.25				
Cʁ4	*soprano* /sopʁano/	C11	4			.75											.25	
		C15	3			.67				.33								
		C16	5	.20		.60					.20							
		C22	5	.20		.20				.20							.40	
Cʁ5	*chapitre* /ʃapitʁ/	C11	4									.25	.25	.25				.25
		C15	6	.17		.33				.33						.17		
		C16	6	.17						.17	.67							
		C22	5	.20		.20		.20		.40								

- **Stage 3 in Mandarin learners' acquisition of French /ʁ/: target-like representation**

Target					*Deletion*		*Epenthesis*		*Feature Change (+ Epenthesis)*								
Type	Example	Subj	n	TL	Stop	Liq	C_1VC_2	C_2V	Liq> Liq	Dev Liq	Liq> [x]	Liq> [h]	Dev Liq + C_1VC_2	Dev Liq + C_1VC_2V	Liq>x] + C_1VC_2	Liq> [x] + C_1C_2V	Liq> [h] + C_1VC_2
ʁ1	*roue* /ʁu/	C1	4	.25						.75							
		C2	4	.25						.50		.25					
		C6	4							.75	.25						
Cʁ1	*pré* /pʁe/	C1	7	.71			.14			.14							
		C2	6	.83		.17											
		C6	7	.43			.14			.14			.14		.14		
Cʁ2	*préfet* /pʁefe/	C1	6	.67		.33											
		C2	6	.83		.17											
		C6	6	.50						.17			.17				.17
Cʁ3	*cyprès* /sipʁe/	C1	4	1.0													
		C2	3	.33					.67								
		C6	3	.33		.33	.33										
Cʁ4	*soprano* /sopʁano/	C1	5	.40		.60											
		C2	3			.67			.33								
		C6	5	.40	.20						.20				.20		
Cʁ5	*chapitre* /ʃapitʁ/	C1	6	.50				.17		.33							
		C2	6			.50				.33				.17			
		C6	6	.14						.14	.30		.14		.14	.14	

APPENDIX C:

Individual subject and control group tallies for experiment in §3.3

C1

Targets involving /l/

Target: Type	Target: Example	Stress	n	TL	*Epenthesis* C_1VC_2	*Epenthesis* C_1C_2V	*Feature Change (+ Epenthesis)* Liq>Nas	*Feature Change (+ Epenthesis)* Liq>Nas + C_1VC_2	*Feature Change (+ Epenthesis)* Liq>Nas + C_1C_2V
l1	*loup* /lu/	Ton	4	.50			.50		
Cl1	*plie* /pli/	Ton	4		.50			.50	
Cl2	*plateau* /plato/	Ton	5	.40	.20			.40	
Cl3	*chapelet* /ʃaple/	PsTon1	4	.25	.75				
Cl4	*diplômé* /diplome/	PsTon1	4	.75	.25				
Cl5	*disciple* /disipl/	PsTon1	3			.67			.33
		PsTon2	1						1.0
		Total	4			.50			.50

Targets involving /ʁ/

Target: Type	Target: Example	Stress	n	TL	*Deletion* Liquid	*Epenthesis* C_1VC_2	*Epenthesis* C_1C_2V	*Feature Change* Dev Liq
ʁ1	*roue* /ʁu/	Ton	4	.25				.75
Cʁ1	*pré* /pʁe/	Ton	7	.71		.14		.14
Cʁ2	*préfet* /pʁefe/	PrTon1	3	.67	.33			
		Ton	3	.67	.33			
		Total	6	.67	.33			
Cʁ3	*cyprès* /sipʁe/	PsTon1	2	1.0				
		Ton	2	1.0				
		Total	4	1.0				
Cʁ4	*soprano* /sopʁano/	PsTon1	5	.40	.60			
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	6	.50			.17	.33

C2

Targets involving /l/

Target Type	Example	Stress	n	TL	Epenthesis C_1VC_2	C_1C_2V
l1	*loup* /lu/	Ton	4	1.0		
Cl1	*plie* /pli/	Ton	4	.75	.25	
Cl2	*plateau* /plato/	Ton	4	1.0		
Cl3	*chapelet* /ʃaple/	PsTon1	4	1.0		
Cl4	*diplômé* /diplome/	PsTon1	4	1.0		
Cl5	*disciple* /disipl/	PsTon1	3			1.0
		PsTon2	1			1.0
		Total	4			1.0

Targets involving /ʁ/

Target Type	Example	Stress	n	TL	*Deletion* Liquid	*Feature Change (+ Epenthesis)* Liq>Liq	Dev Liq	Liq>[h]	Dev Liq + C_1VC_2V
ʁ1	*roue* /ʁu/	Ton	4	.25			.50	.25	
Cʁ1	*pré* /pʁe/	Ton	6	.83	.17				
Cʁ2	*préfet* /pʁefe/	PrTon1	4	.75	.25				
		Ton	2	1.0					
		Total	6	.83	.17				
Cʁ3	*cyprès* /sipʁe/	PsTon1	3	.33		.67			
Cʁ4	*soprano* /sopʁano/	PsTon1	3		.67	.33			
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	5		.40		.40		.20
		PsTon2	1		1.0				
		Total	6		.50		.33		.17

C3

Targets involving /l/

Target: Type	Target: Example	Stress	n	TL	*Epenthesis* C_1VC_2	C_1C_2V	C_1VC_2V	*Feature Change (+ Epenthesis)* Liq>Nas	Liq>Nas + C_1VC_2	Liq>[h] + C_1VC_2V
l1	*loup* /lu/	Ton	4	1.0						
Cl1	*plie* /pli/	Ton	4		.75			.25		
Cl2	*plateau* /plato/	Ton	4	.50	.50					
Cl3	*chapelet* /ʃaple/	PsTon1	4	.50	.25				.25	
Cl4	*diplômé* /diplome/	PsTon1	4	.75				.25		
Cl5	*disciple* /disipl/	PsTon1	3			.33	.33			.33
		PsTon2	1			1.0				
		Total	4			.50	.25			.25

Targets involving /ʁ/

Target: Type	Target: Example	Stress	n	TL	*Deletion* Liquid	*Feature Change (+ Epenthesis)* Liq>[h]	Del Liq + C_1C_2V	Liq>[x] + C_1C_2V	Liq>[x] + C_1VC_2V	Liq>[h] + C_1VC_2	Liq>[h] + C_1VC_2V
ʁ1	*roue* /ʁu/	Ton	4			1.0					
Cʁ1	*pré* /pʁe/	Ton	6	.17	.33					.50	
Cʁ2	*préfet* /pʁefe/	PrTon1	1		1.0						
		Ton	5		.40					.60	
		Total	6		.50					.50	
Cʁ3	*cyprès* /sipʁe/	PsTon1	3		.67					.33	
Cʁ4	*soprano* /sopʁano/	PsTon1	5		.80					.20	
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	4		.25			.25	.25		.25
		PsTon2	1				1.0				
		Total	5		.20		.20	.20	.20		.20

C4

Targets involving /l/

Target Type	Example	Stress	n	TL	*Deletion* Stop	Liquid	*Epenthesis* C_1VC_2	C_1C_2V
l1	*loup* /lu/	Ton	4	1.0				
Cl1	*plie* /pli/	Ton	4	.50			.50	
Cl2	*plateau* /plato/	PrTon1	1	1.0				
		Ton	3	.67	.33			
		Total	4	.75	.25			
Cl3	*chapelet* /ʃaple/	PsTon1	4	.75		.25		
Cl4	*diplômé* /diplome/	PsTon1	4	.75			.25	
Cl5	*disciple* /disipl/	PsTon1	1					1.0
		PsTon2	3					1.0
		Total	4					1.0

Targets involving /ʁ/

Target Type	Example	Stress	n	*Del* Liq	*Feature Change (+ Epenthesis)* Liq > Liq	Liq > [x]	Liq > [h]	Del Liq + C_1C_2V	Liq/Liq + C_1VC_2	Liq> [x] + C_1VC_2	Liq>[x] + C_1VC_2V	Liq> [h] + C_1VC_2	Liq>[h] + C_1VC_2V
ʁ1	*roue* /ʁu/	Ton	4			.50	.50						
Cʁ1	*pré* /pʁe/	Ton	5	.40					.20	.20		.20	
Cʁ2	*préfet* /pʁefe/	PrTon1	3	.67								.33	
		Ton	3		.33							.67	
		Total	6	.33	.17							.50	
Cʁ3	*cyprès* /sipʁe/	PsTon1	3		.67				.33				
		Ton	1	1.0									
		Total	4	.25	.50				.25				
Cʁ4	*soprano* /sopʁano/	PsTon1	4	.75	.25								
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	5			.20	.20	.20			.20		.20
		PsTon2	1					1.0					
		Total	6			.17	.17	.33			.17		.17

C6

Targets involving /l/

Target Type	Example	Stress	n	TL	*Epenthesis* C_1VC_2	C_1C_2V	C_1VC_2V	*Feature Change* Liq>Nas + C_1VC_2
l1	*loup* /lu/	Ton	4	1.0				
Cl1	*plie* /pli/	Ton	4		1.0			
Cl2	*plateau* /plato/	Ton	5	.40	.40			.20
Cl3	*chapelet* /ʃaple/	PsTon1	3	.67	.33			
		Ton	1	1.0				
		Total	4	.75	.25			
Cl4	*diplômé* /diplome/	PsTon1	3	1.0				
		Ton	1	1.0				
		Total	4	1.0				
Cl5	*disciple* /disipl/	PsTon1	4			.25	.75	

Targets involving /ʁ/

Target Type	Example	Stress	n	TL	*Del* Stop	Liq	*Epen* C_1VC_2	*Feature Change (+ Epenthesis)* Dev Liq	Liq > [x]	Dev Liq + C_1VC_2	Liq> [x] + C_1VC_2	Liq> [x] + C_1C_2V	Liq>[x] + C_1VC_2V	Liq>[h] + C_1VC_2
ʁ1	*roue* /ʁu/	Ton	4					.75	.25					
Cʁ1	*pré* /pʁe/	Ton	7	.43			.14	.14		.14	.14			
Cʁ2	*préfet* /pʁefe/	PrTon1	1					1.0						
		Ton	5	.60						.20				.20
		Total	6	.50				.17		.17				.17
Cʁ3	*cyprès* /sipʁe/	PsTon1	2			.50	.50							
		Ton	1	1.0										
		Total	3	.33		.33	.33							
Cʁ4	*soprano* /sopʁano/	PsTon1	5	.40	.20				.20		.20			
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	5					.20	.40			.20	.20	
		PsTon2	2	.50						.50				
		Total	6	.14				.14	.29	.14		.14	.14	

C9

Targets involving /l/

Target					*Deletion*	*Epenthesis* (+ *Deletion*)		
Type	Example	Stress	n	TL	Liquid	C_1VC_2	C_1C_2V	Del Liq + C_1C_2V
l1	*loup* /lu/	Ton	4	1.0				
Cl1	*plie* /pli/	Ton	5	.20		.80		
Cl2	*plateau* /plato/	Ton	6	.50		.50		
Cl3	*chapelet* /ʃaple/	PsTon1	4	1.0				
Cl4	*diplômé* /diplome/	PsTon1	4	1.0				
Cl5	*disciple* /disipl/	PsTon2	4		.25		.50	.25

Targets involving /ʁ/

Target				*Deletion*		*Feature Change* (+ *Epenthesis*)					
Type	Example	Stress	n	Stop	Liquid	Liq>[x]	Liq>[h]	Del Liq + C_1C_2V	Liq>[x] + C_1VC_2	Liq>[x] + C_1VC_2V	Liq>[h] + C_1VC_2
ʁ1	*roue* /ʁu/	Ton	5			.80	.20				
Cʁ1	*pré* /pʁe/	Ton	6		.50				.50		
Cʁ2	*préfet* /pʁefe/	Ton	6	.17	.67						.17
Cʁ3	*cyprès* /sipʁe/	PsTon1	4		.75				.25		
Cʁ4	*soprano* /sopʁano/	PsTon1	4		.75	.25					
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	3		.67					.33	
		PsTon2	3		.67			.33			
		Total	6		.67			.17		.17	

C11

Targets involving /l/

Target Type	Target Example	Stress	n	TL	Epenthesis C_1VC_2	Epenthesis C_1C_2V
l1	*loup* /lu/	Ton	4	1.0		
Cl1	*plie* /pli/	Ton	4	1.0		
Cl2	*plateau* /plato/	Ton	4	.75	.25	
Cl3	*chapelet* /ʃaple/	PsTon1	3	1.0		
		Ton	1	1.0		
		Total	4	1.0		
Cl4	*diplômé* /diplome/	PsTon1	4	1.0		
Cl5	*disciple* /disipl/	PsTon2	3			1.0
		Ton	1			1.0
		Total	4			1.0

Targets involving /ʁ/

Target Type	Target Example	Stress	n	TL	*Del* Liq	Liq > Liq	Dev Liq	Liq > [x]	Liq > [h]	Del Liq + C_1C_2V	Dev Liq + C_1VC_2	Liq> [x] + C_1VC_2	Liq> [h] + C_1VC_2	Liq>[h] + C_1VC_2V
ʁ1	*roue* /ʁu/	Ton	4				.25	.50	.25					
Cʁ1	*pré* /pʁe/	Ton	6		.50						.17		.33	
Cʁ2	*préfet* /pʁefe/	PrTon1	1	1.0										
		Ton	5		.20	.20						.20	.40	
		Total	6	.17	.17	.17						.17	.33	
Cʁ3	*cyprès* /sipʁe/	PsTon1	3	.33	.33								.33	
Cʁ4	*soprano* /sopʁano/	PrTon1	1		1.0									
		PsTon1	3		.67								.33	
		Total	4		.75								.25	
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	2							.50				.50
		PsTon2	2						.50		.50			
		Total	4						.25	.25	.25			.25

C14

Targets involving /l/

Target Type	Example	Stress	n	TL	*Epenthesis* C_1VC_2	C_1VC_2V
l1	*loup* /lu/	Ton	4	1.0		
Cl1	*plie* /pli/	Ton	4		1.0	
Cl2	*plateau* /plato/	Ton	4	.50	.50	
Cl3	*chapelet* /ʃaple/	PsTon1	4		1.0	
Cl4	*diplômé* /diplome/	PsTon1	2	.50	.50	
Cl5	*disciple* /disipl/	PsTon1	4			1.0

Targets involving /ʁ/

Target Type	Example	Stress	n	*Del* Liquid	*Feature Change (+ Epenthesis)* Liq>[x]	Del Liq + C_1C_2V	Dev Liq + C_1C_2V	Liq>[x] + C_1VC_2	Liq>[x] + C_1VC_2V	Liq>[h] + C_1VC_2	Liq>[h] + C_1VC_2V
ʁ1	*roue* /ʁu/	Ton	4		1.0						
Cʁ1	*pré* /pʁe/	Ton	6	.33				.33		.33	
Cʁ2	*préfet* /pʁefe/	Ton	4	.50			.25			.25	
Cʁ3	*cyprès* /sipʁe/	PsTon1	2							1.0	
Cʁ4	*soprano* /sopʁano/	PsTon1	4	.75						.25	
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	2						.50		.50
		PsTon2	1			1.0					
		Total	3			.33			.33		.33

C15

Targets involving /l/

Target Type	Target Example	Stress	n	TL	Epenthesis C_1VC_2	Epenthesis C_1C_2V
l1	*loup* /lu/	Ton	4	1.0		
Cl1	*plie* /pli/	Ton	4	.25	.75	
Cl2	*plateau* /plato/	Ton	3	.67	.33	
Cl3	*chapelet* /ʃaple/	PsTon1	2	1.0		
		Ton	2	1.0		
		Total	4	1.0		
Cl4	*diplômé* /diplome/	PrTon1	1	1.0		
		PsTon1	3	1.0		
		Total	4	1.0		
Cl5	*disciple* /disipl/	PsTon2	4			1.0

Targets involving /ʁ/

Target Type	Target Example	Stress	n	TL	*Del* Stop	*Del* Liq	*Epen* C_1VC_2	*Feature Change (+ Epenthesis)* Dev Liq	Liq> [x]	Dev Liq + C_1VC_2	Liq>[x] + C_1VC_2	Liq>[x] + C_1VC_2V	Liq> [h] + C_1VC_2
ʁ1	*roue* /ʁu/	Ton	4					.75	.25				
Cʁ1	*pré* /pʁe/	Ton	6			.33	.17			.17	.17		.17
Cʁ2	*préfet* /pʁefe/	PrTon1	2		.50	.50							
		Ton	3	.33						.67			
		Total	5	.20	.20	.20				.40			
Cʁ3	*cyprès* /sipʁe/	Ton	2	.50				.50					
Cʁ4	*soprano* /sopʁano/	PrTon1	3			.67		.33					
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	5	.20		.40		.40					
		PsTon2	1									1.0	
		Total	6	.17		.33		.33				.17	

C16

Targets involving /l/

Target Type	Example	Stress	n	TL	*Del* Stop	*Epenthesis* C_1VC_2	C_1C_2V
l1	*loup* /lu/	Ton	4	1.0			
Cl1	*plie* /pli/	Ton	5	.40	.20	.40	
Cl2	*plateau* /plato/	Ton	4	1.0			
Cl3	*chapelet* /ʃaple/	PsTon1	5	.80		.20	
Cl4	*diplômé* /diplome/	PsTon1	4	1.0			
Cl5	*disciple* /disipl/	PsTon1	4				1.0

Targets involving /ʁ/

Target Type	Example	Stress	n	TL	*Del* Liq	*Feature Change (+ Epenthesis)* Dev Liq	Liq>[x]	Liq>[h]	Dev Liq + C_1VC_2	Liq>[x] + C_1VC_2	Liq>[h] + C_1VC_2
ʁ1	*roue* /ʁu/	Ton	6				.33	.67			
Cʁ1	*pré* /pʁe/	Ton	6						.17	.67	.17
Cʁ2	*préfet* /pʁefe/	Ton	6	.17						.33	.50
Cʁ3	*cyprès* /sipʁe/	PsTon1	5				.60			.40	
Cʁ4	*soprano* /sopʁano/	PrTon1	1		1.0						
		PsTon1	3		.67		.33				
		Ton	1	1.0							
		Total	5	.20	.60		.20				
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	6	.17		.17	.67				

C17

Targets involving /l/

Target Type	Example	Stress	n	TL	*Epenthesis* C_1VC_2	C_1C_2V	C_1VC_2V	Liq>[x] + C_1VC_2V
l1	*loup* /lu/	Ton	4	1.0				
Cl1	*plie* /pli/	Ton	4	.25	.75			
Cl2	*plateau* /plato/	Ton	4	.75	.25			
Cl3	*chapelet* /ʃaple/	PsTon1	2		.50			.50
		Ton	1		1.0			
		Total	3		.67			.33
Cl4	*diplômé* /diplome/	PrTon1	1	1.0				
		Ton	3	.67	.33			
		Total	4	.75	.25			
Cl5	*disciple* /disipl/	PsTon1	1				1.0	
		PsTon2	2				1.0	
		Ton	1			1.0		
		Total	4			.25	.75	

Targets involving /ʁ/

Target Type	Example	Stress	n	TL	*Deletion* Stop	Liquid	*Feature Change (+ Epenthesis)* Dev Liq	Liq > [x]	Liq>Liq + C_1VC_2	Dev Liq + C_1C_2V	Liq> [x] + C_1VC_2	Liq>[x] + C_1VC_2V
ʁ1	*roue* /ʁu/	Ton	4					1.0				
Cʁ1	*pré* /pʁe/	Ton	6			.50			.17		.33	
Cʁ2	*préfet* /pʁefe/	PrTon1	4			.75					.25	
		Ton	2			.50					.50	
		Total	6			.67					.33	
Cʁ3	*cyprès* /sipʁe/	PsTon1	2			.50					.50	
		Ton	4		.25	.50		.25				
		Total	6		.17	.50		.17			.17	
Cʁ4	*soprano* /sopʁano/	PrTon1	4			.75		.25				
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	5	.20			.20			.20	.20	.20

C20

Targets involving /l/

Target: Type	Target: Example	Stress	n	TL	Del: Liquid	Epenthesis: C_1VC_2	Epenthesis: C_1C_2V	Feature Change + Epenthesis: Del Liq + C_1C_2V	Feature Change + Epenthesis: Liq>Liq + C_1C_2V
l1	*loup* /lu/	Ton	4	1.0					
Cl1	*plie* /pli/	Ton	4	.50		.50			
Cl2	*plateau* /plato/	Ton	4	1.0					
Cl3	*chapelet* /ʃaple/	PsTon1	3	.67		.33			
Cl4	*diplômé* /diplome/	PsTon1	3	1.0					
		Ton	1	1.0					
		Total	4	1.0					
Cl5	*disciple* /disipl/	PsTon1	1		1.0				
		PsTon2	3				.33	.33	.33
		Total	4		.25		.25	.25	.25

Targets involving /ʁ/

Target: Type	Target: Example	Stress	n	Del: Liq	Feature Change (+ Epenthesis): Dev Liq	Liq>[x]	Liq>[h]	Del Liq + C_1C_2V	Liq>[x] + C_1VC_2	Liq>[x] + C_1VC_2V	Liq>[h] + C_1VC_2
ʁ1	*roue* /ʁu/	Ton	4			.50	.50				
Cʁ1	*pré* /pʁe/	Ton	6	.50					.17		.33
Cʁ2	*préfet* /pʁefe/	Ton	6	.67					.17		.17
Cʁ3	*cyprès* /sipʁe/	PsTon1	4	.50							.50
Cʁ4	*soprano* /sopʁano/	PsTon1	4	.75							.25
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	2		.50					.50	
		PsTon2	3	.33		.33		.33			
		Total	5	.20	.20	.20		.20		.20	

C22

Targets involving /l/

Target Type	Target Example	Stress	n	TL	Epenthesis C_1VC_2	Epenthesis C_1C_2V	Liq>Nas
l1	*loup* /lu/	Ton	4	.75			.25
Cl1	*plie* /pli/	Ton	4	.25	.75		
Cl2	*plateau* /plato/	Ton	4	.75	.25		
Cl3	*chapelet* /ʃaple/	PsTon1	3	.67	.33		
Cl4	*diplômé* /diplome/	PrTon1	1	1.0			
		PsTon1	3	1.0			
		Total	4	1.0			
Cl5	*disciple* /disipl/	PsTon1	2		.50	.50	
		PsTon2	1			1.0	
		Total	3		.33	.67	

Targets involving /ʁ/

Target Type	Target Example	Stress	n	TL	*Del* Liq	*Epenthesis* C_1VC_2	*Epenthesis* C_1VC_2V	*Feature Change (+ Epenthesis)* Dev Liq	Liq> [x]	Liq> [h]	Dev Liq + C_1VC_2	Liq>[x] + C_1VC_2	Liq>[h] + C_1VC_2
ʁ1	*roue* /ʁu/	Ton	4					.25	.25	.50			
Cʁ1	*pré* /pʁe/	Ton	5			.40					.20	.40	
Cʁ2	*préfet* /pʁefe/	PrTon1	4		.25	.50							.25
		Ton	2			.50					.50		
		Total	6		.17	.50					.17		.17
Cʁ3	*cyprès* /sipʁe/	PsTon1	2	.50							.50		
		Ton	2	.50						.50			
		Total	4	.50						.25	.25		
Cʁ4	*soprano* /sopʁano/	PrTon1	1					1.0					
		PsTon1	4	.25	.25								.50
		Total	5	.20	.20			.20					.40
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	4	.25	.25			.50					
		PsTon2	1				1.0						
		Total	5	.20	.20		.20	.40					

Mandarin learners: Group Means

Target					Deletion		Epenthesis			Feature Change (+ Epenthesis)						
Type	Example	Stress	n	TL	Stop	Liq	C_1VC_2	C_1C_2V	C_1VC_2V	Liq>Nas	Del Liq + C_1C_2V	Liq>Nas + C_1VC_2	Liq>Nas + C_1C_2V	Liq>Liq + C_1C_2V	Liq>x] + C_1VC_2V	Liq>[h] + C_1VC_2V
I1	*loup* /lu/	Ton	52	.94						.06						
Cl1	*plie* /pli/	Ton	54	.31	.02		.61			.02		.04				
Cl2	*plateau* /plato/	PrTon1	1	1.0												
		Ton	54	.67	.02		.26					.06				
		Total	55	.67	.02		.25					.05				
Cl3	*chapelet* /ʃaple/	PsTon1	45	.64		.02	.29					.02			.02	
		Ton	5	.80			.20									
		Total	50	.66		.02	.28					.02			.02	
Cl4	*diplômé* /diplome/	PrTon1	3	1.0												
		PsTon1	42	.90			.07			.02						
		Ton	5	.80			.20									
		Total	50	.90			.08			.02						
Cl5	*disciple* /disipl/	PsTon1	30			.03	.03	.57	.30				.03			.03
		PsTon2	19			.05		.63	.11		.11		.05	.05		
		Ton	2					1.0								
		Total	51			.04	.02	.61	.22		.04		.04	.02		.02

Target					*Deletion*		*Epenthesis*			*Feature Change (+ Epenthesis)*														
Type	Example	Stress	n	TL	Stop	Liq	C_1VC_2	C_1C_2V	C_1VC_2V	Liq> Liq	Dev Liq	Liq> [x]	Liq> [h]	Del Liq + C_1C_2V	Liq> Nas + C_1VC_2	Liq> Liq + C_1VC_2	Dev Liq + C_1VC_2	Dev Liq + C_1C_2V	Dev Liq + C_1VC_2V	Liq> [x] + C_1VC_2	Liq> [x] + C_1C_2V	Liq> [x] + C_1VC_2V	Liq> [h] + C_1VC_2	Liq> [h] + C_1VC_2V
r1	*roue* /ʁu/	Ton	55	.04							.24	.42	.31											
Cr1	*pré* /pʁe/	Ton	78	.18		.27	.05	.01			.03					.03	.06			.22			.15	
Cr2	*préfet* /pʁefe/	PrTon1	23	.26	.04	.43	.09				.04									.04			.09	
		Ton	52	.17	.02	.29	.02			.04							.10			.10			.27	
		Total	75	.20	.03	.33	.04			.03	.01						.07			.08			.21	
Cr3	*cyprès* /sipʁe/	PsTon1	35	.14		.29	.03			.11		.09				.03	.03			.11			.17	
		Ton	12	.42	.08	.25					.08	.08	.08											
		Total	47	.21	.02	.28	.02			.09	.02	.09	.02			.02	.02			.09			.13	
Cr4	*soprano* /sopʁano/	PrTon1	10			.70					.20	.10												
		PsTon1	44	.11	.02	.59				.05		.07								.02			.14	
		Ton	1	1.0																				
		Total	55	.11	.02	.60				.04	.04	.07								.02			.11	
Cr5	*chapitre* /ʃapitʁ/	PsTon1	54	.13		.15		.02			.22	.13	.02	.04				.02	.02	.02	.04	.13		.07
		PsTon2	16	.06		.25			.06			.06	.06	.31			.13					.06		
		Total	70	.11		.17		.01	.01		.17	.11	.03	.10			.03	.01	.01	.01	.03	.11		.06

Native Speaker Controls: Group Means

Targets involving /l/

Target Type	Target Example	Stress	n	TL	Deletion Stop	Epenthesis C_1VC_2	Epenthesis C_1C_2V
l1	*loup* /lu/	Ton	40	1.0			
Cl1	*plie* /pli/	Ton	39	.97		.03	
Cl2	*plateau* /plato/	PsTon1	37	1.0			
Cl3	*chapelet* /ʃaple/	Ton	39	1.0			
Cl4	*diplômé* /diplome/	PrTon1	36	1.0			
		PsTon1	2	1.0			
		Ton	2	1.0			
		Total	40	1.0			
Cl5	*disciple* /disipl/	PsTon1	40	.30			.70

Targets involving /ʁ/

Target Type	Target Example	Stress	n	TL	Deletion Stop	Epenthesis C_1VC_2	Epenthesis C_1C_2V	Dev Liq
ʁ1	*roue* /ʁu/	Ton	40	.98				.03
Cʁ1	*pré* /pʁe/	Ton	59	.90		.10		
Cʁ2	*préfet* /pʁefe/	PrTon1	59	.98		.02		
		Ton	1	1.0				
		Total	60	.98		.02		
Cʁ3	*cyprès* /sipʁe/	Ton	40	.93		.08		
Cʁ4	*soprano* /sopʁano/	PrTon1	46	1.0				
		PsTon1	2	.50		.50		
		Ton	2	1.0				
		Total	50	.98		.02		
Cʁ5	*chapitre* /ʃapitʁ/	PsTon1	59	.34	.02		.64	