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**The Influence of Age of Learning on Syllable Structure
in the L2 Speaker**

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**Thesis submitted to
the School of Graduate Studies and Research
in partial fulfillment of the requirements for
the degree of
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Abstract

Age of Arrival (AOA) in the L2 community has been a factor in several L2 acquisition studies examining various phonological phenomena, such as consonant perception and vowel perception and production (e.g. Flege *et al.*, 1995; Flege *et al.*, 1997). The literature on phonological acquisition in L2 is not informative, however, on the question of syllable structure. This study addresses the issue of the degree to which syllable structure is subject to modification as a function of AOA.

Subjects in the study were mature Italian speakers, whose L2 (English) phonology has presumably plateaued. They were divided into two groups based on their AOA in Canada (Early NI [arrival in Canada between the ages of 2 and 13] and Late NI [arrival in Canada between the ages of 15 and 26]). Italian differs from English in a number of ways. The legality constraints, such as permissible consonant phonemes and their combinations in coda position differ for the two languages. These constraints were examined in this study along-side the effect of stress. Stress, a language-particular constraint, was expected to affect syllabification of Native English (NE) speakers. Legality and stress were explored in a “word game”, where subjects were asked to resyllabify bisyllabic nonsense words.

Results showed that, as predicted, syllable structure varies according to native language and age of L2 learning. As expected, NE speakers were more sensitive to stress than native Italian speakers, who as a function of their different AOAs, exhibited two different patterns of syllabification. Early NI speakers were more sensitive to stress than Late NI speakers. Similarly, NE speakers were more sensitive to English legality than the Early NI speakers, who were in turn more sensitive to English collocational constraints than the Late NI speakers. Overall, the Italian speakers preferred to keep their syllables open, whereas the English speakers chose to close their syllables with a consonant. This tendency was strengthened further when the stress fell on the first syllable of the word.

For my parents

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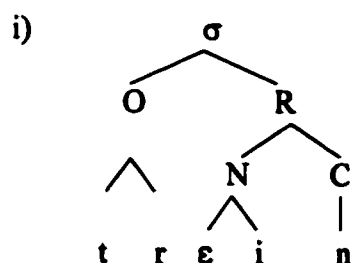
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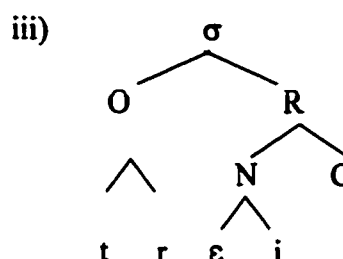
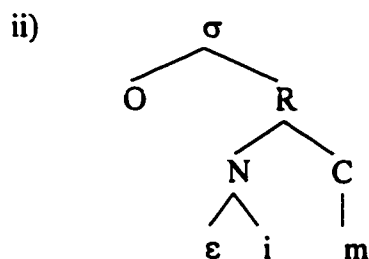
Chapter 1: Introduction

1.1. Syllabification

The syllable has been at the centre of controversy for a long time. Some linguists (Chomsky and Halle, 1968) had not acknowledged the syllable to be a linguistic unit, whereas others disagreed on its internal organization. Two competing views of the syllable emerged as it began to be widely reintegrated into phonological theory. Hooper (1972) saw the syllable as a linear string of phonemes, without an internal structure. Another view was that the syllable had a hierarchical internal organization (Halle and Vergnaud, 1980; Selkirk, 1982), that is there existed intermediate units between the syllable and the phoneme. In this view the syllable was divided into two main units: the onset and the rime. The onset is the initial consonant or consonants of the syllable (e.g. *tr-ain*), whereas the rime consists of the vowel and any consonants following it (e.g. *tr-ain*, shown in [i]). The rime can be further divided into the nucleus (usually a vowel) and the coda (consonant(s) following the nucleus).

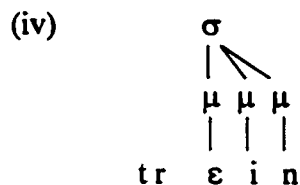


In English the onset is not obligatory, and so *aim* (as illustrated in [ii]) is a possible English syllable. An English rime can simply consist of a long or diphthongized vowel, without any consonants (e.g. *tr-ay*) (as shown in [iii]).



Another major and recently widely accepted framework dealing with syllabification is the moraic theory within autosegmental phonology. According to moraic theory, a mora, or weight unit, is used to encode both the opposition between heavy (bimoraic) and light (monomoraic) syllables, and the equivalence of various types of heavy syllables (e.g. Hayes, 1989; Hyman, 1985). For languages such as English that treat all types of heavy syllables as equivalent each unit in the syllable rime contributes a mora. Syllable onsets, on the other hand, are assumed to have no moraic value since they do not contribute to syllable weight. The moraic theory allows for some variation in the moraic structure of syllable rimes. Hayes (1989) proposes that in English, for example, vowels are underlyingly associated with morae, where short vowels (lax vowels) are assigned to one mora, and long vowels (tense vowels and diphthongs) take up two moraic slots. By contrast, consonants receive their moraic value by language-specific rules. In

English, for example, *Weight-by-Position* assigns a mora to each consonant in coda position. The moraic structure of *train* is illustrated below in (iv).



1.1.1. Three general areas of agreement

Those who grant the syllable a central place (Kahn, 1976; Pulgram, 1970; Selkirk, 1982; Itô, 1986; Clements and Keyser, 1983; Goldsmith, 1990; Broselow, 1995, etc.) have been in disagreement as to its boundaries. Most linguists seem to agree on three general points. The first area of agreement is that a syllable must contain a vowel or a syllabic consonant (nucleus). Second, *the principle of legality* has also been generally accepted (Pulgram, 1970; Selkirk, 1982 [although not always by Bailey (1978), Hoard (1971), or Kahn (1976)]), which states that each syllable of a word when taken individually must also be a phonologically legal word of the language¹. The third area of general agreement concerns syllabification before stressed vowels. It has been suggested

¹ Counter-examples to this rule are provided by Spanish. For example, *transcribir* contains the sequence *nscr* which cannot be assigned to the preceding and following syllables in such a way as to create codas and onsets that are grammatical in Spanish. *-ns* is not allowed as a coda in Spanish, nor is *scr-* permitted as an onset. Also, many English syllables are not grammatically formed words; for instance no monosyllable contains the vowel schwa as its nucleus, but that vowel is common as the nucleus of syllable of a polysyllabic word.

that consonants are drawn to stressed vowels and in particular short stressed vowels (Bailey, 1978; Pulgram, 1970; Zec, 1988).

1.1.2. Other principles and theories

Some linguists (e.g. Pulgram, 1970) propose *the maximum onset principle*, which states that the onsets of syllables contain the maximum number of consonants allowed by the phonology of the language. Interacting with the maximum onset principle is *the sonority contour principle*, proposed by, among others, Clements (1988). The sonority of a sound is its relative loudness compared to other sounds, everything else – pitch, etc. – being equal. In this sonority hierarchy vowels are most sonorant, followed by glides, liquids, nasals, and obstruents (Hooper, 1976). This sonority hierarchy is illustrated in (v).

v) *The sonority hierarchy*

vowels > glides > liquids > nasals > obstruents

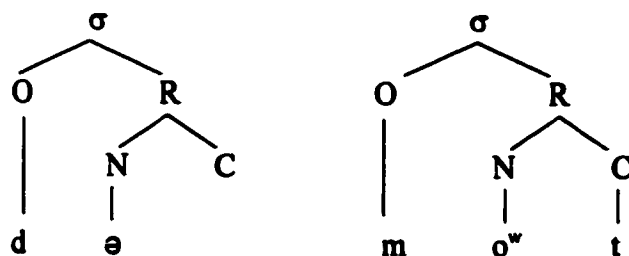
Syllables are associated with peaks of sonority and therefore the number of peaks would predict the right number of syllables. For example, *late* has only one peak of sonority, whereas *later* has two, rendering the words mono- and bisyllabic respectively.

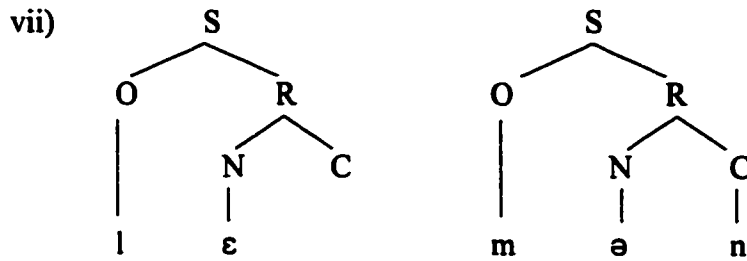
A proponent of the moraic approach, Zec (1988), suggests that *the sonority principle* constrains which consonant may be mora-bearing. Consonants that fill a moraic

slot are more sonorous than those that do not carry any moraic weight. Based on evidence from Lithuanian, Zec (1988) argues that sonorant consonants, but not obstruents, are moraic in coda position. Hence, a bisyllabic word containing a sonorant medial consonant, such as a liquid or a nasal, will tend to be syllabified as part of the rime (VC-V), whereas an obstruent in that position will tend to form an onset of the second syllable (V-CV).

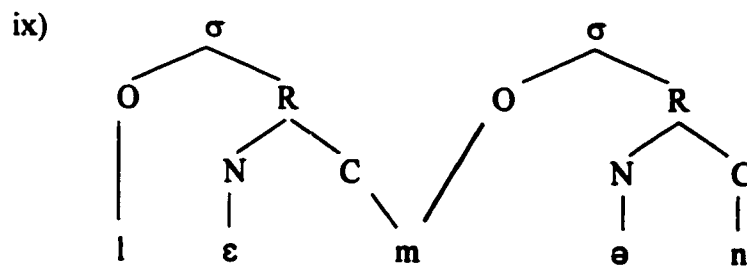
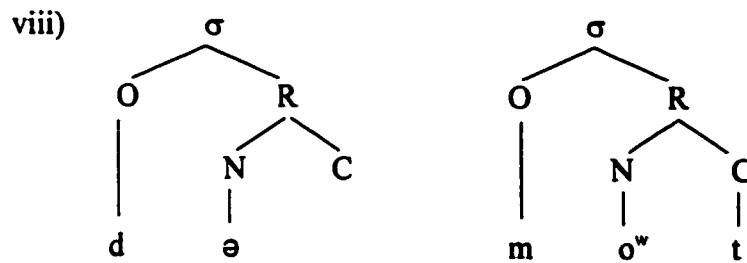
Another theory of syllabification takes into account ambisyllabicity (Kahn, 1976), which suggests that a medial consonant in a two-syllable word may belong to two syllables at the same time. Kahn (1976) has also proposed that speaking rate may affect syllabification, where a consonant may be syllable-initial at one rate of speech and syllable-final at another. Kahn (1976) claims that syllabification in slow speech differs from that in normal or fast speech. In slow speech, the onsets of all syllables are as long as possible, subject to the phonological constraints of English. Both sequences of the two stress patterns, 'VCV and VC'V (where 'V is a stressed vowel) would be syllabified as V-CV. So /m/ in *demote* and in *lemon* would both belong to the second syllable. This is illustrated in (vi) and (vii).

vi)





In normal and fast speech, on the other hand, the consonant in the VC'V sequence will remain as part of the second syllable (V-C'V), whereas the consonant of the 'VCV sequence will simultaneously be syllable-final and syllable-initial, or ambisyllabic. The /m/ of *demote* in this case remains part of the second syllable, whereas the /m/ of *lemon* is assigned to both the first and the second syllable. This is shown in (viii) and (ix).

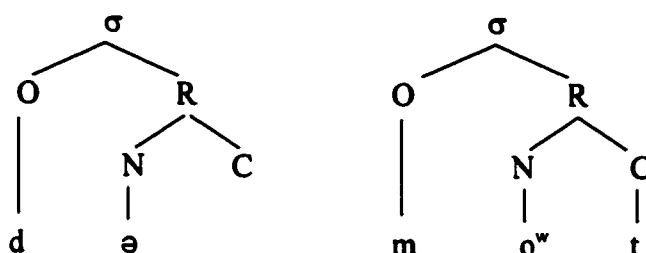


For Selkirk (1982) there exist two levels of syllabification, an underlying and a surface level. At the underlying or deep level, the sequences VC'V or 'VCV will both be

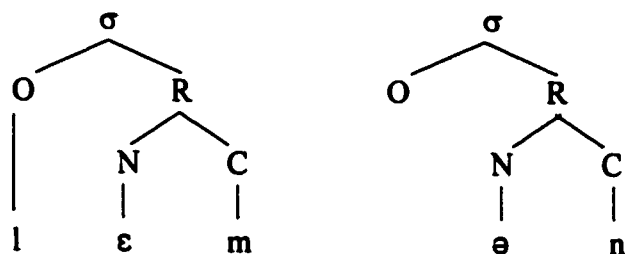
syllabified V-CV. The /m/ in *demote* and /m/ in *lemon*, for example, will both be syllable-initial, as shown in (vi) and (vii).

At the surface or phonetic level, the VC'V sequence will be syllabified V-CV, while the 'VCV sequence will be resyllabified as VC-V. In other words the /m/ of *demote* remains syllable-initial, whereas the /m/ in *lemon* is resyllabified to a syllable-final position. This is illustrated in (x) and (xi).

x)



xi)



Some theories include the morphological structure as central to the way we syllabify (Selkirk, 1982). For example, *carted* and *carpet* may be syllabified differently, treating the morpheme *-ed* as a unit and therefore as a complete syllable.

In addition to linguistic theories, there are several theories of word recognition and reading that grant the syllable an important role. The theory of the vocalic center

group or VCG suggest that a VC(C)V sequence is first parsed after the vowel (V-C(C)V) (Spoehr and Smith, 1973). Next, spelling-sound rules are applied in order to derive a phonological representation. If the phonological representation matches the representation stored in long-term memory, then the V-C(C)V division will be retained. If, however, there is no match obtained, the sequence will be resyllabified as VC-V or in the case of two medial Cs, VC-CV. For example, *carpet* would be first divided *ca-rpet*. Since *ca* does not have a matching representation stored in long-term memory, *carpet* would then be resyllabified *car-pet*².

Another syllable-centred theory of word recognition stipulates that printed words can be syllabified based on their orthography (Adams, 1981; Seidenberg, 1987). In this view syllable boundaries correspond to bigram troughs. A bigram is a series of two orthographic characters. Bigram troughs occur at bigrams of lower frequencies. For example, the bigram *rp* in *carpet* is relatively low in frequency compared to the bigrams *ar* or *pe*, and so the division of *carpet* into syllables would occur at this trough, yielding *car-pet*.

In the last two decades research has focused on the structure of the syllable via experimental work with adults (e.g. Treiman and Danis, 1988) and with children (Fallows, 1981). These studies have focused on principles applied during the process of syllabification in the speakers' first language. However, the literature is less informative about the degree to which syllable structure is subject to modification in second language learners as a function of L2 mastery.

² This example is further complicated by the phonetic blending of /a/ and /r/. In English, the sequence *ar* produces a rarely breakable sound /aʹ/.

The present study focuses on the principles that are relatively uncontroversial in the literature: the effect of stress and of collocational constraints on syllable structure. These principles are explored at greater length in the next two sections.

1.1.3. Stress

According to *the stress principle* of syllabification, a stressed syllable or more precisely a stressed vowel attracts consonants (Bailey, 1978; Pulgram, 1970). In other words, the onset of the stressed syllable is maximized (Kahn, 1976; Pulgram, 1970; Selkirk, 1982). A VC'V sequence (where V is an unstressed vowel, C is a consonant that is possible word initially, and 'V is a stressed vowel) would be syllabified V-C'V. For example, /r/ in *erase* would belong to the second syllable, attaching itself to the stressed vowel. Linguists generally agree on this syllabification; however, they disagree on the treatment of 'VCV sequences, where the first vowel carries the stress of the word.

Pulgram (1970) argues that it is the nature of the stressed vowel that determines the syllabification in this case. If the vowel can end a word – that is, it is a long vowel – then the consonant is assigned to the second syllable. The /m/ in *demon*, for example, would belong to the second syllable, because the long stressed vowel [i] can end the first syllable. If, however, the stressed vowel is short, and therefore illegal word-finally, the medial consonant is assigned to the first syllable. The /m/ in *lemon*, for example, would be placed in the first syllable.

1.1.3.1. Stress in experimental studies

In their 1988 study Treiman and Danis asked their subjects to perform a reversal task involving spoken words (Experiment 1). Subjects were asked to reverse the syllables in words like *lemon*. The possible answers were *onlem* (where the consonant /m/ is placed in the first syllable), *monle* (where /m/ is placed in the second syllable), or *monlem* (where /m/ is ambisyllabic). The results revealed that subjects' responses were affected by stress. When the second syllable was stressed, as in words like *device* and *canoe*, subjects placed the medial consonant in the second syllable significantly more frequently than in the first syllable. The stress effect was strengthened even more when the medial consonant was an obstruent (see 1.1.4 Legality). When the first syllable was stressed, subjects showed a preference for placing the medial consonant in the first syllable.

Treiman and Zukowski (1990) found a relatively small but still statistically significant effect of stress on syllabification. The task involved syllabifying mostly bisyllabic stimuli with medial clusters that were legal finally in English. Approximately half of the bisyllabic words had primary stress on the first vowel (e.g. *pontiff*) and half had the second vowel stressed (e.g. *pontoon*). Results revealed that when a consonant could legally be placed as either a coda or an onset, people preferred to place it in the onset (as part of the second syllable), thereby satisfying the maximum onset principle. However, when the first syllable was stressed, the tendency was to place the consonant in that syllable. The small size of the stress effect led the experimenters to suggest that the stress principle is not very robust or that the effects of stress are carried by the vowel. If a

consonant is not directly next to a stressed vowel, like the /t/ in *pontiff*, the attraction may be relatively low, whereas adjacent consonants could feel a stronger pull towards the vowel. Treiman and Zukowski (1990) further proposed that the stress principle and the sonority contour principle are related. If a stressed vowel is considered to be more sonorant than an unstressed vowel, then a stressed vowel will attract an adjacent consonant in order to produce a syllable with a decline in sonority from nucleus to coda.

1.1.4. Legality

The legality principle of syllabification states that each syllable of a word, when taken independently, must form a phonologically legal word in that language. When we talk about the legality principle, we are in fact talking about two principles. The first principle states that a consonant or a consonant cluster can occur only as an onset of a syllable if it can also occur at the beginning of a word. In English, for example, words do not begin with /ls/ and so /ls/ is eliminated as a possible syllable onset. The second principle states that clusters are possible syllable-finally only if they are also possible word-finally. Therefore, the sequence /tl/ is not a possible English coda, as it is not a legal word final cluster. The legality principle of syllabification does not assume, however, that sequences that occur word-initially or word-finally must also occur syllable-marginally. For example, the fact that *spr* occurs word-initially in English does not mean that this sequence must be syllabified as a single onset if it occurs word-internally.

1.1.4.1. Experimental studies and the onset/rime division

Behavioural evidence points to a preference for preservation of onsets and rimes as units (Treiman, 1989). This evidence comes from speech errors and from novel word games. D. MacKay (1972) examined errors in a task where speakers combined two words with similar meanings (e.g. *butterfly* + *caterpillar* → *butterpillar*). He found that within-syllable breaks were more frequent before the vowel than after it (e.g. *start* + *go* → *sto*). This suggested that subjects tended to break syllables along the onset/rime division line. MacKay (1972) also found that subjects avoided dividing consonant clusters³. These findings in turn are consistent with the assumption that codas form a group with the nucleus and initial consonant clusters, or onsets, are a separate unit.

In her novel word games, Treiman (1983) explored the issue of onset/rime boundary further. Subjects were asked to learn different types of word blending games, where each game had a different set of rules with respect to the place of division. The rules that were most easily acquired by the subjects were those that divided each syllable along the onset/rime boundary. The rules that divided the syllables within the rime produced the most errors. In a phoneme substitution task, games that replaced onsets or rimes as units were also easier to learn than those that broke up onsets or rimes (Treiman, 1986). The onset/rime division seemed the most natural to the subjects, as predicted by the hierarchical view of the syllable.

³ There is an unavoidable confound in the data collection based on categorial perception of the listener rather than what the speaker said (cf. Mowrey and MacKay, 1990)

More recent studies suggest that the structure of the rime is more complicated than a simple V+C(C). Certain types of consonants permitted a different division. For example, D. MacKay (1978) found that rimes like /arp/ had a VC+C structure. Effects of postvocalic liquids and nasals were also found in studies on speech errors (Danis and Treiman, 1988) and word games (Treiman, 1984). These studies found that postvocalic /r/ and /l/ were more closely associated with the vowel than were other consonants. When nasals, and especially liquids, followed the vowel, subjects had a more difficult time learning rules of rime splitting along the V-C line than when the vowel was followed by an obstruent. These results suggested that subjects will treat rimes differently, depending on the type of the postvocalic consonant. Final consonant clusters that begin with an obstruent do seem to behave like units, but those beginning with a liquid or, to a lesser degree, with a nasal, do not. Treiman (1984) interpreted this distinction between postvocalic liquids, nasals, and obstruents in terms of the sonority principle. Liquids, being the most sonorant of the above, tend to be more closely associated with the nuclear vowel, whereas obstruents, being the furthest on the sonority continuum, are least attached to the vowel. These sonority effects were not found to be directional, i.e. they do not exist with onsets (Treiman, 1986). Once again, this provides further support for the claim that an internal syllable boundary exists between onsets and rimes.

1.1.4.2. Other experimental studies on Legality

Treiman and Danis (1988) compared performance on a word reversal task (Experiment 2), where subjects were asked to reverse syllables in bisyllabic words (as described in Experiment 1, p. 10 of this thesis), with respect to medial liquids, nasals, and obstruents. Results revealed that subjects placed the medial consonant in the first syllable more often in the case of liquids and nasals than in the case of obstruents. The effect was even stronger when the type of vowel was taken into account. The medial consonant was placed in the second syllable more often than in the first syllable when the vowel of the second syllable was long and the consonant was an obstruent (e.g. *device*). Liquids and nasals have a greater attachment to the preceding vowel and therefore are more likely to form a coda of that vowel's syllable.

Analysis of variance showed that the proportion of ambisyllabic responses also varied as a function of vowel type. There were more ambisyllabic responses for short vowels than for long vowels. In addition there was a main effect of consonant type. Subjects made fewer ambisyllabic responses when the medial consonant was an obstruent than when it was a liquid or a nasal. Liquids and nasals did not differ significantly.

In a study by Treiman and Zukowski (1990) (Experiment 4), subjects were asked to divide bisyllabic words, which varied in type of medial cluster, into two syllables. The cluster was either *st* or a non-*s* cluster, in which case it consisted of an obstruent followed by a liquid. According to the maximum onset principle, divisions such as *Ma-drid* and *e-state* should be favoured. However, even though people favoured *Ma-drid*, they

preferred *es-tate* over *e-state*. *State* does not exhibit a steady rise in sonority like *tate* or *drid* does, and therefore having the subjects syllabify based on what seems to be the sonority rise favours the sonority contour principle. Moreover, subjects tended to avoid syllables with final short vowels. In other words they preferred to close such syllables with a consonant. The experimenters suggested that this was due not to their illegality but to the fact that such vowels do not show a decline in sonority at the end.

Consequently, Treiman and Zukowski (1990) have proposed a third part of the legality principle, stating that syllables can only end in vowels that are possible in word-final positions, that is long or diphthongized vowels. This principle would be weaker than the other two principles of legality (see p. 11 of this thesis).

The above studies have shown the effect of stress and of legality on the way English speakers syllabify. What is more, several of these studies have also found an interaction between the two factors; that is, the influence of stress is strengthened by legality.

1.1.5. Syllabification in Italian

English and Italian have all of the following four syllable types: V (nucleus alone), C(C)V (onset + nucleus), C(C)VC (onset + nucleus + coda) and VC (nucleus + coda). Differences between the two languages can be found in permissible combinations of vowel phonemes as peaks, permissible combinations of consonant phonemes as onsets and /or codas, relative prominence of peaks (levels of stress) and types of transition from

one syllable to another (Agard and Di Pietro, 1969). In line with the permissible onsets and codas in English so far discussed, only those differences pertaining to consonantal divergences between Italian and English syllable structure will be discussed here. All of the consonants in Italian may occur singly in the onset, /ɲ/ and /ʎ/ (e.g. *gnocco*, *gli*) being less frequent. Occurrence of single consonants in syllable codas depends on the position of the syllable. Word-finally, three different single consonants are frequently found in the coda /l/, /r/, /n/ (e.g. *del*, *per*, *con*). Apocopation, a rather frequent phenomenon in Italian, which involves dropping of final vowels, occurs with a limited inventory of phonemes. The resulting word-final consonants are usually /l/, /r/, /n/, /m/ (*amabil*, *ancor*, *cantan*, *andiam*). Within the onset margin of one syllable, sequences of two and three consonants are permissible (longer sequences are found only across syllable boundaries). The occurrence of single consonants in syllable codas is highly restricted in comparison with that in onset position. No consonant sequences occur in a syllable coda except at the end of a few borrowed words (e.g. *sport*, *film*) (Agard and Di Pietro, 1969).

Regula and Jernej (1975) organize the syllabification legality constraints in Italian in the following way. If only one medial consonant is present in a polysyllabic word, then it will form the onset of the following syllable (e.g. *fa-ci-le*, *co-lo-re*). Combinations of the type obstruent + /l/ or obstruent + /r/ will belong to the following vowel forming an onset, as in *a-cre*, *so-pra*, but not in *tim-bro*, since the cluster *mbr* cannot be word-initial in Italian. Liquids /l/ and /r/ and nasals /m/ and /n/ followed by another consonant will form a syllable with the preceding vowel. In other words, sequences liquid + obstruent and nasal + obstruent will be placed in separate syllables (e.g. *al-be-ro*, *sem-plici-ce*). The

sonorant /s/ will attach itself to the succeeding consonants to form an onset (e.g. *fe-sta, tra-spor-ta-re, e-sclu-de-re*). In case of two identical consonants (i.e. geminates), the first will belong to the coda of the preceding syllable, whereas the second will form the onset of the next syllable (e.g. *car-ro, mol-le*). Finally, diphthongs and triphthongs are indivisible in Italian, as illustrated by *i-ta-lia-no* and *a-iuo-la*. All of the above rules can be summed up under the maximum onset principle, which states that a maximum number of consonants will form an onset of a syllable, as long as such clusters can also occur at the beginning of a word.⁴

Italian is a free stress language, i.e. there is no way to predict on which syllable of a word the stress will fall. No differences in syllabification can be predicted on the basis of stress location (Lepschy and Lepschy, 1988).

⁴ There are some exceptions, which can be found in words such as *a-vro* 'I shall have' and *do-vrei* 'I should'. No word in Italian begins with the sequence *vr-* (Agard and Di Pietro, 1969).

1.1.6. Present study

Research in the area of syllable structure has been done mostly on English, although some work on Chinese (Fudge, 1969), Spanish (Goldsmith, 1981), and other languages has also been done. What this thesis explores is the performance of L2 learners of English, and more specifically Italian-born Canadians, on a word game, which was designed to examine permissible codas. The present study has looked at both legality and stress principles. Legality has been limited to the collocational constraints, or phonologically allowable sequences in English and in Italian.

The stimuli were constructed in such a way that there were only two medial consonants in bisyllabic nonwords, thus reducing the scope of the maximum onset principle. The sonority contour principle was examined with respect to liquids, nasals, and obstruents, as these three collocational parameters were taken into account in stimulus construction. Treiman (1986) found that subjects preferred to keep onsets and rimes intact. The present study explores under what conditions subjects are willing or even prefer to separate the nucleus and the coda. Collocational constraints and stress are examined.

Kahn's (1976) proposed ambisyllabic treatment of syllables was not explored here. As section 2.3 explains, subjects were asked to take the first syllable of the first word they heard and combine it with the second syllable of the second word they heard. For example, if the subject heard ['zɛklən], ['yɪtrəs], s/he may have responded ['zɛktrəs]. It was impossible then to determine whether any of the medial consonants of the first original word (in the example above, [kl]) if included in the first syllable were

also considered by the subject to be part of the second syllable of the first original word. By the same token, it was impossible to determine if the subject considered the medial cluster (or one of the consonants of the cluster) of the second original word (here [tr]) to be part of both the first and the second syllables of that word. The second syllable of the first word and the first syllable of the second word were not used in recombining.

Proposed theories of word recognition and readings such as the vocalic center group (VCG) theory were not looked at by virtue of the design of the task. Since subjects were not presented the stimuli in writing, spelling rules were not available as a possible tool for parsing. This allowed for an isolation and adequate investigation of the factors of interest, which were legality and stress.

1.2. Factors affecting accent transfer to L2

The literature reveals competing views on the factors affecting accent transfer to L2. The Critical Period Hypothesis (CPH), introduced by Lenneberg (1967) and supported for decades by various researchers (Patkowski, 1989; Scovel, 1988) has been questioned by others in more recent years (Flege, 1987; Long, 1990; Singleton, 1995). Other important factors influencing accent in L2 brought forth in the literature were *length of residence* (in the location where L2 is spoken – pertinent to immigrants), *frequency of use of L2*, *quantity and quality of input of L2*, *gender*, *musical ability*, *number of languages spoken* and several others. These factors, studied separately as control variables, have shown that an age-based limitation on the acquisition of native fluency in L2 is by no means the only component in accent studies.

1.2.1. The Critical Period Hypothesis (CPH)

The Critical Period Hypothesis places emphasis on the relationship between age and neural functions of the brain. After puberty, around the age of 12, the loss of cerebral plasticity and CPH exclude the possibility of native-like pronunciation. The theory has gained popularity based on Lenneberg's (1967) clinical tests, where brain-damage and other handicaps associated with effects on language skills were examined. Lenneberg set out to demonstrate that these skills depend on the age at which the handicap occurred. Children, unlike adults, were able to recover completely from certain types of aphasia, by transferring language functions from the dominant to the non-dominant hemisphere after

the trauma. Lenneberg's theory of transfer explains that lateralization and the ability to transfer are linked; transfer meaning the shifting of the linguistic capacities, which have not fully lateralized, from the right to the left hemisphere. Once lateralization is complete, a full transfer would not be possible. Lenneberg claims that lateralization of cerebral function is complete at puberty, creating a barrier for accent-free language acquisition.

Krashen (1973) presented evidence that lateralization of function is completed much earlier, by the age of 5. He claims that this process is not associated with Lenneberg's critical period. Both Krashen's and Lenneberg's tests, however, were more suitable for morphological and syntactic rather than phonological aspects of the language, and were mostly concerned with first-language learning.

Similarly, Long (1990) does not support the CPH claim that there is a sudden loss in L2 abilities at puberty. Plasticity loss is not an abrupt, one-time event, but rather a gradual process. Long believes, however, that L2 learning will be irregular and even incomplete if begun late in life.

1.2.2. Non-biological factors affecting the degree of perceived foreign accent

Asher and Garcia (1969) suggested that children learn the new language in play situations, whereas adults learn in more formal non-action situations, explaining children's superiority in language learning. Asher and Garcia tested this predisposition hypothesis on a group of 71 Cuban immigrants in the United States. Their findings

showed that no child was accent-free, no matter what the age of acquisition was. Already in this early study the conclusion was reached that the age of learning (AOL) was not the sole variable to be considered when testing for degree of foreign accent. The authors found a strong correlation between the AOL and the number of years the subject had lived in the new country.

Another factor that Asher and Garcia examined was whether gender had any effect on the acquisition of a near-native pronunciation. Their 1969 study showed that a child with the highest chances of acquiring near-native pronunciation was under 6 years of age when the learning began and had been in the US for 5 to 8 years. Girls tended to be better than boys, but only in their early years. Children between the ages of 6 and 12 were much more successful than those over the age of 12. This study focused on biological variable, but at the same time it laid the groundwork for future studies that would examine not only the age factor, but also other important factors affecting foreign accent, including *gender*, *length of residence*, and *frequency of use* among several others.

Tahta, Wood and Lowenthal (1981) agreed that the effect of age on L2 acquisition is very marked, especially at the age of 6 years, when foreign accents first become detectable. They saw the period of 7 to 11 years as a very sensitive period to change, whereas the age of 12 was seen as a marker for an invariable accent transfer.

Nonetheless, Tahta *et al.* proposed several other factors that must be considered, since they are relevant in determining the degree of accent in L2 speech. They agreed with Asher and Garcia (1969) and Krashen (1973) that sex, number of years of residence in the L2 country and the models of L2 are important for the subject's performance in the target

language. They also suggested three additional variables that may have an effect on accent transfer: *number of languages spoken, chronological age, and musical ability.*

Flege (1987) questioned the CPH, concluding that there was no irrefutable support for this age-based postulation and that a non-testable hypothesis could not, in fact, constitute a hypothesis. Flege pointed out that some cerebral lateralization of language happens not at puberty (Lenneberg, 1967), but as early as birth (Whitaker *et al.*, 1981). Secondly, he referred to studies that have shown faster initial L2 learning rates for adults than for children (Snow and Hoefnagel-Hohle, 1977), which testifies against the prediction made by the CPH. Flege added that the concept of a critical period was originally developed to describe animal and not human behaviour. Finally, Flege disagrees with the CPH expectations of a marked discontinuity in the ability to pronounce L2 by individuals with different AOLs. He favours a linear relationship between age and perceived foreign accent. Flege concluded that the CPH, if simply assumed to be valid, may actually impede progress in the field of L2 acquisition. According to Flege, the CPH oversimplifies the speech learning process. Human speech is supposed to be mental, material and social. Excluding any one of these leads to limited conclusions. He suggests that the phenomena observed in children were confounded with other conditions because they happen to co-exist with chronological age.

In a study by Flege, Munro and I. MacKay (1995), subjects showed a continuous monotonic pattern of “global foreign accent” as a function of age of arrival (AOA) in the L2 speech community, even if they had begun the acquisition of L2 long before Lenneberg’s critical period. The 1995 study found the effects of age of learning not to be a step function, as described by Patkowski (1989). On the contrary, the degree of

perceived global foreign accent increased smoothly and monotonically as a function of AOA. In other words the older one is at the time of first exposure to L2, the greater the perceived accent. Flege *et al.* (1995) obtained an AOA value of 3.1 for the earliest onset of a foreign accent, this result being much lower than the age of 6 claimed by many (e.g. Tahta *et al.*, 1981; Long, 1990) to be the point where a foreign accent emerges for the first time. The higher end of the scale, AOA=12 or AOA=15, as claimed by Patkowski (1989), was not shown to be an age boundary either. Flege *et al.* (1995) agree that after a certain age it is virtually impossible for an adult to attain native-like pronunciation, but these concrete values (AOA=12 or 15) were not proven by the results. The study collected additional data on subjects through a questionnaire, including quantity and quality of L2 input, concern for native-like pronunciation, and amount of L2 and L1 use in specific situations. Seventy-five percent of the variance on foreign accent rating could be accounted for by factors that were covered by the different questionnaire items, including AOA, which accounted for 63% for females and 55% for males. The amount of L1 and L2 use was the second most important factor and it accounted for 15% of the variance for both genders. The study's aim was not to pinpoint which factors caused listeners to detect a foreign accent, but to show that other factors in addition to AOA accounted for this detection.

1.2.2.1. The Speech Learning Model (Flege, 1995)

Flege, Munro and MacKay (1995) suggest that segmental, subsegmental, and prosodic divergences from the norm are the cues for a listener to judge speech as foreign-accented. Flege's Speech Learning Model (SLM) (1995) attempts to account for the segmental aspects of foreign accent. L2 speakers lose the ability to detect certain differences between L1 and L2 sounds that are phonetically relevant, as a function of their AOA, producing these sounds inaccurately. Because these auditorily detectable differences between sounds are not recognized by the learner, a category for a new L2 sound is not established. Subsequently, the production of the sound is not accurate. Flege (1995) predicts that the closest L1 sound will gradually come to resemble the L2 sound in production. Sometimes new phonetic categories can be established for L2 sounds, but with no guarantee that they will be produced in native-like fashion. In addition, since L1 and L2 sounds exist in a common phonological space, the phonetic categories for neighbouring sounds may be deflected away from one another, according to this model. The SLM, an alternative to the CPH, can be a useful tool in explaining the correlation between AOA and the strength of perceived accent. It also suggests that a bilingual's pronunciation of L1 will be affected. Flege and Fletcher (1992) raise the issue of whether it is even possible for a bilingual to fully separate the sound systems of L1 and L2.

1.2.3. Can the biological variable be discarded?

An important question, raised by Bongaerts *et al.* (1995) and Flege *et al.* (1997), still remains unsolved. Is it feasible for adult learners to speak an L2 without a foreign accent?

For one of the 3 groups used in the 1995 study, Bongaerts *et al.* selected ten native speakers of Dutch, who were considered to be outstanding language learners; their English was judged excellent. The purpose of working with this group was to test the subjects' biological disadvantage (late AOL) against other variables: frequent L2 use (in social situations and academic milieux), exposure to phonetics and pronunciation workshops, and high motivation. The results showed that four of the subjects from this group of Dutch speakers came closest to receiving an ideal score, outperforming a control group of native speakers of English. Bongaerts *et al.* do not claim that the biological variable does not play any role in the equation determining emergence of a foreign accent. Their study is meant to show that other L2 acquisition factors can compensate for a late AOL. Patkowski (1989) would argue with the validity of this study, since for him the CPH concerns naturalistic language acquisition and not formal language learning, to which these subjects were heavily exposed.

To test the other end of the spectrum, Flege *et al.* (1995) set out to examine whether subjects who began learning L2 as very young children would speak it with a strong foreign accent. The study found that one of the native English-speaking listeners judged an Italian immigrant as a non-native speaker of English, even though the subject had immigrated to Canada at the age of 3. Perhaps this individual's acquisition of L2 was

affected by extreme factors, such as severe limitation of exposure to L2 or highly predominant use of L1. Even if this were to be treated as an isolated case, the result cannot be discredited. Not only Flege, but many others (e.g. Tahta *et al.*, 1989; Long, 1990) have shown that children acquiring L2 at AOL as young as 6 will have a foreign accent. As noted earlier, in Asher and Garcia's study (1969), not one of the 71 Cuban immigrants with an AOL between 2 and 12 was found to be accent free.

From this literature we know that the L2 learner acquires aspects of the phonetic and phonological structure of the target language with varying degrees of success, the outcome influenced by such factors as chronological age, the age at which L2 learning is begun, exposure to L1 and L2, number of languages spoken and others.

Another influential factor is the contrast between the phonological structures of L1 and L2. Permissible syllable structure varies by language, and English generally permits more complex onsets and codas than does Italian. The literature on phonological acquisition in L2 referred to above is silent on the question of syllable structure, though change in permissible syllable structure to accommodate the L2 is implicit in the notion of L2 acquisition. It leaves unaddressed the question of the degree to which syllable structure is subject to modification as a function of L2 mastery. The present study sets out to investigate certain aspects of this question. Specifically, in L2 speakers whose L2 phonology has presumably plateaued, do the permissible syllable structures vary according to the age at which learning of L2 began? While not directly studied in the present experiment, the following related questions also present themselves at this time. Does the preferred syllable structure depend on the degree to which L1 continues to be

used in daily life? Secondly, is it the case that the younger the learner and the less the L1 is used in daily life, the more the abstract syllable representation is like that of native speakers of the learner's target language?

1.3. Hypothesis

Syllable structure varies according to native language (for instance, English generally permits more complex codas than does Italian), age of L2 learning and the extent to which L1 continues to be used.

The focus of this thesis is to explore the effect of age of learning on the syllable structure of the L2 speaker. Although it stands to reason that AOA is not the only factor to account for subjects' performance, since the amount the L1 is spoken has been demonstrated as a relevant factor elsewhere, the amount of continued L1 use will not be investigated separately at this time. As a precaution, however, the self-reported use of L1 will be held uniform across groups, as it has proved to be the second most important element accounting for accent transfer in L2 studies (see for example Flege *et al.*, 1995; Flege *et al.*, 1997).

In this study, syllable stress and legality are the two conditions explored in detail with respect to syllable structure. More particularly, this thesis examines the assignment of consonants to the coda, as a means of investigating one aspect of syllable structure. In general, I expect to see the following:

Syllable Stress: English has a more complex stress system of word stress than Italian does (Agard and Di Pietro, 1969). In English stress is used more often to distinguish words, which can be unintelligible if stressed incorrectly. In the 1988 experiment (syllable reversal task [see p. 10 of this thesis]), Treiman and Danis found an effect of stress on syllabification, especially when the original bisyllabic words were

stressed on the second syllable. Treiman and Zukowski (1990) also found stress to be playing a significant role in syllabification. Based on these previous studies, it can be expected that stress will affect constraints on syllabification in English. In addition, given that stress plays a stronger role in syllabic phonology in English than in Italian, it can be expected that these effects will be seen more broadly in English than in Italian.

Legality of clusters (codas): This study will focus on a subset of the factors known to influence syllabification, more specifically the collocational constraints on codas in English and Italian. English and Italian place different constraints on legality of clusters. Monolingual speakers of both languages can be expected to be sensitive to constraints of their native language. Experimental studies (e.g. Treiman and Zukowski, 1990; Treiman and Danis, 1988) found a strong effect of medial consonant type in syllabification in English. The medial consonant was placed in the first syllable more often, thus forming a coda, in the case of liquids and nasals. Medial obstruents were placed more frequently in the second syllable, thus forming an onset. Italian allows a limited number of consonants in the coda. Those frequently found in this position include the liquids /l/ and /r/ and the nasal /n/. This study will look at the effect of legality constraints and any differences between native speakers of English and Italian.

Stress and legality proved significant in experimental work, not only as separate factors, but also as one strengthening the other (e.g. Treiman and Danis, 1988). This study examines this interaction for the native speaker of English, as well as across Italian-speaker groups, investigating how these vary by age of arrival (AOA) in Canada. Specific constraints and predictions follow in the next chapter.

Chapter 2: Method

2.1. Subjects

The participants in this study were Italian-born male and female subjects, who at the time of the study were living in or near Ottawa, Ontario. All of the Italian participants were highly experienced in English, having lived in Canada for an average of 37 years. In addition, a control group of monolingual native English speakers from the Ottawa area participated in the study. Recruiting targeted participants who were 30 to 60 years of age.

Most of the Italian subjects belonged to the Ottawa Roman Catholic community and conveniently for all, the testing took place at the local St. Anthony's Catholic Church. All subjects were paid for their participation and in addition a charitable donation was made in their name.

Before participating, each subject passed a pure-tone hearing screening at octave frequencies of 500–4000 Hz (30dBHL in the best ear). Only subjects who had reported no hearing problems were recruited.

Each participant signed a consent form informing them of the details of the procedures. The consent form briefly outlined the reasons for doing language research, assured the subjects of their privacy and informed them that at any time they might withdraw from the study without prejudice. Subjects were made aware of the fact that their voices would be taped during the experiment.

The native-Italian (NI) subjects were assigned to one of two NI speaker groups; the two groups differed with respect to age of first exposure to English (normally age of

arrival [AOA] in Canada). Each group consisted of 18 subjects. The NI subjects had arrived in Canada between the ages of 1.0 and 24.5⁵ and had lived here for an average of 37 years. The Early NI group consisted of subjects whose AOA was between 1.0 and 13.2, whereas the Late NI group encompassed those subjects whose AOA fell between the ages of 14.5 and 24.5. The two groups were matched for their self-reported continued use of the Italian language⁶ ($t(34)=-299$; $p<.05$). Locating sufficient individuals to permit matching groups was unavoidably a hard task, as the Early NI speakers tend to use Italian less than the Late NI speakers, who are generally more active in local Italian clubs and communities.

A group of 18 Native-English (NE) speakers was used as a control group. The NE speakers were all born and raised in Canada. These monolingual NE speakers were chosen based on their standard variety of Canadian English (Ottawa Valley⁷ and Atlantic varieties were excluded).

The participants in each of the three groups were 49.9 years old on average ($SD = 6.6$). An ANOVA by group showed no significant differences in age ($F(2,51)=1.06$, $p>.05$), and therefore, age was considered to be an adequately controlled factor. Each group was balanced for male and female participants.

As summarized in Table 2.1.1, the two NI groups were matched for self-reported use of Italian, but differed significantly in their AOA in Canada.

⁵ Age statistics are based on taking subject's age at time of testing in years and months and converting this to a real number with 3 significant digits (i.e., one decimal place). All mathematical manipulations are based on such values.

⁶ It was explained that speaking 'Italian' included speaking any regional dialect of Italian or any combination of Standard Italian and regional varieties.

⁷ Urban Ottawa is not in the Ottawa Valley dialect area.

Table 2.1.1 Characteristics of the three subject groups

Groups	Age	AOA	LOR	PerIt
NE	48.5 (7.2)†	N/A	48.5 (7.2)	0
Early NI	49.7 (4.3)†	7.7 (4.1)†	42.0 (4.4)†	30 (16)†
Late NI	51.7 (7.8)†	19.6 (2.9)†	32.1 (7.4)†	32 (22)†
Mean (for groups marked †)	49.9 (6.6)	13.6 (6.9)	37.0 (7.8)	31 (19)

Table 2.1.1. NE = native English speakers (control group); Early NI = native Italian speakers; early arrival in Canada; Late NI = native Italian speakers; later arrival in Canada; Age = age at the time of testing; AOA = age of arrival in Canada (synonymous with first exposure to English); LOR = length of residence in Canada; PerIt = percentage of Italian spoken in subject's daily life (average for the last 5 years). Standard deviations are in parentheses.

2.2. Questionnaire

Two experimenters, A.B. and I.M., tested subjects. Repeated mutual observation of testing procedures assured inter-experimenter consistency. All interaction (verbal and written) between the experimenter and subjects was in English.

A questionnaire was administered to the subjects before the experiment began. The questionnaire aimed at verifying information gathered during initial recruitment, i.e. subjects' age of arrival in Canada (AOA), and self-reported percentage of Italian used (PerIt). Subjects were carefully questioned on the extent of their use of any variety of Italian in the last 5-year period. Percentages were recorded for frequency of Italian used in different situations, including amount of Italian spoken at home, at work, during family

visits, with friends, at church or church functions, on the phone, on vacation, at the barber/hairdresser, while shopping and at social gatherings. Subjects were also asked to list people that they typically spoke Italian with and those with whom they spoke Italian occasionally⁸. Native Italian groups were selected such that subjects in the two groups were as homogenous as possible with respect to their self-reported use of Italian⁹.

Other items in the questionnaire included city and region of birth and years of formal education completed in Italy and in Canada. All the subjects in this study have some degree of familiarity with standard Italian in addition to their dialects.

Italian dialects are usually classified as Northern, Tuscan, Central and Southern (Lepschy, 1988). Most of the subjects immigrated from the southern regions of Italy, including Calabria, Molise, Abruzzi, and Campania, where the Southern dialects are spoken. Hence, no significant inter-dialectal differences were expected. The collocational constraints with respect to syllable structure are very similar among those Italian varieties. Northern dialects allow a more diverse syllable structure through a greater complexity of permissible clusters; thus, a greater number of different syllables can be constructed from a similar sized inventory of phonemes. Moreover, speakers of northern dialects tend to elide unstressed vowels. In the south, the opposite is the case; unstressed vowels are rarely deleted. In fact, epenthetic vowels may be introduced to

⁸ Asking subjects to go over such details is believed to increase the accuracy of the self-reported PerIt by reminding the subjects of various situations in which they use their two languages, and in what proportion.

⁹ Subjects who reported speaking a third language (1) fluently, (2) more often than either one of English or Italian, or (3) more than 5% of their total talking time were eliminated from the study.

break consonant clusters. This epenthesis was occasionally observed in the present study, where subjects tended to separate medial clusters with vowels.

The Early NI speakers tended to have very little if any formal education in Italy, and in general 12 to 17 years of education in Canada. Most of the Late NI speakers had finished elementary school in Italy, and they had very little (1-2 years) formal schooling in Canada. Therefore with respect to the highest level of education completed, the subjects within each of the two groups did not differ significantly. Subjects were asked if they had lived in non-Italian or non-English speaking environments for a period of at least a year. This could have possibly influenced their performance on the task. There were no such cases. Finally, subjects were asked to rate their ability in speaking, understanding, reading and writing in English and in Italian.

2.3. Task

Subject (S) heard two bisyllabic nonword strings (nonce words) such as ['zɛklən] and ['yɪtrəs] and responded by creating a new 'word' composed of the first syllable of the first string and the second syllable of the second string. This particular example yields six possible combinations: ['zɛtrəs], ['zɛrəs], ['zɛktɹəs], ['zɛkrəs], ['zɛkləs] and ['zɛkəs], depending upon where the boundaries between syllables are drawn. All nonce

forms were pronounced as General Canadian English and were presented as being “English nonsense”.

A demonstration of two items was played through headphones to familiarize S with the task, which was referred to as a ‘language game’ in English. The demonstration and practice simulated the task as closely as possible in terms of procedure. Nonetheless, demonstration and practice were deliberately different from the real task in the number of internal consonants. Since the demonstration and the practice items contained only one medial consonant, there were only two possible ways of recombining to create a new ‘word’. The demonstration covered these two possibilities and S was told that s/he might respond either way, whichever s/he preferred.

Subsequent to the two demonstration items, practice of at least four, and up to 16, items was given before the test began. Practice items were bisyllabic nonwords containing tense vowels in the stressed syllable and a single medial consonant, one example being [‘deləs], [‘benən] (see Appendix III).

S heard two nonce words and repeated them both. The experimenter (E) helped the encoding process through production rehearsal. These two steps (listening and repetition) were repeated until S was comfortable with both words. Subjects could also use the rehearsal time to think about what the parts were and they could verify their decision when they heard both items together again. This rehearsal process also ensured that S really heard the item correctly. Once S was comfortable with the two words and E judged that the items were repeated correctly, S responded with a new recombined ‘word’.

There was no mention of a 'syllable' and S's did not see anything in writing. This was intended to minimize the influence of orthography or rules for orthographic hyphenation learned at school. Even in an oral task, people's responses tend to be affected by spelling rules, so in order to further reduce orthographic influences, only nonsense words were used.

In order to help subjects understand the task, E showed S a graphic in which two syllables (called 'parts') are represented as distinctly coloured rectangles. These are placed within larger rectangles representing the nonsense words. A separate graphic representing the recombination of the coloured portions is designed to aid S in understanding the task (see Appendix I). This graphic was left in front of S throughout the experiment. S was told that some people were more visual and others more auditory and that if the graphic helped, S should use it. If the graphic did not help, s/he should ignore it¹⁰.

Test items were 20 pairs of two-syllable nonce words, half of the items having stress on the first syllable, and the remaining ten with the stress on the second syllable. There were two types of cluster sequences presented in order to investigate collocational constraints on syllable structure. Clusters characterized here as * Coda are obstruent-liquid sequences. Such clusters are proscribed codas in either language. An obstruent

¹⁰ Informal observation by E revealed that many S's consulted the graphic during testing and that some ignored it once the testing began.

alone may close a syllable in English, but not in Italian¹¹. Both languages allow the clusters as syllable onsets. Clusters labelled **OK Coda** include liquid-nasal, nasal-obstruent, and liquid-obstruent sequences. The cluster in its entirety is a possible coda in English, as is the initial consonant in the cluster, but only the initial consonant of the sequence may close syllables in Italian. Neither language allows the clusters as onsets.

Table 2.3.1 illustrates the goodness of the first consonant in each cluster type when placed in the coda and as part of the onset. Differences are shown for English and Italian.

Table 2.3.1 Goodness of a single consonant of each medial cluster

Consonant Type	Coda		Onset	
	English	Italian	English	Italian
Obstruent	OK	*	OK	OK
Liquid	OK	OK	OK	OK
Nasal	OK	OK	OK	OK

OK = legal consonant or cluster in specified position

* = illegal consonant or cluster in specified position

¹¹ In the case of double consonants (e.g. *tutto, grappa*), the division into syllables is made between the double consonants. However, the chief phonetic feature of double-consonant sequences is length. In the case of obstruents, the position of articulation is held one and a half to two times as long as with single consonants before being released. From a strictly phonetic viewpoint, there are no double consonants in Italian except /rr/. Pronunciation of the sequences does not involve two completely separate articulations but rather the holding of a single articulation, which is released in the onset of the second syllable (Agard and Di Pietro, 1969)

Table 2.3.2 illustrates allowable and non-allowable sequences for both languages for coda and onset respectively.

Table 2.3.2 Goodness of each cluster type

Cluster Type	Coda		Onset	
	English	Italian	English	Italian
Obstruent-liquid	*	*	OK†	OK††
Liquid-nasal	OK	*	*	*
Liquid-obstruent	OK	*	*	*
Nasal-obstruent	OK	*	*	*

†Some exceptions apply here. For example the sequences *tl-* or *dl-* are not found in English.

†† Likewise, Italian does not permit the sequence *vr-* word-initially.

2.4. Predictions

Native English speakers will be sensitive to both collocational constraints and relative stress (e.g. Treiman and Danis, 1988). Native Italian speakers who began to learn English at an early age should pattern more closely with NE speakers. NI speakers who learned English later in life are expected to pattern least like NE speakers (this was true in other L2 acquisition studies; see for example Flege *et al.*, 1995)

Monolingual Italian speakers (though none were tested) are expected to be sensitive primarily to collocational constraints, since the placement of stress is not predictable in Italian (Vogel, 1982).

2.4.1. Specific Predictions

Syllable Stress: All the groups are expected to syllabify items with a stress on the first syllable (i.e., strong-weak or SW) as CV.CCV (for example [$'z\epsilon . kl\epsilon n$]) or CVC.CV (e.g. [$'z\epsilon k . l\epsilon n$]) for * **Coda**, and everyone should syllabify them as CVC.CV (e.g. [$z\Gamma l . p\epsilon n$]) or CVCC.V (e.g. [$z\Gamma l p . \epsilon n$]) for **OK Coda**. No differences across groups are expected within a stress level. However, there should be group differences across stress levels. For example, for a * **Coda** item, a NE speaker can be expected to syllabify SW items as CVC.CV ([$'z\epsilon k . l\epsilon n$]), but those items with stress on the second syllable (WS) CV.CCV (e.g. [$y\theta . 'pr\epsilon n$]) (Treiman, 1986). A monolingual Italian, on the other hand, could be expected to syllabify both as CV.CCV ([$'z\epsilon . kl\epsilon n$]), [$y\theta . 'pr\epsilon n$]), since the majority of monosyllabic Italian words are not closed with a consonant. The predicted preferred responses for [$'z\epsilon kl\epsilon n$], [$'y\Gamma tr\epsilon s$] for the NE speaker would be [$'z\epsilon kr\epsilon s$], whereas for the NI speaker the preferred response should be [$'z\epsilon tr\epsilon s$]. In case of the WS pair [$y\theta 'pr\epsilon n$], [$f\theta 'kl\Gamma s$] the preferred response for both the NE and the NI speakers would be [$y\theta 'kl\Gamma s$].

Cluster Legality: A native English speaker presented with SW stimuli [$'z\epsilon kl\epsilon n$], [$'y\Gamma tr\epsilon s$] is predicted to construct a new nonword [$'z\epsilon kr\epsilon s$] or [$'z\epsilon ktr\epsilon s$]. The first consonant in the cluster is derived from the first nonword since English favours closed syllable constructions. It will be possible to determine where the syllable break occurred

by determining which consonants were included. Therefore, in the above example, the syllable break would occur in 2 possible places: CVC . CVC [zɛk . lən] and CVC . CVC [yɪt . rəs] or CVC . CVC [zɛk . lən] and CV . CCVC [yɪ . trəs]. In either case, it can be definitively ascertained that the first syllable of the first nonword was closed with a consonant.

2.5. Stimulus construction

There are 20 pairs of nonwords. The first 10 pairs are of Strong-Weak (SW) stress pattern, next 10 are Weak-Strong (WS). The vowel of a stressed syllable is either /ɛ/, /ɪ/, or /ɑ/, whereas the vowel of the unstressed syllable is always a schwa /ə/. The vowels in the stressed syllables are called ‘short’ or ‘lax’ vowels and cannot end a word in English. An attempt was made to avoid strings which sounded similar to real words in either language, which contained embedded real words in either the first or second syllable, or which, when paired and concatenated in every possible way, yielded real words or embedded real words in either language.

The final syllable of all nonce forms ends with /s/ or /n/. Among the rare codas of Italian, these two are among the more common (e.g. *con*). /l/ is a more common coda in Italian than /s/; however, postvocalic /l/ in English generally has a distinct on-glide, which may be perceived as a separate syllable by NI speakers and thereby destroy the ‘two-part’ (i.e. two-syllable) character of the stimuli. Additionally, experience with NI

subjects shows that the highly velarized English final /ɫ/ is often perceived as /o/ or /u/ by NI speakers, a perception that would contaminate the target observations.

Voices of a male and of a female native English speaker of General Canadian English were used to record the stimuli, so that half the items were recorded with the male voice and half using the female voice. At the same time half of the * Coda items and half of the OK Coda items were recorded by a male and female with varied order. This way any single speaker effects as well as any gender and speaker order effects were controlled for.

The stimuli were recorded and edited using a sound editing program (Cool Edit version 96) in the Phonetics Laboratory at the University of Ottawa. The stimuli were normalized and edited to an average length of 90 ms. A brief period of silence preceding and following the stimulus ensured that no acoustic onset or offset effects interfered with the percepts of the stimuli.

The stimuli were programmed into Wnsparcs software (V3.00)¹² that was in turn used to run the experiment. Subjects heard the test items through a set of headphones; at the same time they were played over loudspeakers, both so that E could monitor progress¹³ and responses during data collection, and so that stimuli were recorded to tape along with S's responses in order to aid in response coding. Subjects' responses were recorded with the help of a Sony DAT recorder (model TCD-D100) via a head-worn condenser microphone (Audio-Technica ATM75).

¹² The software is proprietary to the Department of Biocommunication, University of Alabama at Birmingham. Written by Steve Smith. Used by permission. Wnsparcs stands for "Stimulus Presentation and Response Collection Software for Windows".

¹³ E could not otherwise hear stimuli, since S wore headphones.

2.6. Coding

The coding of the responses was performed by two people (A.B. and D.M.) to insure the validity of the coding process. The initial inter-coder reliability attained the 92.5% level, final agreement reached being 100%. I. M. was consulted in cases of disagreement as a tie-breaker. Each of the responses was coded according to pre-set guidelines agreed on by the coders. Initial coding entailed placing a checkmark under one of the possible correct responses or under 'other' (for coding sheets see Appendix V). All responses were transcribed. Subsequently answers that had been placed under 'other' were qualified further as to the nature of error performed.

Errors were classified into 6 categories: non-response, non-recombination, unknown origin, incorrect nonword repetition, incorrect recombination and task misunderstanding (see Appendix VI). An analysis of errors was not performed at this time; however, this classification was performed at the time of coding and it can certainly be employed in a future study. The analysis looked specifically at codas; therefore those responses that did not qualify as one of the possible answers, but were analyzable in terms of the coda, were coded in terms of presence or absence of the medial consonants originating from the first nonword in the pair.

The two factors tested among the stimuli were Stress (SW, WS) and Legality (* Coda vs. OK Coda). Four distinct designs of stimuli can be found in Table 2.6.1. An

example for each cell in the design is included in the table. A complete list of the stimuli is provided as Appendix IV.

Table 2.6.1 Design of stimulus pairs

Legality	Stress	
	SW	WS
* Coda	Items 1-5 e.g. [ˈzɛklən] [ˈyɪtrəs]	Items 11-15 e.g. [yəˈprɛn] [fəˈklɪs]
OK Coda	Items 6-10 e.g. [ˈzɪlpən] [ˈgɛrtəs]	Items 16-20 e.g. [zəlˈtɑn] [nərˈkɛs]

If the subject committed 3 or more (out of 5) errors of any type within one or more of the four cells, as seen in Table 2.6.1, then the subject was excluded from further analysis. There was one such subject in the Early NI group, who was then replaced by another subject who fit the same criteria.

Chapter 3: Results

The results of the study are presented in this chapter in the following way. First, descriptive statistics of the three groups (**NE, Early NI, Late NI**) will be discussed: *chronological age (Age)*, *age of arrival (AOA)*, and *self-reported amount of continued Italian usage (PerIt)*. Second, an analysis of experimental effects will follow. The analysis will concentrate on the structure of codas, that is the medial consonants chosen by the subject from the first original nonword in each pair. These consonants (if they exist) form the coda of the first syllable that the subject integrates to his/her new nonword. The second syllable of the newly constructed nonword comes from the second word the subject hears (not analyzed here). For example, ['zɛklən] and ['yɪtrəs] could yield ['zɛktɾəs], where [zɛk] comes from the first nonword and [trəs] from the second nonword. The analyzed part in this example is the coda of the first syllable: /k/. In other words, we are interested in what happens to /k/. Deletion represents a 'more Italian' response, given the language's preference for open syllables. Inclusion of /k/ represents a 'more English' response, given that English allows obstruent codas while Italian does not.

Any one of the following four combinations could have been chosen by the subject to form the coda of the first syllable: first consonant of the medial cluster of the first original word (**C1**), second consonant of that cluster (**C2**)¹⁴, both consonants (**C1C2**),

¹⁴ A response containing the second consonant of the cluster (**C2**) without the first consonant of that cluster (**C1**) was a rare occurrence, but nonetheless such responses were present.

or neither one of the consonants (\emptyset). For example, the pair ['zɛklən], ['yɪtrəs] could yield ['zɛkrəs] (C1), ['zɛləs] (C2), ['zɛkləs] (C1C2), or ['zɛtrəs] (\emptyset).

Frequency scores were converted to ratios in order to perform ANOVAs, such that the response categories (C1, C2, C1C2, \emptyset) were analyzed with respect to the placement of the consonants in the cluster. The dependent variable in each of the four analyses is the proportion of responses deriving from the first nonword.

The factors examined were **Groups** (NE, Early NI, Late NI), **Stress** (SW and WS), and **Legality** (* Coda, OK Coda). A series of mixed-design ANOVAs was performed for each possible coda type (C1, C2, C1C2, \emptyset). Subsequently, 2-tailed Tukey's post-hoc t-tests were used to explore significant interactions between factors, and 1-tailed t-tests to test directional predictions.

3.1. Description of the groups

Age and continued use of L1 are factors known to affect speech processing. In this experiment both of these factors were controlled for, leaving one dependent variable, namely *age of arrival* (AOA), to be explored.

Table 3.1.1 illustrates subject characteristics for Age, PerIt, and AOA. Standard deviations for each group are listed in parentheses.

Table 3.1.1 Age, PerIt, and AOA across Groups

Group	Age	PerIt	AOA
NE (Control)	48.5 (7.2)	0	0
Early NI	49.7 (4.3)	29.8 (16.5)	7.7 (4.1)
Late NI	51.7 (7.8)	31.7 (22.1)	19.6 (2.9)

Table 3.1.1. NE = native English speakers (control group); Early NI = native Italian speakers; early arrival in Canada; Late NI = native Italian speakers; later arrival in Canada; Age = age at time of testing; AOA = age of arrival in Canada (contemporaneous with first exposure to English); PerIt = percentage of Italian spoken in subject's daily life (average for the last 5 years). Standard deviations are in parentheses.

The participants selected for the study, which include 18 Native English (NE) speakers and 36 Native Italian (NI) speakers did not differ significantly in age ($F(2,51)=1.06, p>.05$). The mean ages for the three groups were as follows (also summarized in Table 3.1.1): NE=48.5(7.2), Early NI=49.7 (4.3), Late NI=51.7 (7.8).

The PerIt (percent usage of Italian) estimates obtained from the two native Italian groups did not differ significantly. A Tukey's test indicated no difference in the amount of use for the Early NI (29.8, SD=16.5) and the Late NI (31.7, SD=22.1) groups ($t(34)=-2.99, p<.05$).

By design, the Early NI group arrived significantly earlier (at a mean AOA of 7.8 years, SD=4.1) than the Late NI group (at 19.6 years, SD=2.9) ($t(34)=-10.087, p<.05$).

Length of residence was correlated with AOA ($r^2=-.73, p<.05$)¹⁵. This confound was unavoidable, as the earlier the subjects arrived in Canada, the longer they have lived here, especially since present age was held uniform across groups.

¹⁵ r^2 =coefficient of determination, or proportion of each variable that is explained by the other.

3.2. Analysis of experimental effects

As stated earlier (2.4 Predictions), NE speakers were expected to be sensitive to both English collocational constraints and stress. If AOA is a factor in syllable structure, then Early NI speakers should pattern closely with NE speakers. Late NI speakers were expected to behave less like NE speakers. If L1 affects syllable structure, then the two Italian-speaking groups should differ in stress or legality or both with respect to NE speakers.

3.2.1. NE speakers

First, it was investigated whether the NE speakers would recombine the nonword pairs according to expected English syllable structure. If the performance of the NE group replicated the results of Treiman and Zukowski (1990), then the control group could be considered satisfactory and/or Treiman and Zukowski's results would be given support. In addition, assurance would be gained that the recombination task is adequate for investigating issues of syllable structure.

As the findings of Treiman and Zukowski (1990) predict, stress influenced NE speakers' syllabification. They gave proportionally more C1 responses for SW items (.892) than for WS items (.574), a significant difference ($t_{1\text{-tailed}}(17)=5.446, p<.05$). There were too few open-syllable responses (\emptyset) to test the prediction that more open syllables should be elicited for WS pairs (.259) than SW ones (.261) ($p>.05$). Even though,

theoretically, a difference may be expected for **C1C2**, such cases also numbered too few to analyze, as was the case in Treiman and Zukowski (1990) study. As expected, no significant difference was obtained for **C2** or **C1C2** across the stress conditions ($p > .05$).

NE speakers have also shown sensitivity to legality when syllabifying words, as predicted by Treiman and Zukowski (1990). More **C1** responses were given when the coda was legal in English (**OK Coda**) (.908) than when it was not (*** Coda**) (.557). This difference reached significance ($t_{1-tailed}(17) = 5.446, p < .05$). No significant differences were found for **C2**, **C1C2** or \emptyset across the legality conditions ($p's > .05$).

No significant interaction was expected between **STRESS** and **LEGALITY**; however an ANOVA revealed that for the NE speakers this interaction was significant in the case of the **C1** measure ($F(1,68)=21.3, p < .05$), and in the case of the neither (\emptyset) measure ($F(1,68)=66.379, p < .05$). The control subjects gave more **C1** responses of type **SW/OK Coda** (.939) than **SW/* Coda** (.844). For the **WS** condition the means were further apart. Subjects gave **WS/OK Coda** responses more often (.878) than **WS/* Coda** responses (.269). A series of Tukey's t-tests have shown a significant interaction between both **SW/OK Coda** and **SW/* Coda** ($t(53)=3.996; p < .05$) and between **WS/* Coda** and **WS/OK Coda** type answers ($t(53)=11.792; p < .05$). NE Subjects also produced more \emptyset responses of type **SW/OK Coda** (.413) than **SW/* Coda** type responses (.109). An opposite trend emerged for the **WS** responses, where **WS/* Coda** responses were more frequent (.433) than **WS/OK Coda** responses (.086). Tukey's t-test have shown significant interaction between the coda-less **SW/OK Coda** and **SW/* Coda** responses ($t(53)=4.142; p < .05$) and between **WS/* Coda** and **WS/OK Coda** responses

($t(53)=12.109$; $p<.05$). No significant interactions for **STRESS X LEGALITY** can be reported for **C2** or **C1C2** ($p's>.05$).

To summarize, all three groups (NE, Early NI, Late NI) were matched for age, and the bilingual groups were matched for amount of L1 spoken. As planned, the two bilingual groups differed with respect to AOA. Control NE subjects performed according to predictions on the recombination task. The results support the findings of Treiman and Zukowski (1990) that English speakers are sensitive to stress and legality. It can be concluded at this point that the design of the experiment was adequate and that the recombination task does, in fact, rely on processes of syllabification.

The next series of steps will investigate whether AOA influences syllable structure. If so, then Early NI arrivals should exhibit more sensitivity to stress and English collocational constraints than Late NI arrivals. If syllable structure is influenced by the speakers' L1 in general, both bilingual groups should syllabify differently than do NE speakers: either in terms of sensitivity to stress or to legality or both. To test these main predictions, a mixed design **(3) GROUP X (2) STRESS X (2) LEGALITY** ANOVA was run for each of the dependent measures (**C1, C1C2, Ø**)¹⁶.

¹⁶ An ANOVA for the dependent measure **C2** was not run. As indicated earlier, second consonant responses without the first consonant were rare (in fact they constituted a type of an error) and therefore did not lend themselves to further analysis.

3.2.2. Analysis for C1

Scores representing proportions of C1 responses were submitted to a **GROUP X STRESS X LEGALITY ANOVA** to determine whether the first syllable of the recombination varies with respect to closure with the first consonant in the cluster. The ANOVA yielded significant main effects of **Group** ($F(2,204)=20.756$), **Stress** ($F(1,204)=9.305$), and **Legality** ($F(1,204)=89.467$) (all $p's < .01$). Of the interactions, both **GROUP X STRESS** ($F(2,204)=9.901$) and **STRESS X LEGALITY** ($F(1,204)=26.15$) reached significance ($p's < .01$). Neither the 2-way interaction, **GROUP X LEGALITY**, nor the 3-way interaction **GROUP X STRESS X LEGALITY** were significant ($p's > .05$).

The effect of **Group** is illustrated in Figure 3.2.2.1, which shows that, as expected, the NE group closed the first syllable with the first consonant of the cluster significantly more often (at a mean proportion of .733) than the Early NI group (at .555), who in turn gave significantly more C1 responses than the Late NI group (at .433) (all $p's < .05$).

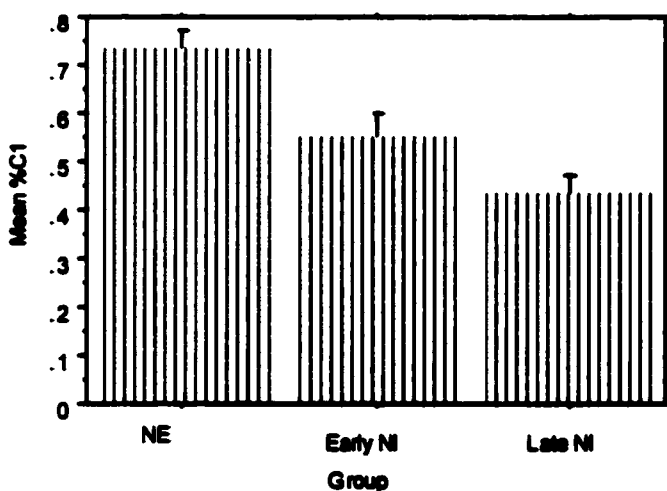


Figure 3.2.2.1 Bar Graph for C1; Effect: Group

The main effect of **Stress** was due to a significantly greater proportion of **C1** responses to **SW** strings (.632) than to **WS** strings (.516). For example, a **SW** string tended to elicit responses such as [ˈzɛkrəs] (from [ˈzɛklən], [ˈyɪtrəs]), but **WS** strings were more likely to elicit responses such as [yəˈklɪs] (from [yəˈprɛn], [fəˈklɪs]). The preference for **C1** closure in **SW** strings is indicated in Figure 3.2.2.2.

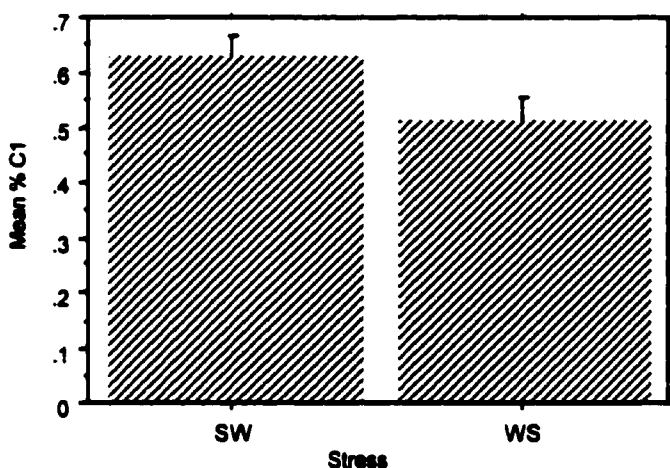


Figure 3.2.2.2 Bar Graph for C1; Effect: **Stress**

The main effect of **Legality** was much more pronounced, as the graph in Figure 3.2.2.3 shows. A mean proportion of only .393 of **C1** responses were given for * **Coda** items, but **OK Coda** items elicited .754. For example, for a * **Coda** string subjects tended to answer with [yəˈklɪs] (from [yəˈprɛn], [fəˈklɪs]), whereas for an **OK Coda** string subjects preferred to answer with [zəlˈkɛs] (from [zəlˈtɒn], [nərˈkɛs]).

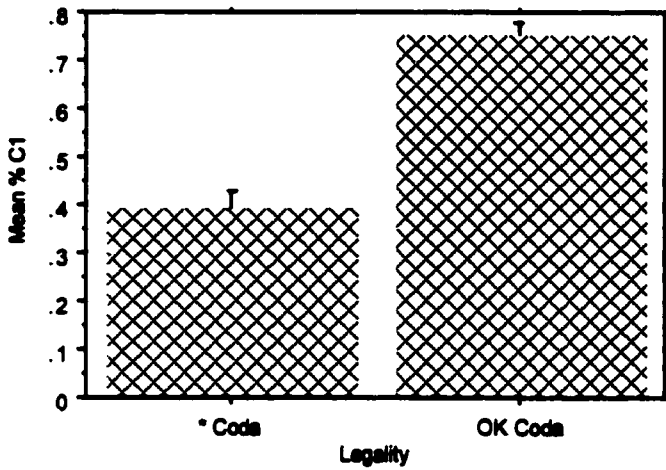


Figure 3.2.2.3 Bar Graph for C1; Effect: Legality

As indicated by Figure 3.2.2.4, an important source of the 2-way **GROUP X STRESS** interaction was a decreasing mean proportion of C1 responses for SW items as AOA increased. The SW condition elicited more C1 responses from the Control group (.892) than from the Early NI group (.619) or from the Late NI group (.385).

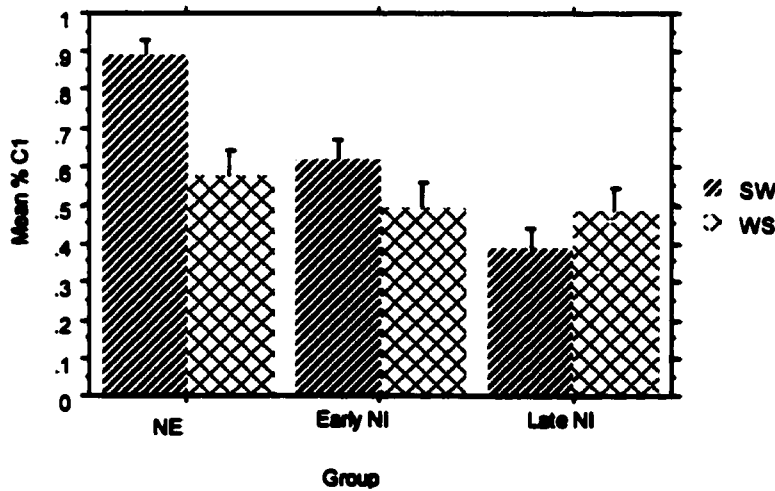


Figure 3.2.2.4 Bar Graph for C1; Effect: Group x Stress

A series of Tukey's post-hocs was run to explore the interaction. All pairwise comparisons between groups in the **SW** condition were significant ($p's < .01$). There were no significant differences between the mean proportions for any of the groups (NE: .574; Early NI: .491; Late NI: .482) in the **WS** condition (all $p's > .05$).

Next, the 2-way **Stress x Legality** interaction was investigated. The mean proportions of **C1** responses for these factors are summarized in Table 3.2.2.1. Interestingly, the greatest mean proportion was observed for **WS/OK Coda** items, whereas the smallest mean proportion was observed for **WS/* Coda** items.

	Count	Mean	Std. Dev.	Std. Err.
SW, * Coda	54	.549	.378	.051
SW, OK Coda	54	.715	.309	.042
WS, * Coda	54	.238	.318	.043
WS, OK Coda	54	.794	.237	.032

Table 3.2.2.1 Means for C1; Effect: **Stress x Legality**

Figure 3.2.2.5 illustrates the cross-over interaction. Note that for *** Coda**, a greater proportion of **C1** responses were given for **SW** items than for **WS** items, but for **OK Coda**, more **C1** responses were observed for **WS** items.

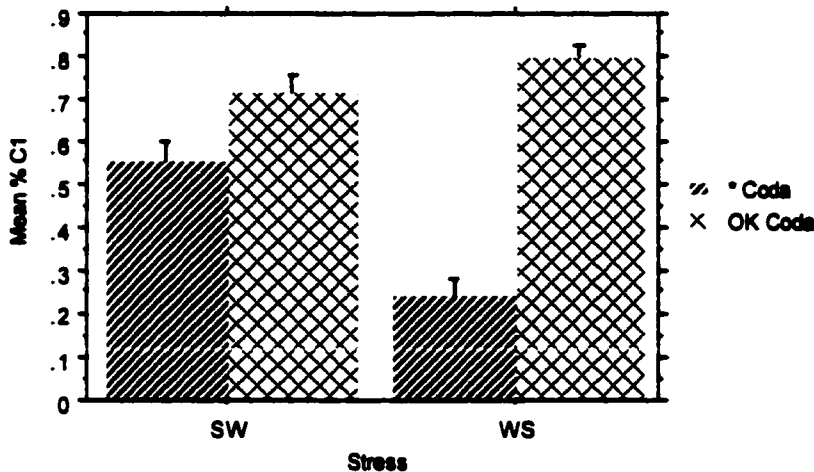


Figure 3.2.2.5 Interaction Bar Graph for C1; Effect: **Stress x Legality**

Unexpectedly, a significant 2-way interaction for **Stress x Legality** was obtained. Since the interaction between **Group** and **Stress** did not prove significant in this analysis, and since this interaction (**Stress x Legality**) does not bear on any of the predictions being tested, it was not explored further.

In brief, the analyses examining the proportion of C1 responses showed main effects of **Group** (NE>Early NI>Late NI), **Stress** (SW>WS), and **Legality** (OK Coda>* Coda). As expected, the significant 2-way **GROUP x STRESS** interaction was due to a decreased sensitivity to stress with increased AOA.

3.2.3. Analysis for C1C2

Scores representing proportions of C1C2 responses were submitted to a (3) GROUP X (2) STRESS X (2) LEGALITY ANOVA to determine whether the first syllable of the recombination varied with respect to closure with a two-consonant coda. The ANOVA produced a significant main effect of Group ($F(2,204)=7.806, p<.01$). Stress and Legality were not found significant ($p's>.05$). Of the interactions, only STRESS X LEGALITY approached significance ($p=.0604$), whereas GROUP X STRESS, GROUP X LEGALITY, and the 3-way interaction GROUP X STRESS X LEGALITY were not found to be significant ($p's>.05$).

The effect of Group is illustrated in Figure 3.2.3.1, which shows that the NE group closed the first syllable with both consonants of the cluster significantly more often (mean=.206) than the Early NI group (.130) and than the Late NI group (.095) ($p's<.05$).

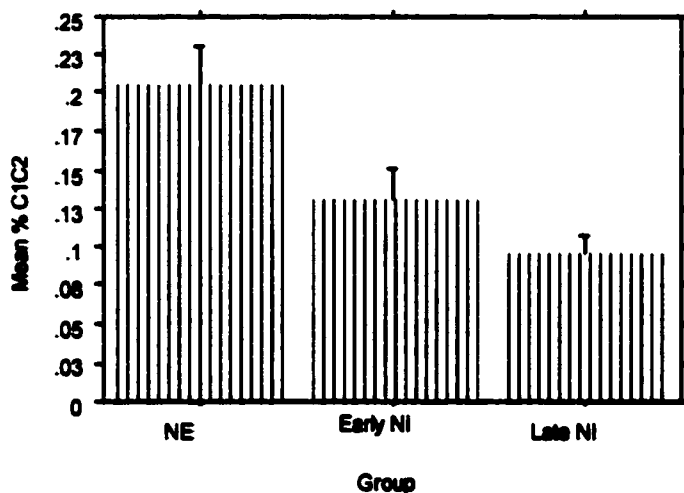


Figure 3.2.3.1 Bar Graph for C1C2; Effect: Group

Due to very small means in this category of responses, no further effects could be explored. More effects may have been observed had there been more responses of type C1C2. This might be the case with a greater number of items in a future experiment.

3.2.4. Analysis for Ø

Scores representing proportions of Ø responses (no coda) were submitted to a (3) GROUP X (2) STRESS X (2) LEGALITY ANOVA in order to examine whether the first syllable of the recombination varies with respect to an absent coda. The ANOVA yielded significant main effects of **Group** ($F(2,204)=30.988$) and **Legality** ($F(1,204)=14.874$) ($p's < .01$), but not **Stress** ($F(1,204)=.006$, $p > .05$). Of the interactions, both **GROUP X LEGALITY** ($F(2,204)=3.523$) and **STRESS X LEGALITY** ($F(1,204)=57.29$) reached significance ($p's < .05$). Neither the 2-way interaction, **GROUP X STRESS**, nor the 3-way interaction were significant ($p's > .05$).

The effect of **Group** is illustrated in Figure 3.2.4.1, which shows, as predicted, that the Late NI group gave open-syllable responses significantly more often (at a mean proportion of .565) than the Early NI group (at .434), who in turn gave more open-ended syllables than the NE group (.260) (all $p's < 0.05$).

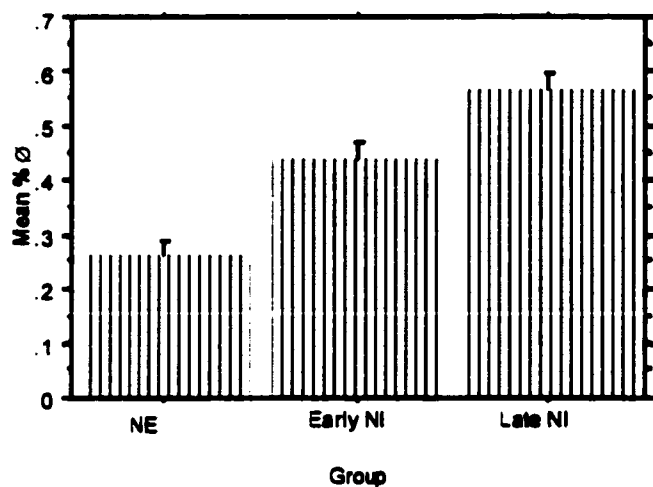


Figure 3.2.4.1 Bar Graph for Ø; Effect: Group

The main effect of **Legality** was due to a greater proportion of Ø responses to *** Coda** strings (.481) than **OK Coda** strings (.358). For example, a *** Coda** string tended to elicit responses such as [ˈketrən] (from [ˈkɛbləs], [ˈzetrən]), whereas **OK Coda** strings elicited responses such as [ˈzɪtəs] (from [ˈzɪlpən], [ˈgertəs]). Differences in preference for Ø closure are indicated in Figure 3.2.4.2.

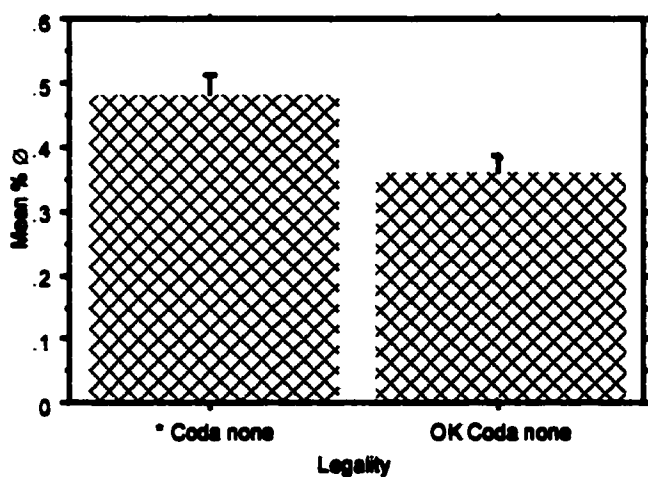


Figure 3.2.4.2. Bar Graph for Ø; Effect: Legality

The two 2-way interactions, **GROUP X LEGALITY** and **STRESS X LEGALITY** are explored next. First, as indicated by Figure 3.2.4.3, an important source of the 2-way **GROUP X LEGALITY** interaction was a more marked increase for open syllable responses (\emptyset) by AOA to * **Coda** items, compared to only a slight increase by AOA for **OK Coda** items. The \emptyset responses elicited by the * **Coda** condition increased from the Control group (.271), through the Early NI group (.493), to the Late NI group (.679). At the same time, as AOA increased, **OK Coda** condition elicited an increase in the \emptyset responses from the Control group (.249), through the Early NI group (.375), to the Late NI group (.451).

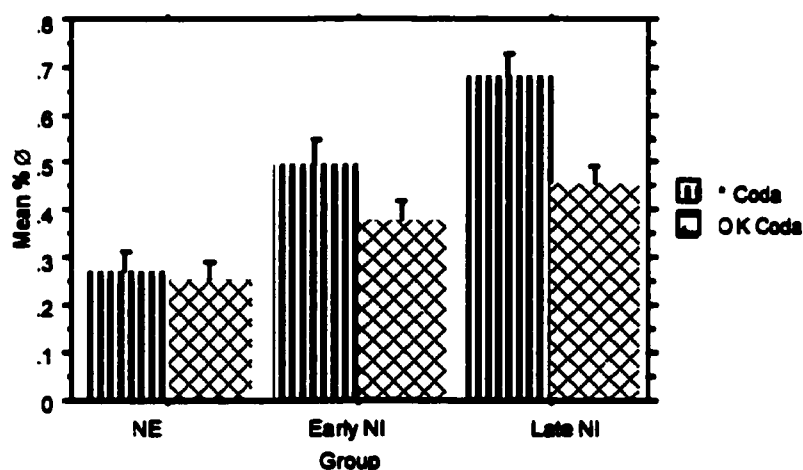


Figure 3.2.4.3 Interaction Bar Graph for \emptyset ; Effect: **Group x Legality**

Means are illustrated in Table 3.2.4.1.

	Count	Mean	Std. Dev.	Std. Err.
Control, * Coda none	36	.271	.245	.041
Control, OK Coda none	36	.249	.225	.037
Early, * Coda none	36	.493	.318	.053
Early, OK Coda none	36	.375	.263	.044
Late, * Coda none	36	.679	.272	.045
Late, OK Coda none	36	.451	.244	.041

Table 3.2.4.1 Means for Ø; Effect: Group x Legality

A series of Tukey's post-hoc tests was run to explore the interaction. For both **Legality** levels, there were significant differences between the Control group and the different NI groups ($p < .05$), but not between the NI groups themselves ($p > .05$). Furthermore, the legality of the consonant cluster influenced Ø responses by the NI groups (* Coda > OK Coda for each, p 's < .05), but not the Control group ($p \geq .05$). These findings are in accord with the observations that neither consonant in the cluster of a * Coda item is an allowable coda in Italian, whereas only the first consonant of the cluster is a possible coda in English.

Next, the 2-way **STRESS X LEGALITY** interaction was investigated. The mean proportions of Ø clusters for the interaction are summarized in Table 3.2.4.2. Interestingly, the greatest mean proportion was observed for **WS/* Coda** items, whereas the smallest mean proportion was observed for **WS/OK Coda** items.

	Count	Mean	Std. Dev.	Std. Err.
SW none, * Coda none	54	.362	.308	.042
SW none, OK Coda none	54	.480	.223	.030
WS none, * Coda none	54	.599	.297	.040
WS none, OK Coda none	54	.237	.229	.031

Table 3.2.4.2 Means for \emptyset ; Effect: Stress x Legality

The cross-over interaction is illustrated in Figure 3.2.4.4. Note that for * Coda, a greater proportion of \emptyset responses were given for WS items, but for OK Coda, more \emptyset responses were observed for SW items.

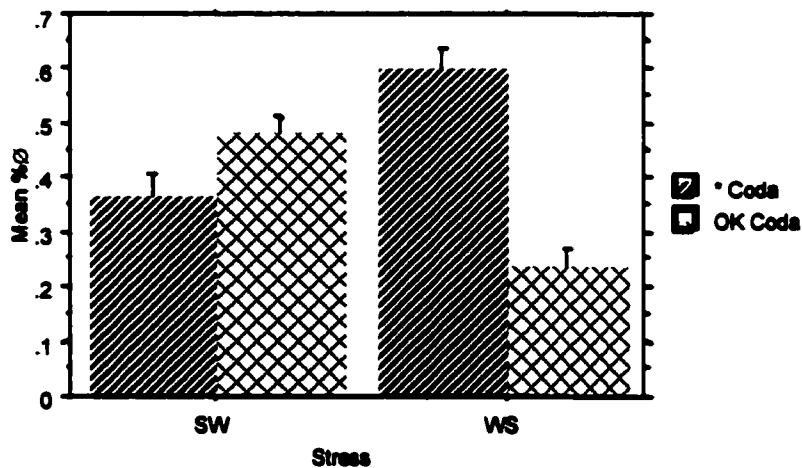


Figure 3.2.4.4 Interaction Bar Graph for \emptyset ; Effect: Stress x Legality

The 2-way interaction **STRESS X LEGALITY** was not an expected one in the design of the experiment. Since the interaction between **Group** and **Stress** did not prove significant in this analysis, no further tests were licensed to investigate this interaction across groups (see speculative explanation in the next chapter).

In brief, the analysis examining the proportion of \emptyset responses showed main effects of **Group** (Late NI>Early NI>Control) and **Legality** (*** Coda** > **OK Coda**). The significant 2-way **GROUP X LEGALITY** interaction was due to a greater tendency to drop the coda, when the coda was classified as **OK Coda** and especially when it was classified as *** Coda**, as a function of greater AOA. Italian speakers prefer to drop codas in either condition, and the *** Coda** condition just heightens this preference. Of the Italian, the Late group was even more inclined to give open-syllable responses.

Chapter 4: Discussion

4.1. Findings

The participants in this study were divided into three groups: Native English speakers constituted the Control group and Native Italian speakers were assigned to one of two groups based on their age of arrival in Canada (AOA); AOA coincided with initial exposure to English. As hypothesized in Chapter 1 of this thesis, the L2 speaker's syllable structure varies according to native language, age of L2 learning and the extent to which L1 continues to be used. The focus of this study was to explore the effect of age of learning on the syllable structure of the L2 speaker. The two Italian groups differed significantly in AOA by design. Both chronological age and amount of continued L1 use were held uniform, as both are known to affect speakers' language processing and performance (e.g. Flege *et al.*, 1995). One small unavoidable confound was the length of residence (LOR), which naturally varied with AOA. The average LOR for the Native Italian subjects was 37 years and therefore they have presumably reached a plateau in their L2 learning.

Several variables have been argued to be relevant in L2 acquisition studies, including *age of learning, frequency of use of L2 and L1, and quantity and quality of input of L2*. The effect of AOA on syllable structure was explored here. More specifically, syllable **Stress** and **Legality** were investigated with respect to syllable structure. The collocational constraints, labelled **OK Coda** and *** Coda**, referred to a

consonant cluster being a legal or an illegal coda in English (see Table 2.3.2.). Stress was investigated in terms of the syllable carrying the primary stress in a bisyllabic word.

Subjects were asked to resyllabify two bisyllabic nonsense words by taking the first part of the first word and the second part of the second word. In other words they were licensed to choose where the syllable break would occur in each word and which of the consonants, if any, they would incorporate into the coda of the first syllable.

As predicted, NE speakers proved to be sensitive to both collocational constraints (**Legality**) and **Stress**. They tended to place the medial consonant in the first syllable more often in the case of liquids and nasals. Clusters of type obstruent-liquid were generally not chosen to form a coda. Items stressed on the first syllable tended to elicit answers with closed syllables, whereas items stressed on the second syllable tended to elicit open syllables. The findings of Treiman and Zukowski (1990) and Treiman and Danis (1988) were paralleled in this experiment. As predicted, NE subjects gave more **C1** responses, or closed their syllables with the first consonant of the medial cluster, in the case of **SW** items as opposed to the **WS** items. Linguists generally agree that **WS** items will be syllabified **V-CV**, where the consonant attaches itself to a (short) stressed vowel. As outlined in Chapter 1, there is some controversy in the literature with respect to **SW** items. According to Pulgram (1970), long, stressed vowels would not require a coda in this condition, whereas short vowels would be followed by a consonant. In this experiment, all the vowels in the **SW** condition were /ɛ/ and /ɪ/. These short, stressed vowels, that normally would not end a word in English, seemed to attract a coda consonant in the **SW** condition.

NE speakers also proved sensitive to **Legality**. They closed their syllables with the first consonant (**C1**) significantly more often when the coda was legal in English (**OK Coda**) than when it was illegal (*** Coda**). For example the OK Coda pair ['zɪlɪpən], ['gɛɪtɪs] tended to elicit responses of type ['zɪltɪs], whereas the * Coda pair ['zɛklən], ['yɪtrəs] tended to elicit ['zɛkrəs] as well as ['zɛtrəs]. The first consonant in clusters classified as **OK Coda** was either a nasal or a liquid. According to Zec (1988), a bisyllabic word containing a sonorant medial consonant, such as liquid or nasal, will tend to be syllabified as part of the rime. This was true in this experiment. Sonorants were especially drawn to the short, stressed vowels that were present in the initial syllable. In other words, NE speakers tended to avoid open stressed syllables. This tendency was especially marked when the consonant following the short stressed vowel was a sonorant. The finding that subjects chose to close syllables with these consonants is in line with the sonority principle. A vowel followed by a liquid or a nasal produces a smooth sonority decline towards the end of the syllable.

Stress and Legality proved to be factors in syllabification of a Native English speaker. An average NE speaker prefers to close syllables with a consonant when the syllable is stressed. The same NE speaker prefers to close a syllable with a consonant cluster when the cluster is legal in coda position.

Although not expected to reach significance, the findings of this study seem to indicate that NE speakers respond to the interaction of **STRESS X LEGALITY**. Examining the **C1** responses, the NE subjects showed a preference for syllable closure when the syllable was stressed and the consonant cluster was legal in English. The stress principle

of consonants being drawn to stressed vowels (Zec, 1988) interacting with the legality of codas are on display here. NE speakers significantly preferred to leave the first syllable open when it was unstressed and the coda was illegal. Both consonants were assumed by the onset of the second syllable, which contained the stressed vowel, pulling the consonant towards it. Moreover, the illegal nature of this coda was respected by eliminating the consonants from the syllable in question. When the coda cluster was legal, NE speakers chose to leave the syllable open more often in the case of first-syllable stress than second-syllable stress. Subjects' behaviour with respect to legality and stress seem to confirm the suggestion by Treiman and Zukowski (1990), that the stress principle and the sonority contour principle are related. Subjects preferred to close syllables with sonorants and they preferred to close those syllables that are stressed. The sonorants in the OK Coda condition are drawn to the stressed vowels.

Overall, the native English Control subjects have shown a greater preference for closed syllables than open syllables. This was especially true when the coda was legal in English. This trend was further supported when the primary stress fell on the first syllable of the word.

Tests performed on the NE group revealed clear-cut results in support of the hypothesized coda preferences for native speakers of English. The NE group had clearly satisfied the role of a control group and further tests were permitted for comparison across all three groups.

Three dependent measures were analyzed: inclusion of the first consonant (C1) into the coda of the first syllable, inclusion of two consonants (C1C2) and exclusion of both consonants (Ø).

The most interesting were the C1 and Ø analyses. These analyses were the most informative about the syllable structure in the L2 speaker. As expected, NE speakers closed the first syllable with a consonant (C1) more often than the Early NI group, who in turn did the same more often than the Late NI group. For example, from the pair [ˈzɛklən], [ˈyɪtrəs] the NE speakers preferred to create [ˈzɛkrəs] or [ˈzɛktrəs]. Conversely, Late NI speakers gave open-syllable responses significantly more often than the Early NI group, who nonetheless gave open-syllable responses more often than the Control group. This clearly supports the hypothesis that NE speakers prefer to close their syllables, whereas NI speakers, especially those who arrived in Canada later in life, prefer to view syllables as open.

Stress was a significant factor in the C1 analysis. NE speakers proved sensitive to stress. Late NI speakers exhibited a pattern very closely related to the predicted behaviour for monolingual Native Italian speakers, that is they demonstrated the least sensitivity to stress. The proportions of closed syllable responses in the case of the Late NI group were very similar across stress levels. Furthermore, the group did not exhibit a preference for closure of the syllables with a consonant when the first syllable was stressed. This is in line with the prediction that no difference in syllabification will be seen on the basis of stress location for Italian speakers (Lepschy and Lepschy, 1988).

Early NI speakers seem to fall in between the two groups. They exhibit a pattern of preference for closure of the first syllable with a consonant when the first consonant is stressed, however this preference is not as pronounced as in the case of NE speakers. Even at a young age of arrival (mean of 7.8), NI speakers showed the influence of their L1.

In the C1 analysis there were no significant differences in **Legality** effects across groups. All three groups were sensitive to **Legality**. NI speakers were expected to be influenced by Italian collocation constraints (Late NI more so than Early NI speakers). Early NI speakers were expected to be more influenced by English collocation constraints than the Late NI speakers. In the C1 analysis, the dependent measure represents the proportion of responses containing the first consonant of the medial cluster; that is, the cluster was broken up. Even though all of the clusters in their entirety present in the experiment were illegal codas in Italian (see Table 2.3.2), the first consonant varied with respect to its coda legality (see Table 2.3.1). More specifically, the first consonant of the cluster in the **OK Coda** condition was either a liquid or a nasal, which by itself is an acceptable coda in Italian. By contrast, either the first consonant, or the cluster in its entirety, in this condition are acceptable codas in English. In the *** Coda** condition only the initial obstruent of the cluster is an acceptable coda in English. In Italian, however, obstruent codas are proscribed. The findings support the predicted trends. All groups were sensitive to constraints on legality; they differed as a function of the language-particular constraints. In the *** Coda** condition, where the initial medial consonant is an obstruent (legal in English, but illegal in Italian), the Late NI speakers tended to follow

Italian constraints on legality by giving very few such responses. The Early NI speakers, on the other hand, were more influenced by English constraints on legality and gave more C1 responses in the * Coda condition than did the Late NI speakers.

In the case of the \emptyset analysis, **Legality** was significantly different across groups. This time, the proportion of open syllables was examined. As expected, the Late NI speakers chose to leave the first syllable open significantly more often than the Early NI group, who in turn preferred to give open syllable responses more frequently than the Control group. Entire clusters in both the **OK Coda** and the * **Coda** items, are illegal codas in Italian. The first consonant legal in each cluster is a legal coda only for **OK Coda** items. It was not surprising, therefore, to find the Late NI speakers frequently choosing to leave the entire cluster out. However, it is also interesting to point out that even the Late NI speakers chose to leave out a cluster that was illegal in English more often than a cluster that was legal in English. Even though this group showed a preference for open syllables, these late-arrival speakers were exhibiting at least some sensitivity to English legality constraints. After all these speakers have lived in Canada for 37 years on average.

In both, the C1 and the \emptyset analyses, there was a significant interaction between **Stress and Legality**. It is interesting to note that the most frequent responses for C1 were observed for **SW/OK Coda** items (e.g. [ˈzɪltɪs] from [ˈzɪlpən], [ˈgɛrtɪs]), whereas the least frequent responses were found for **WS/* Coda** items (e.g. [yəˈplɪs] or [yəˈpkɪs] were rare from [yəˈprɛn], [fəˈklɪs]). Conversely, in the \emptyset condition, the greatest mean

proportion of no coda (\emptyset) responses was observed for **WS/* Coda** items (e.g. [yə'klɪs] from [yə'prɛn], [fə'klɪs]), whereas the smallest mean proportion was observed for **WS/OK Coda** items (e.g. [zə'kɛs] was rare from [zəl'tɔn], [nɔr'kɛs]). Clearly, the subjects as a whole preferred to close the syllable when the **SW** stress pattern was present and when the coda cluster was legal in English. **NE** speakers did this considerably more often than the **Early NI** speakers, who exhibited this pattern more frequently than the **Late NI** speakers. Conversely, the subjects as a group preferred to leave the syllable open when the stress pattern was **WS** and the coda was illegal in English. In this case the three groups were uniform in their behaviour. All three groups were expected to be sensitive to legality. Only **NE** speakers were expected to be sensitive to stress. These findings show, that in fact, the Italian speakers (especially those who arrived late in life) were consistent in their syllabification with respect to stress. Regardless of whether the item was stressed on the first or on the second syllable, **C1** responses containing legal codas were higher than those containing illegal codas. **NE** speakers, and to some degree **Early NI** speakers, showed that **Stress** and **Legality** feed one another.

No three-way interaction was found significant for any of the conditions tested. Presumably with a larger number of stimuli and even a larger number of subjects, the two-way interaction could be defined more precisely.

The **C1C2** category included those responses that contained both consonants of the cluster. The limited number of **C1C2** responses given by subjects yielded a

significant effect only for Group. In line with the findings for responses containing the first syllable of the cluster (C1), the three groups differed significantly in their choice to include both consonants as the coda of the first syllable. The NE group closed the first syllable with both consonants of the cluster significantly more often than the Early NI group and than the Late NI group. Overall, it was relatively infrequent to maximize the coda. Codas were closed, but generally with a single consonant. Nonetheless, when syllables were closed with a cluster, it was the native English speakers who would do this.

To summarize, the experiment has shown, as predicted, that syllable structure, more particularly the assignment of consonants to the coda, varies according to native language and age of L2 learning. As expected, NE speakers were more sensitive to stress than native Italian speakers, who, as a function of their different AOAs have exhibited two very different patterns in their choice of dividing the experimental nonwords into syllables. Those subjects who arrived in Canada as young children were more sensitive to stress than those Italians who arrived as adults. Similarly, English speakers were more sensitive to English legality than the Early NI speakers, who in turn gave more legal coda responses than the Late NI speakers. The Late NI speakers showed a greater sensitivity to Italian constraints on legality. Overall, the Late NI speakers preferred open-ended syllables across all conditions, which is in line with the expected behaviour for monolingual NI speakers.

Previous studies have found similar behaviour between groups that differ in age of learning for other phonological phenomena. Flege *et al.* (1995) and Flege *et al.* (1997), for example, have found AOA to be the most significant factor accounting for the variability between groups in the case of phoneme perception and production. However, a survey of the literature revealed no previous study that has looked at the syllable structure in the L2 speaker in light of AOA.

For decades, the existence of the Critical Period in second language acquisition has been debated. It has been claimed that a child can acquire a second language without interference from L1 phonology if s/he is exposed to it early enough in life (e.g. Patkowski, 1989). The present study has shown that syllable structure differs according to the speaker's first language. Even in the L2 learner who learned the second language early in life and who has been speaking it for 37 years on average, the persistence of the phenomena can be clearly seen. Consistent with the finding of Flege (1995), the present study reveals that age of arrival in Canada plays a significant role in determining the syllable structure for both those who arrived in Canada as children and those who arrived as adults. Those who came early in life patterned more closely with the syllabification behaviour of Native English speakers. Italian speakers who arrived in Canada later in life behaved similarly to the predicted behaviour for monolingual Italian speakers. It would be useful to include another group in this study, namely a group of monolingual Italian speakers. It would be interesting to examine especially those differences (if any) between the Late NI group and the monolingual Italian group. This, however, was beyond the scope of the present study.

Early NI speakers, who for the most part can be considered bilingual, did not perform either like NE or like Late NI speakers. In most cases their performance can be characterized as being “between” that of NE and Late NI speakers. According to Cutler *et al.* (1989), there are limits on bilingualism. A bilingual speaker has only one dominant language and s/he will behave according to the processes encouraged by her/his first/dominant language. In this case, the bilingual Italians (Early NI), who arrived in Canada between ages of 1 and 13, did not clearly exhibit an anglophone behaviour, nor did they perform exactly as predicted for native Italian speakers.

In conclusion, Age of Arrival (AOA) has proven to be a factor in several phonological areas, such as consonant perception, vowel perception and production. Here we see another area, namely syllabification, in which differences in performance between L2 speakers and native speakers persist years after L2 proficiency has plateaued (in this case averaging 37 years!).

4.2. Future Research

Responses where subjects closed the syllable with the second consonant (C2) or both consonants (C1C2) were too few to reach significance in this study. A future study with a larger number of test items could explore these potential differences further.

Late NI speakers exhibited some sensitivity to English legality constraints, as evidenced by occasionally choosing to close syllables, as opposed to leaving them open,

and by choosing codas that, in Italian, are unacceptable. It would be interesting to compare the Late NI speakers with a monolingual NI group. The latter would be expected to show no preference for the * Coda or the OK Coda conditions for the \emptyset measure, as both are illegal in Italian. However, a difference should be observed for the C1 measure.

Similarly, Italian speakers who began learning English early in life pattern closely, though not exactly the same as the NE speakers. It would be useful, for the sake of investigating Cutler *et al.*'s (1989) argument that there are limits on bilingualism, to subdivide this group further, that is, to create a subgroup of those speakers who began their learning of L2 very early in life, before the age of 5/6, for example. This would permit a further comparison between this subgroup, whose dominant language may be English, and the group of NE speakers.

Another variable that could be looked at in the future is the percentage of continued L1 use. The Italian groups in this study were balanced with respect to their first language usage. Nonetheless, this factor has proven extremely significant in second language studies dealing with perception and production of L2 (e.g. Flege *et al.*, 1995). More precisely, the investigation would look at not only the influence of age, but also the influence of subjects' first language on their preferred syllable structure. Any possible interactions between AOA and amount of L1 use would be explored.

Appendix I: Graphic

You hear:

Word 1
A B

Word 2
C D

You say:

Word 1
A B

Word 2
C D

Repeat above until you can comfortably say both nonsense words correctly, including all consonant sounds.

Then recombine as follows:

Word 1
A B

Word 2
C D

Word 1
A B

Word 2
C D

New Word
A D

Appendix II: Instructions to Subjects

In today's study, we are asking you to play a kind of word game in English, in which parts of words are moved around or recombined to form new words, as in the picture I have given you.

It's important to realize that none of the words are real words in either English or Italian. All of the "words" are nonsense, but we'd like you to treat them as if they were real.

[point to picture while explaining] You will hear two nonsense words spoken. Please repeat them. You might have some trouble remembering both, but do your best. Then you will hear them again. Please repeat them again. You'll probably do better this time, as these unfamiliar words become more familiar.

When you can say the two words comfortably, we'd like you to reorganize the parts of the words. Please take the first part of the first word and the second part of the second word, and put them together to make a new nonsense word, as we've shown in this picture. *[point]*

You might find you need to repeat the words once, twice, or three times before you're ready to recombine the parts of the words. That's fine. We'll record your response whenever you're ready.

Do you have any questions?

I will guide you through some practice items that will clarify what we want you to do.

[During demo/practice, comment on the different answers given by the "participant" in the following way: You "might" respond this way (point) or you "might" respond this way (demonstrate next). Say "whichever you think is better".]

Appendix III: Practice Items

SW	WS
1 deləs benən	9 də'lus bə'nen
2 lunən kuməs	10 lə'non kə'mus
3 benən deləs	11 kə'mus lə'non
4 kuməs lunən	12 bə'nen də'lus
5 zopən tidəs	13 mə'don gə'bes
6 gebəs midən	14 tə'dis zə'pon
7 tidəs zopən	15 zə'pon tə'dis
8 midən gebəs	16 gə'bes mə'don

Appendix IV: Experiment Items

Legality	Stress	
	SW	WS
* Coda	1 ['zɛklən] ['yɪtrəs] 2 ['nɪdrən] ['yɛgləs] 3 ['zɛtrən] ['vɪgləs] 4 ['yɪtrən] ['kɛbləs] 5 ['kɛbləs] ['zɛtrən]	11 [yø'prɛn] [fə'klɪs] 12 [nø'drɛn] [fə'glɪs] 13 [nø'prɛn] [vø'glɪs] 14 [kə'blɛn] [gø'trɪs] 15 [fə'klɪs] [nø'drɛn]
OK Coda	6 ['zɪlpən] ['gɛrtɪs] 7 ['zɪmpən] ['gɛntəs] 8 ['zɪlmən] ['zɛməs] 9 ['gɛrtəs] ['zɪlpɛn] 10 ['zɛməs] ['zɪlmən]	16 [zəl'tan] [nər'kɛs] 17 [zən'tan] [fəm'pɛs] 18 [zəl'man] [pər'nɪs] 19 [nər'kɛs] [zəl'tan] 20 [pər'nɪs] [zəl'man]

Appendix VI: Types of Errors

E1 = non-response

Subject refuses to answer, or experiment is advanced to the next item.

E2 = non-recombination

Subject gives one of the nonwords as a response.

E3 = unknown origin

Unknown origin of a consonant. Unable to tell from which nonword the consonant in the recombination is derived.

E4 = incorrect nonword repetition

Recombination derives from nonwords repeated back incorrectly, such that the consonants given are not in the same order of the same natural class as the target consonants.

E5 = incorrect recombination

Recombination is not constructed from the first part of the first nonword and the second part of the second nonword. This is mostly an error in the sequencing of consonants in the target nonwords.

E6 = task misunderstanding

Subject does not follow instructions. This includes recombination using the first parts of both nonwords, or interpreting “first part” to be only the nonword’s initial consonant.

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