Vowel Quality in Finnish Loanwords of Swedish Origin:
An Acoustic Study

Generals Paper 1
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1.0 Introduction

Like many related Balto-Finnic languages such as Votic, Veps, Karelian, and dialects of Estonian, Finnish has a palatal harmony system. Vowel harmony may be defined as co-occurrence restrictions on the vowels within a particular domain. In palatal harmony systems, vowels group into front and back sets. Within the domain of harmony, only vowels of a particular set may co-occur, resulting often in extensive suffix allomorphy.

Past accounts of harmony in Finnish have centred largely on the behaviour of loan words with regard to suffix allomorphy (Levomäki 1972; Ringen and Heinämäki 1999; Välimaa-Blum 1999). The majority of these analyses have been based solely on written studies of suffix selection. This paper examines both the stem internal vowels of such loan words as well as the suffix harmony but from an acoustic perspective. The speech of eight Finnish speakers of two age groups was acoustically analyzed to determine, first, the normal formant values for Finnish. The stem vowels of disharmonic loans were then examined to determine whether the loans were pronounced as they are written, disharmonically, or if any degree of stem harmonization occurs. Finally, the suffix vowels of the loan words, both disharmonic and back neutral (BN), were evaluated to establish how Finns are suffixing such loans in speech.

The results of the study indicate that the disharmonic loan words examined are normally pronounced as they are written. As well, they tend to be suffixed with front allomorphs
even, at times, when there is no front vowel in the stem to condition the front suffix. The BN loans seem to evidence some lexical patterning but, overall, the loans select front suffixes. As a group, the back neutral loans pattern with the front-final and back neutral compounds.

This paper is structured as follows. Section 2 details the native harmony pattern of Finnish, which is, overall, very regular. Section 3 describes the harmony patterns found in loan words, both in terms of stem harmony and suffix harmony. The following section, Section 4, summarizes previous work on Finnish vowel phonetics and Finnish vowel harmony. Section 5 outlines the experiment that forms the basis of this paper. Sections 6 and 7 present the experimental results and discussion respectively. The results are related to those of previous studies. Finally, overall conclusions are presented in the final section.

2.0 Native Harmony

The eight vowels of the Finnish inventory are organized into the following three groups: front harmonic vowels /y,ø,æ/; back harmonic vowels /u,o,a/; and two transparent neutral vowels, /i,e/, which are phonetically front\(^1\). Front and back vowels do not co-occur in a word, which is the domain of harmony\(^2\).

(1) Vowel Inventory:

<table>
<thead>
<tr>
<th>Neutral Vowels (N)</th>
<th>Front Vowels (F)</th>
<th>Back Vowels (B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>i [i]</td>
<td>y [y]</td>
<td>u [u]</td>
</tr>
<tr>
<td>e [e]</td>
<td>ö [ø]</td>
<td>o [o]</td>
</tr>
<tr>
<td>ä [æ]</td>
<td></td>
<td>a [α]</td>
</tr>
</tbody>
</table>

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\(^1\) Since Finnish pronunciation is assumed to be nearly identical to the orthography, the orthographic representations are understood to represent the phonetic values throughout.

\(^2\) In fast speech, harmony may sometimes extend across word boundaries (Campbell 1980: 246).
Finnish is an agglutinative language with extensive suffixation. Suffixes that contain harmonic vowels, such as the partitive -tA³, have two allomorphs, one with a front vowel and the other with a back vowel. The suffix allomorph must agree with the harmonic class of the stem.

Relevant examples are provided in (2). The partitive suffix surfaces as –A when the inflectional stem ends in a consonant followed by a short vowel. Stems with only front vowels, such as pöytä (2a), select the front allomorph whereas stems with only back vowels, such as pouta (2b), select the back allomorph. Stems, such as siili (2c), with only neutral vowels, select front allomorphs. The two final examples, kymppi (2d) and kamppi (2e), demonstrate that the neutral vowels are transparent to harmony.

(2) a. pöytä-ä ‘table (par.)’
   b. pouta-a ‘nice weather (par.)’
   c. siili-ä ‘hedgehog (par.)’
   d. kymppi-ä ‘a ten (par.)’
   e. kamppi-a ‘a trip (par.)’

Outside of a very small number of exceptions, harmony is quite regular and is pervasive in Finnish. Exceptions consist only of very few stems which may vacillate in terms of harmony, depending on the case (see Tables 1 and 2). Such words may evidence variation in suffix selection (Campbell 1980: 253). Disharmonic stems do not occur natively in Finnish.

³ The capital A represents an archiphoneme unspecified for front or back.
Table 1: Neutral Stems with Varying Suffix Harmony (Anderson 1980)

<table>
<thead>
<tr>
<th>Nominative Singular</th>
<th>Partitive Singular</th>
<th>Partitive Plural</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>vesi⁴</td>
<td>vet-ta</td>
<td>ver-i-ä</td>
<td>‘water’</td>
</tr>
<tr>
<td>meri</td>
<td>mer-ta</td>
<td>mer-i-ä</td>
<td>‘sea’</td>
</tr>
</tbody>
</table>

Table 2: Ci/eCa- Stem with Varying Suffix Harmony (Anderson 1980)

<table>
<thead>
<tr>
<th>Lexical Item</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>hilja</td>
<td>‘quiet’</td>
</tr>
<tr>
<td>hilja-is-uus</td>
<td>‘quietness’</td>
</tr>
<tr>
<td>hilje-mpa-na</td>
<td>‘quieter (essive)’</td>
</tr>
</tbody>
</table>

3.0 Harmony in Loan Words

3.1 Stem Disharmony

Historically, disharmonic words entering the lexicon were assimilated in terms of harmony. This is shown with the following words from Swedish which originally contained both front and back vowels. The word for potato (3a) was harmonized to contain only back harmonic and neutral vowels whereas the word for doctor (3b) was harmonized to contain only front and neutral vowels (Skousen 1975: 51; Itkonen and Joki 1981: 526).

(3) a. Swedish pärna → Finnish peruna ‘potato’
    b. Swedish läkare → Finnish lääkäri ‘doctor’

More recently, since at least the 1800’s, some loans have been accepted into the language in their disharmonic form, resulting in stems with either back vowels followed by front vowels, as in (4a), or front vowels followed by back vowels, as in (4b). These loans clearly violate stem vowel harmony. Though such disharmonic words occur also in the

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⁴ In vesi, a rule ti → si has applied.
standard lexicon, mostly in the form of learned words, they are also particularly common in Finnish slang (Campbell 1981: 157).

(4) a. analyysi ‘analysis’
   |   |   |
   B B F

   b. tyranni ‘tyrant’
   |   |
   F B

However, some of these loans have varying pronunciations which are not reflected in their orthography. For example, according to Koukkunen (1990), the loan dynamiitii ‘dynamite’ may be either a back harmonic word, a disharmonic word, or a front harmonic word, depending on the dialect, as shown below in (5). Thus, in these cases, orthography is not sufficient to determine the phonetics of the lexical item.

(5) dynamiitti
    a. Back harmonic: tinameeti, tinamentti, tinametti
    b. Disharmonic: tinamyyti, tynameeti, tynamentti, tynamiit(t)i, tynamuutti, tytamiitti
    c. Front harmonic: tynämeeti, tynämentti, tynämetti, tynämiini, tynämiit(t)ti, tynämintti, tynämyntti

There is much uncertain about the pronunciation of these disharmonic loans. According to Skousen (1975: 51-2), the vowels of disharmonic loans, if harmonized, will harmonize to the primary stressed vowel, which is always the initial vowel. Campbell (1977: 246) also notes that harmonization may occur though he states that the direction is not fixed. For example, though the loan olympialaiset most often harmonizes with the initial back vowel giving olumpialaiset, the front variant is also possible, yielding ölympiäläiset.
Wiik (1995 as reported in Välimaa-Blum (1997)) states that the harmonic vowels of disharmonic words may not have the same quality as those of native words but may, instead, have an intermediate quality. For example, the second vowel in *olympialaiset* may be neither [y] nor [u] but more central. As well, Wiik (1965: 50-52) states that prosodic structure is central to the pronunciation and that the domain of harmony is the “stress unit” rather than the word. A stress unit is defined as “a sequence of syllables beginning with a primary-stressed or secondary-stressed syllable and possibly followed by one or more tertiary-stressed syllables” (Wiik 1965: 51). When the disharmonic vowels are in the same stress unit, speakers are likely to have more difficulty perceiving the different harmonic classes and, therefore, are likely to harmonize such vowels. However, when the vowels are in different stress units, the different harmonic categories are more salient and therefore more likely to be maintained.

### 3.2 Suffix Disharmony

The second type of disharmony relates to the suffixation. As previously discussed, suffixes containing harmonic vowels assimilate to the harmonic class of the stem. However, the situation is not so simple with disharmonic loans.

The three types of loans discussed in this section are as follows: those with back harmonic vowels followed by front harmonic vowels such as *analyysi* (referred to as BF); those with front harmonic vowels followed by back harmonic vowels such as *tyranni* (referred to as FB); and those with back harmonic vowels followed by neutral vowels
such as *karamelli* (referred to as BN). The final word type is not actually disharmonic yet displays unexpected behaviour.

It has been stated in the literature that BF loans evidence variation in their suffix choice. The variation is said to be most robust when the front vowel is the high vowel, as shown in (6a). There is disagreement as to whether or not the mid vowel allows suffix variation, as in (6b). When the front vowel is low though, the suffix normally only appears as front, as in (6c) (Campbell 1980: 250-251).

(6) a. hieroglyfi-ä ~ hieroglyfi-a  ‘hieroglyph (par.\(^5\))’
   b. sutenööri-ä ~ ?sutenööri-a  ‘pimp (par.)’
   c. miljonääri-ä  ‘millionaire (par.)’

FB loans display different behaviour. In these cases, as shown in (7), the suffix selected is almost exclusively back regardless of the height of the final stem vowel (Ringen and Heinämäki 1999: 304). It should be noted that there are far fewer of these types of loans\(^6\).

(7) a. följetöngi-a  ‘serial (par.)’
   b. syntaksi-a  ‘syntax (par.)’

A more surprising type of suffix disharmony occurs with back vowel words of four or more syllables which have back vowels in any but the final disyllabic sequence, which has only neutral vowels (BN words). These words, which have no front vowels to condition front suffixes, may sometimes select front suffixes regardless (Campbell 1980: 251-252).

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\(^5\) Par. represents partitive case.
\(^6\) I was unable to find an example of a disharmonic loan word with a high back vowel as the final harmonic vowel.
Though this is unexpected under the traditional accounts of Finnish harmony, it is not unheard of. Campbell (1980: 252) cites Rapola’s (1965: 251) account of the same phenomenon in Old Literary Finnish as well as some modern dialects such as Luopioinen keskuhiitistä (elative plural).

A common analysis is that speakers may optionally analyze these words as compounds since Finnish words are, prototypically, disyllabic. In compound words the suffix agrees with the final element. Thus, if a word such as arkkitehti were to be analyzed as a compound containing two disyllabic elements, the final element, tehti, would contain only neutral vowels, which would account for the front suffix allomorph (9a). When the word is analyzed as a single element, the suffix allomorph selected would be back (9b).

(9) a. Compound analysis: [ark.ki][teh.ti-ä]
    b. Single morpheme analysis: [ark.ki.teh.ti-a]

These loans are clearly notable, even for speakers, and are subject to prescriptive rules concerning suffix selection. These rules stipulate that the suffix should agree with the harmonic class of the final harmonic vowel. Only if the final harmonic vowel is the high front vowel /y/, is either allomorph considered acceptable (Eronen 2000).

4.0 Previous Studies

Much work has already been done on Finnish vowel harmony, especially in relation to loan words. However, most of this work is based on the analysis of written loans. This is
argued to be sufficient since the orthography normally mirrors the pronunciation of Finnish. However, it is widely suggested that disharmonic loans may be harmonized by speakers. In written format, it would be impossible to determine if harmonization has occurred or, if it has, whether the assimilation is progressive or regressive. As well, it has also been suggested by Wiik (1995 as reported in Välimaa-Blum (1997)) that the vowels of disharmonic loans are not the same as the native vowels but are rather centralized and, thus, are neither truly front nor back.

These claims were tested in the acoustic experiment, outlined in Section 5. Section 4 first provides a summary of relevant work on both the phonetics of Finnish vowels, which will provide the basis for a comparison of the vowel formants in the experimental data, and Finnish vowel harmony in loan words.

4.1 Phonetics of Finnish Vowels

Previous work on the formant structure of Finnish vowels has been published by Wiik (1965) and, more recently, by Iivonen and Laukkanen (1993) and Iivonen and Harnud (2005). The results all show a great deal of regularity indicating that the vowel space of Finnish has remained constant for many years.

4.1.1 Wiik (1965)

The following chart plots the long and short stressed vowels as spoken by five male speakers. The black circles are the means of the long vowels and the white circles, those of the short vowels. The slight centralization of the short vowels is apparent, being most
pronounced with the high back vowel /u/. For all vowels, except for /u/, there is overlap between the short and long variants.

![Figure 1: F1 and F2 distribution of long and short stressed vowels of Finnish as produced by 5 male speakers (Wiik 1965)](http://www.helsinki.fi/speechsciences/projects/vowelcharts/)

4.1.2 Iivonen and Laukkanen (1993)

Iivonen and Laukkanen (1993) studied the Finnish vowels in relation to quantity, adjacent consonants, and word length. A single male speaker produced 352 bisyllabic and trisyllabic words for analysis. The resulting vowel chart is reproduced below in Figure 2. As previously established by Wiik (1965), the short vowels are slightly centralized. Only in the case of /u/ is there a difference of more than one Bark between the short and long vowels.

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7 Data from Wiik (1965); chart from [http://www.helsinki.fi/speechsciences/projects/vowelcharts/](http://www.helsinki.fi/speechsciences/projects/vowelcharts/).
Since the words were not selected to be comprehensive in terms of having each vowel flanked by each consonant type, the influence of adjacent consonants could not be definitively determined. However, the results suggest that, for the vowel /aa/, preceding alveolar consonants result in vowel fronting and preceding labial consonants, in vowel retraction.

Figure 2: F1 and F2 distribution of long and short stressed vowels of Finnish as produced by 1 male speaker (Iivonen and Laukkanen 1993)

Figure 3: F1 and F2 distribution of /aa/ tokens with different preceding consonants (Iivonen and Laukkanen 1993)
Word length had no effect on the quality of the long vowels. Of the short vowels, /u/, /o/, and /y/ were affected, though the changes were all less than one Bark. The back vowels /u/ and /o/ were centralized and the front vowel /y/ was more peripheral in longer words so the effects were not systematic.

4.1.3 Iivonen and Harnud (2005)

Iivonen and Harnud (2005) analyzed the speech of a single male Finnish speaker. They used isolated test words for each of the eight vowels in each of the two quantities. There were 10 words for each vowel category and only stressed vowels were examined8. Their findings are presented below in Figure 4.

Figure 4: F1 and F2 distribution of long and short stressed vowels of Finnish as produced by 1 male speaker (Iivonen and Harnud 2005)

Iivonen and Harnud (2005: 65, 66) note that there are no relevant quality differences between the long and short categories except for the long and short variants of /u/ where short /u/ is more central and more open than long /uu/, as was also seen in previous work.

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8 Primary stress is always on the initial syllable in Finnish.
As well, they observe that their results are almost the same as Wiik’s (1965), with the exception of /æ/, which is more open in Iivonen and Harnud’s data.

4.2 Suffix Disharmony

The following subsections provide descriptions of several previous analyses of suffix harmony in loan words. Those studies of Levomäki (1972) and Ringen and Heinämäki (1999) are based on written surveys provided to university students in Finland. Välimaa-Blum (1999) presents an auditory and acoustic analysis of the speech of three speakers of varying ages. Kiparsky (2003) presents an analysis of the harmony patterns based on an examination of the suffix harmony of loans from Ringen and Heinämäki (1999), Välimaa-Blum (1999), and in the magazine Suomen Kuvalehti (1987).

4.2.1 Levomäki (1972)

Levomäki’s (1972) study involved giving 144 University of Helsinki students a written test focusing on harmonic suffix selection with loan words. The test consisted of 70 FB and BF disharmonic and BN loans. The loan words were presented in nominative form and the respondents were required to inflect the loans with various cases to accord with the syntactic and semantic requirements of the sentence.

The results indicated a great deal of variation in suffix selection. Some lexical items consistently selected front allomorphs, others displayed vacillation, and others consistently selected back allomorphs. As a group, the disharmonic BF loans displayed more variation than the BN loans. However, phonology alone could not account for the
behaviour since phonologically similar stems such as those shown below in Table 3 displayed widely divergent behaviour. % Front denotes the percentage of respondents who selected the front allomorph.

Table 3: Examples of variation in suffix harmony in BN loans (Levomäki 1972)

<table>
<thead>
<tr>
<th>Loan Word</th>
<th>Case</th>
<th>% Front</th>
</tr>
</thead>
<tbody>
<tr>
<td>amulettainA</td>
<td>essive plural</td>
<td>9.2</td>
</tr>
<tr>
<td>appelsiineistA</td>
<td>elative plural</td>
<td>33.3</td>
</tr>
<tr>
<td>arkkitehdeiltA</td>
<td>ablative plural</td>
<td>73.0</td>
</tr>
</tbody>
</table>

Levomäki ultimately concludes that the variation was not completely predictable based on the phonology. However, he does state that the suffix harmony rule which applies to loan words is normally the same as that which applies to the native vocabulary: the suffix accords with the final harmonic vowel of the stem.

4.2.2 Ringen and Heinämäki (1999)

Ringen and Heinämäki (1999) administered written questionnaires, similar in format to Levomäki’s (1972), to three groups of university students. The first group of 50 students was simply asked to list the most natural variant(s). The responses for these speakers are shown below in Table 4. % Front indicates the percentage of respondents who selected the front allomorph, % Back, the percentage who selected the back allomorph, and % Both, the percentage who listed both variants as possible.
Table 4: Suffix variants chosen for disharmonic (FB and BF) loan stems, when asked for the most “Natural” form (Ringen and Heinämäki 1999)

<table>
<thead>
<tr>
<th>Word Type</th>
<th>Word</th>
<th>% Front</th>
<th>% Back</th>
<th>% Both</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disharmonic: FB</td>
<td>syntaksi</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>‘syntax’</td>
</tr>
<tr>
<td></td>
<td>symptomi</td>
<td>2</td>
<td>96</td>
<td>2</td>
<td>‘symptom’</td>
</tr>
<tr>
<td></td>
<td>tyranni</td>
<td>0</td>
<td>98</td>
<td>2</td>
<td>‘tyrant’</td>
</tr>
<tr>
<td></td>
<td>följetongi</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>‘serial’</td>
</tr>
<tr>
<td></td>
<td>kysta</td>
<td>0</td>
<td>100</td>
<td>0</td>
<td>‘cyst’</td>
</tr>
<tr>
<td>Disharmonic: BF</td>
<td>hieroglyfi</td>
<td>80</td>
<td>12</td>
<td>8</td>
<td>‘hieroglyph’</td>
</tr>
<tr>
<td></td>
<td>analyysi</td>
<td>50</td>
<td>36</td>
<td>14</td>
<td>‘analysis’</td>
</tr>
<tr>
<td></td>
<td>marttyri</td>
<td>42</td>
<td>42</td>
<td>16</td>
<td>‘martyr’</td>
</tr>
<tr>
<td></td>
<td>sutenööri</td>
<td>94</td>
<td>2</td>
<td>4</td>
<td>‘pimp’</td>
</tr>
<tr>
<td></td>
<td>jonglööri</td>
<td>86</td>
<td>6</td>
<td>8</td>
<td>‘juggler’</td>
</tr>
<tr>
<td></td>
<td>amatööri</td>
<td>82</td>
<td>10</td>
<td>8</td>
<td>‘amateur’</td>
</tr>
<tr>
<td></td>
<td>miljonääri</td>
<td>100</td>
<td>0</td>
<td>0</td>
<td>‘millionaire’</td>
</tr>
<tr>
<td></td>
<td>hydrosfääri</td>
<td>96</td>
<td>2</td>
<td>2</td>
<td>‘hydrosphere’</td>
</tr>
<tr>
<td></td>
<td>afääri</td>
<td>80</td>
<td>16</td>
<td>4</td>
<td>‘affair’</td>
</tr>
</tbody>
</table>

The FB words invariably selected back allomorphs. Due to lexical constraints though, there is a paucity of different vowel combinations studied.

There was significant variation with many of the BF loans though, seemingly based, at least partly, on the height of the final harmonic vowel. Most variation was evidenced by words with the final harmonic vowel /yy/ and least by words with the final harmonic vowel /ää/.

A second group of 30 students was asked to respond with the ‘correct’ variant. The results for the BF loans were identical to those of the previous group in three words and, in the remaining six words, demonstrated an increased selection of front allomorphs. These findings conflict with previous assumptions by Campbell (1980) and Välimaa-Blum (1987) that back allomorphs are considered more prestigious by speakers.
The final group of 50 students completed the questionnaire twice, with a month in between writings. The results of these tests demonstrated inter- and intra-speaker variation and are summarized in Tables 5 and 6.

Table 5: Suffix variants chosen for disharmonic (FB and BF) loan stems with one month between trials (Ringen and Heinämäki 1999)

<table>
<thead>
<tr>
<th>Word Type</th>
<th>Word</th>
<th>% Front</th>
<th>% Back</th>
<th>% Both</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disharmonic: BF</td>
<td>hieroglyfi</td>
<td>68.0</td>
<td>6.0</td>
<td>26.0</td>
<td>‘hieroglyph’</td>
</tr>
<tr>
<td></td>
<td>analyysi</td>
<td>40.0</td>
<td>12.0</td>
<td>48.0</td>
<td>‘analysis’</td>
</tr>
<tr>
<td></td>
<td>marttyyri</td>
<td>24.0</td>
<td>44.0</td>
<td>32.0</td>
<td>‘martyr’</td>
</tr>
<tr>
<td></td>
<td>sutenööri</td>
<td>90.0</td>
<td>0.0</td>
<td>10.0</td>
<td>‘pimp’</td>
</tr>
<tr>
<td></td>
<td>jonglööri</td>
<td>80.0</td>
<td>2.0</td>
<td>18.0</td>
<td>‘juggler’</td>
</tr>
<tr>
<td></td>
<td>amatööri</td>
<td>72.0</td>
<td>2.0</td>
<td>26.0</td>
<td>‘amateur’</td>
</tr>
<tr>
<td></td>
<td>miljonääri</td>
<td>96.0</td>
<td>0.0</td>
<td>4.0</td>
<td>‘millionaire’</td>
</tr>
<tr>
<td></td>
<td>hydrosfääri</td>
<td>92.0</td>
<td>0.0</td>
<td>8.0</td>
<td>‘hydrosphere’</td>
</tr>
<tr>
<td></td>
<td>afääri</td>
<td>68.7</td>
<td>6.3</td>
<td>25.0</td>
<td>‘affair’</td>
</tr>
</tbody>
</table>

Variation was observed with some long back neutral loan words though the majority selected back suffixes. The words in italics are three syllables long while the rest are four. Ringen and Heinämäki suggest that words which evidence variation are those which may be analyzed as compound words.

Table 6: Suffix variants chosen for BN loan stems (Ringen and Heinämäki 1999)

<table>
<thead>
<tr>
<th>Word Type</th>
<th>Word</th>
<th>% Front</th>
<th>% Back</th>
<th>% Both</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonic</td>
<td>arkkitehti</td>
<td>48.0</td>
<td>34.0</td>
<td>18.0</td>
<td>‘architect’</td>
</tr>
<tr>
<td></td>
<td>bolshevikki</td>
<td>26.0</td>
<td>70.0</td>
<td>4.0</td>
<td>‘Bolshevik’</td>
</tr>
<tr>
<td></td>
<td>karamelli</td>
<td>16.0</td>
<td>78.0</td>
<td>6.0</td>
<td>‘candy’</td>
</tr>
<tr>
<td></td>
<td>katrilli</td>
<td>6.0</td>
<td>94.0</td>
<td>0.0</td>
<td>‘quadrille’</td>
</tr>
<tr>
<td></td>
<td>fakulteetti</td>
<td>4.8</td>
<td>95.2</td>
<td>0.0</td>
<td>‘faculty’</td>
</tr>
<tr>
<td></td>
<td>adjektiivi</td>
<td>4.0</td>
<td>92.0</td>
<td>4.0</td>
<td>‘adjective’</td>
</tr>
<tr>
<td></td>
<td>artikkeli</td>
<td>4.0</td>
<td>96.0</td>
<td>0.0</td>
<td>‘article’</td>
</tr>
<tr>
<td></td>
<td>fakiiri</td>
<td>0.0</td>
<td>100.0</td>
<td>0.0</td>
<td>‘fakir’</td>
</tr>
<tr>
<td></td>
<td>matrikkeli</td>
<td>0.0</td>
<td>96.0</td>
<td>4.0</td>
<td>‘fakir’</td>
</tr>
<tr>
<td></td>
<td>partikkeli</td>
<td>0.0</td>
<td>96.0</td>
<td>4.0</td>
<td>‘particle’</td>
</tr>
<tr>
<td></td>
<td>ateisti</td>
<td>0.0</td>
<td>96.0</td>
<td>4.0</td>
<td>‘athiest’</td>
</tr>
</tbody>
</table>
Ringen and Heinämäki propose an OT analysis which is capable of predicting the observed allomorphs. Three constraints are concerned with primary and secondary stress and sonority and the fourth is a [-back] alignment constraint. As well, they assume that loan words which are phonotactically possible compounds may be considered as such part of the time by speakers.

However, that, on different occasions, many speakers chose different allomorphs as being acceptable calls into question the reliability of such tests which ask speakers to introspectively determine which variant they would use. As well, it is unclear from such an experiment how the subjects are actually pronouncing the tokens, both in terms of stem and suffix vowels. Ringen and Heinämäki (1999) admit the possibility of stem harmonization but do not account for this possibility within their study. The influence of orthography is a possible factor that is also not discussed.

4.2.3 Välimaa-Blum (1999)

Välimaa-Blum (1999) carried out an acoustic study using three female speakers, ages 22, 50, and 78. The speakers differed greatly in terms of both age and education. They read five repetitions of 54 sentences which required inflecting loan words into various cases suffixes which contained the low vowels /æ~/-/ɑ/. Of the 14 loan words included, three were BF, eight had one or two back vowels followed by neutral vowels, and three were FB.
Though Välimaa-Blum does not discuss whether she examined the stem vowels of the loan words to ensure there was no harmonization, she does discuss the suffixation. She found that, auditorilly, some of the loan words selected a vowel that is neither front nor back but of an intermediate quality. Impressionistically, Välimaa-Blum found that she was unable to classify between 5 and 19% of the suffix allomorphs as either front or back. These auditory results are shown below in Table 7. Unfortunately, the results were averaged and so it is impossible to determine if there is any lexical component to the variation or any age effect.

Table 7: Auditory Analysis of Suffix Vowels in Loan Words (Välimaa-Blum 1999)

<table>
<thead>
<tr>
<th>σ₁σ₂σ₃σ₄</th>
<th>N</th>
<th>Front[æ] %</th>
<th>Back [ɑ] %</th>
<th>[a] %</th>
<th>Speech Error %</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. B+B+F+N</td>
<td>135</td>
<td>84</td>
<td>4</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>b. B+B+N+N</td>
<td>181</td>
<td>47</td>
<td>40</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>c. B+N+N+N</td>
<td>180</td>
<td>51</td>
<td>39</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>d. F+B+N+N</td>
<td>135</td>
<td>19</td>
<td>60</td>
<td>19</td>
<td>2</td>
</tr>
</tbody>
</table>

The results indicate that, with disharmonic loans (a and d in Table 7), the suffix vowel normally corresponds with the final harmonic vowel, though there is some variation. These results conflict with Ringen and Heinämäki’s findings that FB disharmonic loans evidence no variation. It is unexpected that the variation is greater with FB disharmonic loans (d in Table 7) than with the BF disharmonic loans (a in Table 7). As discussed in section 2.2, the common assumption is that the FB loans do not display any variation at all. However, there is a structural difference between the two types of words in Välimaa-Blum’s study which could be responsible. In the FB disharmonic loans, the final harmonic vowel is in the second syllable (first foot) whereas, in the BF disharmonic loans, it is in the third syllable (second foot). In terms of the compound hypothesis, this is
an important difference which could potentially account for the increased front allomorph selection by FB loans.

Significant suffix variation was found with both types of BN loans (b and c in Table 7). Though not discussed by Välimaa-Blum, it does not appear that there is any count effect⁹, as has been seen in Hungarian (Hayes and Londe 2006).

When the eldest speaker’s suffix vowels were analyzed acoustically and averaged, the results were as shown below in Table 8.

<table>
<thead>
<tr>
<th>Vowel</th>
<th>N</th>
<th>F1</th>
<th>F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>[a]</td>
<td>107</td>
<td>mean 686.8</td>
<td>1909.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>st.dev. 99.7</td>
<td>132.9</td>
</tr>
<tr>
<td>[æ]</td>
<td>80</td>
<td>mean 682.6</td>
<td>2060.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>st.dev. 89.3</td>
<td>124.7</td>
</tr>
<tr>
<td>[a]</td>
<td>29</td>
<td>mean 681.9</td>
<td>2014.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>st.dev. 82.6</td>
<td>122.4</td>
</tr>
</tbody>
</table>

F1 was not statistically different for any of the vowels. F2, however, was statistically different for each pair indicating that there are three separate vowels: the front variant, the back variant, and a central variant. However, the statistical difference between [æ] and [a] is only marginally significant.

⁹ A count effect indicates that a greater number of neutral vowels intervening between the back harmonic vowel and the suffix vowel increases the likelihood of front suffix allomorphs.
Auditory analysis of the suffix vowels of native words did not demonstrate this third, centralized vowel. However, it does not appear that acoustic analysis was done to confirm these findings.

Välimaa-Blum’s average for F2 of the back vowel [ɑ] is much higher than the averages for the same vowel as measured by Wiik (1965), Iivonen and Laukkanen (1993), and Iivonen and Harnud (2005). Higher F2 values overall are expected since Välimaa-Blum’s speakers were all female and the participants in the other three studies were male. This gender difference cannot, though, account for the very small F2 difference between the low front and back vowels found in Välimaa-Blum’s study. However, the front and back low vowels were statistically significantly different in her data though they look to be extremely close and the means are separated by only 151.1 Hz. The central vowel is even closer to both the front and back vowels and it is questionable whether the difference is great enough to be perceptually salient.

4.2.4 Kiparsky (2003)

Kiparsky (2003) hypothesizes that different stress patterns are responsible for the suffix selection in many longer words. The usual stress pattern of Finnish is termed rhythmic. Primary stress is always on the initial syllable and, in longer words, secondary stress alternates between the third and fourth syllable, depending on syllable weight.

Words with rhythmic stress, stress that shifts based on syllable weight, are unlikely to demonstrate suffix allomorph variation. Conversely, words with lexical stress, which is
fixed on a particular syllable, regardless of weight, may display suffix variation. This
difference in behaviour is due to the fact that rhythmic stress is unlikely to initiate a new
harmonic domain whereas lexical stress may, though optionally. Thus, words such as
those in (10a) below which have a secondary stress that may shift from the third to the
fourth syllable are classed as rhythmic stems. These stems are expected to not display
suffix allomorph variation. Words such as those in (10b) below have a secondary stress
which is invariently placed on the third syllable and are classes as lexically stressed.
These are the words which are expected to display variation.

(10) a. Rhythmic Stems:
    ár.tik.ke.lil.la  ¿* ár.tik.ke.lil.lä  ‘article’ (Adess.Sg.)

    b. Lexical Stems:
    ból.še.vì.kil.la  ból.še.vì.kil.lä  ‘Bolshevik’ (Adess.Sg.)

5.0 Outline of Experiment

5.1 Experimental Purpose

Previous work has been unable to definitively establish the behaviour of the loan words.
The issues with Levomäki’s (1972) and Ringen and Heinämäki’s (1999) experiments
include the transparent nature of the studies as well as the fact that the researchers cannot
definitively establish the pronunciation of either the stems or the suffixes. As well, they
rely exclusively on the intuition of speakers, which is introspective and, therefore has the
potential to be somewhat unnatural. Välimaa-Blum’s (1999) study does not examine stem
vowels and so cannot ensure that the stems are, indeed disharmonic. As well, the words
were not comprehensive in terms of vowels and surrounding phonological environment.
Finally, the F2s of the vowels were extremely close as well as being unlike previous work
by Wiik (1965), Iivonen and Laukkanen (1993), and Iivonen and Harnud (2005). Thus, an acoustic study which is not transparent in terms of purpose and is controlled in terms of adjacent segments is necessary.

The aims of this study were to determine the following: whether BF disharmonic loans are pronounced as they are written; how BF disharmonic loans are suffixed; and how BN loans are suffixed.

5.2 Participants

Eight native speakers of Finnish participated in the study. The speakers were divided into two age groups, younger and older. The younger group consisted of one male and three females between the ages of 17 and 18. The older group consisted of two males and two females between the ages of 56 and 80.

Table 9: Speaker Distribution by Age and Gender

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Young</td>
<td>1</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Older</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>3</td>
<td>5</td>
<td>8</td>
</tr>
</tbody>
</table>

All were currently residing in Finland and were in Canada for a period of two weeks or less. The four older speakers were current residents of Järvenpää, a town near Helsinki, though all had lived elsewhere in Finland as well. The four younger speakers had only lived in Mikkeli, a town in the Savo region (see map below).

10 Within this paper, speakers are referred to using the following convention. The first element indicates gender: F (female) or M (male). The second, age: Y (younger) or O (older). The final element is a number referring to the individual. For example, the three young females are referred to as FY1, FY2, and FY3.
Finnish spoken in Finland is divided into two major dialects, the Eastern and Western dialects. In the map shown below in Figure 5, the Eastern dialects are indicated by numbers 7 and 8 and the Western dialects by all other numbers. Järvenpää is located in the Western dialect area (approximately in 3c) and Mikkeli, in the Eastern dialect area (in 7b). Though I am not aware of any dialectal differences concerning vowel harmony, it is still a possibility that some may exist\textsuperscript{11}.

![Figure 5: Dialect Map of Finnish\textsuperscript{12}](image)

Though all participants were native Finnish speakers of Finnish, all but one also spoke at least one other language. One older female was mono-lingual while the others spoke

\textsuperscript{11} Iivonen and Harnud remark that Kuronen (2000), in an acoustic study of the stressed vowels of four speakers from Tampere, found that /æ/ and /ɑ/ were quite close together with a distance between of barely one Bark. They state that, in this region, /æ/ and /ɑ/ are often confused auditorily.

\textsuperscript{12} From \url{http://www.kotus.fi/} Research Institute for the Languages of Finland. Map created by Tapani Lehtinen, The Department of Finnish Language and Literature at the University of Helsinki.
some combination of Swedish (the other official language of Finland), English, French, German, and/or Russian. There is some possibility that the knowledge of non-harmonic languages could have an effect on the harmonization, or lack thereof, of the disharmonic loans. However, with only a single monolingual speaker, this possibility remains for further study.

In terms of education, the younger speakers were identical; all were students at the Finnish equivalent of an academic high school, preparing for either college or university. The older speakers were varied in their educational background. Two had completed high school, one, college, and one, university.

A possible issue (which may be related to age) is the application of vowel coalescence. Vowel coalescence is an optional rule which applies to a sequence of unstressed heterosyllabic vowels when the second vowel is low (Iso Suomen Kielioppi 2005: 58-59; Anttila 2009). In effect, if this rule applies, it eliminates the harmonic alternation of the partitive, as shown in the following examples from Anttila (2009).

\[
\begin{array}{lll}
\text{Standard Partitive Form} & \text{Coalesced Form} \\
\text{a. lá.si.-a} & \rightarrow & \text{lá.si-i} \\
\text{b. kén.k-i-ä} & \rightarrow & \text{kén.k-i-i}
\end{array}
\]

Anttila (2009) reports that coalescence is more common among younger speakers. However, within the experiment, no speakers produced coalesced forms.
For disharmonic loans, only a subset of speakers was used due to the labour-intensive nature of this analysis. One participant from each category was selected for analysis: one young male; one young female; one older male; and one older female. In cases where there was more than one possible participant in a given group, for example there were three young females, the speaker with the greatest number of tokens was selected.

5.3 Materials

The materials used in this study consisted of the following sets: control words to determine the overall vowel space of each speaker; target Finnish words originally borrowed from Swedish; and Finnish compound words used as control words for the loan words.

The eight control words, originally used by Wiik (1965), are shown in Table 10. These words are inflected Finnish words embedded in the carrier phrase Sano __ taas. “Say __ again.” The sentences were randomized and the set read 5 times.

<table>
<thead>
<tr>
<th>Word</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>tïkin</td>
<td>‘stitch (genitive singular)’</td>
</tr>
<tr>
<td>tekin</td>
<td>‘you, too’</td>
</tr>
<tr>
<td>tykin</td>
<td>‘cannon (genitive singular)’</td>
</tr>
<tr>
<td>tökin</td>
<td>‘I keep pushing’</td>
</tr>
<tr>
<td>täkin</td>
<td>‘bedspread (genitive singular)’</td>
</tr>
<tr>
<td>tukin</td>
<td>‘log (genitive singular)’</td>
</tr>
<tr>
<td>tokin</td>
<td>‘herd of reindeer (instructive)’</td>
</tr>
<tr>
<td>takin</td>
<td>‘coat (genitive singular)’</td>
</tr>
</tbody>
</table>

Though the control words contained short vowels and the target and compound words contained both long and short vowels, it was determined by Iivonen and Harnud (2005)
that the difference between the quality of the short and long vowels is insignificant. Only
the high back vowel /ut:/ displayed any significant difference between the long and short
variants. This is also apparent in the findings of Wiik (1965) and Iivonen and Laukkanen
(1993), discussed in section 4.1. Thus, the difference was considered to be sufficiently
minimal to allow reliable comparison.

The loan words and compounds are of two types: a set to test the BN loans; and a set to
test the BF disharmonic loans. The purpose of the first set, shown in Table 11, was to test
the behaviour of the BN loan words, such as *adjektiivi*. These six loans were four-syllable
nouns with a back vowel in the first disyllabic sequence and only neutral vowels in the
final disyllabic sequence.

<table>
<thead>
<tr>
<th>Table 11: Back Neutral (BN) Loan and Native Compound Control Words</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Word Type</strong></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Targets</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Controls</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

The six compound words were each composed of two independent disyllabic elements.
Each compound was selected to be as phonologically similar to the loan words as
possible, within the confines of the Finnish lexicon. Due to the constraints of the lexicon,
it was not possible to control fully for the preceding and following consonants and vowels. Compound words were necessary as native Finnish (underived) words are normally two to three syllables in length. Compound words select the suffix allomorph which corresponds to the harmonic category of their final element. Thus, the compounds with front harmonic vowels in their final (disyllabic) element are expected to select front allomorphs whereas compounds with back harmonic vowels in their final (disyllabic) element are expected to select back allomorphs. Compounds with only neutral vowels in their final (disyllabic) element are expected to select front allomorphs.

Only compound words with neutral vowels in the final element were used as controls for these words since additional compound words which had only back or front vowels (and neutral vowels) in the final element were used as controls for the disharmonic words (discussed below). Thus, clear tokens for comparison of back allomorphs and front allomorphs would also be available.

A limitation of having used only compounds with neutral vowels in the final element as controls for the back neutral words is that the absolute number of native compounds which would be expected to select front suffixes (front-final compounds and neutral-final compounds) is higher than the number of native compounds which would be expected to select back suffixes (back-final compounds only). A result of this is a possible priming effect towards front suffixes. This possibility is further discussed in section 6.2.1.
An additional function of the compounds was to allow for an assessment of the prosodic compound theory which has been previously used to explain the behaviour of the loans. This theory, described in section 2.2, maintains that loans are optionally analyzed by speakers as being prosodic compounds.

The purpose of the second set, shown in Table 12, was to test the behaviour of the BF disharmonic loan words, such as *analyysi*. These nine loans were four-syllable nouns with back vowels followed by front vowels. There were three loans with each of the front harmonic vowels /y, ø, æ/ as the final harmonic vowel. The disharmonic loans were documented in the *Kielitoimiston sanakirja* (The New Dictionary of Modern Finnish) as being pronounced disharmonically, as written. The eighteen compound words were selected in the same manner described above.

Table 12: BF Disharmonic Loan and Compound Target and Control Words

<table>
<thead>
<tr>
<th>Vowel</th>
<th>Word Type</th>
<th>Nominative</th>
<th>Partitive</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>/yy/</td>
<td>Targets</td>
<td>molekkyli</td>
<td>molekkyliA</td>
<td>‘molecule’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>analyysi</td>
<td>analyysiA</td>
<td>‘analysis’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>manikyyri</td>
<td>manikyyriA</td>
<td>‘manicure’</td>
</tr>
<tr>
<td></td>
<td>Front-Final Controls</td>
<td>[taksi][kyyti]</td>
<td>Taksikyytiä</td>
<td>‘taxi ride’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[nyky][lyydi]</td>
<td>Nykylyydiä</td>
<td>‘modern Lyydi (a language)’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>[arki][tyyli]</td>
<td>Arkityyliä</td>
<td>‘weekday style (of clothing)’</td>
</tr>
<tr>
<td>/öö/</td>
<td>Targets</td>
<td>amatööri</td>
<td>amatööriA</td>
<td>‘amateur’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>konduktööri</td>
<td>konduktööriA</td>
<td>‘conductor’</td>
</tr>
<tr>
<td></td>
<td></td>
<td>kuvernööri</td>
<td>kuvernööriA</td>
<td>‘governor’</td>
</tr>
</tbody>
</table>
The final consonants of all the disharmonic loans, all but one BN loan, and all but three of the control compounds were alveolar. The non-alveolars, in *ruohorööki*, *rantakäärmė*, *adjektiivi*, and *kureliivi* were velar and labial. According to Iivonen and Laukkanen (1993), /ɑ:/ is fronted following alveolars, in a medial position following velars, and retracted following labials. It is unclear whether their results relate to this situation though. Here, the low vowel is short and the plural marker /i/ intervenes between the consonant and the partitive /ɑ/. Even if the tendency towards fronting is present in this data, since the suffix vowels are (mostly) in similar alveolar environments, it is expected that the tendency should apply equally to all forms.
The target loans listed in the *Vierassanojen etymologien sanakirja* (Foreign Word Etymological Dictionary) were borrowed via Swedish and were included in Finnish dictionaries in the mid-1800s, as shown in Table 13. This, of course, does not mean that they entered the language at the same time, merely that they were sufficiently well known by this period to be included in contemporary dictionaries.

Table 13: Etymology of Loan Words (Koukkunen (ed.) 1990)

<table>
<thead>
<tr>
<th>Date of Inclusion in Finnish Dictionary</th>
<th>Language of Origin</th>
<th>Word</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1838</td>
<td>Swedish</td>
<td>amatööri</td>
<td>‘amateur’</td>
</tr>
<tr>
<td>1838</td>
<td>Swedish</td>
<td>arkkitehti</td>
<td>‘architect’</td>
</tr>
<tr>
<td>1838</td>
<td>Swedish</td>
<td>atmosfäärri</td>
<td>‘atmosphere’</td>
</tr>
<tr>
<td>1838</td>
<td>Swedish</td>
<td>krokotiili</td>
<td>‘crocodile’</td>
</tr>
<tr>
<td>1853</td>
<td>Swedish</td>
<td>adjektiivi</td>
<td>‘adjective’</td>
</tr>
<tr>
<td>1853</td>
<td>Swedish</td>
<td>analyysi</td>
<td>‘analysis’</td>
</tr>
<tr>
<td>1853</td>
<td>Swedish</td>
<td>karamelli</td>
<td>‘candy’</td>
</tr>
<tr>
<td>1853</td>
<td>Swedish</td>
<td>konduktööri</td>
<td>‘conductor’</td>
</tr>
<tr>
<td>1865</td>
<td>Swedish</td>
<td>karriääri</td>
<td>‘career’</td>
</tr>
<tr>
<td>1865</td>
<td>Swedish</td>
<td>karuselli</td>
<td>‘carousel’</td>
</tr>
<tr>
<td>1865</td>
<td>Swedish</td>
<td>konstaapeli</td>
<td>‘constable’</td>
</tr>
<tr>
<td>1865</td>
<td>Swedish</td>
<td>molekyyli</td>
<td>‘molecule’</td>
</tr>
<tr>
<td>Not listed</td>
<td>Swedish</td>
<td>kuvernööri</td>
<td>‘governor’</td>
</tr>
<tr>
<td>Not listed</td>
<td>Swedish</td>
<td>manikyyri</td>
<td>‘manicure’</td>
</tr>
<tr>
<td>Not listed</td>
<td>Swedish</td>
<td>miljonääri</td>
<td>‘millionaire’</td>
</tr>
</tbody>
</table>

It must be noted that this phase of Finnish history was characterized by a surge of nationalism which was marked by the belief that the Finnish language, previously only spoken by peasants, was, indeed, a language of worth. Though Finnish has been largely resistant to loan words, the great increase in uses for the language necessitated a number of loans. That the loans all were from Swedish is owing to the fact that, at the time, Swedish was official language of Finland and was the language of the government and the intellectual elite. The overall attitude towards loan words was not positive though and intellectuals were encouraged to maintain the ‘purity’ of the language by using native
resources to coin words (Hakulinen 1961). In the early 1900s periodicals held contests where readers were invited to submit new words based on Finnish linguistic resources to replace loan words (B. Vähämäki p.c.).

Perhaps unsurprisingly, the majority of the target loans are of quite low frequency. According to the *Suomen kielen taajussanasto* (Frequency Dictionary of Finnish)\(^{13}\), most of the loans used in this study are not among the 12,663 most common words of Finnish. The following chart lists those target words (bolded) or related words which are present in the list.

<table>
<thead>
<tr>
<th>Frequency Ranking</th>
<th>Word</th>
<th>Translation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3740</td>
<td>analysoida</td>
<td>‘to analyze’</td>
</tr>
<tr>
<td>3740</td>
<td>arkkitehtti</td>
<td>‘architect’</td>
</tr>
<tr>
<td>5842</td>
<td>adjektiivi</td>
<td>‘adjective’</td>
</tr>
<tr>
<td>6684</td>
<td>analysointi</td>
<td>‘the process of analyzing’</td>
</tr>
<tr>
<td>6684</td>
<td>molekyli</td>
<td>‘molecule’</td>
</tr>
<tr>
<td>7844</td>
<td>analytiikka</td>
<td>‘analytics’</td>
</tr>
<tr>
<td>7844</td>
<td>analyyttinen</td>
<td>‘analytic(al)’</td>
</tr>
<tr>
<td>9466</td>
<td>arkkitehtuuri</td>
<td>‘architecture’</td>
</tr>
<tr>
<td>9466</td>
<td>konstaapeli</td>
<td>‘constable’</td>
</tr>
<tr>
<td>11536</td>
<td>kuvernememntti</td>
<td>‘government’</td>
</tr>
<tr>
<td>11536</td>
<td>regressioanalyysi</td>
<td>‘regression analysis’</td>
</tr>
</tbody>
</table>

The low frequency did not seem to impair understanding in that none of the speakers asked for clarification of the meanings of any of the loan words and so it is assumed that they were known.

---

\(^{13}\) The *Suomen kielen taajussanasto* is a corpus of Finnish comprised of 408,301 word occurrences from fiction and non-fiction books, newspapers and periodicals, and radio broadcasts. Overall, there were 43,670 different words in the corpus.
5.4 Methods

The words were presented in nominative case in parentheses following a verb which syntactically required the noun to be in partitive case. The speaker was required to inflect the word into the partitive (-(t)a/-(t)ä) to complete the sentence. Since Finnish orthography differentiates between the front and back partitive allomorphs, it was essential that the words in question be written in the nominative to avoid bias.

\[
\begin{align*}
(12) & \quad a. \text{Given:} \quad \text{Tutkii } \_ \_ \quad (\text{molekyyli}) \\
& \quad b. \text{Inflected:} \quad \text{Tutkii molekyyliA} \quad \text{‘S/he examines the molecule’}
\end{align*}
\]

In a pilot study it was noted that the above method was overly transparent for the speakers in terms of experimental purpose. All speakers tested commented on the disharmonic nature of some of the loan words and their uncertainty regarding the correct suffix allomorph. Many were also aware of the existence of a prescriptive rule though most were unable to articulate it.

As a solution to the possibility that responses were overly considered and therefore unnatural, a language game was used to divert attention from the suffixation. The language game has been previously discussed by Campbell (1980), Harrikari (1999), and Vago (1988) and is widely known. It consists of transposing the initial onset and nucleus of adjacent words as shown in the example below. If necessary, the harmonic vowels are adjusted to accord with the new first harmonic vowel of the word.

\[
(13) \quad \text{Tykkääin urheilusta } \rightarrow \text{ ukkaan tyrheilystä}^{14} \\
\quad \text{‘I like sports’}
\]

---

\[^{14}\text{Example from Campbell (1980).}\]
All speakers were trained in the rules of the game prior to recording. Each sentence was first to be read in the normal manner and then to be read with the switched CVs. The lexical items from tables 11 and 12 (loans and native compounds) were randomized and the full list of 39 sentences was repeated four times by each speaker. The speakers were instructed to read the sentences at a normal rate of speech, as they would usually pronounce them. As well, they were assured that there was no ‘proper’ pronunciation nor was there one ‘correct’ way to play the game. Some speakers had played a slightly different variant as children and so were encouraged to use their own method (normally switching only the initial consonants).

It seemed that the language game sufficiently diverted the attention from the suffixation since none of the speakers commented on the loan words. The language game, however, proved to be overly difficult for some speakers. As a result, three speakers only used the language game for the first repetition or part thereof and then, for the remainder, read the sentences only in the normal reading. The game proved to be more difficult for the older speakers with only one older speaker being able to complete the entire experiment using the game while all the younger speakers were able to.

The second function of the language game was to assess the conflicting claims concerning whether stem-internal vowels will harmonize to the new initial syllable (Vago 1988). However, in most cases, the resulting ‘words’ were sufficiently distorted that this claim was impossible to test. Nevertheless, five speakers were able to competently manage the game and, thus, their responses are available for analysis at a future date.
5.5 Procedure

The recording took place in a quiet room in either Toronto or Vancouver. The speakers were part of two separate choirs visiting Canada and the recording was done in the city in which they were performing. The recordings were made with an Audio-Technica AT831b lavaliere microphone and a Fostex FR-2 recorder with 16-bit quantification and 44.1 kHz sampling rate.

The data was inputted into Praat, speech analysis software for Windows (Boersma and Weenink 2005), and, for each vowel in the test and control words, F1 and F2 were measured at the vowel mid-point to minimize the co-articulatory effects of adjacent segments. F2 is particularly important as it represents the front-back dimension of the vowel space. Higher F2s are associated with vowels that are further front.

The spectrogram shown below is from the sentence [sɑno tikin tɑːs] with the highlighted portion the first vowel of [tikin]. The measurements were taken at the midpoint of this vowel, shown here by the line.
Some tokens were ultimately discarded due to either mispronunciations, incorrect case inflections, or unclear vowel formants. Diphthongs were excluded from analysis as there was not a sufficient number for comparison. In some cases speakers inflected the word in the partitive plural. Such cases were included in the analysis. When they occurred with lexical items which had partitive singulars with -tA, such as marjakuusi, the plural forms actually made for a closer comparison with the other partitive singulars, as shown below in Table 15.

Table 15: Comparison of Partitive Singular and Plural Forms

<table>
<thead>
<tr>
<th></th>
<th>Nominative Sg.</th>
<th>Partitive Sg.</th>
<th>Partitive Pl.</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘yew tree’</td>
<td>marjakuusi</td>
<td>marjakuusta</td>
<td>marjakuusia</td>
</tr>
<tr>
<td>‘week day style (of clothing)’</td>
<td>arkkityyli</td>
<td>arkkityyliä</td>
<td>arkkityylejä</td>
</tr>
</tbody>
</table>

The case error rates, per informant, are shown below in Table 16. Partitive plurals, instead of singulars, were not considered to be case errors.
Table 16: Error Rates by Speaker

<table>
<thead>
<tr>
<th>Speaker</th>
<th>Case Errors N.</th>
<th>Case Errors %</th>
</tr>
</thead>
<tbody>
<tr>
<td>MY1</td>
<td>8/156</td>
<td>5%</td>
</tr>
<tr>
<td>FY1</td>
<td>0/156</td>
<td>0%</td>
</tr>
<tr>
<td>FY2</td>
<td>3/156</td>
<td>2%</td>
</tr>
<tr>
<td>FY3</td>
<td>6/156</td>
<td>4%</td>
</tr>
<tr>
<td>MO1</td>
<td>8/156</td>
<td>5%</td>
</tr>
<tr>
<td>MO2</td>
<td>0/101</td>
<td>0%</td>
</tr>
<tr>
<td>FO1</td>
<td>0/147</td>
<td>0%</td>
</tr>
<tr>
<td>FO2</td>
<td>34/156</td>
<td>22%</td>
</tr>
</tbody>
</table>

Speaker FO2, an older female, made a far greater number of speech errors than any other informant. The speech of this speaker was characterized by many hesitations and case errors. Though she began the first repetition using the game, it proved to be too difficult and she quickly abandoned it. This informant was the only mono-lingual speaker and she was noticeably more likely to modify foreign sounds and clusters to accord with Finnish phonotactics.

(14)  
(a) Substitution of foreign consonant: atmosfäär→ [atmosväär]  
(b) Simplification of foreign cluster: krokoitiili → [rokoitiili]

For speaker FO2, two cases, elative and inessive, were incorrect yet were included in the analysis. Both cases contain the low harmonic vowel which is preceded by an alveolar. Thus, it is assumed that they would behave similarly to the partitive case\(^{15}\).

(15)  
(a) Elative case -stA  
(b) Inessive case -ssA  
(c) Partitive case -tA

\(^{15}\) There is no evidence (of which I am aware) that specific suffixes exhibit different harmonic behaviour in Finnish. However, there is some indication that this may occur in Hungarian and so it is not altogether inconceivable (Kontra and Ringen 1986).
Speaker MO1, the oldest speaker at 80 years old, was unable to complete the experiment due to fatigue. Since he had completed 65% of the sentences with no errors, his responses were kept for analysis.

In the control words, only the relevant vowel was measured. With the compounds and loans, all vowels, with the exception of diphthongs, were measured. Overall, 308 control vowels, 3,346 compound vowels, and 2,194 loan vowels were analyzed. Of the compound tokens, 708 were partitive suffix vowels and 2,638 were stem vowels. Of the loan tokens, 435 were partitive suffix vowels and 2,203 were stem vowels. In total, 5,848 vowels were analyzed.

6.0 Results
6.1 Phonetics of Finnish Vowels

Figure 7 plots the Finnish vowel inventory in an acoustic F1 x F2 space from control tVkin in Table 10, as produced by female (a) and male (b) speakers.
To examine differences among the eight vowels in F1 and F2, two separate ANOVA’s were performed with the factors Vowel (eight vowels), Gender (female and male), and Age (Young and Old). With respect to F1, there was a main effect of Vowel ($F(7,307) = 401.079, p<.001$). A Bonferroni post hoc test revealed that all vowels were significantly different from each other ($p < .001$), except for the vowel pairs /u/ and /i/, /y/ and /i/, and /ö/ and /e/. F1 was highest for /a/ (738 Hz) and lowest for /y/ (395 Hz). There was also a highly significant effect of Gender ($F(1,307) = 726.831, p < .001$). On average, females have higher F1 values than do males. The F1 mean for females was 584 Hz and for males, 466 Hz. There was, however, a significant interaction of Vowel and Gender ($F(7,307) = 11.239, p < .001$), indicating that Gender differences (higher F1 values for female speakers) were greater for some vowels than others. There was a greater difference between males and females in terms of F1 for the low vowels vs. the non-low vowels. The factor of Age was not significant ($F(1,307) = 1.910, p = .168$). However, there was a significant Vowel, Age, and Gender interaction ($F(7,307) = 4.246, p < .001$).
The interaction reflected some gender- and age-specific differences among certain vowels. Specifically, older female speakers had higher F1 values for the low vowels and [i], and lower values for [y, ö, u] than did younger female speakers. Older male speakers had lower F1 values for [i, y, ä] than younger male speakers.

With respect to F2, there was also a main effect of Vowel (F(7,307) = 433.864, p < .001). A Bonferroni post hoc test revealed that all vowels were significantly different from each other (p < .001), except for the vowel pair /ö/ and /ä/. F2 was highest for /i/ (2295 Hz) and lowest for /u/ (997 Hz). There was also a main effect of Gender (F(1,307) = 205.129, p < .001). The mean F2 value for females, at 1742 Hz, was higher than that of the males, at 1550 Hz. This difference is fully expected based on anatomical differences. There was also a significant Vowel and Gender interaction (F(7,307) = 5.414, p < .001), indicating that Gender differences were greater for the front vowels compared to the back vowels, as seen in Figure 8.

Figure 8: Differences between male and female speakers in F2 (in Hz) by vowel
The factor of Age also exerted a significant effect on F2 (F(1,307) = 4.612, p = .033). Young speakers, with a mean of 1678 Hz, had a slightly higher mean F2 value than the older speakers, with a mean of 1659 Hz. There were, however, significant interactions of Vowel and Age (F(7,307) = 6.014, p < .001) and Vowel, Age, and Gender (F(7,307) = 2.372, p = .023). These indicated that some of the Gender differences hold only for specific vowels produced by either both or one of the gender groups. Specifically, older speakers had higher F2 values for [i, e] than younger speakers of both genders. Older females had lower values for [u, o] than did younger females. Older males also had higher values for [y] and marginally for [u] than younger males. Overall, this suggests a lack of consistent differences between the two age groups in F2.

6.2 Back Neutral Loans

This section presents the results for the BN loans both as a group and as individual lexical items. As a group, the statistics indicate that the BN loans pattern with the word types which select front suffixes (front-final and back neutral compounds). However, closer examination reveals that not all BN loans pattern identically.

6.2.1 Back Neutral Loans as a Word Type

An ANOVA was performed for F2 of the suffix vowel with the following factors: Age (Young and Old); Gender (Female and Male); and Word Type (Back-Final Compounds, Front-Final Compounds, Back Neutral Compounds, and BN Loans). The ANOVA revealed a main effect of Age (F(1,877) = 54.534, p < .001). The mean F2 of the older speakers, at 1647 Hz, is slightly higher than that of the younger speakers, at 1616 Hz.
Gender also exerted a significant effect of F2 ($F(1, 877) = 545.803, p < .001$). Female speakers have higher mean F2s, as is expected, based on anatomical differences. The mean F2 for females was 1700 Hz and for males, 1497 Hz.

Word Type was also significant: ($F(3, 877) = 236.851, p < .001$). Bonferroni post hoc tests for Word Type revealed that the mean F2 of the suffix vowels of back-final compounds was highly significantly different from the means of the other three word types ($p < .001$). The other word types, front-final compounds, back neutral compounds, and BN loans, all had mean F2s which were not significantly different from each other, indicating that these word types all selected the same suffix allomorph. F2 was the highest for the back neutral compounds (1716 Hz) and lowest for the back-final compounds (1451 Hz). These results are shown in the chart below in Figure 9.

![Figure 9: Mean Suffix F2 Values (in Hz) by Word Type](chart.png)
As well, there was a significant interaction between Age and Gender \( (F(1,877) = 31.532, \ p < .001) \). As the chart in Figure 10 below shows, there is little difference in the mean F2s for younger and older male speakers (1483 Hz and 1506 Hz respectively). There is, however, a larger difference in the mean F2s of younger and older female speakers (1657 Hz and 1770 Hz respectively).

Figure 10: Mean Suffix F2 Values (in Hz) by Age and Gender

The interaction between Age, Gender, and Word Type, was also significant \( (F(3,877) = 10.511, \ p < .001) \). As the charts below in Figure 11 show, there are some differences in the actual means of suffix vowels for the various word types, but no differences in the overall patterning in that the BN loans pattern with the front-selecting word types.
Figure 11: Mean Suffix F2 Values (in Hz) for Four Word Types Produced by (a) Female and (b) Male Speakers
The notable difference seen in the charts is the variation in the front suffixes as produced by the female speakers. The means for the back suffixes for the younger and older speakers are near identical (1518 Hz and 1524 Hz respectively) but the means for the front suffixes are much lower, in all cases, for the younger speakers. The F2 means for the younger speakers are as follows: Front-final compounds, 1726 Hz; Back neutral compounds, 1719 Hz; and BN loans, 1697 Hz. The F2 means for the older speakers are as follows: Front-final compounds, 1885 Hz; Back neutral compounds, 1901 Hz; and BN loans, 1849 Hz. Male speakers do not demonstrate any such age difference.

These differences in the suffix vowels of older and younger females are unexpected based on the results of the tVkin control words, discussed in section 6.1. In these controls, there was no significant difference between the /æ/ vowels of the older and younger females. However, it must be noted that the /æ/ vowels in the controls were stressed vowels in the initial syllable of disyllabic words whereas the /æ/ vowels in the suffixes shown above in Figure 10a are unstressed vowels in the final syllable of five-syllable words and are, therefore, difficult to compare. However, in light of the F2 differences, future research may examine the possible cause(s) of the shift.

In section 5.3, the possibility of priming was discussed. Because only compounds with neutral vowels in the final element were used as controls for the BN loans the absolute number of native compounds which would be expected to select front suffixes (front-final compounds and neutral-final compounds) is higher than the number of native compounds which would be expected to select back suffixes (back-final compounds only). A possible
result of this is priming towards front suffixes. An ANOVA was performed to determine whether this may, indeed, have been a significant concern. If there was a priming effect, it is likely that later repetitions of the same word would display an increased likelihood of being suffixed with front allomorphs. An ANOVA was performed for F2 of the suffix vowel with the following factors: Repetition (1-5) and Lexical Item (adjektiivi, arkkitehti, karamelli, karuselli, konstaapeli, and krokotiili). No significant effects were found for Repetition (F(1,169) = .944, p =.421), indicating that priming is not likely to be a significant issue.

6.2.2 BN Loans by Lexical Item

An ANOVA and Bonferroni post hoc tests were performed to determine if all BN loan words behaved identically in terms of suffix F2. The factors were: Gender (Female and Male); Age (Young and Old); and Lexical Item (adjektiivi, arkkitehti, karamelli, karuselli, konstaapeli, and krokotiili). There was a main effect of Gender (F(1, 169) = 117.370, p < .001). As expected, the mean F2 value for females, at 1754 Hz, was higher than that of the males, at 1544 Hz. There was a highly significant effect of Age (F(1, 169) = 24.918, p < .001). The mean F2 for older speakers was 1729 Hz and for younger speakers, 1652 Hz.

There was some apparent lexical patterning in that Lexical Item (F(5, 169) = 5.047, p < .001) was also highly significant. Some loans, such as adjektiivi, arkkitehti, and konstaapeli, tended towards variation whereas others, such as karamelli and karuselli,
displayed more consistent behavior. The loans *adjektiivi* and *konstaapeli* were, in fact, suffixed with back allomorphs 50% or more of the time by over half of the speakers.

A Bonferroni post hoc test revealed that, of the lexical items, only *adjektiivi*, with the lowest mean F2 of 1614 Hz, and *karamelli*, with the highest mean of 1747 Hz, were statistically different from each other (p < .001). However, it should be noted that when the actual tokens are graphed, most lexical items show considerable overlap. In the chart below in Figure 12, there is clearly great variability in the F2s of the suffix vowels for all groups. It is also clear though that all the BN loans pattern with the other front selecting word types. There are no BN loans which consistently pattern with the back-final compounds.

![Figure 12: Mean Suffix F2 Values (in Hz) by Lexical Item](image-url)

Figure 12: Mean Suffix F2 Values (in Hz) by Lexical Item
The variation seen with the BN loans is greater than that of the phonologically similar BN compounds, indicating potential uncertainty or the treatment by different speakers as different classes (F vs. B, single morpheme vs. compound). In particular, *karamelli* and *karuselli* both display extensive variation in suffix F2 values. It should be noted though that the back neutral compound words also demonstrated some variation in suffix selection with some suffix tokens having F2s in the back vowel range.

The interaction between Age and Gender was significant (F(1, 169) = 5.381, p = .022). Males had similar mean F2s, regardless of age. The younger males had mean F2s of 1519 Hz whereas the older males had mean F2s of 1563 Hz. Females differed with age. Younger females demonstrates a lower mean F2 at 1697 Hz. Older females mean F2 value was 1849 Hz. This interaction was shown in Figure 11 where the productions of four word types (back-final compounds, front-final compounds, BN compounds, and BN loans) were presented.

The interaction between Gender and Lexical Item was found to be highly significant (F(5, 169) = 3.975, p = .002). As the chart below in Figure 13 indicates, females are more consistent in their treatment of the BN loans. For all loans, the females selected suffix vowels with an F2 consistent with front vowels. As well, there was little difference in the F2 values for the different lexical items for females, which varied between means of 1715 and 1793 Hz. Though the men still suffixed all lexical items with allomorphs with F2s consistent with front suffixes, there was much greater variation in the actual F2 means for the different lexical items, which varied between means of 1429 and 1662 Hz. Some
loans, such as *adjektiivi*, *arkkitehti*, and, to a lesser extent, *konstaapeli*, had lower F2 averages which were close to the midpoint between the means of the front-final and back-final compounds.

---

Figure 13: Mean suffix F2 values (in Hz) for Six Lexical Items Produced by Female and Male Speakers

When the F2s of the suffix vowels are charted by informant, it is revealed that there is a fair amount of inter- and intra-speaker variation. The charts below are those of two of the three young female speakers, a group which, as shown in the chart above in Figure 12, overall has a great deal of consistency in their suffix selections. However, when looking at the individual tokens, most words demonstrate considerable variation in F2. The following charts depict the F2s of individual suffix vowels for each BN loan. As shown
by *arkkitehti* and *karamelli*, the words which are most consistent for one speaker are not necessarily consistent for the other.

Figure 14: Suffix F2 Values (in Hz) for BN Loans Produced by Speaker FY1

Figure 15: Suffix F2 Values (in Hz) for BN Loans Produced by Speaker FY2
Charts for all speakers are listed in Appendix 1. It is clear from these charts that there is no consistency either between lexical items or between speakers. Some speakers are very uniform in their treatment of a given lexical item whereas, for another speaker, that lexical item shows great variation. With almost every speaker, there is variation in the suffixation of the BN loans as a group with some words patterning exclusively with the front-final and back neutral compounds and other words demonstrating variation or displaying suffixes with F2s values of an intermediate value.

The individual behavior of each speaker is shown in Table 17 below. In this table, the numbers indicate the percentage of responses in which the F2 value of the loan suffix was above the midpoint line between the average F2 of back-final compounds and BN compounds. Thus, for speaker FY1, a young female, 75% of her suffixes for adjektiivi had F2s which were closer to the average F2 of BN compounds than the average F2 of back-final compounds indicating that 75% of the time, this speaker suffixes adjektiivi with a front allomorph. In the following table, those cells which represent front allomorph selection 50% or less of the time are shaded.

Table 17: Summary of suffixation of BN loans by informant

<table>
<thead>
<tr>
<th>Speaker</th>
<th>adjektiivi</th>
<th>arkkitehti</th>
<th>karamelli</th>
<th>karuselli</th>
<th>konstaapeli</th>
<th>krokotiili</th>
<th>Mean %F</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY1</td>
<td>75</td>
<td>100</td>
<td>25</td>
<td>75</td>
<td>66</td>
<td>50</td>
<td>65</td>
</tr>
<tr>
<td>FY2</td>
<td>100</td>
<td>75</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>88</td>
</tr>
<tr>
<td>FY3</td>
<td>0</td>
<td>100</td>
<td>75</td>
<td>75</td>
<td>50</td>
<td>75</td>
<td>63</td>
</tr>
<tr>
<td>MY1</td>
<td>25</td>
<td>25</td>
<td>100</td>
<td>100</td>
<td>50</td>
<td>100</td>
<td>67</td>
</tr>
<tr>
<td>FO1</td>
<td>25</td>
<td>75</td>
<td>100</td>
<td>66</td>
<td>50</td>
<td>50</td>
<td>61</td>
</tr>
<tr>
<td>FO2</td>
<td>100</td>
<td>-</td>
<td>100</td>
<td>75</td>
<td>100</td>
<td>100</td>
<td>95</td>
</tr>
<tr>
<td>MO1</td>
<td>100</td>
<td>100</td>
<td>-</td>
<td>100</td>
<td>-</td>
<td>-</td>
<td>100</td>
</tr>
<tr>
<td>MO2</td>
<td>0</td>
<td>-</td>
<td>100</td>
<td>100</td>
<td>25</td>
<td>100</td>
<td>65</td>
</tr>
<tr>
<td>Mean</td>
<td>53</td>
<td>79</td>
<td>86</td>
<td>80</td>
<td>63</td>
<td>82</td>
<td></td>
</tr>
</tbody>
</table>
This method does not distinguish between those tokens which were strongly front and those which were more centralized. Another possibility would be to divide the space between the means for /æ/ and /ɑ/ into three sections instead of two. In this way, centralized vowels (those in the middle third) could be identified. However, this option was not chosen since it would result in tokens which are clearly front in relation to other stem vowels being identified as central. For example, in Figure 16, the chart for *atmosfääri* for speaker MY1 demonstrates this difficulty. The stem vowel /æ:/ is clearly front in relation to the stem vowel /ɑ/. However, if the vowel space were to be divided into thirds, the vowel /æ:/ would be considered central. Future work though may wish to examine the suffix (and stem) vowels as either front, back, or central. For data on four speakers’ pronunciations of the disharmonic loans, see Appendix 2.

![Figure 16: Mean F1 and F2 Values (in Hz) of Eight Finnish vowels and Suffix Vowels for BF Loan *atmosfääri* for Speaker MY1](image)

Speaker FO2, an older female, and speaker MO1, an older male, each seemed to treat the BN loans as patterning exclusively with the front allomorph selecting compounds. Only speaker FY3, a young female, and speaker MO2, an older male, clearly treated any loan
as suffixing exclusively with the back allomorph. Both these speakers always suffixed *adjektiivi* with allomorphs with F2s consistent with back suffixes. Note also that in no case was the overall mean for any lexical item 50% or less, though that of *adjektiivi* was very close at only 53%. As well, no speaker had a mean of 50% or less. Overall, the speakers all tended towards suffixing BN loans with front allomorphs. There was no particular clear pattern which could be discerned either in relation to gender or age.

### 6.3 BF Disharmonic Words

Due to the labour-intensive nature of the analysis for this section, only four speakers were studied, one from each age and gender category. They were selected by the number of clear tokens produced. When multiple participants in a given category had an identical number of tokens, one was arbitrarily selected.

For each individual disharmonic word token, the harmonic vowels of the stem and suffix were compared with the control vowels previously analyzed (see Table 10). In most cases it was clear from visual examination which vowel was being pronounced in the loan words. However, in cases where it was unclear, control vowels from the native compounds in the language game task were compared. These compound words had maximally similar phonological environments as the loan words to eliminate, as much as possible, the effect of consonant interactions.

Some vowels were clearly centralized. In these cases, the midpoint between the relevant front and back harmonic vowels was ascertained and the F2 value of the vowel in question was compared to this midpoint. When the vowel lay on the ‘front’ side of the
midpoint, it was considered to be a front vowel and, when it lay on the ‘back’ side, it was considered a back vowel. Though this procedure limits the full descriptiveness of the analysis, it was necessary for the sake of clarity. The individual vowel charts for each disharmonic loan word for each of the four speakers studied are presented in Appendix 2. As well, a summary of the results for each of these speakers in presented in Appendix 2.

6.3.1 Overall Results
The overall results are shown below in Table 18. Here, the stem harmony was indicated with D for a phonetically disharmonic stem, B for a stem which was harmonized to back vowels, and F for a stem which was harmonized to front vowels. When the tokens of a word differed in terms of stem harmony for a given speaker, the percentage of tokens which evidenced the stem harmony type was listed as well. The suffix vowel allomorph selection was listed as a percentage of front suffixes. Centralized vowels were treated as either front or back, depending on their position in relation to the means of the low vowels as determined in Part 1. Those results which were not disharmonic or did not have exclusively front allomorphs are shaded.
Table 18: Summary of suffixation of BF loans by informant

<table>
<thead>
<tr>
<th>Speaker</th>
<th>analyysi</th>
<th>manikyyri</th>
<th>molekylli</th>
<th>amatööri</th>
<th>konduktööri</th>
<th>kuvernööri</th>
<th>atmosfiäri</th>
<th>karriääri</th>
<th>miljonääri</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Young Female</strong></td>
<td>Stem Harmony</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>50 D</td>
<td>D</td>
<td>50 B</td>
</tr>
<tr>
<td></td>
<td>Suffix % F</td>
<td>100</td>
<td>75</td>
<td>75</td>
<td>100</td>
<td>66</td>
<td>75</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td><strong>Young Male</strong></td>
<td>Stem Harmony</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Suffix % F</td>
<td>50</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>Older Female</strong></td>
<td>Stem Harmony</td>
<td>75 D</td>
<td>25 B</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Suffix % F</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>Older Male</strong></td>
<td>Stem Harmony</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Suffix % F</td>
<td>75</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

In terms of stem harmonization, the three loans which exhibited harmonization were *analyysi*, *atmosfääri*, and *miljonääri*. Two tokens of *analyysi* were harmonized to [ɑnālu:si] and one token of *atmosfääri* to [ɑtmosfɑ:ri]. In these cases the harmonization was progressive. The four tokens of *miljonääri* which were harmonized evidenced regressive harmonization to [miljɔnæ:ri]. However, in the final example it is likely that the harmonization was strongly influenced by the palatal glide [j]. There are not enough harmonized tokens to make any claims about the direction of harmonization.
7.0 Discussion

7.1 Vowel Space

Overall, the vowel space is highly similar to those found by Wiik (1965), Iivonen and Laukkanen (1993), and Iivonen and Harnud (2005). The low vowels are like those in Wiik’s study in that there is a height difference between the front and back low vowels not seen in Iivonen and Laukkanen’s (1993) or Iivonen and Harnud’s (2005) work. As well, since age is not a significant factor, there also does not appear to be any current change in the vowel space reflected in the data.

7.2 BN Words

Overall, BN words as a group are suffixed with front suffix allomorphs. They pattern not with the back-final compounds but rather with the front-final and back neutral compounds. This is consistent with the prosodic compound analysis long held in the literature on Finnish which presumes that Finnish speakers analyze words of four syllables as compound words with the suffix allomorph agreeing with the final foot. In this case the final foot consists of only neutral vowels, which select front allomorphs when alone in a stem.

That all eight speakers, all or part of the time, produce front allomorphs with BN loans provides strong support for the prosodic compound hypothesis. For some speakers it appears to be either the only (or at least the dominant) means of phonological analysis for such words. Other speakers, however, will optionally treat these long loan words as prosodic compounds and optionally as monomorphemic words.
Though the range of suffix F2 variation varied depending on the lexical item, in no case did a given BN loan pattern always with the back-final compounds. Among the loans, *adjektiivi*, *karamelli*, and *karuselli* displayed the most F2 variation. This seems to have no correlation with frequency as *arkkitehti* and *adjektiivi* are the most frequent stem, according to *Suomen kielen taajussanasto* (Frequency Dictionary of Finnish). In terms of individual speakers’ treatment of various lexical items, *adjektiivi* (53% F overall) and *konstaapeli* (63% F overall) were most likely to be suffixed with back allomorphs. Again though, this does not correlate with frequency. However, it should be noted that the *Suomen kielen taajussanasto* did not present any information on the frequency of individual inflected tokens. As well, a more recent determination of frequency might produce different results.

There was both inter- and intra-speaker variation for each loan item. This, however, was also seen with the native compounds. Some individual tokens are in the vowel space consistent with back /ɑ/ but this also occurs with native front-final and back neutral compounds as shown below in Figure 17. In Figure 17, three of the four suffix vowels for the native compound *kauravelli* would be characterized as front and one would be characterized as back, by the practice used in this paper (those vowels on the side of the midpoint closer to the /æ/ control means are considered front whereas those on the side closer to the /ɑ/ control means are considered back). If the vowel space were to be divided into thirds, allowing for central vowels, then two of the four suffix vowels would be front, and two would be central. Either way, the suffix vowels for this native compound are not categorically phonetically front.
Thus, some degree of F2 suffix variation is normal within the harmony system, even with words that are clearly front harmonic words. Having said that, some speakers clearly treat some words as [BN-B]. There is a degree of lexicalization involved in that individual speakers will treat phonologically highly similar loans differently, for example suffixing adjektiivi exclusively with back suffixes while the same speaker will suffix arkkitehti exclusively with front suffixes (see speaker FY3, Table 17). However, none of the words were treated identically by all speakers. It appears that a given speaker has their own individual treatment of a particular lexical item though adjektiivi and konstaapeli do show clear tendencies to be suffixes with back allomorphs. The suffix selection is not based solely on the phonology since there is no phonological basis for the suffixation of one BN stem with a front allomorph and another with a back allomorph. Yet, many speakers have a high degree of consistency in their individual pronunciations.
Neither age nor gender appears to relate clearly to allomorph selection. Only two of the speakers, an older female and an older male, consistently suffixed all the loans with front suffixes. None of the speakers consistently chose back suffixes for all the words. In fact, very few words were consistently suffixed with back suffixes indicating that the more usual suffixation for a loan of this phonological shape is with the front allomorph.

7.2.1 Relation to Previous Studies

The present study shared only two BN loan words with Levomäki’s (1972) study, arkkitehti and karamelli. In Levomäki’s study, arkkitehti was suffixed with front allomorphs 73.0% of the time and, karamelli, 52.6%. These loans both demonstrate majority suffixation with front allomorphs in Levomäki’s work, as in the present study, though the difference in behavior of the two loans seen in Levomäki’s study was not mirrored in the present work. In fact, these loans displayed highly similar behaviour. As well, the great variation in suffix allomorph selection seen in the other lexical items studied by Levomäki (5.5% F – 73% F) was completely absent from this study (53% F – 86% F). Here, the BN loans demonstrated considerable consistency.

In Ringen and Heinämäki’s (1999) study, the majority of the BN loans selected back suffixes (0% F – 48% F). Those which displayed some variation were loans which could, phonotactically, be seen as compound words. Even in these cases, the loans still only selected front allomorphs less than half of the time (arkkitehti 48% F, bolshevikki 26% F, karamelli 16% F). The loan adjektiivi, which is not a plausible compound

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16 Selecting a front suffix 75% or more of the time was considered to be consistent selection of front suffixes.
phonotactically, selected front suffixes only 4% of the time. However, the data from the acoustic experiment does not match these findings (though it should be noted that five of the six words in the acoustic experiment are possible compounds phonotactically). In fact, in the majority of cases, the loans in the present study were suffixed with front, not back, allomorphs and at greater percentages than shown in Ringen and Heinämäki’s study. In the present study, there was no difference in the behavior of plausible (arkkitehti, karamelli, karuselli, konstaapeli, krokotiili) and implausible (adjektiivi) compounds.

That the two written surveys of suffixation displayed higher percentages of back suffixes than did the acoustic study may relate to the influence of orthography and prescriptive rules. As written language is more likely to conform to prescriptive norms than is spoken language, this could account for the increased percentages of back allomorphs in the written studies.

The results of the present study are difficult to compare with those of Välimaa-Blum (1999). What Välimaa-Blum considered a third vowel was analyzed in this study as a centralized vowel, but still either front or back. Having said that, for BN loans, Välimaa-Blum found that these loans selected front suffixes about half of the time and the unknown vowel 10% of the time. The current study found that the selection of front suffixes was higher.

In relation to Kiparsky’s (2003) stress hypothesis, rhythmic stress is not expected to initiate a new harmonic domain whereas lexical stress may. Of the lexical items discussed
by Kiparsky, three were tested in this work, *arkkitehti, karamelli*, and *konstaapeli.*

Kiparsky states that *konstaapeli* has rhythmic stress whereas *arkkitehti* and *karamelli* both have lexical stress. Thus, it is expected that *konstaapeli* should select back suffixes while *arkkitehti* and *karamelli* should display some variation in allomorph selection.

However, these predictions are not born out by the data. In fact there is only a slight difference between the behaviour of these three words in that *konstaapeli* did display a greater percentage of back suffixes but this was not consistent across all speakers. If the difference between lexical and rhythmic stress is significant, it may only be for some speakers. As well, it should be noted that rhythmic stress is the typical stress pattern for Finnish words. Perhaps those words with lexical stress are those which are less assimilated into the lexicon and so this may vary for a given speaker.

Overall, the acoustic results of this study do not support the analyses of either Ringen and Heinämäki (1999) or Kiparsky (2003). Instead, they indicate that BN loan words normally select front allomorphs, providing support for the prosodic compound analysis. Even words such as *adjektiivi*, which are not possible compounds phonotactically, seem to be treated as such for the purposes of harmony indicating that the prototypical disyllabic sequence is of more importance in harmony than the phonotactics of the word.

However, there may be some difference between the treatment of a particular loan by different speakers. Given speakers are normally fairly consistent in their suffixation of a specific loan though they do not necessarily agree with other speakers on its treatment. If there is some nature to the pattern in terms of frequency, age, or gender, it is not apparent
in this study and requires further examination. Only lexical item seemed to have any effect in that adjektiivi and konstaapeli displayed a greater percentage of back allomorphs when examined by speaker.

7.3 BF Disharmonic Words

It is clear that the BF disharmonic loans are, overwhelmingly pronounced as they are written and are suffixed with front allomorphs. Only the young female displayed any degree of variation. Without further study, it is unclear whether her pronunciations are idiosyncratic or if they are typical of young female speakers and may be evidence of the beginnings of a language change.

Välimaa-Blum (1999) found that, for BF disharmonic loans, 84% of the time, they were suffixed with front vowels and 5% of the time, with the unknown vowel. This is very close to the findings of this study which found that the vowels were front almost invariably.

The differences in vowel height seen in Ringen and Heinämäki’s (1999) study are not apparent here. Instead, all vowels of a particular place of articulation pattern alike. The harmony rule for disharmonic BF loans appears to be the same as that for native roots; suffixes are dependent on the final harmonic vowel in the stem. Only the young female speaker demonstrates any strong evidence of suffix vowels that are not dependent on the final harmonic vowel.
Interestingly, of the seven tokens which are harmonized, only three (three tokens of *miljonääri* [miljönääri]) have suffixes which are expected based on their harmonic class. In spite of the absence of front harmonic vowels in the stem, the three harmonized tokens of *analyysi* and *atmosfäeri* were suffixed with front vowels, as though they still were front-final. Possibly either the back stem internal vowels were merely pronunciation errors which were meant to be front or else the suffix vowels could have been front based on previous remembered tokens of these words, regardless of the actual stem vowels. Without more such tokens, it is impossible to speculate further.

Wiik (1995 as reported in Välimaa-Blum (1997)) suggested that the vowels of disharmonic loans are not like those of native words but are, rather, centralized. Though centralized vowels were seen in many tokens, particularly those of the young female, it is not clear that this is a property specific to loan words. Many instances of native compounds, such as those shown below in Figure 18, also demonstrated centralized vowels, assuming centralized vowels to be those vowels which occur in the middle third of the space between the control means for /æ/ and /ə/.

In Figure 18, three of the four suffix vowels for the native compound *lenkosääri* would be characterized as front and one would be characterized as back, by the criteria used in this paper (those vowels on the side of the midpoint closer to the /æ/ control means are considered front whereas those on the side closer to the /ə/ control means are considered back). If the vowel space were to be divided into thirds, allowing for central vowels, then two of the four suffix vowels would be front, and two would be central. Either way, as
shown for the compound in Figure 18, the suffix vowels for this native compound are not categorically phonetically front.

![Figure 18: Mean F1 and F2 Values (in Hz) of Eight Finnish vowels and Suffix Vowels for Native Compound lenkosäärtä Produced by Speaker MY1.](image)

Overall, the disharmonic loans are typically pronounced as they are written. In terms of suffix harmony, the disharmonic loans are unremarkable and the suffix is based on the final harmonic vowel of the stem. Only the loan *analyysi* displayed any degree of suffix variation. This may be partly due to the number of frequent related words with back vowel derivational suffixes, shown in Table 14 in section 5.3.

### 8.0 Conclusions

There were three main purposes to this study: to determine how BF disharmonic loans are pronounced; to determine how BF disharmonic loans are suffixed; and to determine how BN loans are suffixed. As well, the somewhat peripheral issue of the formant values of Finnish vowels over time was examined. It was found that vowel formants have remained constant since Wiik’s (1965) study.
With regard to the BF disharmonic loan words, it was found that, overwhelmingly, they are pronounced as they are written i.e. disharmonically. These loans are normally suffixed with front allomorphs, even, at times, when there is no front vowel in the stem to condition the suffix harmony. Suffix harmony, though, may vary for some speakers (e.g. young female). Due to the small number of speakers analyzed for this word type, further research is necessary to determine if this is an idiosyncratic finding particular to this speaker or if it may be common across young female speakers.

The partitive suffixes may have centralized vowels. However, this is also seen with native words and so it is unremarkable with the loan words.

In terms of the BN loan words, there seems to be some lexical patterning but the loans select front suffixes most of the time. All speakers tend to suffix with front allomorphs most of the time. As a group then, the BN loans pattern with the front-final and back neutral compounds.

This paper bears on the issue of loan word adaptation in Finnish. Though stem and suffix harmony are robust and pervasive in the native lexicon, it seems that disharmonic words are freely incorporated into Finnish without any repair. In terms of suffixation, the loans follow the native pattern of harmonizing with the closest available harmonic vowel, in spite of prescriptive rules allowing either suffix allomorph when the final harmonic vowel is /y/.
BN loans, though phonotactically well-formed in terms of harmony, display seemingly aberrant behaviour. Here, suffixation seems to be overwhelmingly front, in spite of the lack of front harmonic vowels in the root available to condition the front suffix allomorph. However, whether this behaviour is truly at odds with the harmony system of Finnish is disputable. Campbell, (1980: 252) citing Rapola (1965: 251), states that suffixation of long back neutral words with front allomorphs was also possible in Old Literary Finnish as well as in some modern dialects. Phonetic analysis of derived four syllable words may shed some light on this issue.

Though this paper provides a first systematic phonetic analysis of loan words in Finnish, much still remains for further research. Additional loan words and speakers, especially young females, should be examined. The behaviour of young females was notable for two reasons. First, the mean F2s for front suffix allomorphs produced by young females were significantly lower than those produced by older females. This difference was not seen in the control vowels and so seems, possibly, to be a consequence of the suffix position. As young females tend to be in the forefront of language change, it is a possibility that this is part of a change in progress. As well, the disharmonic loans of the young female analyzed demonstrated more variability in terms of stem harmonization and suffix variation. Additional young females should be examined to determine if this is idiosyncratic to the particular speaker or if it is part of a larger pattern. As well, the categorization into front and back suffixes for both the BN loans and the BF disharmonic loans was somewhat simplistic in that it did not allow for the centralization
of vowels. Further work should be done to more finely classify the vowels of both loans and native words to determine the range of variation which is possible in the native lexicon and, therefore, to determine where the variation of the loan vowels fall.

Overall though, the main purposes of determining the pronunciation of the BF disharmonic stem vowels and the suffix allomorphs of the BF and BN loans have been fulfilled. The actual pronunciation of the stem vowels of the BF loans has received much speculation but no previous phonetic analysis. That the stem vowels are normally pronounced without harmonization, without adaptation to the otherwise strong harmony system is an unexpected finding. As well, that the suffixation for these disharmonic loans is highly regular and is typically front is also unexpected in light of previous written studies on the harmony of loans in Finnish. However, that the young female evidences some variation warrants further investigation. Finally, the overwhelming suffixation of the BN loans with front suffix allomorphs provides strong evidence that the compound hypothesis is a very common means of phonological analysis for speakers.
Appendix 1

The following charts depict the F2s of individual suffix vowels for each long BN loan. For each speaker, the lowest solid line represents the mean of their suffix F2s for the back-final compounds, the top two solid lines the means for their front-final and BN compounds, and the dashed line the midpoint between the means of the back-final compounds and the BN compounds.

Speaker FY1

![Chart showing the F2s of individual suffix vowels for Speaker FY1]
Speaker FY2

Speaker FY3
Speaker FO2

Speaker MO1
Appendix 2

The following charts depict the vowels of each repetition of the disharmonic loan words. The means of the control vowels from Table 10 for the speaker in question are also given for comparison. When a stem vowel is apparently intermediate to the front and back control means, the control compound words are also plotted for comparison.

Young Female Speaker (FY2)

The speech of the young female speaker evidenced most variation in terms of the disharmonic loans. Seven of the nine lexical items were always pronounced disharmonically. The loan *atmosfäärı* had two disharmonic tokens and two with only back vowels (e.g. [atmosfɑː:ri]). However, all of the *atmosfäärı* tokens, including those with no front stem vowels, displayed front suffix allomorphs. The loan *miljonääri* had only front vowels for this speaker (e.g. [miljɔnæ:ri]). Of the four suffix tokens for this loan, three were front and one was back, without any back vowels in the stem to condition the back allomorph.

Of the remaining seven loans, two, *amatööri* and *karriääri*, were exclusively suffixed with front suffixes and another, *analyysi*, was suffixed on three occasions with front suffixes and on the final occasion, with a centralized, though still front, suffix. Two loans, *manikyyri* and *molekyyli*, evidenced a majority of front suffixes (three each) but each also had a central but slightly back suffix. The loan *konduktööri* was suffixed with two front allomorphs and a [ə]-like vowel. Finally, the loan *kuvernööri* was suffixed with two front allomorphs, a central but front allomorph, and a back allomorph.
/yy/-Final Disharmonic Loans
/õõ/-Final Disharmonic Loans

![Graph 1: Control Means, Amatööri Reps 1-4](image1)

![Graph 2: Control Means, Konduktööri Reps 1-4](image2)

![Graph 3: Control Means, Kuvernööri Reps 1-4](image3)
/ää/-Final Disharmonic Loans

![Graph of F2 vs. F1 for different replications of atmospheric, karriääri, and miljonääri words, showing vowel variation and distribution.](image-url)
Young Male Speaker (MY1)

For the young male speaker, all tokens of disharmonic loan words were, indeed, disharmonic. For two lexical items, *amatööri* and *konduktööri*, the front mid vowels, /o:/ were noticeably centralized in comparison with the control /ø/ vowels from Tables 10 and 12 but were still front of the midpoint between control /ø/ and /o/ and so should be considered front vowels. For the lexical item *miljonääri* the mid /o/ was fronted. This is likely due to the preceeding palatal glide /j/. A fronting effect of the glide was previously reported by Ogden (1996: 213-214) and was also seen with the low back /ɑ/ in this acoustic study.

In terms of suffixation, all loans, with the exception of *analyysi*, were suffixed with front allomorphs. In most cases, the suffix vowel was more front than any stem-internal low front /æ/ vowels. With *analyysi*, there was variation in suffixation. One token selected a front allomorph while the remaining three were suffixed with back allomorphs.
/yy/-Final Disharmonic Loans
/öö/-Final Disharmonic Loans

[Graphs showing vowel and consonant position analysis]
/ää/-Final Disharmonic Loans

![Graph 1](image1)

![Graph 2](image2)

![Graph 3](image3)
Older Female Speaker (FO1)

Of the nine loan words, seven were invariably disharmonic. Only *analyysi* and *konduktööri* displayed any differences between the orthographic representation and the pronunciation. Of the four *analyysi* tokens, one evidenced harmonization of the third vowel from front <yy> to back [u:]. Interestingly, the suffix vowel in this instance was front, though there was no front vowel in the stem to condition the front allomorph. All of the three *konduktööri* tokens displayed fronting of the second vowel <u> to [y]. As well, one token evidenced centralization of the third vowel. Though this vowel was actually closer to the control [o] than the control [ø] from Table 10, it was more front-like when compared with the placement of the stem-internal first syllable [o] and the control vowel [o:] from *housurooli*.

All tokens displayed front suffix allomorphs, even when there appeared to be no front stem-internal vowel to condition the front suffix, as in the case of *analyysi*, discussed above.
/yy/-Final Disharmonic Loans

Suffix

Suffix

Suffix

Suffix

control means
analyysi rep 1
analyysi rep 2
analyysi rep 3
analyysi rep 4
control means
manikyyri rep 1
manikyyri rep 2
manikyyri rep 3
control means
molekyyli rep 1
molekyyli rep 2
molekyyli rep 3
/öö/-Final Disharmonic Loans
/ää/-Final Disharmonic Loans

![Graphs showing F2 and F1 for different conditions: control means, atmosfääri rep 1, atmosfääri rep 2, atmosfääri rep 3, atmosfääri rep 4, karriääri rep 1, karriääri rep 2, karriääri rep 3, karriääri rep 4, miljonääri rep 1, miljonääri rep 2, miljonääri rep 3.](image)
Older Male Speaker (MO2)

All of the older male speaker’s tokens were disharmonic though several displayed some centralized stem vowels. In *konduktööri* all four of the second syllable vowels <u> were centralized, though still back. As well, one *konduktööri* token also displayed centralization of the third syllable vowel <öö>. In the four tokens of *miljonääri*, the second syllable vowel <ö> was centralized, though back. This was also seen in the speech of the young male speaker and may be due to the preceding glide.

With the exception of two suffix tokens, all suffixes were front. One suffix of *analyysi* was back and one suffix of *kuvernööri* was centralized, though front.
/yy/-Final Disharmonic Loans
/öö/-Final Disharmonic Loans
/ää/-Final Disharmonic Loans

![Graphs showing phonetic analysis](image-url)
References


