Appendix 1: Test data

In the text, the outcomes of statistical tests are mentioned. The exact data can be found in this appendix. The data are ordered according to the order they appear in the text, see section numbers, eventually joined by graph or table numbers.

FE = Fisher Exact Probability Test
1-t = 1 tailed
2-t = 2 tailed
$\chi^2$ = chi²-value
p = probability value
df = degrees of freedom
n = number of observations

Appendix 1.1: $\chi^2$ test for goodness of fit

§ 1.3.7.6
Introduction $\chi^2$ test for goodness of fit

Example 1

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3</td>
<td>5.0</td>
</tr>
<tr>
<td>B</td>
<td>7</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
</tr>
</tbody>
</table>

$\chi^2 = \text{p} = \text{df} = \text{n} =$

1.60 20.6% 1 10

Graph 1.4: Dative plural of 'seke': $\chi^2$-test and correlation

<table>
<thead>
<tr>
<th>observed</th>
<th>$&lt;\text{Vm}&gt;$</th>
<th>other</th>
<th>avg. year %</th>
<th>$&lt;\text{Vm}&gt;$</th>
<th>expected</th>
<th>$/\text{Vm}/$</th>
<th>other</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1430</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1402</td>
<td>100%</td>
<td>-1430</td>
<td>0.6</td>
</tr>
<tr>
<td>-1460</td>
<td>6</td>
<td>2</td>
<td>8</td>
<td>1450</td>
<td>75%</td>
<td>-1460</td>
<td>2.5</td>
</tr>
<tr>
<td>-1490</td>
<td>4</td>
<td>12</td>
<td>16</td>
<td>1476</td>
<td>25%</td>
<td>-1490</td>
<td>4.9</td>
</tr>
<tr>
<td>-1510</td>
<td>0</td>
<td>13</td>
<td>13</td>
<td>1502</td>
<td>0%</td>
<td>-1510</td>
<td>4.0</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>27</td>
<td>39</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$\chi^2 = \text{p} = \text{df} = \text{n} =$

17.88 <0.1% 3 39

$r^2 = \text{p 1-T} = \text{p 2-T} = \text{df} = \text{n} =$

0.94 1.6% 3.3% 2 4

In the upper version, there is one cell with expected value < 1. In the second version, this has been solved by aggregating the timeframes into only 2 contrasting periods.
A.P. Versloot: *Mechanisms of Language Change*

### Table 1.3.5/1.3.7.6

<table>
<thead>
<tr>
<th>observed</th>
<th>&lt;1460</th>
<th>&gt;1460</th>
<th>expected</th>
<th>&lt;1460</th>
<th>&gt;1460</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;Vm&gt;</td>
<td>8</td>
<td>1</td>
<td>9</td>
<td>2.5</td>
<td>6.5</td>
</tr>
<tr>
<td>other</td>
<td>2</td>
<td>25</td>
<td>27</td>
<td>7.5</td>
<td>19.5</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>26</td>
<td>36</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = p = df = n = \]
\[ 22.34 <0.1% 1 36 \]

Yates’ correction: \[ 18.46 <0.1% <0.1\% \]

### Graph 1.2: Vowel alternation in the plural of 'son'

<table>
<thead>
<tr>
<th>observed</th>
<th>&lt;e&gt;</th>
<th>&lt;o&gt;</th>
<th>avg. year</th>
<th>% &lt;e&gt;</th>
<th>expected</th>
<th>&lt;e&gt;</th>
<th>&lt;o&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1460</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1444</td>
<td>67%</td>
<td>-1460</td>
<td>2.1</td>
</tr>
<tr>
<td>-1490</td>
<td>9</td>
<td>3</td>
<td>12</td>
<td>1481</td>
<td>75%</td>
<td>-1490</td>
<td>8.6</td>
</tr>
<tr>
<td>-1510</td>
<td>12</td>
<td>4</td>
<td>16</td>
<td>1503</td>
<td>75%</td>
<td>-1510</td>
<td>11.4</td>
</tr>
<tr>
<td>-1550</td>
<td>12</td>
<td>6</td>
<td>18</td>
<td>1528</td>
<td>67%</td>
<td>-1550</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td>35</td>
<td>14</td>
<td>49</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = p = df = n = \]
\[ 0.41 93.9% 3 49 \]

\[ r^2 = p 1-T = p 2-T = df = n = \]
\[ 0.01 45.1% 90.1% 2 4 \]

In the upper version, there is 1 cell with expected values < 1. In the second version, this has been solved by aggregating the timeframes into only 2 contrasting periods.
§ 1.3.8
Syncope in Old Frisian: Unia group A-1 versus A-2

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th>lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-1</td>
<td>15</td>
<td>8.3</td>
<td>804</td>
</tr>
<tr>
<td>A-2</td>
<td>13</td>
<td>19.7</td>
<td>1899</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 7.61, \quad p = 0.06\%, \quad df = 1, \quad n = 28
\]

For this test, only the instances of the 3rd pers. sg. and the past participle without syncope were counted. The number of attestations was related to the length of the sections, expressed by the number of lines in the transcription. So, to compute the expected number of -eth in A-1: length of A-1 (= 804) / length of A-1 + A-2 (= 2703) * the number of attestations of -eth in the total of both sections (= 28) ~ 8.3; etc.

§ 2.1
Vowel Balance in Modern West Frisian

<table>
<thead>
<tr>
<th></th>
<th>observed short</th>
<th>observed long</th>
<th>expected short</th>
<th>expected long</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>622</td>
<td>241</td>
<td>863</td>
<td>331.7</td>
</tr>
<tr>
<td>ø</td>
<td>1047</td>
<td>801</td>
<td>1848</td>
<td>710.3</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 59.10, \quad <0.1\%, \quad df = 1, \quad n = 2711
\]

§ 2.2.3
Spelling <l> or <ll> before /i/

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th></th>
<th>expected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>bitalia(ne)</td>
<td>bitalad</td>
<td>&lt;l&gt;</td>
<td>bitalia(ne)</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td>24</td>
<td>67</td>
<td>228</td>
</tr>
<tr>
<td></td>
<td>136</td>
<td>322</td>
<td>458</td>
<td>156.2</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 30.93, \quad <0.1\%, \quad df = 1, \quad n = 525
\]

-317-
§ 2.3.3.1
Table 2.6: Vowel Balance in the dative plural ending in Unia, group A; the full data are given in table 2.6; here the tests for the relevant contrast are presented.

<table>
<thead>
<tr>
<th></th>
<th>Long roots compared with the overall values</th>
<th>Short roots with no OSL, compared with the overall values</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Long expected</td>
<td>no OSL expected</td>
</tr>
<tr>
<td></td>
<td>&lt;um&gt; 171 1824</td>
<td>No OSL expected</td>
</tr>
<tr>
<td></td>
<td>&lt;em/im&gt; 58 46.6</td>
<td>No OSL expected</td>
</tr>
<tr>
<td></td>
<td>229 229</td>
<td>25 25</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 3.52 \quad p = 0.07 \quad df = 1 \quad n = 229 \]

These two tests are tricky, because both the long-rooted and 'no-OSL' words contributed to the overall figures, which is strictly speaking not allowed (cf. Field 2005, 680). The following tests are more proper.

<table>
<thead>
<tr>
<th></th>
<th>Long roots compared with short roots with OSL</th>
<th>Long roots compared with short roots with no OSL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>observed</td>
<td>expected</td>
</tr>
<tr>
<td></td>
<td>&lt;um&gt; 171</td>
<td>7 178</td>
</tr>
<tr>
<td></td>
<td>&lt;em/im&gt; 58</td>
<td>3 61</td>
</tr>
<tr>
<td></td>
<td>229 10</td>
<td>239</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 0.11 \quad p = 0.74 \quad df = 1 \quad n = 239 \]

\[ \chi^2 = 5.75 \quad p = 0.02 \quad df = 1 \quad n = 254 \]

\[ \chi^2 = 5.75 \quad p = 0.02 \quad df = 1 \quad n = 254 \]
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Short roots with OSL compared with short roots with no OSL

<table>
<thead>
<tr>
<th>Short roots</th>
<th>OSL</th>
<th>no OSL</th>
<th>Expected</th>
<th>OSL</th>
<th>no OSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;um&gt;</td>
<td>7</td>
<td>24</td>
<td>31</td>
<td>8.9</td>
<td>22.1</td>
</tr>
<tr>
<td>&lt;em/im&gt;</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>1.1</td>
<td>2.9</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(\text{observed} - \text{expected})^2}{\text{expected}} \]

| 10 | 25 | 35 |

Yates' correction

<table>
<thead>
<tr>
<th>\chi^2</th>
<th>p</th>
<th>df = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.77</td>
<td>2.9%</td>
<td>1</td>
</tr>
</tbody>
</table>

Long roots compared with short roots with uncertain OSL

<table>
<thead>
<tr>
<th>Long roots</th>
<th>Short OSL?</th>
<th>Expected</th>
<th>Long OSL?</th>
<th>OSL?</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;um&gt;</td>
<td>171</td>
<td>7</td>
<td>178</td>
<td>169.8</td>
</tr>
<tr>
<td>&lt;em/im&gt;</td>
<td>58</td>
<td>4</td>
<td>62</td>
<td>59.2</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(\text{observed} - \text{expected})^2}{\text{expected}} \]

| 229 | 11 | 240 |

Yates' correction

<table>
<thead>
<tr>
<th>\chi^2</th>
<th>p</th>
<th>df = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.67</td>
<td>41.4%</td>
<td>1</td>
</tr>
</tbody>
</table>

Short roots with uncertain OSL compared with short roots with no OSL

<table>
<thead>
<tr>
<th>Short roots</th>
<th>OSL?</th>
<th>no OSL</th>
<th>Expected</th>
<th>OSL?</th>
<th>no OSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;um&gt;</td>
<td>7</td>
<td>24</td>
<td>31</td>
<td>9.5</td>
<td>21.5</td>
</tr>
<tr>
<td>&lt;em/im&gt;</td>
<td>4</td>
<td>1</td>
<td>5</td>
<td>1.5</td>
<td>3.5</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(\text{observed} - \text{expected})^2}{\text{expected}} \]

| 11 | 25 | 36 |

Yates' correction

<table>
<thead>
<tr>
<th>\chi^2</th>
<th>p</th>
<th>df = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.69</td>
<td>1.0%</td>
<td>1</td>
</tr>
</tbody>
</table>

Vowel Balance in the dative plural ending in the charters from 1379-1430

<table>
<thead>
<tr>
<th>Long no OSL</th>
<th>Expected</th>
<th>Long no OSL</th>
<th>OSL?</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;um&gt;</td>
<td>4</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>&lt;em/im&gt;</td>
<td>36</td>
<td>5</td>
<td>41</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(\text{observed} - \text{expected})^2}{\text{expected}} \]

| 40 | 10 | 50 |

Yates' correction

<table>
<thead>
<tr>
<th>\chi^2</th>
<th>p</th>
<th>df = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.67</td>
<td>0.3%</td>
<td>1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>\chi^2</th>
<th>p</th>
<th>df = 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.17</td>
<td>1.3%</td>
<td>1</td>
</tr>
</tbody>
</table>
§ 2.3.3.2

Map 2.3 and 2.4: OSL in *bitalia(ne), bitalad and nama*

<table>
<thead>
<tr>
<th>observed</th>
<th>Gaasterl. rest</th>
<th>expected</th>
<th>Gaasterl. rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;ae&gt;</td>
<td>7</td>
<td>22</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>517</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>539</td>
<td>18</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(7 - 22)^2}{22} = 126.41 \quad p = 0.1\% \]

Yates' correction


idem, Gaasterlân vs. Wûnseradiel (both SW-Fryslân)

<table>
<thead>
<tr>
<th>observed</th>
<th>Gaasterl. Wûnser.</th>
<th>expected</th>
<th>Gaasterl. Wûnser.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;ae&gt;</td>
<td>7</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>32</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>36</td>
<td>43</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(7 - 4)^2}{4} = 24.32 \quad p = 0.1\% \]

Yates' correction


Spelling /r/ in gerund and past participle of *swera* and *kera; > 1450*

<table>
<thead>
<tr>
<th>observed</th>
<th>gerund past part.</th>
<th>expected</th>
<th>gerund past part.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-eren</td>
<td>1</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>-eren</td>
<td>14</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>13</td>
<td>28</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(15 - 11)^2}{11} = 14.41 \quad p = 0.1\% \]

Yates' correction


§ 2.3.3.3

<VVCC> and following vowel, total

<table>
<thead>
<tr>
<th>observed</th>
<th>expected</th>
<th>Unia</th>
</tr>
</thead>
<tbody>
<tr>
<td>-(i)a</td>
<td>142</td>
<td>85.8</td>
</tr>
<tr>
<td>-c</td>
<td>50</td>
<td>106.2</td>
</tr>
<tr>
<td></td>
<td>192</td>
<td>192</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(192 - 192)^2}{192} = 0.00 \quad p = 0.1\% \]
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### <VVCC> and following vowel, type 1

<table>
<thead>
<tr>
<th>Type</th>
<th>Expected</th>
<th>Unia</th>
</tr>
</thead>
<tbody>
<tr>
<td>-(i)a</td>
<td>67</td>
<td>39.8</td>
</tr>
<tr>
<td>-e</td>
<td>22</td>
<td>49.2</td>
</tr>
</tbody>
</table>

\[ \chi^2 = p = df = n = 33.75 <0.1% 1 89 \]

### <VVCC> and following vowel, type 2

<table>
<thead>
<tr>
<th>Type</th>
<th>Expected</th>
<th>Unia</th>
</tr>
</thead>
<tbody>
<tr>
<td>-(i)a</td>
<td>39</td>
<td>27.2</td>
</tr>
<tr>
<td>-e</td>
<td>22</td>
<td>33.8</td>
</tr>
</tbody>
</table>

\[ \chi^2 = p = df = n = 9.16 0.25% 1 61 \]

### <VVCC> and following vowel, type 3

<table>
<thead>
<tr>
<th>Type</th>
<th>Expected</th>
<th>Unia</th>
</tr>
</thead>
<tbody>
<tr>
<td>-(i)a</td>
<td>21</td>
<td>10.7</td>
</tr>
<tr>
<td>-e</td>
<td>3</td>
<td>13.3</td>
</tr>
</tbody>
</table>

\[ \chi^2 = p = df = n = 17.82 <0.1% 1 24 \]

### <VVCC> and following vowel, type 4

<table>
<thead>
<tr>
<th>Type</th>
<th>Expected</th>
<th>Unia</th>
</tr>
</thead>
<tbody>
<tr>
<td>-(i)a</td>
<td>15</td>
<td>8.0</td>
</tr>
<tr>
<td>-e</td>
<td>3</td>
<td>10.0</td>
</tr>
</tbody>
</table>

\[ \chi^2 = p = df = n = 10.89 <0.1% 1 18 \]

#### Regional contrast for VVCC type 1

<table>
<thead>
<tr>
<th>Observed</th>
<th>SW+MW</th>
<th>Rest</th>
<th>Expected</th>
<th>SW+MW</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>VVCC</td>
<td>17</td>
<td>21</td>
<td>38</td>
<td>VVCC</td>
<td>9.3</td>
</tr>
<tr>
<td>No VVCC</td>
<td>216</td>
<td>700</td>
<td>916</td>
<td>No VVCC</td>
<td>223.7</td>
</tr>
</tbody>
</table>

\[ \chi^2 = p = df = n = 8.85 0.3% 1 954 \]

#### Regional contrast for VVCC type 2

<table>
<thead>
<tr>
<th>Observed</th>
<th>SW+MW</th>
<th>Rest</th>
<th>Expected</th>
<th>SW+MW</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>VVCC</td>
<td>14</td>
<td>29</td>
<td>43</td>
<td>VVCC</td>
<td>10.5</td>
</tr>
<tr>
<td>No VVCC</td>
<td>219</td>
<td>692</td>
<td>911</td>
<td>No VVCC</td>
<td>222.5</td>
</tr>
</tbody>
</table>

\[ \chi^2 = p = df = n = 1.61 20.4% 1 954 \]
### regional contrast for VVCC type 3 <weessa>; charter count

<table>
<thead>
<tr>
<th>observed</th>
<th>SW+MW</th>
<th>rest</th>
<th>expected</th>
<th>SW+MW</th>
<th>rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>VVCC</td>
<td>8</td>
<td>12</td>
<td>20</td>
<td>4.9</td>
<td>15.1</td>
</tr>
<tr>
<td>no VVCC</td>
<td>225</td>
<td>709</td>
<td>934</td>
<td>228.1</td>
<td>705.9</td>
</tr>
<tr>
<td></td>
<td>233</td>
<td>721</td>
<td>954</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(O - E)^2}{E} \]
\[ p = df = n = \]

Yates' correction

### regional contrast for VVCC type 4 <treeeda>; charter count

<table>
<thead>
<tr>
<th>observed</th>
<th>SW+MW</th>
<th>rest</th>
<th>expected</th>
<th>SW+MW</th>
<th>rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>VVCC</td>
<td>3</td>
<td>11</td>
<td>14</td>
<td>3.4</td>
<td>10.6</td>
</tr>
<tr>
<td>no VVCC</td>
<td>230</td>
<td>710</td>
<td>940</td>
<td>229.6</td>
<td>710.4</td>
</tr>
<tr>
<td></td>
<td>233</td>
<td>721</td>
<td>954</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(O - E)^2}{E} \]
\[ p = df = n = \]

Yates' correction

### regional contrast for VVCC sum of types

<table>
<thead>
<tr>
<th>observed</th>
<th>SW+MW</th>
<th>rest</th>
<th>expected</th>
<th>SW+MW</th>
<th>rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>VVCC</td>
<td>36</td>
<td>59</td>
<td>95</td>
<td>23.2</td>
<td>71.8</td>
</tr>
<tr>
<td>no VVCC</td>
<td>197</td>
<td>662</td>
<td>859</td>
<td>209.8</td>
<td>649.2</td>
</tr>
<tr>
<td></td>
<td>233</td>
<td>721</td>
<td>954</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(O - E)^2}{E} \]
\[ p = df = n = \]

Yates' correction

<table>
<thead>
<tr>
<th>observed</th>
<th>SW+MW</th>
<th>rest</th>
<th>expected</th>
<th>SW+MW</th>
<th>rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>VVCC</td>
<td>9</td>
<td>9</td>
<td>18</td>
<td>11.6</td>
<td>6.4</td>
</tr>
<tr>
<td>no VVCC</td>
<td>11</td>
<td>2</td>
<td>13</td>
<td>8.4</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>11</td>
<td>31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(O - E)^2}{E} \]
\[ p = df = n = \]

Yates' correction

### Table 2.11: bitalad/-th vs. bitalia(ne)

<table>
<thead>
<tr>
<th>observed</th>
<th>bitalad/thitalia(ne)</th>
<th>expected</th>
<th>bitalad/thitalia(ne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;ael&gt;</td>
<td>9</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>&lt;aell&gt;</td>
<td>11</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>11</td>
<td>31</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(O - E)^2}{E} \]
\[ p = df = n = \]
Table 2.11: \textit{bitalia(ne)} vs. \textit{bitalinge}

<table>
<thead>
<tr>
<th>\textit{bitalia(ne)}</th>
<th>\textit{bitalinge}</th>
<th>\textit{expected}</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{a}</td>
<td>9</td>
<td>70</td>
</tr>
<tr>
<td>\textit{a'}</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>11</td>
<td>76</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(O - E)^2}{E} \]

\[ p = \text{df} = \text{np} = \]

Yates' correction

\[ \chi^2 = \frac{(O - E)^2}{E} \]

\[ p = \text{df} = \text{np} = \]

Yates' correction

Note: one expected cell value < 1; \textit{p-value} = 1.10^-5

Table 2.11: \textit{bitalad/-th} vs. \textit{bitalinge}

<table>
<thead>
<tr>
<th>\textit{bitalad/-th}</th>
<th>\textit{bitalinge}</th>
<th>\textit{expected}</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{a}</td>
<td>9</td>
<td>70</td>
</tr>
<tr>
<td>\textit{a'}</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>11</td>
<td>76</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(O - E)^2}{E} \]

\[ p = \text{df} = \text{np} = \]

Yates' correction

\[ \chi^2 = \frac{(O - E)^2}{E} \]

\[ p = \text{df} = \text{np} = \]

Yates' correction

Table 2.11: \textit{bitalinge} vs. Rest

<table>
<thead>
<tr>
<th>\textit{bitalinge}</th>
<th>Rest</th>
<th>\textit{expected}</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{a}</td>
<td>70</td>
<td>224</td>
</tr>
<tr>
<td>\textit{a'}</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>76</td>
<td>227</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(O - E)^2}{E} \]

\[ p = \text{df} = \text{np} = \]

Yates' correction

\[ \chi^2 = \frac{(O - E)^2}{E} \]

\[ p = \text{df} = \text{np} = \]

Yates' correction

VVCC type 2 in Harlingen; charter count

<table>
<thead>
<tr>
<th>VVCC</th>
<th>Harl.</th>
<th>Rest</th>
<th>VVCC</th>
<th>Harl.</th>
<th>Rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>\textit{a}</td>
<td>4</td>
<td>39</td>
<td>43</td>
<td>\textit{a}</td>
<td>0.6</td>
</tr>
<tr>
<td>\textit{a'}</td>
<td>10</td>
<td>901</td>
<td>911</td>
<td>\textit{a'}</td>
<td>13.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>14</td>
<td>940</td>
<td>954</td>
<td><strong>Total</strong></td>
<td>14.0</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(O - E)^2}{E} \]

\[ p = \text{df} = \text{np} = \]

Yates' correction

\[ \chi^2 = \frac{(O - E)^2}{E} \]

\[ p = \text{df} = \text{np} = \]

Yates' correction

Note: one expected cell value < 1; \textit{p-value} = 1.10^-5
VVCC type 2: geographical contrast <aepp> & <epp> vs. <app>

<table>
<thead>
<tr>
<th>observed</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;(a)epp&gt;</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>&lt;Vpp&gt;</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>expected</th>
<th>East</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;aepp&gt;</td>
<td>6.5</td>
<td>3.5</td>
</tr>
<tr>
<td>&lt;app&gt;</td>
<td>4.5</td>
<td>2.5</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 13.25 \quad p = 0.001 \quad df = 1 \quad n = 17
\]

VVCC type 2: geographical contrast: Wûnserdiel and the rest of western Fryslân

<table>
<thead>
<tr>
<th>observed</th>
<th>Wûn</th>
<th>rest-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;pp&gt;</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>&lt;p&gt;</td>
<td>52</td>
<td>164</td>
</tr>
<tr>
<td></td>
<td>56</td>
<td>166</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>expected</th>
<th>Wûn</th>
<th>rest-West</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;pp&gt;</td>
<td>1.5</td>
<td>4.5</td>
</tr>
<tr>
<td>&lt;p&gt;</td>
<td>54.5</td>
<td>161.5</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 5.61 \quad p = 0.03 \quad df = 1 \quad n = 222
\]

VVCC type 3: North /e:/ versus South /æ:/

<table>
<thead>
<tr>
<th>observed</th>
<th>SW+SE</th>
<th>rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>/e:/</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>/æ:/</td>
<td>12</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>expected</th>
<th>SW+SE</th>
<th>rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>/e:/</td>
<td>4.0</td>
<td>4.0</td>
</tr>
<tr>
<td>/æ:/</td>
<td>8.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 12.00 \quad p = 0.001 \quad df = 1 \quad n = 24
\]
### § 2.3.4.2

Table 2.13: relation between ending and \(<n(a)\) in the word *Monday*

<table>
<thead>
<tr>
<th></th>
<th>-en</th>
<th>-a/-e</th>
<th>observed</th>
<th>-en</th>
<th>-a/-e</th>
<th>expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>(&lt;nn&gt;)</td>
<td>11</td>
<td>10</td>
<td>21</td>
<td>15.4</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>(&lt;n&gt;)</td>
<td>19</td>
<td>1</td>
<td>20</td>
<td>14.6</td>
<td>5.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>11</td>
<td>41</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{9.48}{0.2\%} = \text{Yates' correction} = 7.43 = 0.6\% \]

### § 2.4.2

ad (1): apocope in weak masc. nouns

<table>
<thead>
<tr>
<th></th>
<th>-ø</th>
<th>-e</th>
<th>overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ofr.</td>
<td>15</td>
<td>19</td>
<td>34</td>
</tr>
<tr>
<td>-ø</td>
<td>15</td>
<td>19</td>
<td>34</td>
</tr>
<tr>
<td>-e</td>
<td>129</td>
<td>65</td>
<td>194</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{4.61}{3.18\%} = 1.35\% \]

ad (1): apocope in strong fem. nouns

<table>
<thead>
<tr>
<th></th>
<th>-ø</th>
<th>-e</th>
<th>overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ofr.</td>
<td>61</td>
<td>20</td>
<td>81</td>
</tr>
<tr>
<td>-ø</td>
<td>61</td>
<td>20</td>
<td>81</td>
</tr>
<tr>
<td>-e</td>
<td>50.2</td>
<td>30.8</td>
<td>81</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{6.10}{1.35\%} = 1.35\% \]

ad (1): apocope in weak fem. nouns

<table>
<thead>
<tr>
<th></th>
<th>-ø</th>
<th>/-ø/</th>
<th>overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ofr.</td>
<td>30</td>
<td>34.7</td>
<td>106</td>
</tr>
<tr>
<td>-ø</td>
<td>30</td>
<td>34.7</td>
<td>106</td>
</tr>
<tr>
<td>/-ø/</td>
<td>26</td>
<td>21.3</td>
<td>56</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{1.68}{19.44\%} = 1.35\% \]
ad (2): vowel length and final schwa

\[
\begin{array}{|c|c|c|}
\hline
\text{root /u/} & \text{expected} & \text{overall} \\
\hline
-\sigma & 64 & 54.5 \quad 1848 \\
-\epsilon & 16 & 25.5 \quad 863 \\
\hline
\end{array}
\]

\[
\chi^2 = 5.16, \quad p = 2.31\% , \quad df = 1, \quad n = 80
\]

\[
\begin{array}{|c|c|c|}
\hline
\text{root /o/} & \text{expected} & \text{overall} \\
\hline
-\sigma & 118 & 146.6 \quad 1848 \\
-\epsilon & 97 & 68.4 \quad 863 \\
\hline
\end{array}
\]

\[
\chi^2 = 17.48, \quad p < 0.1\% , \quad df = 1, \quad n = 215
\]

ad (3): root in /b/

\[
\begin{array}{|c|c|c|}
\hline
\text{root /-b/} & \text{expected} & \text{overall} \\
\hline
-\sigma & 16 & 36.8 \quad 1848 \\
-\epsilon & 38 & 17.2 \quad 863 \\
\hline
\end{array}
\]

\[
\chi^2 = 36.96, \quad p < 0.1\% , \quad df = 1, \quad n = 54
\]

ad (3): root in /d/

\[
\begin{array}{|c|c|c|}
\hline
\text{root /-d/} & \text{expected} & \text{overall} \\
\hline
-\sigma & 86 & 113.2 \quad 1848 \\
-\epsilon & 80 & 528 \quad 863 \\
\hline
\end{array}
\]

\[
\chi^2 = 20.47, \quad p < 0.1\% , \quad df = 1, \quad n = 166
\]

§ 2.4.3.1

Graph 2.5: Overall picture using % with <a>
Graph 2.5: Position of /a/ in the word: all originals

<table>
<thead>
<tr>
<th>observed</th>
<th>word fn.</th>
<th>morph fn.</th>
<th>expected</th>
<th>word fn.</th>
<th>morph fn.</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;a&gt;</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>10</td>
<td>1.6</td>
</tr>
<tr>
<td>&lt;e&gt;</td>
<td>1</td>
<td>5</td>
<td>22</td>
<td>28</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

χ² = p = df = n =
<br>20.81 % 2 38
<br>Yates' correction 13.89 <0.1%

Graph 2.5: word final /a/ in monn(ia)

<table>
<thead>
<tr>
<th>observed &lt;1510 &gt;1510</th>
<th>expected</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;a&gt; 5 1 6</td>
<td>&lt;a&gt; 3.8</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>&lt;e&gt; 0 2 2</td>
<td>&lt;e&gt; 1.3</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

χ² = p = df = n =
<br>4.44 3.5% 1 8
<br>Yates' correction 1.60 20.6% 10.7% 10.7%

Graph 2.5: morpheme final /a/ in monnadey

<table>
<thead>
<tr>
<th>observed &lt;1496 &gt;1496</th>
<th>expected</th>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;a&gt; 25 1 26</td>
<td>&lt;a&gt; 19.7</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>&lt;e&gt; 3 8 11</td>
<td>&lt;e&gt; 8.3</td>
<td>2.7</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

χ² = p = df = n =
<br>19.92 <0.1% 1 37
<br>Yates' correction 16.36 <0.1%

Graph 2.5: word final /a/ in monna vs. morpheme final /a/ in monnadey between 1496-1510

<table>
<thead>
<tr>
<th>observed monnamonnadei</th>
<th>expected monna</th>
<th>monnadei</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;a&gt; 2 1 3</td>
<td>&lt;a&gt; 0.6</td>
<td>24</td>
</tr>
<tr>
<td>&lt;e&gt; 0 7 7</td>
<td>&lt;e&gt; 1.4</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

χ² = p = df = n =
<br>5.83 1.6% 1 10
<br>Yates' correction 241 12.1% 6.7% 6.7%
§ 2.4.3.2

Reduction of /a/ in the verb habba: Unia section A + OFO I-1 vs. Unia section B/C

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A+OFO B/C</td>
<td>A+OFO B/C</td>
<td></td>
</tr>
<tr>
<td>&lt;a&gt;</td>
<td>40</td>
<td>37.7</td>
<td>37.7</td>
</tr>
<tr>
<td>&lt;e&gt;</td>
<td>10</td>
<td>12.3</td>
<td>12.3</td>
</tr>
<tr>
<td></td>
<td>50</td>
<td>53</td>
<td>53</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(o - e)^2}{e} \]

\[ p = \frac{1}{1 + \frac{df}{n}} \]

No geographical contrast of <a> in forms of habbath: 1392-1432

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NE rest</td>
<td>NE rest</td>
<td></td>
</tr>
<tr>
<td>&lt;a&gt;</td>
<td>4</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>&lt;e/i&gt;</td>
<td>12</td>
<td>11.8</td>
<td>11.8</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>28</td>
<td>28</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(o - e)^2}{e} \]

\[ p = \frac{1}{1 + \frac{df}{n}} \]

Graph 2.7: individual point values for 1420 compared with the average for that period. Only the values for U-tha-an and Ch-tha-an could be tested because only there straight forward token values are available. Neglecting the extreme values from Unia section B, the average portion of -an is 25% for that period.

<table>
<thead>
<tr>
<th></th>
<th>1420 U-tha-an</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;an&gt;</td>
<td>4</td>
<td>2.0</td>
</tr>
<tr>
<td>&lt;en&gt;</td>
<td>4</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(o - e)^2}{e} \]

\[ p = \frac{1}{1 + \frac{df}{n}} \]

<table>
<thead>
<tr>
<th></th>
<th>1420 Ch-tha-an</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;an&gt;</td>
<td>5</td>
<td>3.0</td>
</tr>
<tr>
<td>&lt;en&gt;</td>
<td>7</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>12</td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(o - e)^2}{e} \]

\[ p = \frac{1}{1 + \frac{df}{n}} \]
Vowel Balance in the plural ending in Unia, group A

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th></th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Long</td>
<td>Short</td>
<td>Long</td>
<td>Short</td>
</tr>
<tr>
<td>&lt;an&gt;</td>
<td>29</td>
<td>12</td>
<td>41</td>
<td>33.0</td>
</tr>
<tr>
<td>&lt;en&gt;</td>
<td>41</td>
<td>5</td>
<td>46</td>
<td>37.0</td>
</tr>
<tr>
<td></td>
<td>70</td>
<td>17</td>
<td>87</td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = 4.67 \quad p = 3.1\% \quad df = 1 \quad n = 87
\]

Vowel Balance in the plural ending in Unia, group B & C

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th></th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Long</td>
<td>Short</td>
<td>Long</td>
<td>Short</td>
</tr>
<tr>
<td>&lt;an&gt;</td>
<td>9</td>
<td>1</td>
<td>10</td>
<td>8.8</td>
</tr>
<tr>
<td>&lt;en&gt;</td>
<td>13</td>
<td>2</td>
<td>15</td>
<td>13.2</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>3</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = 0.06 \quad p = 80.2\% \quad df = 1 \quad n = 25
\]

Vowel Balance in the plural ending in the charters, between 1379 and 1440

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th></th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Long</td>
<td>Short</td>
<td>Long</td>
<td>Short</td>
</tr>
<tr>
<td>&lt;an&gt;</td>
<td>7</td>
<td>7</td>
<td>14</td>
<td>6.1</td>
</tr>
<tr>
<td>&lt;en&gt;</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>9</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = 1.78 \quad p = 18.2\% \quad df = 1 \quad n = 16
\]

Geographical contrast between North-East and the rest, before 1440

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th></th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>NE rest</td>
<td></td>
<td>NE rest</td>
<td></td>
</tr>
<tr>
<td>&lt;an&gt;</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>26</td>
</tr>
<tr>
<td>&lt;en&gt;</td>
<td>2</td>
<td>7</td>
<td>9</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>10</td>
<td>16</td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = 2.05 \quad p = 15.2\% \quad df = 1 \quad n = 16
\]
### Unia: *sunndei* vs. *jus sunndei*

<table>
<thead>
<tr>
<th></th>
<th>Unia</th>
<th>Jus</th>
<th></th>
<th>Unia</th>
<th>Jus</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>&lt;an&gt;</em></td>
<td>3</td>
<td>0</td>
<td><em>&lt;en&gt;</em></td>
<td>1.1</td>
<td>1.9</td>
</tr>
<tr>
<td><em>&lt;en&gt;</em></td>
<td>0</td>
<td>5</td>
<td></td>
<td>1.9</td>
<td>3.1</td>
</tr>
</tbody>
</table>

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>&lt;an&gt;</em></td>
<td>3</td>
<td>0</td>
<td><em>&lt;en&gt;</em></td>
<td>1.1</td>
<td>1.9</td>
</tr>
<tr>
<td><em>&lt;en&gt;</em></td>
<td>0</td>
<td>5</td>
<td></td>
<td>1.9</td>
<td>3.1</td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{p}{df} = \frac{n}{\text{Yates' correction}}
\]

\[
8.00 \quad 0.5\% \quad 1 \quad 8
\]

### *abbate* vs. *abbet-* in Unia and Jus

<table>
<thead>
<tr>
<th></th>
<th>Unia</th>
<th>Jus</th>
<th></th>
<th>Unia</th>
<th>Jus</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>&lt;a&gt;</em></td>
<td>2</td>
<td>1</td>
<td><em>&lt;e&gt;</em></td>
<td>1.2</td>
<td>1.8</td>
</tr>
<tr>
<td><em>&lt;e&gt;</em></td>
<td>0</td>
<td>2</td>
<td></td>
<td>0.8</td>
<td>1.2</td>
</tr>
</tbody>
</table>

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><em>&lt;a&gt;</em></td>
<td>2</td>
<td>1</td>
<td><em>&lt;e&gt;</em></td>
<td>1.2</td>
<td>1.8</td>
</tr>
<tr>
<td><em>&lt;e&gt;</em></td>
<td>0</td>
<td>2</td>
<td></td>
<td>0.8</td>
<td>1.2</td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{p}{df} = \frac{n}{\text{Yates' correction}}
\]

\[
222 \quad 13.6\% \quad 1 \quad 5
\]

### Table 2.17: *abbate*, excluding *abt*

<table>
<thead>
<tr>
<th></th>
<th>NE rest</th>
<th></th>
<th></th>
<th>NE rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>abbate</td>
<td>14</td>
<td>1</td>
<td>15</td>
<td>abbate</td>
</tr>
<tr>
<td>abte</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>abte</td>
</tr>
</tbody>
</table>

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>abbate</td>
<td>14</td>
<td>1</td>
<td>15</td>
<td>abbate</td>
<td></td>
</tr>
<tr>
<td>abte</td>
<td>0</td>
<td>5</td>
<td>5</td>
<td>abte</td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{p}{df} = \frac{n}{\text{Yates' correction}}
\]

\[
15.56 <0.1\% \quad 1 \quad 20
\]

### Table 2.17: *abbate*, including *abt*

<table>
<thead>
<tr>
<th></th>
<th>NE rest</th>
<th></th>
<th></th>
<th>NE rest</th>
</tr>
</thead>
<tbody>
<tr>
<td>abbate</td>
<td>14</td>
<td>1</td>
<td>15</td>
<td>abbate</td>
</tr>
<tr>
<td>abt(e)</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>abt(e)</td>
</tr>
</tbody>
</table>

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>abbate</td>
<td>14</td>
<td>1</td>
<td>15</td>
<td>abbate</td>
<td></td>
</tr>
<tr>
<td>abt(e)</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>abt(e)</td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{p}{df} = \frac{n}{\text{Yates' correction}}
\]

\[
10.80 \quad 0.1\% \quad 1 \quad 27
\]
§ 2.4.3.9

Table 2.22: dative -e in idiomatic expression *fria kapte*, 1470-1517

<table>
<thead>
<tr>
<th>observed idiom</th>
<th>other</th>
<th>expected idiom</th>
<th>other</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>58</td>
<td>-e</td>
<td>60.1</td>
</tr>
<tr>
<td>e</td>
<td>8</td>
<td>o</td>
<td>5.9</td>
</tr>
<tr>
<td></td>
<td>66</td>
<td>23</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>89</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = 3.06, p = 0.08, \text{df} = 1, n = 89 \]

<table>
<thead>
<tr>
<th>Yates' correction</th>
<th>FE 1-t</th>
<th>FE 2-t</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.76</td>
<td>18.5%</td>
<td>8.1%</td>
</tr>
<tr>
<td>5.9%</td>
<td>10.6%</td>
<td></td>
</tr>
</tbody>
</table>

Table 2.22: dative -e in *kâp* and *lôg*, original charters

<table>
<thead>
<tr>
<th>observed &lt;1470&gt; 1470</th>
<th>expected &lt;1470 &gt; 1470</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>20</td>
</tr>
<tr>
<td>e</td>
<td>8</td>
</tr>
<tr>
<td>o</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>160</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 56.10, p < 0.1%, \text{df} = 1, n = 160 \]

§ 2.5.1

Graph 2.17: Vowel Balance in 3 Frisian dialects in the preservation of final -e

<table>
<thead>
<tr>
<th>Modern West Frisian, Long vs. Short Root</th>
</tr>
</thead>
<tbody>
<tr>
<td>observed Long -e Short -e</td>
</tr>
<tr>
<td>-e</td>
</tr>
<tr>
<td>e</td>
</tr>
<tr>
<td>o</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = 3.58, p = 0.059, \text{df} = 1, n = 74 \]

Yates' correction 257 10.9%
Graph 2.17: Modern West Frisian, Ofr. -a vs. Ofr. -e

<table>
<thead>
<tr>
<th>observed</th>
<th>Ofr -a</th>
<th>Ofr -e</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>28</td>
<td>29</td>
</tr>
<tr>
<td>ø</td>
<td>6</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>34</td>
<td>74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>expected</th>
<th>Ofr -a</th>
<th>Ofr -e</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>17.9</td>
<td>39.1</td>
</tr>
<tr>
<td>ø</td>
<td>16.1</td>
<td>34.9</td>
</tr>
</tbody>
</table>

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>χ²</td>
<td>p</td>
<td>df</td>
</tr>
<tr>
<td>17.42</td>
<td>&lt;0.1%</td>
<td>1</td>
</tr>
</tbody>
</table>

Yates' correction

Graph 2.17: Mainland North Frisian (Ockholm), Long vs. Short Root

<table>
<thead>
<tr>
<th>observed</th>
<th>Long</th>
<th>Short</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>ø</td>
<td>33</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>44</td>
<td>27</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>expected</th>
<th>Long</th>
<th>Short</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>15.5</td>
<td>9.5</td>
</tr>
<tr>
<td>ø</td>
<td>28.5</td>
<td>17.5</td>
</tr>
</tbody>
</table>

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>χ²</td>
<td>p</td>
<td>df</td>
</tr>
<tr>
<td>5.29</td>
<td>2.1%</td>
<td>1</td>
</tr>
</tbody>
</table>

Yates' correction

Graph 2.17: Mainland North Frisian (Ockholm), Ofr. -a vs. Ofr. -e

<table>
<thead>
<tr>
<th>observed</th>
<th>Ofr -a</th>
<th>Ofr -e</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>20</td>
<td>5</td>
</tr>
<tr>
<td>ø</td>
<td>6</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>expected</th>
<th>Ofr -a</th>
<th>Ofr -e</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>9.2</td>
<td>15.8</td>
</tr>
<tr>
<td>ø</td>
<td>16.8</td>
<td>29.2</td>
</tr>
</tbody>
</table>

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>χ²</td>
<td>p</td>
<td>df</td>
</tr>
<tr>
<td>31.29</td>
<td>&lt;0.1%</td>
<td>1</td>
</tr>
</tbody>
</table>

Yates' correction

Graph 2.17: Harlingerland (East Frisian), Long vs. Short Root

<table>
<thead>
<tr>
<th>observed</th>
<th>Short -a</th>
<th>Short -e</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>ø</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>expected</th>
<th>Short -a</th>
<th>Short -e</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>4.1</td>
<td>4.9</td>
</tr>
<tr>
<td>ø</td>
<td>5.9</td>
<td>7.1</td>
</tr>
</tbody>
</table>

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>χ²</td>
<td>p</td>
<td>df</td>
</tr>
<tr>
<td>6.42</td>
<td>1.1%</td>
<td>1</td>
</tr>
</tbody>
</table>
Graph 2.17: Harlingerland (East Frisian), Ofr. -a vs. Ofr. -e for Long Roots

<table>
<thead>
<tr>
<th>observed</th>
<th>Long -a</th>
<th>Long -e</th>
<th>expected</th>
<th>Long -a</th>
<th>Long -e</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>10</td>
<td>33</td>
<td>43</td>
<td>-e</td>
<td>10.5</td>
</tr>
<tr>
<td>ø</td>
<td>8</td>
<td>23</td>
<td>31</td>
<td>ø</td>
<td>7.5</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>56</td>
<td>74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(observed - expected)^2}{expected} \]

Yates' correction

\[ \chi^2 = \frac{(observed - expected)^2}{expected} \]

Modern Vowel Balance in West Frisian in data set used for graph 2.17

<table>
<thead>
<tr>
<th>observed</th>
<th>Short</th>
<th>Long</th>
<th>expected</th>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>-e</td>
<td>34</td>
<td>13</td>
<td>47</td>
<td>-e</td>
<td>25.9</td>
</tr>
<tr>
<td>ø</td>
<td>20</td>
<td>31</td>
<td>51</td>
<td>ø</td>
<td>28.1</td>
</tr>
<tr>
<td></td>
<td>54</td>
<td>44</td>
<td>98</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(observed - expected)^2}{expected} \]

Yates' correction

\[ \chi^2 = \frac{(observed - expected)^2}{expected} \]

§ 2.5.2

Graph 2.18: Vowel Balance in the reduction of protected /a/ between 1430-1460

<table>
<thead>
<tr>
<th>observed</th>
<th>Short</th>
<th>Long</th>
<th>expected</th>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;a&gt;</td>
<td>22</td>
<td>10</td>
<td>32</td>
<td>&lt;a&gt;</td>
<td>8.3</td>
</tr>
<tr>
<td>&lt;e/i&gt;</td>
<td>68</td>
<td>246</td>
<td>314</td>
<td>&lt;e/i&gt;</td>
<td>81.7</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>256</td>
<td>346</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[ \chi^2 = \frac{(observed - expected)^2}{expected} \]

Yates' correction

\[ \chi^2 = \frac{(observed - expected)^2}{expected} \]
### Mechanisms of Language Change

Graph 2.18: Vowel Balance in the reduction of protected /a/ between 1460-1490

<table>
<thead>
<tr>
<th></th>
<th>Short</th>
<th>Long</th>
<th></th>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;a&gt;</td>
<td>21</td>
<td>5</td>
<td>&lt;a&gt;</td>
<td>7.2</td>
<td>18.8</td>
</tr>
<tr>
<td>&lt;e/i&gt;</td>
<td>262</td>
<td>728</td>
<td>&lt;e/i&gt;</td>
<td>275.8</td>
<td>714.2</td>
</tr>
<tr>
<td></td>
<td>283</td>
<td>733</td>
<td>1016</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[\chi^2 = \frac{(o - e)^2}{e}\]

\[
p = \text{df} = \text{n} =
\]

Yates' correction

\[\chi^2 = \frac{(o - e)^2}{e}\]

\[
p = \text{df} = \text{n} =
\]

Graph 2.18: Vowel Balance in the reduction of protected /a/ between 1490-1510

<table>
<thead>
<tr>
<th></th>
<th>Short</th>
<th>Long</th>
<th></th>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;a&gt;</td>
<td>5</td>
<td>0</td>
<td>&lt;a&gt;</td>
<td>1.4</td>
<td>3.6</td>
</tr>
<tr>
<td>&lt;e/i&gt;</td>
<td>268</td>
<td>690</td>
<td>&lt;e/i&gt;</td>
<td>271.6</td>
<td>686.4</td>
</tr>
<tr>
<td></td>
<td>273</td>
<td>690</td>
<td>963</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[\chi^2 = \frac{(o - e)^2}{e}\]

\[
p = \text{df} = \text{n} =
\]

Yates' correction

\[\chi^2 = \frac{(o - e)^2}{e}\]

\[
p = \text{df} = \text{n} =
\]

Graph 2.20: Contrast -a vs. -ia in verbs after 1470

<table>
<thead>
<tr>
<th></th>
<th>-a</th>
<th>-ia</th>
<th></th>
<th>-a</th>
<th>-ia</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;a&gt;</td>
<td>785</td>
<td>32</td>
<td>817</td>
<td>&lt;a&gt;</td>
<td>757.8</td>
</tr>
<tr>
<td>&lt;e&gt;</td>
<td>470</td>
<td>66</td>
<td>536</td>
<td>&lt;e&gt;</td>
<td>497.2</td>
</tr>
<tr>
<td></td>
<td>1255</td>
<td>98</td>
<td>1353</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[\chi^2 = \frac{(o - e)^2}{e}\]

\[
p = \text{df} = \text{n} =
\]

Yates' correction

\[\chi^2 = \frac{(o - e)^2}{e}\]

\[
p = \text{df} = \text{n} =
\]

Graph 2.20: *bitalia* vs. *kâpia*, 1470-1510

<table>
<thead>
<tr>
<th></th>
<th>bitalia</th>
<th>kâpia</th>
<th></th>
<th>bitalia</th>
<th>kâpia</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;a&gt;</td>
<td>24</td>
<td>6</td>
<td>30</td>
<td>&lt;a&gt;</td>
<td>21.9</td>
</tr>
<tr>
<td>&lt;e&gt;</td>
<td>22</td>
<td>11</td>
<td>33</td>
<td>&lt;e&gt;</td>
<td>24.1</td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>17</td>
<td>63</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[\chi^2 = \frac{(o - e)^2}{e}\]

\[
p = \text{df} = \text{n} =
\]

Yates' correction

\[\chi^2 = \frac{(o - e)^2}{e}\]

\[
p = \text{df} = \text{n} =
\]

-334-
Graph 2.20 (+ text): *bitalia + metje* vs. *kâpia + metje*, 1470-1510

<table>
<thead>
<tr>
<th>observed</th>
<th>Short</th>
<th>Long</th>
<th>expected</th>
<th>Short</th>
<th>Long</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;a&gt;</td>
<td>35</td>
<td>11</td>
<td>46</td>
<td>&lt;a&gt;</td>
<td>29.5</td>
</tr>
<tr>
<td>&lt;e&gt;</td>
<td>31</td>
<td>26</td>
<td>57</td>
<td>&lt;e&gt;</td>
<td>36.5</td>
</tr>
<tr>
<td></td>
<td>66</td>
<td>37</td>
<td>103</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{(observed - expected)^2}{expected} = 5.21\text{ df = 1 n = 103}
\]

\[p = \gamma = 2.2\%\]

Yates’ correction \[
\chi^2 = p = 4.31\text{ df = 1 n = 103}
\]

\[p = \gamma = 3.8\%\]

§ 2.6.2

Table 2.25: Vowel Harmony in Unia, A-1 and A-2: *kuma - kome*

<table>
<thead>
<tr>
<th>observed</th>
<th>-a/-i</th>
<th>-e</th>
<th>expected</th>
<th>-a/-i</th>
<th>-e</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;u&gt;</td>
<td>15</td>
<td>8</td>
<td>23</td>
<td>&lt;u&gt;</td>
<td>9.4</td>
</tr>
<tr>
<td>&lt;o&gt;</td>
<td>14</td>
<td>34</td>
<td>48</td>
<td>&lt;o&gt;</td>
<td>19.6</td>
</tr>
<tr>
<td></td>
<td>29</td>
<td>42</td>
<td>71</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{(observed - expected)^2}{expected} = 836\text{ df = 1 n = 71}
\]

\[p = \gamma = 0.4\%\]

Yates’ correction \[
\chi^2 = p = 6.94\text{ df = 1 n = 71}
\]

\[p = \gamma = 0.8\%\]

Table 2.25: Vowel Harmony in the 18th century language of Eelke Meinerts (North-East); data from 13 lemmas

<table>
<thead>
<tr>
<th>observed</th>
<th>-i-</th>
<th>-e/-a-</th>
<th>expected</th>
<th>-i-</th>
<th>-e/-a-</th>
</tr>
</thead>
<tbody>
<tr>
<td>bi-</td>
<td>14</td>
<td>12</td>
<td>26</td>
<td>bi-</td>
<td>9.6</td>
</tr>
<tr>
<td>be-</td>
<td>0</td>
<td>12</td>
<td>12</td>
<td>be-</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>24</td>
<td>38</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{(observed - expected)^2}{expected} = 10.23\text{ df = 1 n = 38}
\]

\[p = \gamma = 0.1\%\]

Yates’ correction \[
\chi^2 = p = 8.05\text{ df = 1 n = 38}
\]

\[p = \gamma = 0.5\%\]

Table 2.25: Vowel Harmony in Unia, a/u/i-i vs. e/o-e in the ending of the 3rd person singular without syncope: *-eth*

<table>
<thead>
<tr>
<th>observed</th>
<th>-/i/</th>
<th>-/o/-</th>
<th>expected</th>
<th>-/i/</th>
<th>-/o/-</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;i&gt;</td>
<td>6</td>
<td>3</td>
<td>9</td>
<td>&lt;i&gt;</td>
<td>29</td>
</tr>
<tr>
<td>&lt;e&gt;</td>
<td>1</td>
<td>12</td>
<td>13</td>
<td>&lt;e&gt;</td>
<td>4.1</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>15</td>
<td>22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{(observed - expected)^2}{expected} = 8.53\text{ df = 1 n = 22}
\]

\[p = \gamma = 0.4\%\]

Yates’ correction \[
\chi^2 = p = 6.02\text{ df = 1 n = 22}
\]

\[p = \gamma = 1.4\%\]

\[FE = 0.7\text{ df = 1 n = 22}
\]

\[FE = 0.7\text{ df = 1 n = 22}
\]
A.P. Versloot: *Mechanisms of Language Change*

Table 2.25: Vowel Harmony in Middle-Frisian *bijalath/-ad*

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-tal(l)-</td>
<td>-tel(l)-</td>
<td></td>
</tr>
<tr>
<td>&lt;i&gt;</td>
<td>54</td>
<td>37</td>
<td>91</td>
</tr>
<tr>
<td>&lt;e&gt;</td>
<td>74</td>
<td>141</td>
<td>215</td>
</tr>
<tr>
<td></td>
<td>128</td>
<td>178</td>
<td>306</td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{(O - E)^2}{E} = 16.32 \quad p = 0.0001 < 0.1% \quad df = 1 \quad n = 306
\]

Table 2.26: Vowel Harmony in Middle Frisian *seke/saka* -1460

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pl-a/others</td>
<td>pl-a/others</td>
<td></td>
</tr>
<tr>
<td>sak-</td>
<td>14/2/16</td>
<td>28/13.2</td>
<td></td>
</tr>
<tr>
<td>sek-</td>
<td>2/75/77</td>
<td>13.2/63.8</td>
<td></td>
</tr>
<tr>
<td></td>
<td>16/77/93</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{(O - E)^2}{E} = 67.04 \quad p = 0.0001 < 0.1% \quad df = 1 \quad n = 93
\]

Table 2.26: Vowel Harmony in Middle Frisian *seke/saka* 1460-1480

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pl-a/-en/others</td>
<td>pl-a/-en/others</td>
<td></td>
</tr>
<tr>
<td>sak-</td>
<td>10/3/13</td>
<td>4.1/8.9</td>
<td></td>
</tr>
<tr>
<td>sek-</td>
<td>25/73/98</td>
<td>30.9/67.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35/76/111</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{(O - E)^2}{E} = 14.05 \quad p = 0.0001 < 0.1% \quad df = 1 \quad n = 111
\]

Table 2.26: Vowel Harmony in Middle Frisian *seke/saka* 1480

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pl-a/pl-en</td>
<td>pl-a/pl-en</td>
<td></td>
</tr>
<tr>
<td>sak-</td>
<td>21/4/25</td>
<td>17.6/7.4</td>
<td></td>
</tr>
<tr>
<td>sek-</td>
<td>17/12/29</td>
<td>20.4/8.6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>38/16/54</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = \frac{(O - E)^2}{E} = 4.15 \quad p = 4.2% \quad df = 1 \quad n = 54
\]

\[
\chi^2 = \frac{(O - E)^2}{E} = 3.02 \quad p = 8.2% \quad df = 1 \quad n = 54
\]
§ 2.6.3
Table 2.27: Vowel Harmony in Middle Frisian *degan/dagen* -1460

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pl-en</td>
<td>others</td>
<td></td>
</tr>
<tr>
<td>sak-</td>
<td>9</td>
<td>26</td>
<td>35</td>
</tr>
<tr>
<td>sek-</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>total</td>
<td>14</td>
<td>27</td>
<td>41</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 7.56 \quad p = 0.6\% \quad df = 1 \quad n = 41 \]

Yates' correction: 5.22, 2.2%

Table 2.27: Vowel Harmony in Middle Frisian *degan/dagen* 1460-1480

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>pl-en</td>
<td>others</td>
<td></td>
</tr>
<tr>
<td>sak-</td>
<td>10</td>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>sek-</td>
<td>4</td>
<td>19</td>
<td>23</td>
</tr>
<tr>
<td>total</td>
<td>14</td>
<td>24</td>
<td>38</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 9.47 \quad p = 0.2\% \quad df = 1 \quad n = 38 \]

Yates' correction: 7.47, 0.6%

Table 2.27: Vowel Harmony in Middle Frisian *degan/dagen* -1460

<table>
<thead>
<tr>
<th></th>
<th>observed</th>
<th>expected</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>nom/acc</td>
<td>dat. -en</td>
<td></td>
</tr>
<tr>
<td>sak-</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>sek-</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>total</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
</tbody>
</table>

\[ \chi^2 = 0.93 \quad p = 33.4\% \quad df = 1 \quad n = 14 \]

Yates' correction: 0.16, 68.7%

FE 1-t: 34.3%, FE 2-t: 58.0%
§ 3.4
Syncope in gerund and past participle of *swera* and *kera*, > 1450

<table>
<thead>
<tr>
<th>observed gerund past part.</th>
<th>expected gerund past part.</th>
</tr>
</thead>
<tbody>
<tr>
<td>-ren</td>
<td>-rn</td>
</tr>
<tr>
<td>15 6</td>
<td>16 6</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 4.88 \quad p = 0.027 \quad df = 1 \quad n = 37
\]

\[
\text{Yates' correction} \quad \chi^2 = 3.08 \quad p = 0.079 \quad FE 1-t = 3.2\% \quad FE 2-t = 6.3\%
\]

§ 5.2.1
Table 5.7: Checking the contrast of the classical verbal endings in *habba* in the charters before 1430; <habbe> and <habba> only.

<table>
<thead>
<tr>
<th>observed</th>
<th>&lt;e&gt;</th>
<th>&lt;a&gt;</th>
<th>expected</th>
<th>&lt;e&gt;</th>
<th>&lt;a&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st sg</td>
<td>6</td>
<td>0</td>
<td>6</td>
<td>3.2</td>
<td>28</td>
</tr>
<tr>
<td>inf</td>
<td>1</td>
<td>6</td>
<td>7</td>
<td>3.8</td>
<td>3.2</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 9.55 \quad p = 0.002 \quad df = 1 \quad n = 13
\]

\[
\text{Yates' correction} \quad \chi^2 = 6.41 \quad p = 0.041 \quad FE 1-t = 4.1\% \quad FE 2-t = 4.7\%
\]

§ 5.2.4

<secke> as a plural form 1430-1510

<table>
<thead>
<tr>
<th>observed</th>
<th>expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;secke&gt;</td>
<td>0 2.2 17%</td>
</tr>
<tr>
<td>others</td>
<td>13 10.8</td>
</tr>
</tbody>
</table>

\[
\chi^2 = 266 \quad p = 0.027 \quad df = 1 \quad n = 13
\]
Appendix 1.2: Correlations (note: correlation data graph 1.4 in appendix 1.1)

§ 1.3.7.7

Graph 1.6: Correlation between point values and trend surface values.

<table>
<thead>
<tr>
<th>municipal.</th>
<th>/e/</th>
<th>/o/</th>
<th>point value</th>
<th>surface value</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tyt</td>
<td>0</td>
<td>1</td>
<td>0%</td>
<td>34%</td>
<td>71%</td>
</tr>
<tr>
<td>Ldl</td>
<td>0</td>
<td>2</td>
<td>0%</td>
<td>39%</td>
<td>71%</td>
</tr>
<tr>
<td>Ldn</td>
<td>10</td>
<td>7</td>
<td>59%</td>
<td>46%</td>
<td>71%</td>
</tr>
<tr>
<td>Men</td>
<td>1</td>
<td>1</td>
<td>50%</td>
<td>52%</td>
<td>71%</td>
</tr>
<tr>
<td>Boa</td>
<td>2</td>
<td>2</td>
<td>50%</td>
<td>64%</td>
<td>71%</td>
</tr>
<tr>
<td>Don</td>
<td>1</td>
<td>0</td>
<td>100%</td>
<td>65%</td>
<td>71%</td>
</tr>
<tr>
<td>Fra</td>
<td>10</td>
<td>1</td>
<td>91%</td>
<td>71%</td>
<td>71%</td>
</tr>
<tr>
<td>Hee</td>
<td>1</td>
<td>0</td>
<td>100%</td>
<td>84%</td>
<td>71%</td>
</tr>
<tr>
<td>Bol</td>
<td>3</td>
<td>0</td>
<td>100%</td>
<td>92%</td>
<td>71%</td>
</tr>
<tr>
<td>Ska</td>
<td>1</td>
<td>0</td>
<td>100%</td>
<td>92%</td>
<td>71%</td>
</tr>
<tr>
<td>Wym</td>
<td>1</td>
<td>0</td>
<td>100%</td>
<td>95%</td>
<td>71%</td>
</tr>
<tr>
<td>Wun</td>
<td>2</td>
<td>0</td>
<td>100%</td>
<td>97%</td>
<td>71%</td>
</tr>
<tr>
<td>Nij</td>
<td>3</td>
<td>0</td>
<td>100%</td>
<td>100%</td>
<td>72%</td>
</tr>
</tbody>
</table>

\[ r = 88.2\% \quad r^2 = 77.8\% \quad df = 11 \quad n = 13 \quad p 1-T = < 0.1\% \quad 24.3\% \quad p 2-T = < 0.1\% \quad 48.7\% \]
Graph 1.7: Correlation between point values and trend surface values.

<table>
<thead>
<tr>
<th>municipal.</th>
<th>/e/</th>
<th>/o/</th>
<th>point value %/e/</th>
<th>surface value %/e/</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>NE</td>
<td>1</td>
<td>1</td>
<td>50%</td>
<td>51%</td>
<td>71%</td>
</tr>
<tr>
<td>MM</td>
<td>10</td>
<td>9</td>
<td>53%</td>
<td>65%</td>
<td>71%</td>
</tr>
<tr>
<td>SE</td>
<td>4</td>
<td>2</td>
<td>67%</td>
<td>75%</td>
<td>71%</td>
</tr>
<tr>
<td>NW</td>
<td>11</td>
<td>2</td>
<td>85%</td>
<td>78%</td>
<td>71%</td>
</tr>
<tr>
<td>SW</td>
<td>6</td>
<td>0</td>
<td>100%</td>
<td>89%</td>
<td>71%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>35</th>
<th>14</th>
<th>r = 94.3%</th>
<th>r² = 88.9%</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td></td>
<td>average /e/ = 71%</td>
<td>r² = 88.9%</td>
</tr>
</tbody>
</table>

Graph 1.8: Correlation between point values and trend surface values.

<table>
<thead>
<tr>
<th>municipal.</th>
<th>/et/it/</th>
<th>/at/</th>
<th>pnt. value %&lt;a&gt;</th>
<th>surf. value %&lt;a&gt;</th>
<th>average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nij</td>
<td>2</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
<td>33%</td>
</tr>
<tr>
<td>Wun</td>
<td>3</td>
<td>0</td>
<td>0%</td>
<td>16%</td>
<td>33%</td>
</tr>
<tr>
<td>Boa</td>
<td>13</td>
<td>2</td>
<td>13%</td>
<td>32%</td>
<td>33%</td>
</tr>
<tr>
<td>Lit</td>
<td>1</td>
<td>1</td>
<td>50%</td>
<td>34%</td>
<td>33%</td>
</tr>
<tr>
<td>Fra</td>
<td>4</td>
<td>2</td>
<td>33%</td>
<td>37%</td>
<td>33%</td>
</tr>
<tr>
<td>Tyr</td>
<td>2</td>
<td>1</td>
<td>33%</td>
<td>37%</td>
<td>33%</td>
</tr>
<tr>
<td>Ldn</td>
<td>7</td>
<td>9</td>
<td>56%</td>
<td>38%</td>
<td>33%</td>
</tr>
<tr>
<td>Dan</td>
<td>4</td>
<td>1</td>
<td>20%</td>
<td>40%</td>
<td>33%</td>
</tr>
<tr>
<td>Don</td>
<td>1</td>
<td>2</td>
<td>67%</td>
<td>42%</td>
<td>34%</td>
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<table>
<thead>
<tr>
<th>37</th>
<th>18</th>
<th>r = 74.5%</th>
<th>r² = 55.5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>67</td>
<td></td>
<td>average /e/ = 67%</td>
<td>r² = 55.5%</td>
</tr>
</tbody>
</table>

| df = 7 | p 1-T= 1.1% | p 2-T= 5.4% |
| n = 9  |             |             |

-340-
### § 1.3.7.9

**Graph 1.9: Level of Mixture, charter count.**

<table>
<thead>
<tr>
<th>Words</th>
<th>Mixed charter</th>
<th>% Mixed charter</th>
<th>Charter var. 1</th>
<th>Charter var. 2</th>
<th>% Overall mixture</th>
<th>Variant 1 vs. Variant 2</th>
<th>Time frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>bital</td>
<td>0</td>
<td>0%</td>
<td>20</td>
<td>73</td>
<td>22%</td>
<td>&lt;a&gt; - &lt;e/i&gt;</td>
<td>-1481</td>
</tr>
<tr>
<td>habbath</td>
<td>1</td>
<td>8%</td>
<td>7</td>
<td>18</td>
<td>28%</td>
<td>&lt;a&gt; - &lt;e/i&gt;</td>
<td>-1435</td>
</tr>
<tr>
<td>kapad</td>
<td>6</td>
<td>9%</td>
<td>107</td>
<td>237</td>
<td>31%</td>
<td>&lt;i&gt; - &lt;e&gt;</td>
<td>all</td>
</tr>
<tr>
<td>wesa</td>
<td>1</td>
<td>4%</td>
<td>19</td>
<td>40</td>
<td>32%</td>
<td>&lt;a&gt; - &lt;e&gt;</td>
<td>-1471</td>
</tr>
<tr>
<td>degum</td>
<td>2</td>
<td>20%</td>
<td>37</td>
<td>54</td>
<td>41%</td>
<td>&lt;un&gt; - &lt;en&gt;</td>
<td>all</td>
</tr>
<tr>
<td>sekce</td>
<td>6</td>
<td>23%</td>
<td>36</td>
<td>38</td>
<td>49%</td>
<td>&lt;e&gt; - ə</td>
<td>1430-1480</td>
</tr>
<tr>
<td>sekce</td>
<td>1</td>
<td>9%</td>
<td>18</td>
<td>19</td>
<td>49%</td>
<td>&lt;a&gt; - &lt;en&gt;</td>
<td>1460-1500</td>
</tr>
</tbody>
</table>

**Graph 1.9: Level of Mixture, token count.**

<table>
<thead>
<tr>
<th>Words</th>
<th>Tokens mixed</th>
<th>% Mixed Tokens</th>
<th>Tokens var. 1</th>
<th>Tokens var. 2</th>
<th>% Overall Tokens</th>
<th>Variant 1 vs. Variant 2</th>
<th>Time frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>bital</td>
<td>0</td>
<td>0%</td>
<td>20</td>
<td>81</td>
<td>20%</td>
<td>&lt;a&gt; - &lt;e/i&gt;</td>
<td>-1481</td>
</tr>
<tr>
<td>habbath</td>
<td>3</td>
<td>11%</td>
<td>10</td>
<td>29</td>
<td>26%</td>
<td>&lt;a&gt; - &lt;e/i&gt;</td>
<td>-1435</td>
</tr>
<tr>
<td>kapad</td>
<td>12</td>
<td>7%</td>
<td>137</td>
<td>306</td>
<td>31%</td>
<td>&lt;i&gt; - &lt;e&gt;</td>
<td>all</td>
</tr>
<tr>
<td>wesa</td>
<td>6</td>
<td>8%</td>
<td>39</td>
<td>68</td>
<td>36%</td>
<td>&lt;a&gt; - &lt;e&gt;</td>
<td>-1471</td>
</tr>
<tr>
<td>degum</td>
<td>4</td>
<td>18%</td>
<td>42</td>
<td>49</td>
<td>46%</td>
<td>&lt;un&gt; - &lt;en&gt;</td>
<td>all</td>
</tr>
<tr>
<td>sekce</td>
<td>29</td>
<td>36%</td>
<td>58</td>
<td>65</td>
<td>47%</td>
<td>&lt;e&gt; - ə</td>
<td>1430-1480</td>
</tr>
<tr>
<td>sekce</td>
<td>3</td>
<td>12%</td>
<td>21</td>
<td>30</td>
<td>41%</td>
<td>&lt;a&gt; - &lt;en&gt;</td>
<td>1460-1500</td>
</tr>
</tbody>
</table>

- r = 75.8%  
- r² = 57.4%  
- df = 5  
- p 1-T = 2.4%  
- n = 7  
- p 2-T = 4.8%

- r = 78.8%  
- r² = 62.2%  
- df = 5  
- p 1-T = 1.7%  
- n = 7  
- p 2-T = 3.5%
§ 2.3.3.3

Graph 2.3: \(<VVCC>-spellings in a temporal dimension.

<table>
<thead>
<tr>
<th>Year</th>
<th>Original Charters</th>
<th>Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
<th>+Unia Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1380</td>
<td>0%</td>
<td></td>
<td></td>
<td>1380</td>
<td>0%</td>
</tr>
<tr>
<td>1410</td>
<td>3%</td>
<td></td>
<td></td>
<td>1410</td>
<td>3%</td>
</tr>
<tr>
<td>1440</td>
<td>11%</td>
<td></td>
<td></td>
<td>1445</td>
<td>11%</td>
</tr>
<tr>
<td>1475</td>
<td>5%</td>
<td></td>
<td></td>
<td>1475</td>
<td>5%</td>
</tr>
<tr>
<td>1500</td>
<td>9%</td>
<td></td>
<td></td>
<td>1500</td>
<td>9%</td>
</tr>
<tr>
<td>1530</td>
<td>18%</td>
<td></td>
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<td>1530</td>
<td>18%</td>
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</tbody>
</table>

Charters only

<table>
<thead>
<tr>
<th>Year</th>
<th>Original Charters</th>
<th>Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
<th>+Unia Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1380</td>
<td>0%</td>
<td></td>
<td></td>
<td>1380</td>
<td>0%</td>
</tr>
<tr>
<td>1410</td>
<td>3%</td>
<td></td>
<td></td>
<td>1410</td>
<td>3%</td>
</tr>
<tr>
<td>1440</td>
<td>11%</td>
<td></td>
<td></td>
<td>1445</td>
<td>11%</td>
</tr>
<tr>
<td>1475</td>
<td>5%</td>
<td></td>
<td></td>
<td>1475</td>
<td>5%</td>
</tr>
<tr>
<td>1500</td>
<td>9%</td>
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<td></td>
<td>1500</td>
<td>9%</td>
</tr>
<tr>
<td>1530</td>
<td>18%</td>
<td></td>
<td></td>
<td>1530</td>
<td>18%</td>
</tr>
</tbody>
</table>

Table 2.11: Skewed distribution of the sequence \(<aell>\).

<table>
<thead>
<tr>
<th>Order</th>
<th>% (&lt;aell&gt;)</th>
<th>(\log(%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>bitala-</td>
<td>0</td>
<td>45%</td>
</tr>
<tr>
<td>bitalia-</td>
<td>1</td>
<td>18%</td>
</tr>
<tr>
<td>bitalinge</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>rest</td>
<td>3</td>
<td>1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Original Charters</th>
<th>Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
<th>+Unia Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1380</td>
<td>0%</td>
<td></td>
<td></td>
<td>1380</td>
<td>0%</td>
</tr>
<tr>
<td>1410</td>
<td>3%</td>
<td></td>
<td></td>
<td>1410</td>
<td>3%</td>
</tr>
<tr>
<td>1440</td>
<td>11%</td>
<td></td>
<td></td>
<td>1445</td>
<td>11%</td>
</tr>
<tr>
<td>1475</td>
<td>5%</td>
<td></td>
<td></td>
<td>1475</td>
<td>5%</td>
</tr>
<tr>
<td>1500</td>
<td>9%</td>
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<td>1500</td>
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</tr>
<tr>
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<td>18%</td>
<td></td>
<td></td>
<td>1530</td>
<td>18%</td>
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</tbody>
</table>

Charters and Unia

<table>
<thead>
<tr>
<th>Year</th>
<th>Original Charters</th>
<th>Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
<th>+Unia Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1380</td>
<td>0%</td>
<td></td>
<td></td>
<td>1380</td>
<td>0%</td>
</tr>
<tr>
<td>1410</td>
<td>3%</td>
<td></td>
<td></td>
<td>1410</td>
<td>3%</td>
</tr>
<tr>
<td>1440</td>
<td>11%</td>
<td></td>
<td></td>
<td>1445</td>
<td>11%</td>
</tr>
<tr>
<td>1475</td>
<td>5%</td>
<td></td>
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<td>1475</td>
<td>5%</td>
</tr>
<tr>
<td>1500</td>
<td>9%</td>
<td></td>
<td></td>
<td>1500</td>
<td>9%</td>
</tr>
<tr>
<td>1530</td>
<td>18%</td>
<td></td>
<td></td>
<td>1530</td>
<td>18%</td>
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</table>

Table 2.11: Skewed distribution of the sequence \(<aell>\).

<table>
<thead>
<tr>
<th>Order</th>
<th>% (&lt;aell&gt;)</th>
<th>(\log(%))</th>
</tr>
</thead>
<tbody>
<tr>
<td>bitala-</td>
<td>0</td>
<td>45%</td>
</tr>
<tr>
<td>bitalia-</td>
<td>1</td>
<td>18%</td>
</tr>
<tr>
<td>bitalinge</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>rest</td>
<td>3</td>
<td>1%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Original Charters</th>
<th>Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
<th>+Unia Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
</tr>
</thead>
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<tr>
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<td></td>
<td>1380</td>
<td>0%</td>
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<tr>
<td>1410</td>
<td>3%</td>
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<td>1410</td>
<td>3%</td>
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<td>11%</td>
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<td>5%</td>
<td></td>
<td></td>
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<td>5%</td>
</tr>
<tr>
<td>1500</td>
<td>9%</td>
<td></td>
<td></td>
<td>1500</td>
<td>9%</td>
</tr>
<tr>
<td>1530</td>
<td>18%</td>
<td></td>
<td></td>
<td>1530</td>
<td>18%</td>
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</tbody>
</table>

Charters only

<table>
<thead>
<tr>
<th>Year</th>
<th>Original Charters</th>
<th>Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
<th>+Unia Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
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</thead>
<tbody>
<tr>
<td>1380</td>
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<td>1475</td>
<td>5%</td>
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<tr>
<td>1500</td>
<td>9%</td>
<td></td>
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<td>1500</td>
<td>9%</td>
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<td>18%</td>
<td></td>
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<td>1530</td>
<td>18%</td>
</tr>
</tbody>
</table>

Charters and Unia

<table>
<thead>
<tr>
<th>Year</th>
<th>Original Charters</th>
<th>Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
<th>+Unia Avg. Year</th>
<th>% (&lt;VVCC&gt;)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1380</td>
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<td></td>
<td>1380</td>
<td>0%</td>
</tr>
<tr>
<td>1410</td>
<td>3%</td>
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<td>1410</td>
<td>3%</td>
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<tr>
<td>1440</td>
<td>11%</td>
<td></td>
<td></td>
<td>1445</td>
<td>11%</td>
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<tr>
<td>1475</td>
<td>5%</td>
<td></td>
<td></td>
<td>1475</td>
<td>5%</td>
</tr>
<tr>
<td>1500</td>
<td>9%</td>
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<td>1500</td>
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</tr>
<tr>
<td>1530</td>
<td>18%</td>
<td></td>
<td></td>
<td>1530</td>
<td>18%</td>
</tr>
</tbody>
</table>
§ 5.1.4

Graph 5.2: Log(Intensity Integral Volume) and average year of reduction.

<table>
<thead>
<tr>
<th>log(IV)</th>
<th>year</th>
<th>phoneme</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1300</td>
<td>biliveth</td>
</tr>
<tr>
<td>9</td>
<td>1350</td>
<td>kumeth</td>
</tr>
<tr>
<td>10</td>
<td>1390</td>
<td>före</td>
</tr>
<tr>
<td>15</td>
<td>1410</td>
<td>kâpad</td>
</tr>
<tr>
<td>19</td>
<td>1450</td>
<td>seke</td>
</tr>
<tr>
<td>24</td>
<td>1460</td>
<td>bitalad</td>
</tr>
<tr>
<td>25</td>
<td>1480</td>
<td>kâpia</td>
</tr>
<tr>
<td>34</td>
<td>1500</td>
<td>wesa</td>
</tr>
</tbody>
</table>

\[ r^2 = p_{1-T} = p_{2-T} = df = n = \]

95%  <0.1%  <0.1%  6  8

§ 5.1.5

Table 5.5: Phonetic increase ratios.

<table>
<thead>
<tr>
<th>pronunciation</th>
<th>from measurement</th>
<th>computed</th>
</tr>
</thead>
<tbody>
<tr>
<td>[a] ~ [o]</td>
<td>41%  39%</td>
<td>[a] ~ [o]</td>
</tr>
<tr>
<td>V# ~ VC#</td>
<td>26%  33%</td>
<td>V# ~ VC#</td>
</tr>
<tr>
<td>short ~ long</td>
<td>22%  20%</td>
<td>short ~ long</td>
</tr>
</tbody>
</table>

\[ r^2 = p_{1-T} = p_{2-T} = df = n = \]

74%  16.9%  33.9%  1  3
§ 5.1.6

Graph 5.3: Binary phonological score and average year of reduction.

<table>
<thead>
<tr>
<th>phonol. score</th>
<th>year</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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</tr>
<tr>
<td>1</td>
<td>1350</td>
</tr>
<tr>
<td>1</td>
<td>1390</td>
</tr>
<tr>
<td>1</td>
<td>1410</td>
</tr>
<tr>
<td>2</td>
<td>1450</td>
</tr>
<tr>
<td>2</td>
<td>1460</td>
</tr>
<tr>
<td>2</td>
<td>1480</td>
</tr>
<tr>
<td>3</td>
<td>1500</td>
</tr>
</tbody>
</table>

- biliveth
- kumeth
- före
- kâpad
- seke
- bitalad
- kâpia
- wesa

\[ r^2 = \begin{array}{cccc} p_1-T & = & 90\% & <0.1\% \\ p_2-T & = & <0.1\% & 6 \\ df & = & 6 & 8 \\ n & = & 8 & \end{array} \]

Graph 5.4: Log(Intensity Integral Volume) and average year of reduction.

<table>
<thead>
<tr>
<th>log(IIV)</th>
<th>year</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1390</td>
</tr>
<tr>
<td>15</td>
<td>1410</td>
</tr>
<tr>
<td>19</td>
<td>1450</td>
</tr>
<tr>
<td>24</td>
<td>1460</td>
</tr>
<tr>
<td>25</td>
<td>1480</td>
</tr>
<tr>
<td>34</td>
<td>1500</td>
</tr>
</tbody>
</table>

- före
- kâpad
- seke
- bitalad
- kâpia
- wesa

\[ r^2 = \begin{array}{cccc} p_1-T & = & 94\% & <0.1\% \\ p_2-T & = & 0.1\% & 4 \\ df & = & 4 & 6 \\ n & = & 6 & \end{array} \]
### § 5.2.3

Table 5.16: Observed and computed production and perception reliability ratios for *habbe* as the form of the 1st pers. sg. pres.

<table>
<thead>
<tr>
<th>&lt;habbe&gt;</th>
<th>observed</th>
<th>computed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st sg.</td>
<td>produc.</td>
<td>percep.</td>
</tr>
<tr>
<td>-1430</td>
<td>86%</td>
<td>86%</td>
</tr>
<tr>
<td>1430-1460</td>
<td>37%</td>
<td>97%</td>
</tr>
<tr>
<td>1460-1490</td>
<td>3%</td>
<td>29%</td>
</tr>
<tr>
<td>1490-1510</td>
<td>2%</td>
<td>7%</td>
</tr>
<tr>
<td>1510-1550</td>
<td>2%</td>
<td>5%</td>
</tr>
</tbody>
</table>

production: perception

<table>
<thead>
<tr>
<th>r² = p 1-T = p 2-T =</th>
<th>r² = p 1-T = p 2-T =</th>
</tr>
</thead>
<tbody>
<tr>
<td>99% &lt;0.1% &lt;0.1%</td>
<td>92% &lt;0.1% &lt;0.1%</td>
</tr>
</tbody>
</table>

**df = n =**

3 5

Table 5.17: Observed and computed production and perception reliability ratios for *habbe* as the form of the infinitive.

<table>
<thead>
<tr>
<th>&lt;habbe&gt;</th>
<th>observed</th>
<th>computed</th>
</tr>
</thead>
<tbody>
<tr>
<td>infinitive</td>
<td>produc.</td>
<td>percep.</td>
</tr>
<tr>
<td>-1430</td>
<td>14%</td>
<td>14%</td>
</tr>
<tr>
<td>1430-1460</td>
<td>3%</td>
<td>3%</td>
</tr>
<tr>
<td>1460-1490</td>
<td>9%</td>
<td>71%</td>
</tr>
<tr>
<td>1490-1510</td>
<td>28%</td>
<td>93%</td>
</tr>
<tr>
<td>1510-1550</td>
<td>63%</td>
<td>95%</td>
</tr>
</tbody>
</table>

production: perception

<table>
<thead>
<tr>
<th>r² = p 1-T = p 2-T =</th>
<th>r² = p 1-T = p 2-T =</th>
</tr>
</thead>
<tbody>
<tr>
<td>48% 9.8% 19.5%</td>
<td>92% 0.5% 1.1%</td>
</tr>
</tbody>
</table>

**df = n =**

3 5
§ 5.2.4

Table 5.18: Observed and computed production ratios for `<secke>` and `<seck>` as a singular form, region North-East.

<table>
<thead>
<tr>
<th>region NE seke (sg)</th>
<th><code>&lt;secke&gt;</code></th>
<th><code>&lt;seck&gt;</code></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>obs.</td>
<td>comp.</td>
</tr>
<tr>
<td>1430-1460</td>
<td>56%</td>
<td>64%</td>
</tr>
<tr>
<td>1460-1490</td>
<td>17%</td>
<td>24%</td>
</tr>
<tr>
<td>1490-1510</td>
<td>0%</td>
<td>7%</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
 r_2 &= 1 - T = p_1 - T = p_2 - T = \\
 100\% &= 0.2\% = 0.4\% = 95\% = 7.5\% = 14.9\%
\end{align*}
\]

df = n = 
1 3

Table 5.19: Observed and computed production ratios for `<secke>` as a form of the singular or plural, from the south and west.

<table>
<thead>
<tr>
<th>produc. MW+SE <code>&lt;secke&gt;</code> = sg <code>&lt;secke&gt;</code> = pl</th>
<th>obs.</th>
<th>comp.</th>
<th>obs.</th>
<th>comp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1430-1460</td>
<td>83%</td>
<td>80%</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>1460-1490</td>
<td>26%</td>
<td>35%</td>
<td>9%</td>
<td>2%</td>
</tr>
<tr>
<td>1490-1510</td>
<td>31%</td>
<td>22%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
 r_2 &= 1 - T = p_1 - T = p_2 - T = \\
 92\% &= 9.4\% = 18.7\% = 1\% = 46.2\% = 92.4\%
\end{align*}
\]

df = n = 
1 3
Table 5.20: Observed and computed production ratios for <secka> as a form of the singular or plural, from the south and west.

<table>
<thead>
<tr>
<th>produc. MW+SE</th>
<th>&lt;secka&gt; = sg</th>
<th>&lt;secka&gt; = pl</th>
<th>obs.</th>
<th>comp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1430-1460</td>
<td>4%</td>
<td>1%</td>
<td>83%</td>
<td>84%</td>
</tr>
<tr>
<td>1460-1490</td>
<td>15%</td>
<td>0%</td>
<td>36%</td>
<td>34%</td>
</tr>
<tr>
<td>1490-1510</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
<td>7%</td>
</tr>
</tbody>
</table>

\[ r^2 = \begin{array}{ll} p_{1-T} = & 7\% \\ p_{2-T} = & 41.6\% \end{array} \]
\[ r^2 = \begin{array}{ll} p_{1-T} = & 99\% \\ p_{2-T} = & 3.0\% \end{array} \]
\[ df = n = \]
\[ 1 \quad 3 \]

Table 5.21: Observed and computed production ratios for <secken> as a form of plural, from the south and west.

<table>
<thead>
<tr>
<th>produc. MW+SE</th>
<th>&lt;secken&gt; = pl</th>
<th>obs.</th>
<th>comp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1430-1460</td>
<td>17%</td>
<td>11%</td>
<td></td>
</tr>
<tr>
<td>1460-1490</td>
<td>55%</td>
<td>64%</td>
<td></td>
</tr>
<tr>
<td>1490-1510</td>
<td>100%</td>
<td>93%</td>
<td></td>
</tr>
</tbody>
</table>

\[ r^2 = \begin{array}{ll} p_{1-T} = & 95\% \\ p_{2-T} = & 6.9\% \end{array} \]
\[ df = n = \]
\[ 1 \quad 3 \]
Table 5.19-5.21: Combined evidence.

<table>
<thead>
<tr>
<th>MW+SE</th>
<th>observed</th>
<th>computed</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.21</td>
<td>83%</td>
<td>80%</td>
</tr>
<tr>
<td>3.21</td>
<td>26%</td>
<td>35%</td>
</tr>
<tr>
<td>3.21</td>
<td>31%</td>
<td>22%</td>
</tr>
<tr>
<td>3.21</td>
<td>0%</td>
<td>5%</td>
</tr>
<tr>
<td>3.21</td>
<td>9%</td>
<td>2%</td>
</tr>
<tr>
<td>3.21</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>3.22</td>
<td>4%</td>
<td>1%</td>
</tr>
<tr>
<td>3.22</td>
<td>15%</td>
<td>0%</td>
</tr>
<tr>
<td>3.22</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>3.22</td>
<td>83%</td>
<td>84%</td>
</tr>
<tr>
<td>3.22</td>
<td>36%</td>
<td>34%</td>
</tr>
<tr>
<td>3.22</td>
<td>0%</td>
<td>7%</td>
</tr>
<tr>
<td>3.23</td>
<td>17%</td>
<td>11%</td>
</tr>
<tr>
<td>3.23</td>
<td>55%</td>
<td>64%</td>
</tr>
<tr>
<td>3.23</td>
<td>100%</td>
<td>93%</td>
</tr>
</tbody>
</table>

Graphical representation of the data from table 5.19-5.21. The observed data are on the x-axis, computed data on the y-axis. The ideal situation, where computed and observed data fully match, is represented with the dashed line (x = y).
Appendix 2: Computing trend surfaces in historical dialect maps

ILWIS - the Remote Sensing and GIS software -
The Integrated Land and Water Information System (ILWIS) is a PC-based GIS & Remote Sensing software, developed by ITC up to its last release (version 3.3) in 2005. ILWIS comprises a complete package of image processing, spatial analysis and digital mapping. It is easy to learn and use; it has full on-line help, extensive tutorials for direct use in courses and 25 case studies of various disciplines.

As per July 1st, 2007, ILWIS software is freely available ('as-is' and free of charge) as open source software (binaries and source code) under the 52°North initiative (GPL license). This software version is called ILWIS 3.4 Open.

(information from http://www.itc.nl/ilwis/)

For this thesis version 3.2 was mostly used. Information from the ILWIS-help function on:

Moving average > Algorithm

Moving average performs a weighted averaging on point values and returns a raster map as output. The user has to specify a weight function and a limiting distance.

1. First, for each output pixel, the distances of all points towards the output pixel are calculated to determine weight factors for the points:

For each output pixel, weight factors for the points are then calculated according to the weight function specified by the user. Two weight functions are available: inverse distance and linear decrease.

Inverse distance: weight = \( \frac{1}{d^n} - 1 \)

Linear decrease: weight = \( 1 - d^n \)

where:

\( d = \frac{D}{D_0} \) = relative distance of point to output pixel

\( D \) = Euclidean distance of point to output pixel

When the spherical distance option is used, distances (D) are calculated over the sphere using the projection of the coordinate system that is used by the georeference of the output raster map.

\( D_0 \) = limiting distance

\( n \) = weight exponent

Figures 1 and 2 below show the manner in which weight values decrease with increasing distance, for different values of n. The X-axes represent d: the distance of a point towards an output pixel divided by the limiting distance. The Y-axes represent the calculated weight values.
Fig. 1: Inverse distance
weight = \((1/d^n) - 1\)
X-axis: \(d = D/D0\)
Y-axis: weight values

Fig. 2: Linear decrease
weight = \(1 - d^n\)
X-axis: \(d = D/D0\)
Y-axis: weight values

The weight functions ensure that points close to an output pixel obtain a larger weight value than points which are farther away from an output pixel.

See that when the distance of a point towards an output pixel equals the limiting distance (value 1.0 at X-axis), or when the distance of a point towards an output pixel is larger than the limiting distance, the calculated weight value will equal 0; the weight functions are thus continuous.

The inverse distance function can be selected when you have very accurately measured point values and when local variation, within a pixel, is small. This function ensures that the computed output values equal the input point values.

The linear decrease function can be selected for point maps in which you know there are measurement errors, and when points lying close to each other have different values. This function will decrease the overall error by correcting erroneous measurements with other close points. The consequence is that the computed output values will not necessarily coincide with the measured point values.

2. Then, for each output pixel, an output value is calculated as the sum of the products of calculated weight values and point values, divided by sum of weights.

\[
\text{output pixel value} = \frac{\sum (w_i \times \text{val}_i)}{\sum w_i}
\]

where:

- \(w_i\) = weight value for point \(i\)
- \(\text{val}_i\) = point value of point \(i\)