Stability of prosodic characteristics across age and gender groups

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I. Summary

- Adult speakers of Czech – a West Slavic language of Central Europe
- Czech native speakers born or permanently living in or around the capital city of the Czech Republic (the region called Central Bohemia)

II. Material & Processing

- Read an extract from book of narratives by K. Čapek (12 ideal breath-groups)
- 106 females, 94 males (see Table 1), processing in Praat & rPraat in R
- Recordings carefully manually segmented on the phone level
- F0 tracks extracted and manually corrected to eliminate errors
- Intensity measured in 10ms steps, cubic interpolation

Table 1: Composition of the speaker sample.

<table>
<thead>
<tr>
<th>Age Band</th>
<th>Interval (years)</th>
<th>n females</th>
<th>n males</th>
</tr>
</thead>
<tbody>
<tr>
<td>20s</td>
<td>(19,29)</td>
<td>19</td>
<td>17</td>
</tr>
<tr>
<td>30s</td>
<td>(29,39)</td>
<td>16</td>
<td>18</td>
</tr>
<tr>
<td>40s</td>
<td>(39,49)</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>50s</td>
<td>(49,59)</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>60s</td>
<td>(59,69)</td>
<td>25</td>
<td>14</td>
</tr>
<tr>
<td>70s</td>
<td>(69,79)</td>
<td>25</td>
<td>19</td>
</tr>
</tbody>
</table>

- To avoid pseudoreplications in scatter plots & regression analyses, each data point represents one speaker rather than all utterances
- Cumulative slope index to measure variability
  \[ CSI = \frac{1}{N_{00}} \sum_{n=1}^{N} (x(n) - x(n-1)) \]

III. Temporal domain

- F0 profiles of several selected 4-syllable stress-groups
- Legendre polynomials (in rPraat)
- K-means cluster analysis
  - Method 1: coefficients of L-polynomials
  - Method 2: equidistantly sampled L-polynomial interpolation of F0 contour

IV. Variation in intensity contours

- Correlation over age
  - CSI of intensity
  \[ F: r = 0.456, M: r = -0.019 \]

V. Fundamental frequency domain

- Correlation over age
  - Mean F0
    - F: \( r = -0.365, M: r = 0.026 \)
    - 90% range of F0
      - F: \( r = 0.348, M: r = 0.168 \)
  - CSI of F0
    - F: \( r = 0.451, M: r = 0.671 \)

Figure 4: (a) Mean F0 over age, (b) CSI of F0 over age.

VI. More regressions and a linear model

- Correlation \( AR_{cont} \) vs CSI
  - F: \( r = -0.736, M: r = -0.631 \)
  - \( AR_{cont} \) vs CSI of F0
    - F: \( r = -0.295, M: r = -0.381 \)

Predicted age

\[ age_F = 55.7 + 3.7 \times CSI_{F0} - 8.8 \times AR_{cont} + 0.9 \times CSI, \]
\[ age_M = 75.0 + 7.8 \times CSI_{F0} - 7.2 \times AR_{cont} - 1.3 \times CSI \]

50% of residuals: F: \(-11.2\) to \(10.0\) yrs, M: \(-9.6\) to \(9.3\) yrs.

VII. Fundamental frequency contours in stress-groups

- Fo profiles of several selected 4-syllable stress-groups
- Legendre polynomials (in rPraat)
- K-means cluster analysis
  - Method 1: coefficients of L-polynomials
  - Method 2: equidistantly sampled L-polynomial interpolation of F0 contour

VIII. Conclusions

- Trends found elsewhere were confirmed and quantitatively specified for Czech population.
- The novel CSI index helps to uncover prosodic variability in more detail than the typical 90% range parameter.
- Fast articulation rates tend to iron out prosodic variation: fast speakers make fewer prosodic boundaries and fewer prominences.
- The age should not be reduced to mere physiological deterioration. Aging is also a mental process that influences the attitudes of an individual to the surrounding world.
- Our elderly subjects seemed more self-confident and more talkative. In comparison with the youngest subjects they were also less anxious about making errors in the reading task.

See also: Connect Praat, Matlab, and R with mPraat and rPraat
http://fu.fccuni.cz/praat/

http://fonetika.ff.cuni.cz/

http://sami.fel.cvut.cz/