Two-Minute Vocal Test and Acoustic Analysis Reveal Voice and Speech Disorders in Early Untreated Parkinson’s Disease

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Disorders of voice and speech in Parkinson’s disease (PD) affect all subsystems including respiration, phonation, articulation, and prosody [1-3]. Quick vocal testing consisted of sustained phonation, fast syllable repetition, and running speech was designed in order to be gender independent [4]. Main aim of this study was to separate early untreated PD from healthy control (HC) participants based upon automated acoustic analysis [5].

Patients and Data
24 PD speakers (20 men & 4 women) examined before the symptomatic treatment was started
• age 60.9 ± SD 11.2 years
• duration of PD symptoms 31.3 ± 22.3 months
• H&Y stage 2.2 ± 0.5
• UPDRS III motor score 17.4 ± 7.1
22 HC speakers (15 men & 7 women)
• no history of neurological or communication disorders
• age 58.7 ± 14.6 years

Methods

Table I: Summary of the speech data. For reproducibility of data, each task was repeated at least 2 times.

<table>
<thead>
<tr>
<th>Measure</th>
<th>HC</th>
<th>PD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustained phonation</td>
<td>85.0 ± 6.1%</td>
<td>71.4 ± 8.3%</td>
</tr>
<tr>
<td>Syllable repetition</td>
<td>75.6 ± 8.3%</td>
<td>75.6 ± 8.3%</td>
</tr>
<tr>
<td>Running speech</td>
<td>81.3 ± 6.9%</td>
<td>81.3 ± 6.9%</td>
</tr>
</tbody>
</table>

Table II: Overview of the measurement methods used.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Method</th>
<th>Subsystem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustained phonation</td>
<td>Voice task of sustained phonation</td>
<td>Voice and speech disorders</td>
</tr>
<tr>
<td>Syllable repetition</td>
<td>Vocal task of syllable repetition</td>
<td>Voice and speech disorders</td>
</tr>
<tr>
<td>Running speech</td>
<td>Vocal task of running speech</td>
<td>Voice and speech disorders</td>
</tr>
</tbody>
</table>

Table III: Result of the speech examination.

<table>
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</tr>
</tbody>
</table>

Figures:

Figure 1: Details of measures used for subsequent analysis. The left panels are for a person with PD, the right panels are for a HC subject.

Figure 2: Optimal SVM parameters.

Statistics
• predictive model was built using a kernel support vector machine (SVM)
• exhaustive search of all possible measure combinations and optimal SVM parameters (C, γ)
• cross-validation with the leave-one-out method was used to validate reproducibility
• best combination of measurements was found to differentiate PD from HC subjects

Results
• 116 vocal recordings were used for classification (56 for PD/60 for HC)
• best performance of 85.0 ± 6.1% in combination of four measures that represent all PD-related affected speech subsystems
  • 81.3 ± 6.9% for running speech
  • 75.6 ± 8.3% for sustained phonation
  • 71.4 ± 8.3% for DK task

Conclusions
• method demonstrated that it can accurately differentiate PD patients from HCs
• subtle abnormalities such as reduced melody in running speech were detectable from the early stage of PD
• acoustic analysis may serve as a simple screening test in view of the expected advent of neuroprotective treatment
• acoustic vocal tests can be used for clinical monitoring of speech progression, effect of medication on speech production, and feedback in voice treatment

References

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