Imprecision of vowel production as a potential subclinical marker in Parkinson’s disease

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INTRODUCTION

Parkinson’s disease (PD) may come with speech motor control disorders. Hypokinetic dysarthria within dysarthric disorders, imprecision of consonant and vowel production is well documented, in particular for moderate dysarthric PD (e.g. Dias et al., 2016; Duzaç & Ghio, 2020; Martel-Sauvageau et al., 2015; Martel-Sauvageau & Tjaden, 2017). The most commonly used acoustic metric to study imprecision of vowel production is the triangular vowel space area (VSA) but some authors consider that VSA is insensitive to mild and moderate forms of dysarthria (Neel, 2008; Jobard et al., 2011). An improved understanding of these impairments in mild dysarthria AND non-dysarthric PD may help detect speech deteriorations at early stages of the disease.

Aims of the study:

- To analyze the production of oral vowels in PD patients WITHOUT hypokinetic dysarthria compared with PD patients suffering from dysarthric PD (mild – moderate – severe) and with control speakers using acoustic metrics AND phonetic description.
- To identify an acoustic metric which is sensitive to early, subclinical alterations in non-dysarthric PD.

METHOD

Speech production task

Production of oral vowels (a, i, u) in isolation
Production of VCV, Glide, VC pseudo-words
Repeatition of CVVCV pseudo-words

- Acoustic analyses

Formant frequencies (F1-F2) : measured from the stable part of each vowel

Focus on

5° each vowel * 98 participants => 1,470 vowels

Acoustic metrics

Triangular vowel space area (VSA, in %)

Vowel articulation index (VAI, in %)

Phi index (PhI, in Hz)

Intra-categorical dispersion (ICD, in Hz)

Inter-categorical dispersion (ICD, in Hz)

RESULTS

98 French-speaking participants (63 participants with PD* – 35 control speakers), divided in three groups:

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<th>PD Group</th>
<th>Non-Dysarthric PD</th>
<th>Control speakers</th>
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<td>43 patients (25M, 18F)</td>
<td>20 patients (11M, 9F)</td>
<td>35 healthy controls (19 M, 16F)</td>
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Disease duration: 1 – 24 years
Stage of PD (Hoehn & Yahr) : 1-5

Vowel dispersion (2011) – pseudo words

Stage of PD (Hoehn & Yahr) : 0-3

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*Diagnosis of PD according to the UK Parkinson’s Disease Brain Bank criteria

**Following expert perceptual assessment

DISCUSSION

Our acoustic analysis suggests that among the 3 metrics, the PHI index (Huet & Harmegnies, 2000) is the only one which is sensitive to early, subclinical differences in vowel articulation between non-dysarthric PD patients and healthy control speakers.

* The total vowel acoustic space/articulatory range is not significantly reduced

** BUT the internal organization of the vocalic system is significantly reduced for non-dysarthric PD patients compared to control speakers in particular, intra-categorical dispersion is significantly higher in non-dysarthric PD patients. **

Further investigations:

- Acoustic analysis based on a picture-description task :
  - extraction of vowels (a, i, u)
  - formant frequencies (F1-F2) : to confirm results for the PHI index in non-dysarthric PD

- Reduced PHI was measured in Parkinsonian speakers without dysarthria
- The PHI index could be applicable to identify subclinical changes in vowel articulation

In progress