Labialization in Italian Dysarthric Speech by Parkinsonian Speakers

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Hypokinetic dysartira and segmental features

- Parkinson's Disease (PD) is usually associated to Hypokinetic Dysartria (HD) (Duffy 2005)
- Reduction of vowel acoustic space and amplitude of speech gestures (e.g., Skodda et al. 2011, Skodda et al. 2012)
- Despite reduction, segmental distinctions are preserved as much as possible, and compensation strategies in the production of geminates are observed (Iraci 2017)

Interestingly:

- Some kinematic investigations also report greater amplitude in PD speech gestures (Wong et al. 2010, 2011)
- Increased horizontal, front-back, tongue displacement in Italian (Gili Fivela et al. 2014, Iraci 2017, Gili Fivela et al. 2020)

Goal

- Reaching a better understanding of production strategies related to anterior-posterior gestures in rounded/protruded and unrounded/unprotruded vowels

Hypothesis

- Measures on PDs' speech < measures on CTRs' speech

But

- interplay of linguistic factors and impairment may favor compensation strategies
  - increased values concerning anterior-posterior gestures, besides a general tendency to reduction

Corpus

- Disyllables 'CVCV
  Vowel context: /i/ - /u/ - /i/
  /u/ - /i/ - /u/
  Target Consonant: /p/ , /b/
- Carrier sentence: "Lu/i 'CVCV blu"

['pi.pu] ['bi.bu]	['pu.pi] ['bu.bi]

Subjects

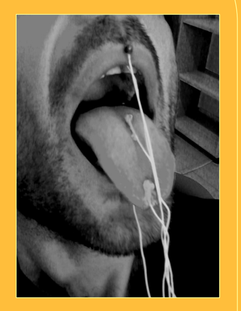
- 4 PD patients with mild-to-severe HD (PD)
- 4 Healthy Control subjects (CTR)
- Lecce Italian
- Age: 65 – 80

Recordings

EMA 3D - AG501 (Cartsens Med., GmbH)
7 sensors:

- 2 on the lips: upper lip, lower lip
- 2 on tongue midsagittally: dorsum, tongue tip
- 1 on the nose and 2 behind ears (normalization)

7 repetitions



Labelling and measurements

- Acoustic: manually on Praat (Boersma & Weenink 2019)
  - segment boundaries
  - formants (F1,F2) in the central 50 ms of the vowel

  Kinematic: on Mayday (Sigona et al. 2015)
  - minima and maxima of tangential velocity (semiautomatic)
  - amplitude of lower lip/tongue dorsum gestures

Statistics

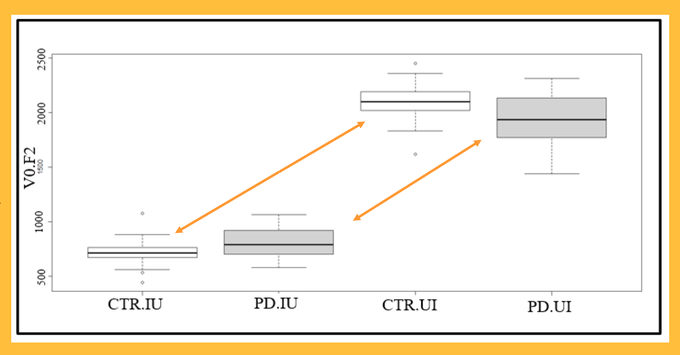
- Mixed models were implemented in R (lme4)
- Fixed effects
  - *Voicing* (voiced vs. unvoiced, *Vowel cycle* (Vcycle IU vs.UI) *Population* (PD vs. CTR), *Repetition* (7 levels)
- Intercepts for subjects, by subjects random slopes

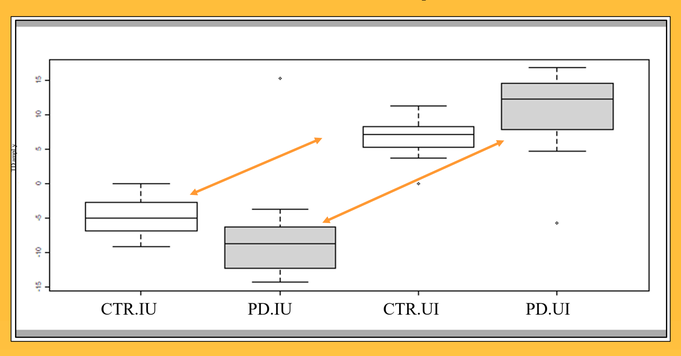
Significance ($p<0.05$), *Likelihood Ratio Test* (Winter 2013)

Results

Acoustic results

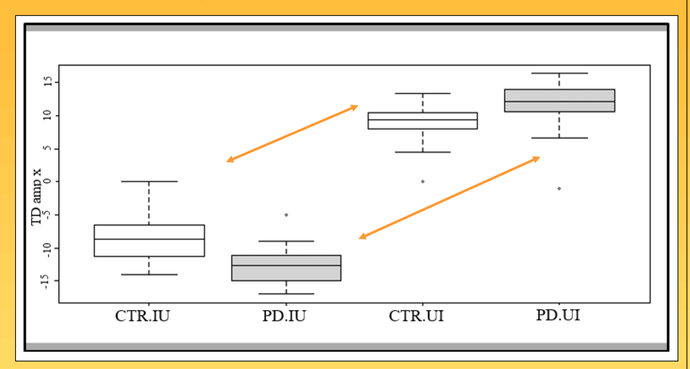
- F1 (V0) decreases by about 40 Hz ± 3.5 (S.E.) in the UI in comparison to the IU cyle
- F2 (V0) increases by about 1252 Hz ± 20.5 (S.E.) in the UI vs. IU cycle
  - Interaction between Vcycle and Population: less F2 increase in PDs than in CTRs: F2 is higher for /u/ and lower for /i/
    - Vowel space reduction on the anterior-posterior axis in PDs



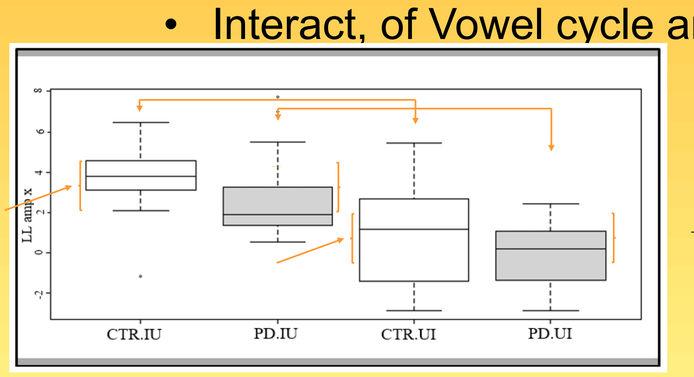


Articulatory results

- Tongue vertical displacement affected by Vowel cycle (IUI vs. UIU), in both the gesture to and from the accented V (about 15 mm ± 0.5(S.E), and 15.5 mm ± 0.53(S.E.) respectively)
  - Interaction between Vowel cycle and population: wider gesture in PDs than in CTRs, in both gestures



- Tongue orizontal displacement affected by Vowel cycle (IUI vs. UIU), in both the gesture to and from the accented V - about 21 mm ± 0.43 (S.E.), and 24 mm ± 0.52 (S.E.) respectvely)
  - Interact, of Vowel cycle and Population: wider gesture in PDs than CTRs, in both gestures



- Lower lip horizontal gesture to the consonant (onset of the accented syllable) is shorter
  - In the gesture to /i/ (by about 2.7 mm ± 0.21 (S.E.))
  - In PD speech vs. CTR (by about 1 mm ± 0.3 (S.E.))

Discussion and conclusions

1. Reduction in acoustic F2 formant values, but increasing amplitude values for the front-back tongue gesture
2. Increase in amplitude of tongue front-back gestures
3. Decrease in amplitude of lip front-back gestures

Our hypotheses were confirmed as we found reduced values for some measures concerning PD speech in comparison to CTR speech (**1,3**), though we also found the opposite, that is PDs showing e.g., wider gesture amplitude, in comparison to CTRs (**2**). We relate this result to compensation strategies motivated by linguistic needs, here the need to make the acoustic correlate of an /u/ vowel as clear as possible by widening the tongue front-back gesture to compensate for a reduced lip protrusion.

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