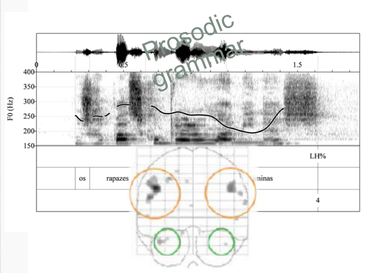
When how means what: (Dys)prosody in Parkinson's Disease



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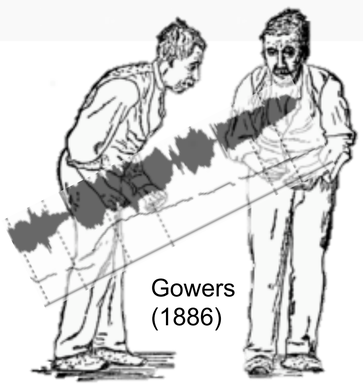

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Background

✓ Parkinson's disease (PD) is characterized by a **neurodegenerative chronic disorder** with a motor symptomatology presence (WHO 2006).

✓ This disease affects 1%-2% world's population (60+ y.o.) and is classically characterized by a **symptomatic triad** that includes rest **tremor**, **akinesia** and **hypertonia**. Although the motor expression of the symptoms involves mainly the limbs, the **muscles implicated in speech production** are also subject to specific dysfunctions. PD speech is characterized by an **impairment in phonation, in articulation, and in prosody** (Tykalova et al. 2014).

✓ Previous studies of (dys)prosody in PD focused on **simple acoustic analysis of prosodic parameters** (e.g., measures of mean F0, F0 variability, duration, speech or articulatory rate) to describe overall trends (Skodda et al. 2008, 2011; Tykalova et al. 2014), or on professional listeners' judgments of prosodic communicative efficiency (Martens et al. 2011).

✓ **Sentence modality** and **chunking** the speech stream into units are two of **prosody's main functions**, affecting phrase-level meanings, and playing a **crucial role in communication**. The structural properties of prosody involved in these functions have not yet been examined in PD. Portuguese uses contrasting nuclear contours to express modality, and intonational breaks for chunking (Frota 2014).

Main Goal

✓ To examine the impact of PD - considering time from diagnosis (G1: 1-5 years; G2: ≥10 years) and medication (OFF vs. ON state) - on the structural properties of prosody involved in the expression of sentence modality and chunking: (i) **presence/absence** and **type of pitch accent and boundary tone**, and (ii) **presence/absence** and **cues for intonational breaks**.

✓ Research questions: How nuclear contours are produced to express various sentence types and pragmatic meanings (broad and narrow focus statements, requests, commands, yes-no questions, vocatives), and how prosodic phrasing is accomplished in utterances containing several phrases (as in the case of parentheticals, topics, and enumeration)

Method

Participants

30 speakers were recorded at CNS-Campus Neurológico Sénior (Torres Vedras) fulfilling the UK's Parkinson's disease Society Brain Clinical Diagnostic Criteria (Gibb & Lee 1988): 10 healthy speakers – control group - and 20 PD patients organized into two groups, considering time from diagnosis: 10 in G1 (1-5 years) and 10 in G2 (≥10 years).

Materials

20 sentences eliciting specific prosody were recorded and obtained during a session with a speech therapist in which the participant completed a series of speaking tasks as part of a larger protocol. The sentences were read in response to a context previously presented.

Procedure

PD participants did the task first in *OFF* state, and then in *ON* state (1 hour after a dopaminomimetic drug intake). The *OFF* and *ON* sentence sets have slight differences in the lexicon used, while keeping the syntactic and prosodic structures unchanged. Recordings were made with a headset microphone and a Marantz PMD recorde

Prosodic analysis and annotation (using P-ToBI, Frota 2014, Frota et al. 2015a,b)

20 sentences per speaker x 2 conditions (OFF/ON state) x 20 PD patients (800 sentences) + 20 sentences x 10 healthy speakers (200 sentences) → total of 1000 sentences analyzed.

➢ Annotation in *Praat* (Boersma & Weenink 2015)
- Tone tier (for intonation)
- Orthographic tier
- Phonetic tier
- Break Indices tier (for phrasing)

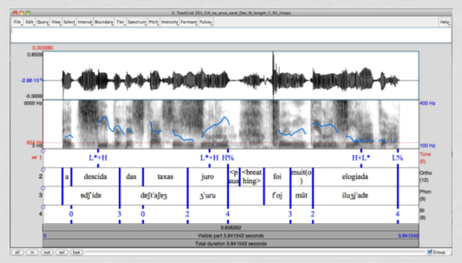

Figure 1. Prosodic annotation in *Praat*.

Statistical analysis

A deviance scale from '1' to '-1' was computed taking the performance of controls as '1' (reference) and positioning PD patients relative to controls. One-way ANOVAs examined group performance and a mixed ANOVA assessed the effects of OFF/ON state ON (within-subject factor) across the two groups of PD (G1, G2).

Results

Intonation

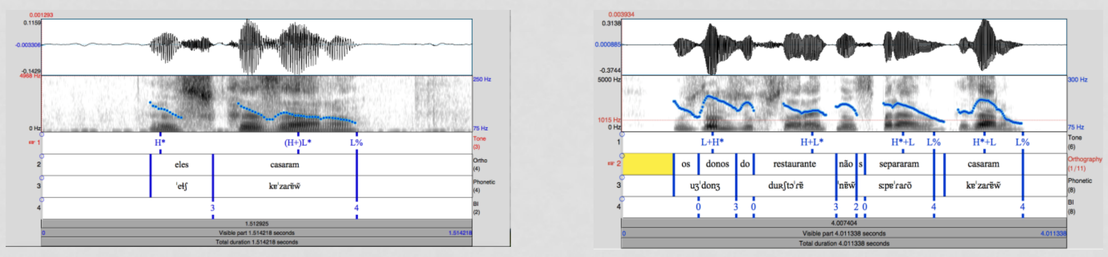

Figure 2. Focused declaratives produced by a G2 speaker: *Off* (left panel) vs. *On* (right panel).

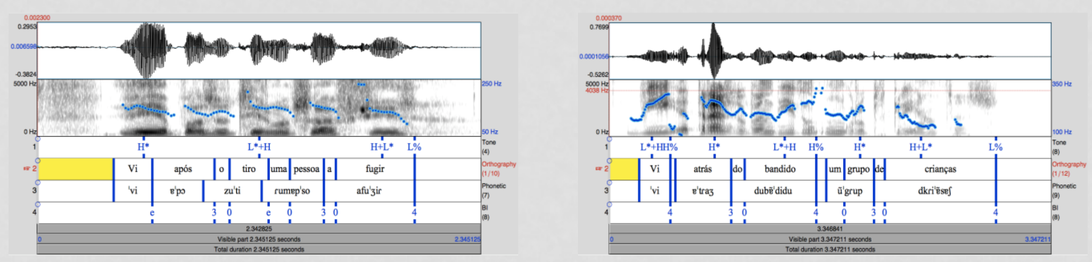

Figure 3. Nuclear contours in PD compared with controls (data for all sentence types).

- *Focused declaratives* and *neutral yes-no questions* (G1, G2), and calling contours (G2) were the most difficult to produce >>> intonationally **more complex**.
- Nuclear contour type distinguishes between groups (F(2,47)=7.92, p=.001, ω=.47), with patients performing worse than controls, but no effect of time from diagnosis.
- Medication improves the expression of modality (F(1,18)=5.29, p<.05, r=.48).

Phrasing

Figure 4. Presence/absence and correctness of intonational breaks (IP, level 4): utterance with a parenthetical produced by a G1 patient in OFF (left) and ON (right) state. 'e' marks phrasing deviations from the expected pattern

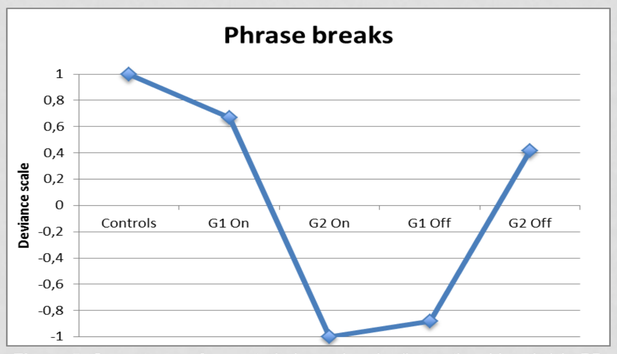

Figure 5. Correctness of expected phrase breaks (intonational breaks) in PD compared with controls.

- Presence/absence of expected phrasing breaks does not differentiate the groups (F(2,47)=1.86, p=.17).
- Although a main effect of ON/OFF state was not found, a significant interaction between medication and PD group (F(1,18)=4.70, p<.05, r=.46) was observed, with G1 phrasing improving in ON state, unlike G2 phrasing.

Main conclusions and implications

→**Intonation**: PD's performance **differs** from control speakers, and **medication improved** PD speakers performance in conveying **modality**.

→Phrasing: PD patients do not perform significantly different from control speakers in terms of type and amount of breaks, but the interaction between medication and PD group showed that only G1, unlike G2, benefit from **medication**. Thus medication did **not help** with dysprosodic phrasing as it helped with dysprosodic nuclear contours.

→The underlying mechanism of chunking, unlike that of modality, seems to be less dependent on dopaminergic deficits, with implications for PD neurophysiology and therapy, as well as for the neural basis of prosodic processing.

Selected references

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