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

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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 (Tkalyova et al. 2014).
- Previous studies of dysprosody 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; Tkalyova et al. 2014), or on professional listeners’ judgments of prosodic communicative efficiency (Martens et al. 2011).
- Sentence melody 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 melody 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 head-mounted microphone and a Marantz PMD recorder.

Prosodic analysis and annotation (using P-Tolli, 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)
  - Orthotonic tier
  - Phonetic tier
  - Break indices tier (for phrasing)

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
- Presence/absence and correctness of intonational breaks (neutral yes-no questions) in PD compared with controls.

Phrasing
- Presence/absence of expected phrasal breaks does not differentiate the groups ((2,47)=1,86, p>.05).
- Although a main effect of ON/OFF state was not found, a significant interaction between medication and PD group ((1,18)=4,70, p=.05, (G1, p=.48) 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